File Copy

DOE/EIS-0122
(BY ADOPTION
12/13/85)

FINAL

ENVIRONMENTAL IMPACT STATEMENT

TUCSON AQUEDUCT PHASE B

INT FES 85-29

A FEATURE OF
CENTRAL ARIZONA PROJECT

UNITED STATES DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
LOWER COLORADO REGION

FINAL
ENVIRONMENTAL IMPACT STATEMENT

TUCSON AQUEDUCT - PHASE B
CENTRAL ARIZONA PROJECT

Prepared by
Lower Colorado Region
Bureau of Reclamation
U.S. Department of the Interior

As Lead Agency in Cooperation With

Department of Energy, Western Area Power Administration

This Environmental Impact Statement analyzes the environmental consequences of the construction and operation of Phase B of the Tucson Aqueduct and its associated electrical transmission system. The Tucson Aqueduct is an authorized feature of the Central Arizona Project. Phase B of the aqueduct would convey Colorado River water to agricultural, municipal, and industrial users in Pima County, Arizona. Depending on the alternative implemented, the Tucson Aqueduct Phase B will consist of a 50-mile long (approximate) aqueduct, six (approximate) pumping plants, and transmission facilities to deliver electrical energy to the pumping plants. The statement identifies four alternatives on the west side of the Tucson Mountains, one on the east side, and a "no federal action" alternative. The affected environment is described, and the impacts of the alternative courses of action are presented.

This Environmental Impact Statement also fulfills the requirements of Executive Order 11988 (Floodplain Management) and Executive Order 11990 (Wetlands Protection), and the requirements of the Nationwide Permit in accordance with the provisions of Section 404 of the Clean Water Act.

For further information regarding the EIS, contact:

Regional Environmental Officer
Lower Colorado Region
U.S. Bureau of Reclamation
Box 427
Boulder City, Nevada 89005
(702) 293-8560

Draft Filed: December 18, 1984

Statement Number: INT FES 85-29

Final Filed: AUG 14 1985

Preface

Response to public comments on the Draft Environmental Impact Statement (EIS) and discussions with the National Park Service, Friends of the Desert, and the Southern Arizona Water Resources Association have resulted in the decision to include an additional alternative in the Final EIS. This alternative is called the Sanders-San Joaquin Modification Plan. Discussions relative to this alternative have been incorporated throughout the Final EIS.

The Final EIS also reflects refinements in engineering and design for the proposed action, the West Side Plan. These refinements include:

- Construction of a single siphon from the northeast side of I-10, crossing the Santa Cruz River and daylighting on the southwest side of the river, a distance of about 8,700 feet;

- Deletion of the tall surge tanks at Brawley, Black Mountain, Snyder Hill, and San Xavier Pumping Plants; air chambers will be used for surge protection;

- Slight modifications of the aqueduct alinement on the San Xavier Indian Reservation and the pipeline to the Tucson Water storage site; and

- A more specific terminus location. The proposed plan is to locate the regulating reservoir just southwest of Black Mountain and the aqueduct terminus at the south boundary of the San Xavier Indian Reservation, with a turnout on the south side of Pima Road. In addition, this portion of the aqueduct will be placed in pipe rather than open canal in order to reduce the potential for water pollution problems from the mine tailings or in the event of failure of the dikes at the mine.

In response to public concern expressed regarding the esthetics of the aqueduct and its associated features, additional environmental commitments have been made regarding revegetation and landscaping.

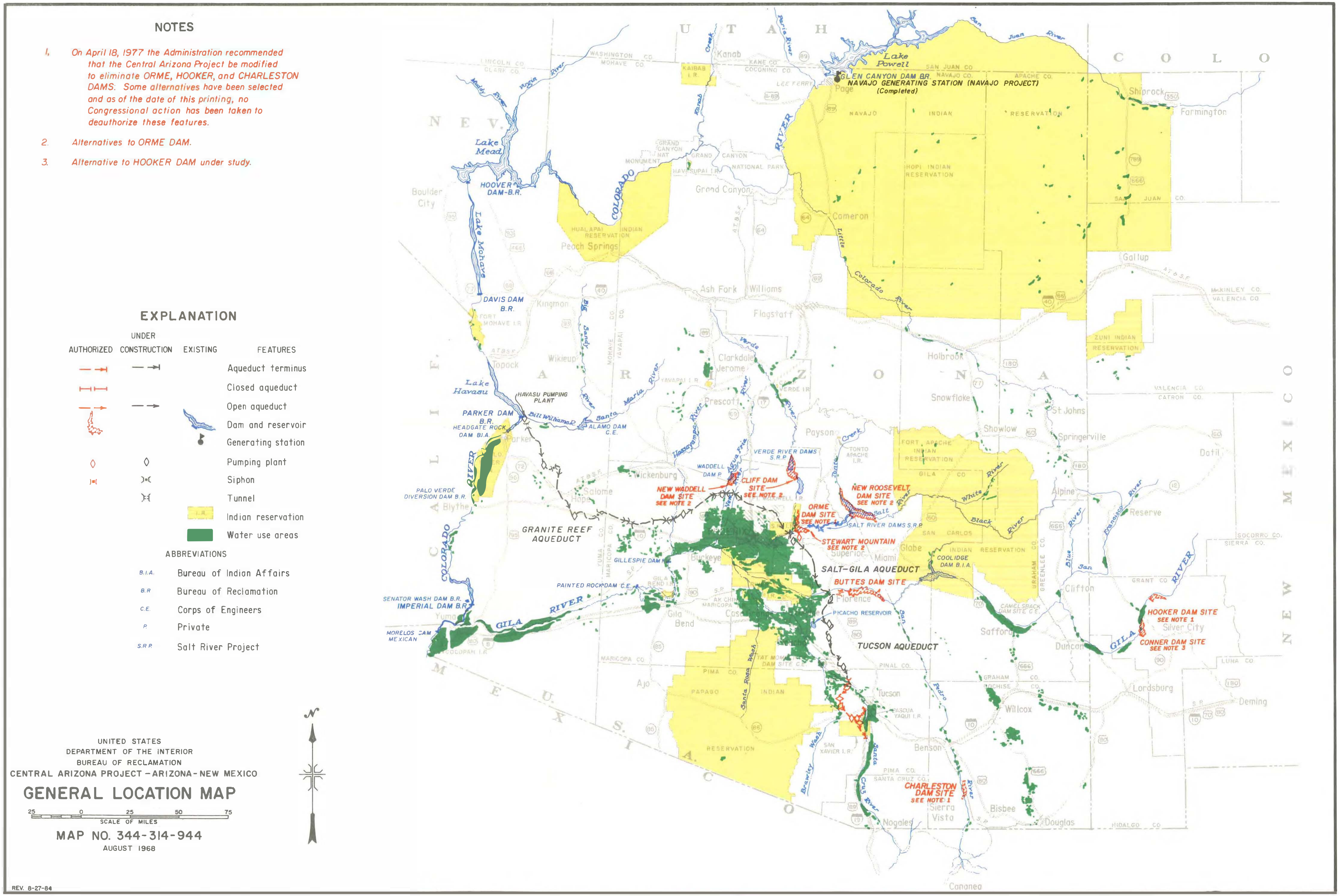

NOTES
1. On April 18, 1977 the Administration recommended that the Central Arizona Project be modified to eliminate ORME, HOOKER, and CHARLESTON DAMS. Some alternatives have been selected and as of the date of this printing, no Congressional action has been taken to deauthorize these features.
2. Alternatives to ORME DAM.
3. Alternative to HOOKER DAM under study.
EXPLANATION
AUTHORIZED
UNDER 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. 8-27-84
N
UTAH
COLO
NEV.
ARIZONA
NEW MEXICO
MEXICO
CALIF.
Lake Powell
GLEN CANYON DAM BR
NAVAJO GENERATING STATION (NAVAJO PROJECT)
(Completed)
Page
NAVAJO INDIAN RESERVATION
HOPI INDIAN RESERVATION
Lake Mead
HOOVER DAM-B.R.
Lake Mohave
DAVIS DAM B.R.
Lake Havasu
HAVASU PUMPING PLANT
PARKER DAM B.R.
HEADGATE ROCK DAM B.I.A.
PALO VERDE DIVERSION DAM B.R.
GRANITE REEF AQUEDUCT
SENATOR WASH DAM B.R.
IMPERIAL DAM B.R.
MORELOS DAM MEXICAN
GILA RIVER
COLORADO RIVER
HUALAPAI INDIAN RESERVATION
Peach Springs
Grand Canyon
Flagstaff
Prescott
Phoenix
VERDE RIVER DAMS S.R.P.
NEW WADDELL DAM SITE SEE NOTE 2
CLIFF DAM SITE SEE NOTE 2
ORME DAM SITE SEE NOTE 1
NEW ROOSEVELT DAM SITE SEE NOTE 2
SALT RIVER DAMS S.R.P.
STEWART MOUNTAIN SEE NOTE 2
SALT-GILA AQUEDUCT
BUTTES DAM SITE
COOLIDGE DAM B.I.A.
FORT APACHE INDIAN RESERVATION
SAN CARLOS INDIAN RESERVATION
PAINTED ROCK DAM C.E.
GILLESPIE DAM P.
PICACHO RESERVOIR
TUCSON AQUEDUCT
Tucson
PAPAGO INDIAN RESERVATION
HOOKER DAM SITE SEE NOTE 1
CONNER DAM SITE SEE NOTE 3
Silver City
CHARLESTON DAM SITE SEE NOTE 1
ZUNI INDIAN RESERVATION
Gallup
Farmington
Yuma
Nogales
Douglas
Bisbee
Safford
Globe
Florence
Deming
Lordsburg

Figure 1

SUMMARY
TUCSON AQUEDUCT - PHASE B

A. Purpose and Need

This environmental impact statement (EIS) describes the proposed construction, operation, and maintenance of the Phase B portion of the Tucson Aqueduct, an authorized feature of the Central Arizona Project (CAP). Phase A of the Tucson Aqueduct extends from the end of the Salt-Gila Aqueduct in central Pinal County to the vicinity of Rillito, Arizona, in northern Pima County. Phase B would convey water about 45 miles from the terminus of Phase A to Tucson Metropolitan Area and to the south boundary of the San Xavier Indian Reservation.

Ground water provides almost the entire water supply available in the Tucson Aqueduct service area. Over much of the Phase B service area, use of ground water in excess of natural recharge has caused ground water level declines of over 200 feet, with declines of over 450 feet in some locations (Arizona Water Commission (AWC) 1978). Declining ground water levels have caused pumping costs to increase substantially, and as the aquifers are dewatered, the basin's land surface subsides and surface fissures occur at the basin margins, causing damage to agricultural facilities, roads, utilities and structures.

B. Alternatives Eliminated

Alternatives considered but eliminated included other sources of import supply (San Pedro River, Gila River), water conservation, and various alinement alternatives from the terminus of the Phase A Aqueduct. Ultimately five alternative routes were selected for display in the EIS, along with the alternative of "no Federal action".

C. Alternatives

Each of the five action alternatives begin at the terminus of the Tucson Aqueduct Phase A, and terminate at the South boundary of the San Xavier Indian Reservation. Four of the alternatives are located on the west side of the Tucson Mountains, and one on the east side of the Tucson Mountains. Summaries of physical characteristics and plan costs are shown in Tables 1 and 2 respectively.

1. Agency Proposed Action (West Side Plan)

This alternative, located primarily west of the Tucson Mountains, is 47.4 miles long, with 28.0 miles of concrete lined canal, 19.4 miles of pipeline, and six pumping plants. The system would deliver an average annual volume of 161,900 acre-feet of CAP water and would require 174 gigawatt hours of electricity. A power transmission line of approximately 33 miles would be required.

The proposed action includes overchutes and culverts to provide aqueduct cross-drainage protection and mitigate adverse impacts on local surface drainages; highway and county bridges to minimize travel disruption; fencing and escape ladders for human safety; and wildlife crossings, watering sites, wildlife fencing, and tortoise barriers to mitigate adverse impacts on

Table 1
Summary Alternative Plans - Physical Characteristics
Tucson Aqueduct - Phase B
Central Arizona Project

Conveyance Facilities (Miles)	West Side	Sandario-San Joaquin	Sandario	Sanders-San Joaquin Modification	East Side	No Federal Action 1/
Main Aqueduct						
Canal	28.0	4.8	16.9	19.2	6.6	6.6
Pipe	19.4	39.8	27.9	28.0	30.2	13.5
Subtotal	47.4	44.6	44.8	47.2	36.8	20.1
Indian Delivery Line						
Canal	0	0	0	0	0	0
Pipe	2.4	3.0	2.4	2.4	9.5	0
Subtotal	2.4	3.0	2.4	2.4	9.5	0
Avra Valley Delivery Line						
Canal	0	0	0	0	13.5	0
Pipe	0	3.8	3.8	0.5	4.2	0
Subtotal	0	3.8	3.8	0.5	17.7	0
Total	49.8	51.4	51.0	50.1	64.0	20.1
Pumping Plants (No.)						
Main Aqueduct	6	5	5	5	5	3
Indian Delivery Line	0	0	0	0	0	0
Avra Valley Delivery Line	0	0	0	0	2	0
Total	6	5	5	5	7	3
Right-of-Way (Acres)						
Main Aqueduct						
Canal	1922	513	1310	1624	593	473
Pipe	235	482	338	339	366	164
Subtotal	2157	995	1648	1963	959	637
Indian Delivery Line						
Canal	0	0	0	0	0	0
Pipe	30	35	30	55	115	0
Subtotal	30	35	30	55	115	0
Avra Valley Delivery Line						
Canal	0	0	0	0	720	0
Pipe	0	35	30	6	55	0
Subtotal	0	35	30	6	775	0
Total	2187	1065	1708	2024	1849	637
Power Transmission Line (miles)	33	33	33	34	32	19.0
Power Requirements						
Main Aqueduct						
Load (MW)	53	67	63	59	59	32
Energy (GWH)	174	220	204	193	197	111
Indian Delivery Line						
Load (MW)	0	0	0	0	0	0
Energy (GWH)	0	0	0	0	0	0
Avra Valley Delivery Line						
Load (MW)	0	0	0	0	1.0	0
Energy (GWH)	0	0	0	0	1.2	0
Total						
Load (MW)	53	67	63	59	60	32
Energy (GHW)	174	220	204	193	197	111

1/ The "No Federal Action" alternative describes the most probable actions that would be taken by Tucson Metropolitan area users to obtain CAP water in the absence of Federal funding.

Table 2
SUMMARY ALTERNATIVE PLANS REGIONAL COST 1/
TUCSON AQUEDUCT - PHASE B
CENTRAL ARIZONA PROJECT
(All Costs are in Thousands of Dollars)
(January 1985 Price Levels)

	West Side	Sandario-San Joaquin	Sandario	Sanders-San Joaquin Modification	East Side	No Federal Action
Aqueduct	213,813	252,813	225,248	231,829	218,677	134,113
Indian Delivery Line	1,064	1,344	1,064	1,064	8,696	0
Avra Valley Delivery Line	0	2,814	2,814	645	26,395	0
TOTAL FIELD COST	214,877	256,971	229,126	233,538	253,768	134,113
Noncontract (25%)	53,719	64,243	57,281	58,384	63,442	33,528
TOTAL CONSTRUCTION COST	268,596	321,214	286,407	291,922	317,209	167,641
Interest During Construction 2/	52,186	61,594	55,503	56,062	60,889	32,316
Mitigation - Biological 3/	4,169	900	3,755	1,175	1,208	885
- Cultural Resource 4/	1,000	1,000	1,000	1,000	1,000	1,000
TOTAL CAPITAL COST	325,951	384,708	346,665	350,159	380,306	201,842
OM&R						
Aqueduct	1,934	1,523	1,712	1,717	1,431	782
Indian Delivery Line	41	53	41	41	41	0
Avra Valley Delivery Line	0	19	19	1	391	0
Energy						
Aqueduct	6,700	8,454	7,830	7,407	7,569	4,082
Indian Delivery Line	0	0	0	0	0	0
Avra Valley Delivery Line	0	0	0	0	26	0
TOTAL OM&R COST	8,675	10,048	9,603	9,167	9,459	4,864
ANNUAL EQUIVALENT OF CAPITAL COST 5/	24,870	29,353	26,450	26,717	29,017	15,400
TOTAL OM&R COST	8,675	10,048	9,603	9,167	9,459	4,864
DAMAGES PAID TO THE PAPAGO TRIBE	0	0	0	0	0	20,040
TOTAL ANNUAL COST	33,545	39,401	36,053	35,884	38,476	40,305

1/ Labels used in this table relate to function and not to funding responsibility. Regional cost includes both non-federal and federal expenditures.

2/ Interest during construction is based on a 5-year construction period and an interest rate of 7.625 percent.

3/ Estimated mitigation expenditures (mitigation has not been finalized).

4/ Estimated mitigation expenditures. Maximum mitigation expenditure can be up to 1 percent of total construction costs.

5/ Formulated based on 100-year project life and an interest rate of 7.625 percent.

wildlife. The plan also includes an undeveloped wildlife corridor in Avra Valley and revegetation of disturbed areas.

2. Sandario - San Joaquin Plan

This alternative, which maximizes use of buried pipeline, is located primarily west of the Tucson Mountains and is 44.6 miles long, with 4.8 miles of concrete lined canal and 39.8 miles of concrete pipeline. The aqueduct has five pumping plants, would deliver an average annual volume of 161,900 acre feet of water, and would require 220 gigawatt hours of electricity. A power transmission line of approximately 33 miles would be required.

The alternative includes overchutes and culverts, highway and county bridges; fencing and escape ladders for human safety; and wildlife crossings, watering sites, and wildlife fencing. The plan also includes the revegetation of disturbed areas and rare plant land acquisition.

3. Sandario Plan

This alternative, located primarily west of the Tucson Mountains, is 44.8 miles long, with 16.9 miles of concrete lined canal and 27.9 miles of concrete pipeline, and five pumping plants. The system would deliver an average annual volume of 161,900 acre feet of water and require 204 gigawatt hours of electricity. A power transmission line of approximately 33 miles would be required.

The action includes overchutes and culverts; highway and county bridges; fencing and escape ladders for human safety; and wildlife crossings, watering sites, wildlife fencing, and tortoise barriers, and revegetation of disturbed areas. This plan also includes an undeveloped wildlife corridor in the Avra Valley.

4. Sanders - San Joaquin Modification Plan

This alternative, located primarily west of the Tucson Mountains, is 47.2 miles long, with 19.2 miles of concrete lined canal and 28.0 miles of concrete pipeline. The aqueduct, with five pumping plants, would deliver an average annual volume of 161,900 acre feet of water and would require 193 gigawatt hours of electricity. A power transmission line of approximately 34 miles would be required.

The alternative includes overchutes and culverts, highway and county bridges; fencing and escape ladders for human safety; and wildlife crossings, watering sites, and wildlife fencing. The plan also includes the revegetation of disturbed areas and rare plant land acquisition.

5. East Side Plan

The East Side Plan, located primarily east of the Tucson Mountains, is 36.8 miles long, with 6.6 miles of concrete lined canal and 30.2 miles of concrete pipeline. The aqueduct, with five pumping plants, would deliver an average annual volume of 161,900 acre feet of water and would require 197 gigawatt hours of electricity. A power transmission line of approximately 32 miles would be required.

The alternative includes overchutes and culverts; highway and county bridges; fencing and escape ladders for human safety; and wildlife crossings, watering sites, wildlife fencing, revegetation of disturbed areas, and rare plant land acquisition.

6. No Federal Action

The "No Federal Action" alternative is defined to mean that no Federal funding would be used to accomplish system construction. The CAP aqueduct would end with the completion of the Tucson Aqueduct - Phase A. An aqueduct system would be constructed by private entities from this point to the Tucson Metropolitan area. This alternative assumes that Tucson receives all CAP water allocated to the Phase B service area.

CAP water for Rio Rico, Green Valley, and the Santa Cruz County users would be reallocated because their involvement in a privately funded project would be economically unfeasible. No CAP water for mining or agriculture (Avra Valley, FICO) would be delivered to the Phase B area. No CAP deliveries would be made to the Papago Indian Reservation areas of San Xavier and Schuk Toak. Monetary damages would be paid in accordance with the Southern Arizona Water Rights Settlement Act.

The length of the aqueduct would be 20.1 miles with 6.6 miles of concrete lined canal and 13.5 miles of concrete pipeline. It would require three pumping plants and an electrical requirement of 111 gigawatt hours to deliver an average annual volume of 88,800 acre feet of water. Electrical power to pumping plants would be provided by non-federal entities. This alternative would include wildlife watering sites.

D. Affected Environment and Environmental Consequences

Table 3 is a comparison of net environmental impacts for each of the alternative plans. The following narrative sections briefly describe the net impacts and their significance.

1. Biological Resources

a. Vegetation

The major plant communities in the area are creosote-bursage, palo verde-mixed cacti, desert grassland, and mesquite bosque.

b. Big Game and Predators

Winter big game surveys estimated a population of 200 to 400 mule deer and 400 to 600 javelina in the Phase B area. Additional species present included coyote (the most common predator), kit fox, gray fox, mountain lion, skunk and bobcat.

c. Small Mammals

Twenty species of small mammals were found in the project area. The most common were the woodrat and the kangaroo rat.

TABLE 3*
COMPARISON OF RESIDUAL ENVIRONMENTAL IMPACTS
TUCSON AQUEDUCT - PHASE B CENTRAL ARIZONA PROJECT

AREA OF IMPACT	West Side Plan	Sandario-San Joaquin Plan
BIOTA		
VEGETATION PERMANENTLY REMOVED (Acres) [2]	367	173
VEGETATION TEMPORARILY REMOVED (Acres)	2380	1701
WILDLIFE [1]		
vement Disruption After Mitigation	Moderate	Moderate to Low
Potential Drowning Loss After Mitigation	Low	Low
SPECIAL STATUS [1] SPECIES ADVERSE IMPACTS AFTER MITIGATION/CONSERVATION MEASURES		
Thornber's Cacti [5]	High	Low
Tumamoc Globe-Berry [9]	High	Low
Desert Tortoise [3]	Moderate	Low
Gila Monster [9]	Moderate	Low
Harris Hawk [10]	Low	Low
Kit Fox [4] [10]	[8]	[8]
WATER RESOURCES		
LOCAL SURFACE WATER	Potential Consolidation and Redirection of some Ephemeral Drainages	Potential Consolidation and Redirection of some Ephemeral Drainages
ANNUAL AQUEDUCT LOSSES		
Seepage	Assuming 50% Ground-water Recharge, Net Loss of 1910 Acre-Feet Per Year	Assuming 50% Ground-water Recharge, Net Loss of 360 Acre-Feet Per Year
Evaporation	Loss of 820 Acre-Feet Per Year	Loss of 150 Acre-Feet Per Year
AIR QUALITY	Minor Adverse Effects From Construction Generated Suspended Particulates	Minor Adverse Effects From Construction Generated Suspended Particulates
SOUND QUALITY	Temporary Disturbance to Wildlife and annoyance to Rural Residents. Blasting Near or in Tucson Mountain Park May Temporarily Degrade Wilderness Values	Temporary Disturbance to Wildlife and annoyance to Rural Residents. Blasting Near or in Tucson Mountain Park May Temporarily Degrade Wilderness Values
VISUAL QUALITY	Moderate	Low
LANDS		
Agriculture	Loss of 96 Acres Agriculture	Loss of 96 Acres Agriculture
Desert Grazing	Loss of Desert Grazing on 1983 Acres	Loss of Desert Grazing on 862 Acres
Private Ownership	Loss of Tax Revenues on 712 Acres of Private Property Acquired	Loss of Tax Revenues on 319 Acres of Private Land Acquired
CULTURAL RESOURCES [6]		
Area Surveyed (Acres) [7]	5189	2611
	After Mitigation Studies The Disturbance or Destruction of 50±17 Sites (EST.)	After Mitigation Studies, The Disturbance or Destruction of 25±9 Sites (EST.)
RECREATION	Good	Moderate
SOCIAL IMPACTS	Low	Low
Number of Relocations (approximate)	15	10
SAFETY	Minimal Drowning Hazards	Minimal Drowning Hazards
GEOLOGY	Special Designs Would be Required in Areas of Subsidence and Earth Fissuring; Risk of Leakage if Structure Cracks	Special Designs Would be Required in Areas of Subsidence and Earth Fissuring; Risk of Leakage if Structure Cracks

*See page 8 for footnotes.

TABLE 3 Cont.
COMPARISON OF RESIDUAL ENVIRONMENTAL IMPACTS
TUCSON AQUEDUCT - PHASE B CENTRAL ARIZONA PROJECT

AREA OF IMPACT	Sandario Plan	Sanders-San Joaquin Modification Plan	East Side Plan [2/]	No Federal Action
BIOTA				
VEGETATION PERMANENTLY REMOVED (Acres) [7/]	263	289	250	135
VEGETATION TEMPORARILY REMOVED (Acres)	2107	2340	2389	1391
WILDLIFE [1/]				
Movement Disruption After Mitigation	Moderate	Low	Low	Low
Drowning After Mitigation	Low	Low	Low	Low
SPECIAL STATUS [1/] SPECIES ADVERSE IMPACTS AFTER MITIGATION/CONSERVATION MEASURES				
Thornber's Cacti [5/]	Moderate	Moderate	High	Low
Tumamoc Globe-Berry [9/]	Low	Low	Low	Low
Desert Tortoise [3/]	Moderate	Low	Low	Low
Gila Monster [9/]	Moderate	Low	Low	Low
Harris Hawk [10/]	Low	Low	Low	Low
Kit Fox [4/], [10/]	[8/]	[8/]	[8/]	[8/]
WATER RESOURCES				
LOCAL SURFACE WATER	Potential Consolidation and Redirection of some Ephemeral Drainages	Potential Consolidation and Redirection of some Ephemeral Drainages	Potential Consolidation and Redirection of some Ephemeral Drainages	Potential Consolidation and Redirection of some Ephemeral Drainages
ANNUAL AQUEDUCT LOSSES				
Seepage	Assuming 50% Ground-water Recharge, Net Loss of 1080 Acre-Feet Per Year	Assuming 50% Ground-water Recharge, Net Loss of 1300 Acre-Feet Per Year	Assuming 50% Ground-water Recharge, Net Loss of 475 Acre-Feet Per Year	Assuming 50% Ground-water Recharge, Net Loss of 475 Acre-Feet Per Year
Evaporation	Loss of 460 Acre-Feet Per Year	Loss of 550 Acre-Feet Per Year	Loss of 210 Acre-Feet Per Year	Loss of 210 Acre-Feet Per Year
AIR QUALITY	Minor Adverse Effects From Construction Generated Suspended Particulates	Minor Adverse Effects From Construction Generated Suspended Particulates	Potential Adverse Effects From Construction Generated Suspended Particulates	Potential Adverse Effects From Construction Generated Suspended Particulates
SOUND QUALITY	Temporary Disturbance to Wildlife and annoyance to Rural Residents. Blasting Near or in Tucson Mountain Park May Temporarily Degrade Wilderness Values	Temporary Disturbance to Wildlife and annoyance to Rural Residents. Blasting Near or in Tucson Mountain Park May Temporarily Degrade Wilderness Values	Temporary Disturbance to Wildlife and annoyance to Rural Residents. Blasting Near or in Tucson Mountain Park May Temporarily Degrade Wilderness Values	Temporary Disturbance to Wildlife and annoyance to Rural Residents. Blasting Near or in Tucson Mountain Park May Temporarily Degrade Wilderness Values
VISUAL QUALITY	Low	Low	Low	Low
LANDS				
Agriculture	Loss of 96 Acres Agriculture	Loss of 96 Acres Agriculture	Loss of 123 Acres Agriculture	No loss of Agricultural lands
Desert Grazing	Loss of Desert Grazing on 1,517 Acres	Loss of Desert Grazing on 1,802 Acres	Loss of Desert Grazing on 1,367 Acres	Loss of Desert Grazing on 447 Acres
Private Ownership	Loss of Tax Revenues on 674 Acres of Private Property Acquired	Loss of Tax Revenues on 724 Acres of Private Property Acquired	Loss of Tax Revenues on 902 Acres of Private Property Acquired	Loss of Tax Revenues on 521 Acres of Private Property Acquired
CULTURAL RESOURCES [6/]				
Area Surveyed (Acres) [7/]	3865	3878	4350	1263
	After Mitigation Studies The Disturbance or Destruction of 37±13 Sites (EST.)	After Mitigation Studies The Disturbance or Destruction of 37±13 Sites (EST.)	After Mitigation Studies, The Disturbance or Destruction of 41±14 Sites (EST.)	After Mitigation Studies, The Disturbance or Destruction of 12±4 Sites (EST.)
RECREATION	Moderate	Moderate	Low to None	Moderate to Low
SOCIAL IMPACTS	Low	Low	Moderate	Moderate
Number of Relocations (approx.)	10	7	35	35
SAFETY		Minimal Drowning Hazards	Minimal Drowning Hazards	Minimal Drowning Hazards
GEOLOGY	Special Designs Would be Required in Areas of Subsidence and Earth Fissuring; Risk of Leakage if Structure Cracks	Special Designs Would be Required in Areas of Subsidence and Earth Fissuring; Risk of Leakage if Structure Cracks	Special Designs Would be Required in Areas of Subsidence and Earth Fissuring; Risk of Leakage if Structure Cracks	Subsidence and Earth Fissures Would Not be a Problem With This Alignment

*See page 8 for footnotes

Footnotes for Table 3

1/ Preliminary recommendations as of September 22, 1983. Extent of impacts and mitigation not yet finalized. These mitigation measures are the subject of ongoing studies.

2/ Includes 17.6 miles Avra Valley Irrigation District Feeder Line on the west side of Tucson Mountains.

3/ Listed in Threatened Native Wildlife of Arizona, Arizona Game and Fish Commission, 1982.

4/ Endangered and Unique Wildlife of the Southwest National Forests, U.S.D.A. Forest Service, 1975, page 203.

5/ Being considered for Federal listing as a Threatened Species (FWS memo to U.S. Bureau of Reclamation, September 7, 1983).

6/ Several Class III surveys conducted in the vicinity of the Tucson Aqueduct Phase B indicate a site density of 6.1 sites per square mile. This figure represents a fairly accurate statistical estimate and should be viewed in that light. The actual site density could range form 4.0 to 8.2 sites per square mile ($\pm$ 2.1 sites per square mile) at a 90 percent confidence interval.

7/ These estimates do not include estimates for aggregate sources, haul and access roads, construction staging areas, or transmission line right-of-ways, which may require some additional acreage. Temporary disturbed area in excess of the pipeline R-O-W along all pipeline is included.

8/ Need for, or extent of, mitigation is unknown. Telemetry studies at the time of construction will provide this information.

9/ Candidates for proposal as threatened or endangered species.

10/ On BLM list of sensitive species.

d. Songbirds and Gamebirds

A total of 143 species of birds were observed in the Phase B area. The most common permanent resident species observed were Gambel's quail, mourning dove, common flicker, verdin, cactus wren, northern mockingbird, curve-billed thrasher, black-tailed gnatcatcher, brown-headed cowbird, house finch, and black-throated sparrow.

e. Raptors

Nineteen species of raptors were observed in the study area, including one species each of eagle, osprey and kite; two species of vultures; three species of falcon; six species of hawks; and five species of owls.

f. Reptiles and Amphibians

A total of 39 species were recorded. Toads were the most common, followed by lizards and snakes.

g. Special Status Species

Two Federally listed endangered species are found in the general area--the peregrine falcon and the Nichols Turks-head cactus. The peregrine falcon would not be affected by the project and Turks head cacti were not found along the alinement. The Thornber's fishhook cactus, a proposed Federally threatened species and the Tumamoc globeberry, Pringles lip fern, and Sheer's strong-spined cory cactus are all candidate species for proposal as threatened or endangered. These last four species occur along all alternatives and would be impacted by the project. Four special status species of wildlife (desert tortoise, kit fox, Harris' hawk and Gila monster) would be impacted by all alternatives. Mitigation and/or conservation measures are being developed for all special status species.

h. Impacts

In general, the significant impacts associated with the six alternatives would consist of habitat loss, drowning losses of wildlife in the aqueduct, and severance of wildlife movement patterns.

1. Indirect

The major impacts associated with the aqueduct would result from the water distribution system. Canals comprising this system would cause wildlife habitat loss, movement pattern severance, and would compound the impacts of the main aqueduct.

In addition, 37,800 acre-feet of water may be used for development of new farmlands on the Papago Indian Reservation. This development would involve losses of creosote, bursage and mesquite bosque habitat types.

2. Direct

Canal construction would permanently remove all vegetation from a strip as wide as the canal and necessary access roads. Permanent habitat loss along a pipeline would be confined to the width of the access road. Over time, disturbed ground areas including pipeline corridors and flood retarding structures would revegetate, but full recovery to original conditions of these disturbed areas may not occur within the life of the project even with revegetation efforts. Desert habitats are very susceptible to damage and re-establishment of some species is extremely slow.

Long term effects of the alternatives include permanent loss of 367 acres of wildlife habitat for the West Side Plan, 289 acres for the Sanders-San Joaquin Modification Plan, 263 acres for the Sandario Plan, 250 acres for the East Side Plan, 173 acres for the Sandario-San Joaquin Plan, and 135 acres for the No Federal Action Plan. All wildlife which require this habitat, primarily small mammals and some species of reptiles and amphibians, would be lost as would their future production. Drowning losses would also cause a long term loss in production as would the effects of habitat and movement pattern severence. Long-term losses (20-30 years) of existing native vegetation on revegetated disturbed areas include the loss of 2,389 acres for the East Side Plan, 2,380 acres for the West Side Plan, 2,340 acres for the Sanders-San Joaquin Modification Plan, 2,107 acres for the Sandario Plan, 1,701 acres for the Sandario-San Joaquin Plan, and 1,391 acres for the No Federal Action Plan.

Impacts to terrestrial wildlife would result from separation of habitat caused by open canal portions of the aqueduct alternatives. This is usually referred to as the barrier effect. Natural river courses form barriers to wildlife; however, the barrier effect is not usually permanent. Animals can cross rivers during low-flow periods, at natural fords, or by floating and swimming downstream until a suitable place to exit is found. The unmitigated canal has no suitable places to cross and steep walls preclude all but a few species from exiting. Canals would be permanent dividers of habitat whereas pipelines would only be barriers during construction. With wildlife crossing structures and corridors, impacts would be mitigated to acceptable levels and residual impacts would be low. Because of the steep sidewalls of the canal section few, if any, wildlife species would be able to exit from the canal if they should fall or jump in. This would result in death by drowning or exposure.

This problem would be especially significant with regard to deer along the west side of the Tucson Mountains. The measures proposed for the Tucson Aqueduct Phase B (fencing, crossings, land acquisition, alternative water sources, rough broom finish of canal lining) will lessen the magnitude of losses. The greatest wildlife drowning and movement severance potential would occur with the West Side Plan because with this plan an open aqueduct is located in a major wildlife movement area. The least drowning impact would occur with the Sandario-San Joaquin Plan which is predominately buried pipe.

All transmission lines will be designed in such a fashion as to preclude the possibility of raptor electrocution. Existing access roads will be used whenever possible.

The desert tortoise, kit fox and Gila monster will be affected by habitat loss, drowning loss, and severance of movement patterns. The Harris' hawk will be affected by nesting disturbance during construction and by habitat loss. The proposed and candidate plants for Federal listing will be impacted by construction disturbance. Mitigation for these impacts to special status species include fencing, barriers, wildlife crossings, search and removal prior to construction, minimizing construction disturbance during nesting periods, and acquiring and managing land that supports other populations of these species. Impacts to all special status species would be greatest with the West Side Plan. The least impacts to desert tortoise, Harris' hawk and Gila monster would occur with the East Side Plan, while the Tumomoc globe-berry, Thornber's fishhook cactus and kit fox would be least impacted by the Sandario-San Joaquin Plan. The No Federal Action Plan would have minimal impacts to any special status species.

The greatest overall biological impacts would occur with the West Side Plan (Agency Proposed Action), followed by the Sanders - San Joaquin Modification Plan, the Sandario Plan, the East Side Plan, the Sandario-San Joaquin Plan, and the No Federal Action Plan, which has the least impacts. Both U.S. Fish and Wildlife Service and Arizona Game and Fish have indicated the mitigation measures committed to in this EIS would adequately reduce impacts to acceptable levels for all of the action alternatives.

2. Water Resources

a. Surface Water

The primary surface water features within the Phase B project area are the Santa Cruz River and its principal tributaries, Brawley Wash, Canada Del Oro Wash, and the Rillito River. These streams are all intermittent. The primary water source for mineral production, domestic, municipal, and agricultural uses is pumped ground water.

Interaction between Phase B of the Tucson Aqueduct and the local surface water system will be very limited, confined to providing cross-drainage control and protection for the aqueduct.

b. Ground Water

The project area generally overlies the eastern portion of the Lower Santa Cruz and the northern portion of the Upper Santa Cruz groundwater basins and the Avra Valley Basin. Ground-water withdrawal has occurred in the service area at a rate greater than the recharge rate, resulting in water level decline throughout the area. These water level declines have caused land subsidence and earth fissures. Implementation of any of the aqueduct alternatives would have a significant beneficial effect on the regional water resources, since the aqueduct would import an additional surface water supply.

c. Water Quality

Quality of the groundwater is generally suitable for most purposes including crop irrigation and drinking. The primary constituents of local ground waters which are of concern from a drinking water perspective are salinity, fluoride, nitrate, sulfate, hardness and trichloroethylene (TCE). Most of the ground water in the project area meets both the Arizona Drinking Water Regulations and the EPA Interim Primary and Secondary Drinking Water Regulations.

The project would import Colorado River water which is of generally poorer quality than the ground water now being used. However, the ground water resources are finite and will continue being severely overtaxed at least until the year 2025. It is anticipated that at that time the provisions of the Ground Water Management Act will result in balance of the ground water basin.

Federal and State Water Quality standards require treatment of all surface waters used for human consumption. With standard treatment methods the Colorado River water meets all quality standards.

3. Air Quality

The air quality in the project area is generally good. The air in sparsely inhabited regions is good while the pollution in the air in cities such as Tucson exceed Federal health standards at times.

A minor adverse effect would be expected for any of the routes due to construction-generated suspended particulates during the aqueduct construction phase. The contractor would be required to carry out proper and efficient measures (such as watering) to reduce dust nuisances.

Soil disturbance in the desert southwest is believed to be the major cause of coccidioidomysosis spores (Valley Fever) becoming airborne. Valley fever is a fungal disease resulting from inhalation of the anthrospores of the fungus. The disease ordinarily causes no severe problems, but occasionally can be a serious and sometimes fatal illness. Aqueduct construction will be closely monitored to insure that effective dust abatement measures are carried out, thus reducing the likelihood of a significant increase in airborne Valley Fever spores.

4. Sound Quality

Sound level measurements taken by Bureau personnel along the potential aqueduct routes ranged from less than 30 decibels to more than 75 decibels. The higher sound levels were due to vehicles and aircraft, and a more representative ambient level would be approximately 45 decibels or less. Construction activities would result in acute, relatively short duration noise due to equipment operation, vehicle access, and blasting.

Of the six alternatives under consideration, the East Side plan would require the most blasting. The proposed West Side alinement would cross about 0.3 miles of probable rock cut, which is less than 1 percent of total excavation; the East Side alinement would cross about 6.5 miles of probable rock cut, which is about 10 percent of total excavation. For the Sandario, Sandario-San Joaquin, and Sanders - San Joaquin Modification Plans, blasting requirements would be comparable with the West Side Plan.

The operation of pumping plants will contribute to the sound levels in adjacent areas. Sound level measurements of comparable pumping plants indicate that sound produced by operational plants will be well within acceptable limits.

During construction, sound levels will be monitored by Bureau personnel to insure compliance with Federal, state, and local laws and regulations.

5. Visual Resources

The implementation of any of the alinement alternatives would introduce open canals, transmission lines, earthen dikes, buried pipelines, pumping plants, surge protection structures, and access roads into the area. The presence of these structures would impose long-term changes on the visual quality of the area. The nature and significance of these changes depend on many factors, including the location from which the structure is viewed, number of viewers, scenic quality involved, and existing disturbance in the area due to man's activities.

The degree of visible change due to the presence of the Tucson Aqueduct facilities would vary significantly according to whether the aqueduct is designed as buried pipeline or open canal. Buried pipeline would result in minimal visual impacts, since the only structures visible after construction would be power transmission lines, low profile pumping plants, and operation and maintenance (O&M) roads. Open canals would have the potential for greater visual impact, depending on their visibility and the sensitivity of the areas through which they pass. Of particular concern is the visibility of the open canal of the West Side Plan as it passes near areas of high visual sensitivity such as the Arizona-Sonora Desert Museum, Saguaro National Monument, and Tucson Mountain Park.

6. Lands

All of the right-of-way (ROW) required for Phase B of the Tucson Aqueduct would be located in Pima County.

Depending on the route selected, the right-of-way requirements for Phase B could range from about 637 to 2,187 acres. The six routes and their estimated right-of-way requirements are listed on the following table.

All lands needed for construction, operation, mitigation and maintenance of the aqueduct would be acquired in fee title unless it is determined at the time of acquisition to be in the best interest of the Government to acquire a lesser interest in specific parcels.

Right-of-Way Requirements
Tucson Aqueduct - Phase B
Central Arizona Project

Route	Length (miles)	Estimated ROW Required (acres)
West Side	49.8	2,187
Sandario	51.0	1,708
Sandario-San Joaquin	51.4	1,065
Sanders - San Joaquin Modification	50.1	2,024
East Side	64.0	1,849
No Federal Action	20.1	637

The land uses along the alternative routes for Phase B of the Tucson Aqueduct vary from desert grazing and irrigated cropland to rural residential, commercial, and industrial. The table below depicts the land use along the alternative routes, and estimates acreage required from each major land use category.

Route	Desert	Agriculture	Residential	Commercial	Industrial	Total
West Side	1,893	96	108	0	0	2,187
Sandario	1,517	96	95	0	0	1,708
Sandario-San Joaquin	862	96	107	0	0	1,065
Sanders - San Joaquin Modification	1,802	96	120	0	0	2,024
East Side	1,367	123	340	3	16	1,849
No Federal Action	447	0	176	0	14	637

7. Geology

None of the aqueduct alternatives would have significant impacts on the geology of the region. Although there has been little measurable subsidence in the Phase B area, portions of the proposed alinements are in areas where future subsidence is expected. These portions would require special design and/or maintenance.

Although there are no earth fissures along any of the proposed alinements, there is some potential for future earth fissuring close to the aqueduct alinements. Detailed geophysical surveys and core drilling would be conducted in areas of possible fissuring and special considerations can be incorporated into canal design.

In the short term (10 to 15 years following initial water delivery), delivery of water to the Tucson Aqueduct service area would significantly lessen the amount of ground water withdrawn from the basins, and will slow the rate of subsidence and earth fissure development. Even though the ground water withdrawal would be lessened significantly, this does not completely cease earth fissures from developing. These processes are slow and continue for years due to readjustment of the basin alluvium associated with subsidence.

8. Cultural Resources

The cultural resources of the project area had not been systematically studied or inventoried prior to this project. Reclamation has therefore negotiated a contract for studies to identify cultural resources, analyze impacts of alternative plans and prepare an avoidance/mitigation plan.

The three phases of study are complete. Phase I consisted of Class I (overview) inventories of the entire Tucson Aqueduct Phase B project area. The second phase of study, a Class II (sample) survey reviewed over 300 cultural resource sites that had been previously recorded within the study area. The report discusses site significance and identifies pertinent research questions for use in evaluating new sites. The third study phase consisted of a Class III survey, an intensive on-the-ground examination of all areas to be affected. Class III surveys are designed to inventory all cultural resources within the project area and evaluate the significance of the cultural resources that may be affected. A primary result is the development of plans to avoid, minimize, or mitigate adverse effects.

The Class I survey identified 539 prehistoric and historic archeological sites within the 1666 square mile study area. Of these, 17 are currently listed on the National Register of Historic Places. Two other sites are listed on the Arizona State Register and an additional 26 are listed on the State Inventory. Although a significant portion of the study area has been surveyed for cultural resources, the total number of sites is undoubtedly much higher.

The Class II survey considered a 392 square mile area. Of that total, approximately 18 percent, or 71 square miles, had been previously surveyed for other non-CAP projects. The results suggested that about 2,400 sites could be located within the study area and estimated that between 20 and 60 sites may be adversely affected by the alternative plans.

The Class III survey has been completed for the proposed West Side Plan. It identified 32 prehistoric archaeological sites of which no sites currently listed on the National Register would be affected.

The completed and ongoing studies will provide documentation for consultation with the Arizona State Historic Preservation Officer, the Keeper of the National Register of Historic Places, the Advisory Council on Historic Preservation, and other interested local groups as stipulated in the National Historic Preservation Act of 1966, as amended in 1980. These consultations have been initiated under provisions of a Programmatic Memorandum of Agreement signed between Reclamation and the ACHP and Arizona SHPO. The consultations will be pursued to insure that the Tucson Aqueduct surveys and the avoidance/mitigation plan are adequate and appropriate.

9. Recreation

The 1977 Arizona Statewide Comprehensive Outdoor Recreation Plan (SCORP) and the 1983 Arizona SCORP Update prepared by the Arizona Outdoor Recreation Coordinating Commission identify those recreational activities which are in demand and are facility/area deficient. Both documents identify a variety of trail activities, such as bicycling, hiking, horseback riding, and pleasure walking/running, which are ranked high in the need for facility and area development and use. In addition, the SCORP identified nature study areas, open space activities, and camping facilities in high demand.

Current recreation activities in the Tucson Aqueduct-Phase B study area are concentrated in the Tucson area, where outdoor recreation is centered around neighborhood parks, schools, city parks, and river parks. On the outskirts of Tucson, a variety of activities such as hiking, nature study, sightseeing, and horseback riding are prominent in the Saguaro National Monument and the Tucson Mountain Park. In addition to dispersed recreation, which usually requires little or no facility development, both the Tucson Mountain Park and the Saguaro National Monument have campgrounds, picnic areas, and other recreational facilities.

Any of the proposed alternatives could result in minor access inconvenience to recreational users, particularly in the vicinity of the Saguaro National Monument and the Tucson Mountain Park. Detours to aqueduct crossing points would be required. Open canal portions would definitely require permanent accessible crossings for public recreation users.

10. Social

Construction of the aqueduct is not expected to change the population size or the racial or age distribution of the communities in the area. Because the aqueduct alinement lies near the second largest city in Arizona (Tucson), local workers would be readily available, and no significant migration of non-local workers into Central Arizona as a result of the project is anticipated.

Relocations will be few with any of the alinements under consideration. The estimated number of relocations vary from 7 with the Sanders-San Joaquin Modification Plan to about 35 for the East Side Plan and No Federal Action Plan. Approximately 15 relocations would be required for the West Side Plan.

Phase B of the Tucson Aqueduct permits delivery of water to the San Xavier Indian Reservation and the Schuk Toak District of the Papago Indian Reservation. If the 37,800 acre feet per year delivered to these communities is used to develop agriculture, Indian employment would be increased.

CONTENTS

Page

FIGURES

Tables

I. PURPOSE AND NEED

I. Purpose and Need

A. Introduction

This environmental impact statement (EIS) describes the proposed construction, operation, and maintenance of the Phase B portion of the Tucson Aqueduct, a feature of the Central Arizona Project (CAP). Phase B of the Tucson Aqueduct is the last segment of the CAP aqueduct system which, when completed, will extend from the Colorado River through central Arizona to the Tucson Metropolitan Area.

The CAP was authorized as a part of the Colorado River Basin Project Act (Public Law 90-537) on September 30, 1968. The primary purpose of the CAP is to furnish water for irrigation, municipal, and industrial uses in central and southern Arizona and western New Mexico. Due to its magnitude, the CAP is divided into several features serving separate but interrelated functions. The locations of the authorized features of the CAP are shown on the frontispiece.

To achieve compliance with the National Environmental Policy Act (NEPA) of 1969, a final overall EIS was prepared for the entire project and filed with the Council on Environmental Quality (CEQ) on September 26, 1972 (USBR 1972). This statement committed the Bureau of Reclamation (Bureau) to prepare individual site-specific EIS's for major features of the project. Since that time seven final EIS's have been filed for individual features of the project: Havasu Intake Channel, Havasu Pumping Plant, and Buckskin Mountains Tunnel--January 1973 (USBR 1973); Granite Reef Aqueduct--January 1974 (USBR 1974); Granite Reef Aqueduct Transmission System--August 1975 (USBR 1975); Salt-Gila Aqueduct--November 1979 (Water and Power 1979); Tucson Aqueduct-Phase A--July 1982 (USBR 1982); Water Allocations and Water Service Contracting--March 1982 (USBR 1982); and Regulatory Storage Division--February 1984 (USBR 1984). With the exception of the Regulatory Storage Division, these features of the CAP are either complete or under construction.

The Tucson Aqueduct is the last segment of the CAP aqueduct system. The planning and environmental statement process for the Tucson Aqueduct has been divided into two phases. Phase A of the Tucson Aqueduct and its associated electrical transmission system extends from the end of the Salt-Gila Aqueduct in central Pinal county to the vicinity of Rillito, Arizona in northern Pima County. Phase B will extend from the terminus of Phase A to the Tucson Metropolitan Area and to the south boundary of the San Xavier Indian Reservation.

Other authorized features of the CAP that are in the planning stage include Buttes Dam and Reservoir, Hooker Dam or suitable alternative (a study of alternatives is the subject of current investigations under the Upper Gila Water Supply Study [UGWSS]), and the Indian Distribution Division.

B. Phase B

1. Purpose

The Tucson Aqueduct-Phase B will convey water from the terminus of Phase A to the Tucson Metropolitan Area for delivery to agricultural, municipal, industrial, and Indian users. Figure 2 shows the location of potential water users in the Phase B service area.

2. <u>Need</u>

Augmentation of existing water supplies in the Tucson Aqueduct Phase B area is needed. The ground water level is dropping and Tucson's only dependable source of water is being depleted. Metropolitan Tucson is among the largest cities in the nation solely dependent on groundwater for its supply. The absence of any alternate source of water makes Tucson's dependence on groundwater unique when compared to other cities that use groundwater.

Of the 430,000 acre-feet currently being pumped within the Tucson AMA, agriculture uses 56 percent, mining and industry use 21 percent, and municipal system delivery accounts for 23 percent. Agricultural water use is expected to decline in the future because some farmland is projected to be converted to residential and industrial use. Much of the reduction in agricultural water use, however, will be offset by increased demand of an expanding population.

In order to help reduce demand, the 1980 Groundwater Management Act was enacted and authorizes the Arizona Department of Water Resources to require water conservation by users. It also provided for the creation of four active management areas (AMA) where intensive groundwater management is required. The AMAs are headquartered in Phoenix, Tucson, Casa Grande, and Prescott. Each AMA has a management plan which imposes progressively strict conservation measures until some future date when the ultimate goal of safe yield (long term balance between groundwater withdrawal and recharge) is reached. The management goal for the Tucson AMA is safe yield by the year 2025. CAP water deliveries are included in this plan. Augmentation and demand reduction will slow the rate of groundwater withdrawal, and in turn slow the rate of earth subsidence and fissuring.

To help mitigate the depletion of the State's ground water resources, the State of Arizona Department of Water Resources (DWR) in January 1982 recommended CAP water allocations that provided 638,824 acre-feet annually in the year 2034 to 85 municipal and industrial entities, with the remaining supply to 23 irrigation districts for farming operations. In March 1982 the Bureau filed the final EIS for water allocations and water service contracting for the CAP. The Bureau's Proposed Action is to allocate 309,828 acre-feet annually to 12 Indian tribes for irrigation or for maintaining tribal homelands. (The CAP water supply is the amount specified in the 1981 contracts between the tribes and the Secretary of the Interior). This EIS includes DWR's recommendations. The Water Allocations & Water Service contracting EIS (1982) lists allocations by individual user entity.

On October 12, 1982, the Southern Arizona Water Rights Settlement Act (SAWRSA) was signed into law (PL 97-293). The Act settles a water rights suit filed by the Papago Indians by providing water to the San Xavier and Shuk Toak portions of the Papago Reservation from CAP, groundwater, and by providing effluent from the city of Tucson to the Secretary of the Interior for use in obtaining additional water for the Papagos as shown below.

	San Xavier	Schuk Toak
CAP	27,000 ac-ft	10,800 ac-ft
Ground Water	10,000 ac-ft	---
Effluent	23,000 ac-ft	5,200 ac-ft
Total	60,000 ac-ft	16,000 ac-ft

Note: The Act has limited ground water pumping at Schuk Toak to that taking place as of January 1, 1981. No pumping of any magnitude is known to have occurred as of that date.

The CAP water supply is the amount specified in the 1981 contract between the Tribe and the Secretary of the Interior. Ground water would come from the existing ground water source development on the reservation. The reclaimed water would be provided by the City of Tucson at no cost to the Secretary. Treatment of this water to make it suitable for irrigation would be the responsibility of the City of Tucson. However, the Secretary could exchange it with other users, or sell it, and make additional water available to the Papago Tribe.

To meet the water supply augmentation needs of the Tucson Aqueduct - Phase B service area, the Bureau of Reclamation proposes to construct the West Side Plan. The ultimate purpose of this document is to disclose the environmental impacts of the proposed action and alternatives.

II. ALTERNATIVES INCLUDING THE AGENCY PROPOSED ACTION

II. Alternatives Including the Agency Proposed Action

The purpose of all action plans is to deliver Central Arizona Project Colorado River water to agricultural, municipal, and industrial users in Pima County, Arizona, both Indian and non-Indian.

To make a decision on what aqueduct alinement should be identified as the agency's proposed action, it was necessary to consider all costs and environmental impacts associated with delivery of CAP water to common points of use. Thus all plans would be comparable. For example: An aqueduct alinement on the west side of the Tucson Mountains would bring the water closer to the Schuk Toak District than an alinement on the east side of the mountains; therefore, the facilities required to convey the water from the aqueduct to a common point of use were included in the appropriate plan. Even though the cost of the Schuk Toak delivery line is non-Tucson Aqueduct, this was included in the total plan costs.

For this evaluation, the auxiliary facilities that were included are those required to deliver water to the Avra Valley Irrigation District and the Schuk Toak District. The facilities that remain the same, regardless of what alinement is used, have not been included in the plans since they do not affect plan selection. These include the distribution systems for Avra Valley Irrigation District, Schuk Toak District, and San Xavier Indian Reservation; the internal distribution system for the City of Tucson; and the facilities to the mines, Farmers Investment Company, and to municipalities south of the San Xavier Indian Reservation.

Project facilities are those that just convey CAP water to the City of Tucson delivery point and the south boundary of the San Xavier Indian Reservation and turnouts for Avra Valley Irrigation District, Schuk Toak District, Tucson water treatment plant, San Xavier Indian Reservation, and water users south of the San Xavier Indian Reservation.

Alternative plans would convey an average annual volume of 161,900 acre-feet of water to the service area. The aqueduct will begin at the terminus of the authorized Tucson Aqueduct-Phase A in northern Pima County. Each Tucson Aqueduct-Phase B alternative has two termini, one at a proposed Tucson water delivery point and a second at the south boundary of the San Xavier Indian Reservation.

Four alternatives plans have been identified on the west side of the Tucson Mountains, and one plan has been identified on the east side. The No Federal Action plan has also been identified. These plans have been analyzed in detail.

A. Agency Proposed Action - West Side Plan

1. Overview of Plan Concept

This alternative is based on providing an average annual volume of 161,900 acre - feet of Colorado River water to the Tucson Aqueduct - Phase B service area by means of an aqueduct system located primarily on the west side of the Tucson Mountains.

This plan would be mostly canal with six pumping plants to lift the water from the beginning of the Phase B aqueduct (elevation 2,040 feet) to the City of Tucson's delivery point (elevation 2,800 feet) and to the south boundary of the San Xavier Indian Reservation (elevation 2,800 feet). Along the portion of the canal through Avra Valley, four turnouts would be provided for the Avra Valley Irrigation District. A turnout would be provided for the Schuk Toak District on the Garcia Strip, an eastern spur of the Papago Reservation. From this turnout a pipeline could be constructed to the reservation. At the south boundary of the San Xavier Indian Reservation two turnouts would be needed; one would be provided for the San Xavier Indian Reservation and the other for the town of Green Valley, the mines, Farmers Investment Company, Rio Rico, and the city of Nogales. A third turnout may be needed near the south boundary of the San Xavier Indian Reservation for the ASARCO mine.

Summaries of physical characteristics and plan costs are shown in Tables 1 and 2, respectively.

2. Detailed Plan

a. Aqueduct Design and Components

The total length of the aqueduct is 47.4 miles which includes 28.0 miles of concrete lined canal and 19.4 miles of concrete pipeline. The aqueduct capacity ranges from 650 cfs to 200 cfs. Typical open canal and pipeline aqueduct designs are shown in Figures 3 and 4. The aqueduct would deviate from the typical open canal configuration in cut sections approaching the pumping plants and on relatively steep cross-slopes along the bajadas of the Tucson Mountains and Black Mountains as shown in Figure 5.

Figure 5 depicts a perception of the deep cuts required for approaches to the pumping plants. Most of the permanent slopes will be 2:1, with some 1-½:1 (probably steeper in rock). Flatter slopes, such as 3:1 slopes, would be used on a limited basis. Cut depths would range from approximately 50 to 115 feet at the five pumping plants with canal inlets.

The West Side Plan would require six pumping plants with a total electrical capacity of about 53 megawatts. Operation of these plants would have a total average annual energy requirement of about 174 gigawatt hours to deliver 161,900 acre-feet (ac ft) of water through the system. Table 3 summarizes the relevant pumping plant data.

It is anticipated that final design will include a surge protection structure at the discharge side lines of Brawley, San Xavier, Synder Hill, and Black Mountain pumping plants. Surge protection will also need to be provided at some point along the delivery pipeline from the Snyder Hill Pumping Plant to the Tucson water delivery point. Through the process of designing the system three different methods of surge control have been studied.

Table 1
Summary Alternative Plans - Physical Characteristics
Tucson Aqueduct - Phase B
Central Arizona Project

Conveyance Facilities (Miles)	West Side	Sandario-San Joaquin	Sandario	Sanders-San Joaquin Modification	East Side	No Federal Action 1/
Main Aqueduct						
Canal	28.0	4.8	16.9	19.2	6.6	6.6
Pipe	19.4	39.8	27.9	28.0	30.2	13.5
Subtotal	47.4	44.6	44.8	47.2	36.8	20.1
Indian Delivery Line						
Canal	0	0	0	0	0	0
Pipe	2.4	3.0	2.4	2.4	9.5	0
Subtotal	2.4	3.0	2.4	2.4	9.5	0
Avra Valley Delivery Line						
Canal	0	0	0	0	13.5	0
Pipe	0	3.8	3.8	0.5	4.2	0
Subtotal	0	3.8	3.8	0.5	17.7	0
Total	49.8	51.4	51.0	50.1	64.0	20.1
Pumping Plants (No.)						
Main Aqueduct	6	5	5	5	5	3
Indian Delivery Line	0	0	0	0	0	0
Avra Valley Delivery Line	0	0	0	0	2	0
Total	6	5	5	5	7	3
Right-of-Way (Acres)						
Main Aqueduct						
Canal	1922	513	1310	1624	593	473
Pipe	235	482	338	339	366	164
Subtotal	2157	995	1648	1963	959	637
Indian Delivery Line						
Canal	0	0	0	0	0	0
Pipe	30	35	30	55	115	0
Subtotal	30	35	30	55	115	0
Avra Valley Delivery Line						
Canal	0	0	0	0	720	0
Pipe	0	35	30	6	55	0
Subtotal	0	35	30	6	775	0
Total	2187	1065	1708	2024	1849	637
Power Transmission Line (miles)	33	33	33	34	32	19.0
Power Requirements						
Main Aqueduct						
Load (MW)	53	67	63	59	59	32
Energy (GWH)	174	220	204	193	197	111
Indian Delivery Line						
Load (MW)	0	0	0	0	0	0
Energy (GWH)	0	0	0	0	0	0
Avra Valley Delivery Line						
Load (MW)	0	0	0	0	1.0	0
Energy (GWH)	0	0	0	0	1.2	0
Total						
Load (MW)	53	67	63	59	60	32
Energy (GHW)	174	220	204	193	197	111

1/ The "No Federal Action" alternative describes the most probable actions that would be taken by Tucson Metropolitan area users to obtain CAP water in the absence of Federal funding.

Table 2
SUMMARY ALTERNATIVE PLANS REGIONAL COST 1/
TUCSON AQUEDUCT - PHASE B
CENTRAL ARIZONA PROJECT
(All Costs are in Thousands of Dollars)
(January 1985 Price Levels)

	West Side	Sandario-San Joaquin	Sandario	Sanders-San Joaquin Modification	East Side	No Federal Action
Aqueduct	213,813	252,813	225,248	231,829	218,677	134,113
Indian Delivery Line	1,064	1,344	1,064	1,064	8,696	0
Avra Valley Delivery Line	0	2,814	2,814	645	26,395	0
TOTAL FIELD COST	214,877	256,971	229,126	233,538	253,768	134,113
Noncontract (25%)	53,719	64,243	57,281	58,384	63,442	33,528
TOTAL CONSTRUCTION COST	268,596	321,214	286,407	291,922	317,209	167,641
Interest During Construction 2/	52,186	61,594	55,503	56,062	60,889	32,316
Mitigation - Biological 3/	4,169	900	3,755	1,175	1,208	885
- Cultural Resource 4/	1,000	1,000	1,000	1,000	1,000	1,000
TOTAL CAPITAL COST	325,951	384,708	346,665	350,159	380,306	201,842
OM&R						
Aqueduct	1,934	1,523	1,712	1,717	1,431	782
Indian Delivery Line	41	53	41	41	41	0
Avra Valley Delivery Line	0	19	19	1	391	0
Energy						
Aqueduct	6,700	8,454	7,830	7,407	7,569	4,082
Indian Delivery Line	0	0	0	0	0	0
Avra Valley Delivery Line	0	0	0	0	26	0
TOTAL OM&R COST	8,675	10,048	9,603	9,167	9,459	4,864
ANNUAL EQUIVALENT OF CAPITAL COST 5/	24,870	29,353	26,450	26,717	29,017	15,400
TOTAL OM&R COST	8,675	10,048	9,603	9,167	9,459	4,864
DAMAGES PAID TO THE PAPAGO TRIBE	0	0	0	0	0	20,040
TOTAL ANNUAL COST	33,545	39,401	36,053	35,884	38,476	40,305

1/ Labels used in this table relate to function and not to funding responsibility. Regional cost includes both non-federal and federal expenditures.

2/ Interest during construction is based on a 5-year construction period and an interest rate of 7.625 percent.

3/ Estimated mitigation expenditures (mitigation has not been finalized).

4/ Estimated mitigation expenditures. Maximum mitigation expenditure can be up to 1 percent of total construction costs.

5/ Formulated based on 100-year project life and an interest rate of 7.625 percent.

Table 3
Pumping Plant Data - West Side Plan
Tucson Aqueduct - Phase B
Central Arizona Project

Pumping Plant	Location	Electric Capacity (megawatts)	Lift (feet)	Discharge Line (length in feet)
Twin Peaks	Sec 14, T12S, R11E	5.2	72	650
Sandario	Sec 17, T13S, R11E	4.9	87	500
Brawley	Sec 33, T13S, R11E	13.0	213	6,100
San Xavier	Sec 34, T15S, R12E	9.3	157	10,600
Snyder Hill	Sec 35, T14S, R12E	12.4	307	25,700
Black Mountain	Sec 23, T15S, R12E	8.5	383	14,100

The first is the standard two-way surge tank. This tank is situated over the discharge line of the point of greatest negative pressure with the top set at the maximum hydraulic grade line. There are no valves or moving parts in this structure and it operates by taking water from the surge tank into the discharge line and back into the tank as the surge reverses itself. This type is the most economical. Figure 6 shows the design of a typical surge tank.

The second type is the low and wide one-way tank. This tank is again located at the point of greatest negative pressure. This tank is sized to contain the volume of water required to maintain the discharge line full and requires a valve system that allows the water out of the tank but stops it from returning when the surge reverses. These valves are rapid closing and cause loud noises on closing. Also, depending on the size and length of discharge line, it may require several valves thus effecting the reliability of the system. This is also the most costly of the systems.

The third method, and the design selected for Phase B, is the air chamber system. This system is a sphere located adjacent to the pumping plant and connected to the discharge line. This chamber is filled with water and pressurized with air to force the water into the discharge line in the event of a down surge caused by a pump failure. This tank requires an air compressor to maintain the correct volume of water and air in the system. This system is rated second in reliability and cost but is the most environmentally acceptable as it is located in the basin with the pumping plants. Figure 7 shows the design of a typical air chamber.

Additional anticipated aqueduct components are summarized on Table 4. Figures 8-10 are photos of some of the components as they appear for the Granite Reef Aqueduct. The tentative locations of these facilities are shown on Figures 11 through 16.

Table 4
Aqueduct Components - West Side Plan 1/
Tucson Aqueduct - Phase B
Central Arizona Project

Structure	Number	Size or Capacity
Check Structures	2	2-550 cfs
Turnouts	9	1-15 cfs, 1-25 cfs, 1-45 cfs, 1-50 cfs, 1-60 cfs, 2-100 cfs, 2-350 cfs
Overchutes	30	1 to 4-72 inch pipes
Siphons	2	1-650 cfs, 1-550 cfs
Collective Dikes	20 miles	8 to 10 feet high
County Roads and Other Bridges	7	HS 20 loading
Wildlife Crossings	13	
Wildlife Watering Sites	7	
Security Fencing	57.8 miles	(Fence length includes both sides of canal)
w/wildlife protection	23 miles	
w/tortoise barrier	8 miles	
Wildlife Movement Corridor	2,530 acres	

1/ The number and type of components listed are based on conceptual designs determined to be suitable, representative and feasible for the functions intended. They do not represent a statement on final construction design. The number, location, and design of cross-drainage structures will be refined by supplemental hydrologic studies conducted during the design phase. The final locations and number of road bridges, wildlife crossings, and wildlife watering sites, and the type of fencing along the right-of-way will be determined through negotiations with the appropriate agencies during final aqueduct design and will be reflected in the construction specifications. The final capacities and locations of turnouts would be determined following consultation with the prospective water users.

Excess earth material would be disposed of at designated spoil areas along the alinement. Because of the deep cuts approaching most pumping plants, it is anticipated that five spoil disposal sites along the right-of-way would be required. Three of the pumping plants (Brawley, San Xavier, Twin Peaks) are proposed to be constructed concurrently with the aqueduct. The excavated material could be used for construction of the dikes. Therefore, the number and size of spoil sites may actually be less than stated here. The approximate site locations and sizes are presented in Table 5 and are shown on Figures 11 through 16.

Table 5
Spoil Disposal Sites - West Side Plan
Tucson Aqueduct - Phase B
Central Arizona Project

Mile Station From (mi.)	To (mi.)	Description - Spoil Area Height (ft.)	Width (ft.)	Length (ft.)
4.5	5.2	8	380	2,900
10.9	12.6	8	400	9,000
14.4	16.4	8	370	10,600
22.7	24.9	8	500	11,600
29.5	30.8	8	560	6,900

b. Power Transmission Facilities

The West Side transmission line route follows the water delivery system whenever possible. The transmission line right-of-way would be located adjacent to that of the aqueduct. Deviations from the route of the aqueduct have been included when such a design would reduce environmental impacts and when cost and engineering constraints required such deviations. Deviations are indicated as approximate, since final design criteria would indicate the location which accommodates as many environmental mitigation measures as possible.

The proposed West Side transmission line route is shown in Figures 11 through 16. As with all the routes for the west side, the line would begin at a tap on Western Area Power Administration's existing Saguaro-Tucson 115-kV line. At the location of the tap a small (about 1 acre) substation would be constructed.

The transmission system for all west side alternatives includes a line which would run from Western's Tucson-Apache 115-kV transmission line to the Black Mountain pumping plant (Figure 15). This 5.75-mile transmission line would be located along Los Reales Road, in part. It would run on the section line along the northern boundaries of the San Xavier and Pasqua Yaqui Indian Reservations. This line would permit the transmission system to be served from the north or south, increasing the reliability of electrical power delivery to the pumps in case of unexpected outages somewhere on the Phase B transmission system. The total length of transmission lines required would be approximately 33 miles long. A substation of approximately 2 acres would be constructed at this tap site.

B. Other Viable Alternatives

1. Sandario-San Joaquin Plan

a. Overview of Plan Concept

This alternative is based on providing an average annual volume of 161,900 acre-feet of Colorado River water to the Tucson Aqueduct -

Phase B service area by means of an aqueduct system located primarily on the west side of the Tucson Mountains (Figures 17 through 22).

This plan would be mostly pipeline, with five pumping plants to lift the water from the beginning of the Phase B aqueduct (2,040 feet) to the City of Tucson's delivery point (2,800 feet) and to the south boundary of the San Xavier Indian Reservation (2,800 feet).

A turnout would be provided for the Schuk Toak District of the Papago Reservation on the Garcia Strip, an eastern spur of the Papago Reservation. From this turnout a pipeline could be constructed to the reservation, however, this pipeline is not a part of the project action. At the south boundary of the San Xavier Indian Reservation two turnouts would be needed; one would be provided for the San Xavier Indian Reservation, and the other for the town of Green Valley, the mines, Farmers Investment Company, and the city of Nogales.

b. Detailed Plan

(1) Aqueduct Design and Components

The total length of the aqueduct is 44.6 miles which consists of 4.8 miles of concrete lined canal and 39.8 miles of concrete pipeline. The aqueduct capacity ranges from 650 cfs to 200 cfs. Typical open canal and pipeline aqueduct designs are shown in Figures 3 and 4.

The Sandario-San Joaquin Plan would require five pumping plants with a total electrical capacity of about 67 megawatts. Operation of these plants would have a total average annual energy requirement of about 220 gigawatt hours to deliver 161,900 ac ft of water through the system. Table 6 summarizes the relevant pumping plant data.

Table 6
Pumping Plant Data - Sandario-San Joaquin Plan
Tucson Aqueduct - Phase B
Central Arizona Project

Pumping Plant	Location	Electric Capacity (megawatts)	Lift (feet)	Discharge Line (length in feet)
Twin Peaks	Sec 22, T12S, R11E	20.3	280	24,500
Sandario	Sec 10, T13S, R11E	13.5	211	40,700
San Xavier	Sec 14, T14S, R11E	20.4	349	74,400[1/]
Snyder Hill	Sec 36, T14S, R12E	6.9	176	13,700
Black Mountain	Sec 23, T15S, R12E	6.0	270	12,500

1/ The discharge line is 19,700 feet long then bifurcates with a 29,700 foot discharge line going south and a 25,000 foot discharge line going east to the Tucson delivery point.

A surge protection structure may be required at the discharge line of one or more of the proposed pumping plants to overcome the effect of water hammer in the event of a rapid change in flow rate from a pumping plant (e.g. instantaneous pump shutdown due to temporary power failure). Figures 6 and 7 depict a typical surge tank and air chamber, respectively.

Additional anticipated aqueduct components are summarized on Table 7. Figures 8-10 are photos of some of these components as they appear on the Granite Reef Aqueduct. The tentative locations of these facilities are shown on Figures 17 through 22.

Table 7
Aqueduct Components - Sandario-San Joaquin Plan[1/]
Tucson Aqueduct - Phase B
Central Arizona Project

Structure	Number	Size or Capacity
Check Structures	0	
Turnouts	9	1-15 cfs, 1-25 cfs, 1-45 cfs, 1-50 cfs, 1-60 cfs, 2-100 cfs, 2-350 cfs
Overchutes	7	2-72 inch pipes
Siphons	1	1-650 cfs
Collective Dikes	4.8 miles	8 to 10 feet high
County Roads and Other Bridges	1	HS 20 loading
Wildlife Crossings	2	
Wildlife Watering Sites	1	
Security Fencing	11 miles	(Fence length includes both sides of canal)
w/wildlife protection	9 miles	
Rare Plant Land Acquisition	640 acres	

1/ See Table 4 footnote.

(2) Power Transmission Facilities

The proposed Sandario-San Joaquin transmission line route is shown in Figures 17 through 22. This line follows the proposed pipeline alinement with a deviation near Sandario Pumping Plant, where it is routed 2 miles to the west along an existing road, then travels south for approximately four miles to a pipeline corridor; the line then follows the pipeline to rejoin the canal alinement 2 miles before the San Xavier pumping plant.

The deviation from the canal alinement was considered as an alternative to crossing through Saguaro National Monument along the Sandario Road scenic route, and as an alternative to passing along the western edge of the monument. The 5.75-mile Los Reales Road transmission line described for the Proposed Action would be required. The total length of the line would be approximately 33 miles.

2. Sandario Plan

a. Overview of Plan Concept

This alternative is based on providing an average annual volume of 161,900 acre-feet of Colorado River water to the Tucson Aqueduct - Phase B service area by means of an aqueduct system located primarily on the west side of the Tucson Mountains (Figures 23 through 28).

This plan would consist of canal and pipeline with five pumping plants to lift water from the beginning of the Phase B aqueduct (elevation 2,040 feet) to the City of Tucson's delivery point (elevation 2,800 feet) and to the south boundary of the San Xavier Indian Reservation (elevation 2,800 feet). It differs from the West Side Plan in that 11.1 miles of canal is replaced by 8.5 miles of concrete pipeline through the Avra Valley area. This pipeline would be down Sandario Road through Saguaro National Monument and adjacent to the road in all other areas.

Along the portion of the canal through Avra Valley, three turnouts would be provided for the Avra Valley Irrigation District (AVID). From each of these turnouts a pipeline conveys AVID water to a point of delivery as shown in the West Side Plan. These pipelines are not a part of the project action and would be addressed in some future environmental compliance document.

A turnout would be provided for the Schuk Toak District of the Papago Reservation on the Garcia Strip, an eastern spur of the Papago Reservation. From this turnout a pipeline could be constructed to the reservation, however, this pipeline is not a part of the project action. At the south boundary of the San Xavier Indian Reservation, two turnouts would be needed: one would be provided for the San Xavier Indian Reservation and the other for the town of Green Valley, the mines, Farmers Investment Company, and the city of Nogales.

b. Detailed Plan

(1) Aqueduct Design and Components

The total length of the aqueduct is 44.8 miles which consists of 16.9 miles of concrete lined canal and 27.9 miles of concrete pipeline. The aqueduct capacity ranges from 650 cfs to 200 cfs. The design of both canal and pipeline segments of the aqueduct would be similar to those previously described.

The aqueduct would deviate from the typical open canal configuration in cut sections approaching the pumping plants and on relatively steep cross-slopes along the bajadas of the Tucson Mountains and Black Mountain shown in Figure 3 and 4.

Figure 5 depicts a perception of the deep cuts required for approaches to two of the pumping plants. Most of the permanent slopes will be 2:1, with some 1-½:1 (probably steeper in rock). Flatter slopes, such as 3:1 slopes, would be used on a limited basis.

The Sandario Plan would require five pumping plants with a total combined electrical capacity of about 63 megawatts. Operation of these plants would have a total average annual energy requirement of about 204 gigawatt hours to deliver 161,900 acre-feet of water through the aqueduct system. Table 8 summarizes the relevant pumping plant data.

Table 8
Pumping Plant Data - Sandario Plan
Tucson Aqueduct - Phase B
Central Arizona Project

Pumping Plant	Location	Electric Capacity (megawatts)	Lift (feet)	Discharge Line (length in feet)
Twin Peaks	Sec 22, T12S, R11E	20.3	258	24,500
Sandario	Sec 10, T13S, R11E	12.0	159	27,300
San Xavier	Sec 4, T15S, R12E	9.3	157	10,600
Snyder Hill	Sec 35, T14S, R12E	12.4	307	25,700
Black Mountain	Sec 23, T15S, R12E	8.5	383	14,100

A surge protection structure may be required at the discharge line of one or more of the proposed pumping plants to overcome the effect of water hammer in the event of a rapid change in flow rate from a pumping plant (e.g. instantaneous pump shutdown due to temporary power failure). Figures 6 and 7 depict a typical surge tank and air chamber, respectively.

Additional anticipated aqueduct components are summarized on Table 9. Figures 8-10 are photos of some of the components as they appear on the Granite Reef Aqueduct. The tentative locations of these facilities are shown on Figures 23 through 28.

Excess earth material would be disposed of at designated spoil areas along the alinement. Because of the deep cuts approaching two of the pumping plants, it is anticipated that two spoil disposal sites along the right-of-way would be required. The approximate site locations and sizes are presented in Table 10 and are shown on Figures 23 through 28.

(2) Power Transmission Facilities

The proposed Sandario transmission line route is shown in Figures 23 through 28. This route is presented as an alternative to locating along the boundary of the Saguaro National Monument. The line deviates from the water delivery system and is displaced about one mile to the west in the vicinity of the Monument. The 5.75-mile Los Reales Road transmission line would be required. The total length of this line would be approximately 33 miles.

Table 9
Aqueduct Components - Sandario Plan[1/]
Tucson Aqueduct - Phase B
Central Arizona Project

Structure	Number	Size or Capacity
Check Structures	2	2-550 cfs
Turnouts	9	1-15 cfs, 1-25 cfs, 1-45 cfs, 1-50 cfs, 1-60 cfs, 2-100 cfs, 2-350 cfs
Overchutes	17	1 to 4-72 inch pipes
Siphons	2	1-650 cfs, 1-550 cfs
Collective Dikes	13.6 miles	8 to 10 feet high
County Roads and Other Bridges	3	HS 20 loading
Wildlife Crossings	9	
Wildlife Watering Sites	5	
Security Fencing	35.3 miles	(Fence length includes both sides of canal)
w/wildlife protection	17 miles	
w/tortoise barrier	8 miles	
Wildlife Migration Corridor	2,530 acres	

1/ See Table 4 footnote.

Table 10
Spoil Disposal Sites-Sandario Plan
Tucson Aqueduct-Phase B
Central Arizona Project

Mile Station		Description - Spoil Area		
From (mi.)	To (mi.)	Height (ft.)	Total Width (ft.)	Length (ft.)
20.7	22.9	8	500	11,600
27.6	28.9	8	560	6,900

3. Sanders-San Joaquin Modification Plan

a. Overview of Plan Concept

This alternative is based on providing an average annual volume of 161,900 acre-feet of Colorado River water to the Tucson Aqueduct - Phase B service area by means of an aqueduct system located primarily on the west side of the Tucson Mountains (Figures 29 through 34).

This plan would be mostly pipeline, with five pumping plants to lift the water from the beginning of the Phase B aqueduct (2,040 feet) to the City of Tucson's delivery point (2,800 feet) and to the south boundary of the San Xavier Indian Reservation (2,800 feet).

A turnout would be provided for the Schuk Toak District of the Papago Reservation on the Garcia Strip, an eastern spur of the Papago

Reservation. From this turnout a pipeline could be constructed to the reservation, however, this pipeline is not a part of the project action. At the south boundary of the San Xavier Indian Reservation two turnouts would be needed; one would be provided for the San Xavier Indian Reservation, and the other for the town of Green Valley, the mines, Farmers Investment Company, and the city of Nogales.

b. Detailed Plan

(1) Aqueduct Design and Components

The total length of the aqueduct is 47.2 miles which consists of 19.2 miles of concrete lined canal and 28.0 miles of concrete pipeline. The aqueduct capacity ranges from 650 cfs to 200 cfs. Typical open canal and pipeline aqueduct designs are shown in Figures 3 and 4.

Figure 5 depicts a perception of the deep cuts required for approaches to most of the pumping plants. Most of the permanent slopes will be 2:1, with some 1-½:1 (probably steeper in rock). Flatter slopes, such as 3:1 slopes, would be used on a limited basis.

The Sanders-San Joaquin Modification Plan would require five pumping plants with a total electrical capacity of about 59 megawatts. Operation of these plants would have a total average annual energy requirement of about 193 gigawatt hours to deliver 161,900 ac ft of water through the system. Table 11 summarizes the relevant pumping plant data.

Table 11
Pumping Plant Data - Sanders-San Joaquin Modification Plan
Tucson Aqueduct - Phase B
Central Arizona Project

Pumping Plant	Location	Electric Capacity (megawatts)	Lift (feet)	Discharge Line (length in feet)
Twin Peaks	Sec 14, T12S, R11E	5.2	72	650
Sandario	Sec 17, T13S, R11E	23.5	367	17,750
San Xavier	Sec 4, T15S, R11E	9.3	159	10,600 1/
Snyder Hill	Sec 35, T14S, R12E	12.4	319	25,700
Black Mountain	Sec 23, T15S, R12E	8.5	383	14,100

A surge protection structure may be required at the discharge line of one or more of the proposed pumping plants to overcome the effect of water hammer in the event of a rapid change in flow rate from a pumping plant (e.g. instantaneous pump shutdown due to temporary power failure). Figures 6 and 7 depict a typical surge tank and air chamber, respectively.

Additional anticipated aqueduct components are summarized on Table 12. Figures 8-10 are photos of some of these components as they appear on the Granite Reef Aqueduct. The tentative locations of these facilities are shown on Figures 29 through 34.

Table 12
Aqueduct Components - Sanders-San Joaquin Modification Plan[1/]
Tucson Aqueduct - Phase B
Central Arizona Project

Structure	Number	Size or Capacity
Check Structures	1	1-550 cfs
Turnouts	9	1-15 cfs, 1-25 cfs, 1-45 cfs, 1-50 cfs, 1-60 cfs, 2-100 cfs, 2-350 cfs
Overchutes	17	2-72 inch pipes
Siphons	1	1-650 cfs
Collective Dikes	13.8 miles	8 to 10 feet high
County Roads and Other Bridges	5	HS 20 loading
Wildlife Crossings	3	
Wildlife Watering Sites	2	
Security Fencing	40 miles	(Fence length includes both sides of canal)
w/wildlife protection	9 miles	
Rare Plant Land Acquisition	640 acres	

1/ See Table 4 footnote.

Excess earth material would be disposed of at designated spoil areas along the alinement. Because of the deep cuts approaching most of the pumping plants, it is anticipated that four spoil disposal sites along the right-of-way would be required. The approximate site locations and sizes are presented in Table 13 and are shown on Figures 29 through 34.

Table 13
Spoil Disposal Sites - Sanders-San Joaquin Modification Plan
Tucson Aqueduct - Phase B
Central Arizona Project

Mile Station From (mi.)	To (mi.)	Description - Spoil Area Height (ft.)	Width (ft.)	Length (ft.)
4.5	5.2	8	380	2,900
11.4	12.8	8	400	7,400
24.2	26.4	8	500	11,600
31.0	32.3	8	560	6,900

(2) Power Transmission Facilities

The proposed Sanders-San Joaquin transmission line route is shown in Figures 29 through 34. This line follows the proposed aqueduct with one deviation at Sandario Pumping Plant. The 5.75 mile Los Reales Road transmission line would be required. The total length of the line would be approximately 34 miles.

4. East Side Plan

a. Overview of Plan Concept

This alternative is based on providing an average annual volume of 161,900 acre-feet of Colorado River water to the Tucson Aqueduct Phase B service area by means of an aqueduct system located primarily on the east side of the Tucson Mountains (Figures 35 through 40).

This plan would be mostly pipeline with five pumping plants to lift the water from the beginning of Phase B aqueduct (2040 feet) to the City of Tucson's delivery point (2800 feet) and to the south boundary of the San Xavier Indian Reservation (2800 feet). One turnout, located about 2 miles south of Tangerine Road, would be provided for the Avra Valley Irrigation District. From this turnout a pipe/canal delivery line and two pumping plants would be constructed by the water users to deliver CAP water to the District's boundary. Between West 22nd Street and West 36th Street, a turnout at elevation 2,800 feet would be provided to deliver water to Tucson's delivery point. Near Ajo Road a turnout would be provided for the Schuk Toak District. From this turnout a pipeline would be constructed to the reservation. At the south boundary of the San Xavier Indian Reservation, two turnouts would be needed; one would be provided for the San Xavier Indian Reservation, and the other for the town of Green Valley, the mines, Farmers Investment Company, and the city of Nogales.

b. Detailed Plan

(1) Aqueduct Design and Components

The total length of the aqueduct is 36.8 miles which consists of 6.6 miles of concrete lined canal and 30.2 miles of concrete pipeline. The aqueduct capacity ranges from 650 cfs to 200 cfs. Typical open canal and pipeline aqueduct designs are shown in Figures 3 and 4.

The East Side Plan would require five pumping plants with a total electrical capacity of about 59 megawatts. Operation of these plants would have a total average annual energy requirement of about 197 gigawatt hours to deliver 161,900 ac ft of water through the system. Table 14 summarizes the relevant pumping plant data.

Table 14
Pumping Plant Data - East Side Plan
Tucson Aqueduct - Phase B
Central Arizona Project

Pumping Plant	Location	Electric Capacity (megawatts)	Lift (feet)	Discharge Line (length in feet)
Rillito	Sec 31, T11S, R12E	13.1	181	10,200
Cortaro	Sec 31, T12S, R13E	14.8	242	24,250
Sweetwater	Sec 30, T13S, R13E	13.7	223	14,900
Camino de Oeste	Sec 6, T14S, R13 E	13.9	226	16,700
Black Mountain	Sec 35, T15S, R12E	3.5	159	5,050

A surge protection structure may be required at the discharge line of one or more of the proposed pumping plants to overcome the effect of water hammer in the event of a rapid change in flow rate from a pumping plant (e.g. instantaneous pump shutdown due to temporary power failure). Figures 6 and 7 depict a typical surge tank and air chamber, respectively.

Additional anticipated aqueduct components are summarized on Table 15. Figures 8-10 are photos of some of the components as they appear on the Granite Reef Aqueduct. The tentative locations of these facilities are shown in Figures 35 through 40.

Table 15
Aqueduct Components - East Side Plan 1/
Tucson Aqueduct - Phase B
Central Arizona Project

Structure	Number	Size or Capacity
Check Structures	2	1-550 cfs, 1-650 cfs
Turnouts	3	1-100 cfs, 1-150 cfs, 1-350 cfs
Overchutes	14	1 to 5-72 inch pipes
Siphons	1	1-550 cfs
Collective Training Dikes	6.6 miles	8 to 10 feet high
County Roads and Other Bridges	3	HS 20 loading
Wildlife Crossings	6	
Wildlife Watering Sites	3	
Security Fencing	14.8 miles	(Fence length includes both sides of canal)
w/wildlife protection	12 miles	
Rare Plant Land Acquisition	640 acres	

1/ See Table 4 footnote.

(2) Power Transmission Facilities

In this alternative a 69 or 115-kV transmission line would be constructed along the entire length of the water delivery system between the Rillito and Black Mountain pumping plants. The line deviates slightly from the pipeline between Anklam Road and 36th Street where it follows section lines in order to avoid the visual impacts and expense associated with multiple angles. Electricity would be supplied over a 4-mile long line which would be routed in the vicinity of Ironwood Hill Drive and Grant Road to Western's Tucson substation. The total length of the new line would be approximately 32 miles.

C. No Federal Action Plan

1. Overview of Plan Concept

A "no Federal action" alternative has been developed in accordance with the Council on Environmental Quality's (CEQ) regulations.

This alternative will allow comparison of the proposed action, action alternatives, and the alternative of no federal action. The scenario described is that most likely to occur in the absence of federal construction of the Tucson Aqueduct - Phase B. It is based upon discussion with water users in the Phase B service area, and the fact that CAP water allocations have already been made for the Phase B service area.

The CAP aqueduct would end with the completion of the Tucson Aqueduct - Phase A. A locally implemented aqueduct system could be constructed from this point to a water treatment plant located in the vicinity of Mission Road and West 22nd Street (Figure 41). This system would have a capacity of 350 cubic feet per second (cfs) and deliver municipal and industrial water to the City of Tucson municipal water service area. Summaries of physical characteristics and plan costs are shown in Tables 1 and 2 respectively. The municipal service area would be similar to that served by the municipal water companies in the Tucson area.

CAP water that had been identified for allocation to Green Valley and the Santa Cruz County users is assumed to be reallocated to users in the Tucson area. No CAP water for mining or agriculture would be delivered to the Phase B area. The small CAP allocation to the Pascua Yaqui Indian Reservation (500 acre-feet per year) would be delivered through the Tucson water system. However, it is assumed that no CAP deliveries would be made to the Papago Indian Reservation areas of San Xavier and Schuk Toak. As a result of non-delivery, damages would be paid as required by the Southern Arizona Water Rights Settlement Act of 1982 (Public Law 97-293).

2. Detailed Plan

a. Aqueduct Design and Components

The length of the aqueduct is 20.1 miles which consists of 6.6 miles of concrete lined canal and 13.5 miles of concrete pipeline. The aqueduct capacity is 350 cubic feet per second (cfs). Typical open canal and pipeline aqueduct designs are shown in Figures 3 and 4. The aqueduct would have typical open canal configuration.

The No Federal Action would require three pumping plants with a total electrical capacity of about 32 megawatts. Operation of these plants would have a total average annual energy requirement of about 111 gigawatt hours to deliver 88,800 ac-ft of water through the system. Table 16 summarizes the relevant pumping plant data.

Table 16
Pumping Plant Data-No Federal Action Plan
Tucson Aqueduct-Phase B
Central Arizona Project

PP	Location	Electric Capacity (megawatts)	Lift (feet)	Discharge Line (length in feet)
Twin Peaks	Sec 31, T11S, R12E	6.2	170	10,175
Cortaro	Sec 31, T12S, R13E	11.5	297	31,200
Sweetwater	Sec 35, T15S, R12E	14.3	366	24,650

A surge protection structure may be required at the discharge line of one or more of the proposed pumping plants to overcome the effect of water hammer in the event of a rapid change in flow rate from a pumping plant (e.g. instantaneous pump shutdown due to temporary power failure). Figures 6 and 7 depict a typical surge tank and air chamber, respectively.

Additional anticipated aqueduct components are summarized on Table 17. Figures 8-10 are photos of some of the components as they appear on the Granite Reef Aqueduct.

Table 17
Aqueduct Components - No Federal Action Plan 1/
Tucson Aqueduct - Phase B
Central Arizona Project

Structure	Number	Size or Capacity
Turnouts	1	1 - 350 cfs
Overchutes	13	1 to 2 - 72 inch pipes
Siphon	1	1 - 350 cfs
Collective Dikes	6 miles	8 - 10 feet high
County Roads and Other Bridges	2	HS 20 loading
Wildlife Watering Sites	3	
Security Fencing	12	(Fence length includes both sides of canal)

1/ The number and type of components listed are assumptions for a non-federal, locally implemented alternative and do not represent a statement on final design.

b. Power Transmission Facilities

To supply power for the aqueduct the City of Tucson would negotiate with the local electric power company. The transmission line route is expected to be built parallel and adjacent to the right-of-way for the aqueduct whenever possible. Deviations from the aqueduct alinement would be included when such a design would reduce environmental impacts and when costs and engineering constraints have to be accommodated.

D. Comparative Evaluation

Table 2 is a comparative summary of costs for each of the alternative routes. Table 18 is a comparative display of the residual environmental impacts (after mitigation) due to construction of any of the five action alternatives and the No Federal Action alternative.

E. Other Plans Considered but Eliminated

1. West Side Modification - Low Pressure Pipeline

This alinement would be located primarily on the west side of the Tucson Mountains and composed mostly of buried, low pressure concrete

TABLE 1B*
COMPARISON OF RESIDUAL ENVIRONMENTAL IMPACTS
TUCSON AQUEDUCT - PHASE B CENTRAL ARIZONA PROJECT

AREA OF IMPACT	West Side Plan	Sandario-San Joaquin Plan
BIOTA		
VEGETATION PERMANENTLY REMOVED (Acres) 7/	367	173
VEGETATION TEMPORARILY REMOVED (Acres)	2380.	1701
WILDLIFE 1/		
Movement Disruption After Mitigation	Moderate	Moderate to Low
Potential Drowning Loss After Mitigation	Low	Low
SPECIAL STATUS 1/ SPECIES ADVERSE IMPACTS AFTER MITIGATION/CONSERVATION MEASURES		
Thornber's Cacti 5/	High	Low
Tumamoc Globe-Berry 9/	High	Low
Desert Tortoise 3/	Moderate	Low
Gila Monster 4/	Moderate	Low
Harris Hawk 10/	Low	Low
Kit Fox 4/, 8/, 10/	Low	Low
WATER RESOURCES		
LOCAL SURFACE WATER	Potential Consolidation and Redirection of some Ephemeral Drainages	Potential Consolidation and Redirection of some Ephemeral Drainages
ANNUAL AQUEDUCT LOSSES		
Seepage	Assuming 50% Ground-water Recharge, Net Loss of 1860 Acre-Feet Per Year	Assuming 50% Ground-water Recharge, Net Loss of 455 Acre-Feet Per Year
Evaporation	Loss of 790 Acre-Feet Per Year	Loss of 190 Acre-Feet Per Year
AIR QUALITY	Minor Adverse Effects From Construction Generated Suspended Particulates	Minor Adverse Effects From Construction Generated Suspended Particulates
SOUND QUALITY	Temporary Disturbance to Wildlife and annoyance to Rural Residents. Blasting Near or in Tucson County Mountain Park May Temporarily Degrade Wilderness Values	Temporary Disturbance to Wildlife and annoyance to Rural Residents. Blasting Near or in Tucson County Mountain Park May Temporarily Degrade Wilderness Values
VISUAL QUALITY (Residual Impact)	Moderate	Low
LANDS		
Agriculture	Loss of 96 Acres Agriculture	Loss of 96 Acres Agriculture
Desert Grazing	Loss of Desert Grazing on 1983 Acres	Loss of Desert Grazing on 862 Acres
Private Ownership	Loss of Tax Revenues on 712 Acres of Private Property Acquired	Loss of Tax Revenues on 319 Acres of Private Land Acquired
CULTURAL RESOURCES 6/		
Area Surveyed (Acres) 7/	5189	2611
	After Mitigation Studies The Disturbance or Destruction of 50±17 Sites (EST.)	After Mitigation Studies, The Disturbance or Destruction of 25±9 Sites (EST.)
RECREATION	Good	Moderate
SOCIAL IMPACTS	Low	Low
Number of Relocations (approx.)	15	10
SAFETY	Minimal Drowning Hazards	Minimal Drowning Hazards
GEOLOGY	Special Designs Would be Required in Areas of Subsidence and Earth Fissuring; Risk of Leakage if Structure Cracks	Special Designs Would be Required in Areas of Subsidence and Earth Fissuring; Risk of Leakage if Structure Cracks

*See page 24 for footnotes.

TABLE 18 Cont.*
COMPARISON OF RESIDUAL ENVIRONMENTAL IMPACTS
TUCSON AQUEDUCT - PHASE B CENTRAL ARIZONA PROJECT

AREA OF IMPACT	Sandario Plan	Sanders-San Joaquin Modification	East Side Plan [2/]	No Federal Action
BIOTA				
VEGETATION PERMANENTLY REMOVED ~~(Acres)~~ [1/]	263	289	150	135
VEGETATION TEMPORARILY REMOVED (Acres)	1510	2340	2389	1391
WILDLIFE [1/]				
Movement Disruption After Mitigation	Moderate	Low	Low	Low
Drowning After Mitigation	Low	Low	Low	Low
SPECIAL STATUS SPECIES ADVERSE IMPACTS AFTER MITIGATION/CONSERVATION MEASURES				
Thornber's Cacti [5/]	Moderate	Moderate	High	Low
Tumamoc Globe-Berry [9/]	Low	Low	Low	Low
Desert Tortoise [3/]	Moderate	Low	Low	Low
Gila Monster [4/]	Moderate	Low	Low	Low
Harris Hawk [10/]	Low	Low	Low	Low
Kit Fox [4/], [8/], [10/]	Low	Low	Low	Low
WATER RESOURCES				
LOCAL SURFACE WATER	Potential Consolidation and Redirection of some Ephemeral Drainages	Potential Consolidation and Redirection of some Ephemeral Drainages	Potential Consolidation and Redirection of some Ephemeral Drainages	Potential Consolidation and Redirection of some Ephemeral Drainages
ANNUAL AQUEDUCT LOSSES				
Seepage	Assuming 50% Ground-water Recharge, Net Loss of 1155 Acre-Feet Per Year	Assuming 50% Ground-water Recharge, Net Loss of 1250 Acre-Feet Per Year	Assuming 50% Ground-water Recharge, Net Loss of 475 Acre-Feet Per Year	Assuming 50% Ground-water Recharge, Net Loss of 950 Acre-Feet Per Year
Evaporation	Loss of 500 Acre-Feet Per Year	Loss of 530 Acre-Feet Per Year	Loss of 210 Acre-Feet Per Year	Loss of 200 Acre-Feet Per Year
AIR QUALITY	Minor Adverse Effects From Construction Generated Suspended Particulates	Minor Adverse Effects From Construction Generated Suspended Particulates	Potential Adverse Effects From Construction Generated Suspended Particulates	Potential Adverse Effects From Construction Generated Suspended Particulates
SOUND QUALITY	Temporary Disturbance to Wildlife and annoyance to Rural Residents. Blasting Near or in Tucson County Mountain Park May Temporarily Degrade Wilderness Values	Temporary Disturbance to Wildlife and annoyance to Rural Residents. Blasting Near or in Tucson County Mountain Park May Temporarily Degrade Wilderness Values	Temporary Disturbance to Wildlife and annoyance to Rural Residents. Blasting Near or in Tucson County Mountain Park May Temporarily Degrade Wilderness Values	Temporary Disturbance to Wildlife and annoyance to Rural Residents. Blasting Near or in Tucson County Mountain Park May Temporarily Degrade Wilderness Values
VISUAL QUALITY (Residual Impact)	Low	Low	Low	Low
LANDS				
Agriculture	Loss of 96 Acres Agriculture	Loss of 96 Acres Agriculture	Loss of 123 Acres Agriculture	No Loss of Agricultural Lands
Desert Grazing	Loss of Desert Grazing on 1,517 Acres	Loss of Desert Grazing on 1,802 Acres	Loss of Desert Grazing on 1,367 Acres	Loss of Desert Grazing on 447 Acres
Private Ownership	Loss of Tax Revenues on 674 Acres of Private Property Acquired	Loss of Tax Revenues on 724 Acres of Private Property Acquired	Loss of Tax Revenues on 902 Acres of Private Property Acquired	Loss of Tax Revenues on 521 Acres of Private Property Acquired
CULTURAL RESOURCES [6/]				
Area Surveyed (Acres) [7/]	3865	3878	4350	1263
	After Mitigation Studies The Disturbance or Destruction of 37±13 Sites (EST.)	After Mitigation Studies The Disturbance or Destruction of 37±13 Sites (EST.)	After Mitigation Studies, The Disturbance or Destruction of 41±14 Sites (EST.)	After Mitigation Studies, The Disturbance or Destruction of 12±4 Sites (EST.)
RECREATION	Moderate	Moderate	Low to None	Low to Moderate
SOCIAL IMPACTS	Low	Low	Moderate	Moderate
Number of Relocations (approx.)	10	7	35	35
SAFETY	Minimal Drowning Hazards	Minimal Drowning Hazards	Minimal Drowning Hazards	Minimal Drowning Hazards
GEOLOGY	Special Designs Would be Required in Areas of Subsidence and Earth Fissuring; Risk of Leakage if Structure Cracks	Special Designs Would be Required in Areas of Subsidence and Earth Fissuring; Risk of Leakage if Structure Cracks	Special Designs Would be Required in Areas of Subsidence and Earth Fissuring; Risk of Leakage if Structure Cracks	Subsidence and Earth Fissuring Would Not be a Problem With This Alignment

*See page 24 for footnotes

Footnotes for Table 18

1/ Preliminary recommendations as of September 22, 1983. Extent of impacts and mitigation not yet finalized. These mitigation measures are the subject of ongoing studies.

2/ Includes 17.6 miles Avra Valley Irrigation District Feeder Line on the west side of Tucson Mountains.

3/ Listed in Threatened Native Wildlife of Arizona, Arizona Game and Fish Commission, 1982.

4/ Endangered and Unique Wildlife of the Southwest National Forests, U.S.D.A. Forest Service, 1975, page 203.

5/ Being considered for Federal listing as a Threatened Species (FWS memo to U.S. Bureau of Reclamation, September 7, 1983).

6/ Several Class III surveys conducted in the vicinity of the Tucson Aqueduct Phase B indicate a site density of 6.1 sites per square mile. This figure represents a fairly accurate statistical estimate and should be viewed in that light. The actual site density could range form 4.0 to 8.2 sites per square mile ($\pm$ 2.1 sites per square mile) at a 90 percent confidence interval.

7/ These estimates do not include estimates for aggregate sources, haul and access roads, construction staging areas, or transmission line right-of-ways, which may require some additional acreage. Temporary disturbed area in excess of the pipeline R-O-W along all pipeline is included.

8/ Need for, or extent of, mitigation is unknown. Telemetry studies at the time of construction will provide this information.

9/ Candidates for proposal as threatened or endangered species.

10/ On BLM list of sensitive species.

pipeline with six pumping plants. A summary of physical characteristics is shown in Table 19. Costs are given in Table 20.

The plan was eliminated for the following reasons:

- The Low Pressure Pipeline Plan is less cost effective than the West Side Plan.

- The tradeoff (i.e. cost) for marginally reduced environmental impacts was found not to be acceptable.

2. CAP/Floodwater Recharge Plans

The CAP/Floodwater recharge plans were initially proposed to Reclamation by Dr.C. Brent Cluff, an associate hydrologist at the University of Arizona, Tucson, Arizona. A compilation of data, numerous reports, and related correspondence is part of the official files at the Arizona Projects Office, Phoenix, Arizona. This extensive collection of material describes the proposals in detail and is available for public review.

Two CAP/Floodwater recharge plans were considered. One uses an alinement on the east side of the Tucson Mountains and closely resembles that proposed by Dr. Cluff. Another uses the Bureau's proposed alinement on the west side of the Tucson Mountains. Both plans were based on the premise that the City of Tucson, Del Lago, Flowing Wells Irrigation Company, Ranch Lands Water Company, Midvale Farms Water Company, Arizona Game and Fish Department, and the Pasqua Yaqui CAP water allocations and captured floodwater from the Santa Cruz River would be recharged into the groundwater aquifer.

The following streams were identified as recharge courses: Pantano, Tanque Verde, Rillito, and Santa Cruz. Once recharged, the City of Tucson's existing wellfield would be used to recover water from the aquifer.

A summary of physical characteristics is shown in Table 19. Costs are shown in Table 20.

These alternatives were eliminated for the following reasons:

- The CAP/Floodwater plans are less cost effective than the West Side Plan.

- Lack of support from the City of Tucson.

- Lack of support from SAWARA.

The City of Tucson's lack of support is documented in a report entitled "Analysis of CAP/Floodwater Recharge Alternative". Although SAWARA did not support Dr. Cluff's proposal, they did pass a general resolution in favor of groundwater recharge.

3. Underground Power Transmission System

Although there has been underground construction of transmission systems in the United States since the late 1920's for lower-voltage distribution lines and some high-voltage (HV) systems, most HV

Table 19
Physical Characteristics of
Alternatives Eliminated
Tucson Aqueduct - Phase B
Central Arizona Project

Conveyance Facilities (Miles)	West Side Recharge Plan	East Side Recharge Plan	West Side Modification Low Pressure Pipeline
Road			
Main Aqueduct			
Canal	32.3	11.9	11.9
Pipe	10.2	23.2	23.2
Subtotal	42.5	35.1	35.1
Indian Delivery Line			
Canal	0	1/	0
Pipe	2.4		2.4
Subtotal	2.4		2.4
Avra Valley Delivery Line			
Canal	0	4.7	0
Pipe	0	17.0	0
Subtotal	0	21.7	0
Recharge Pipelines			
Canal	7.5	2.1	0
Pipe	34.8	28.3	0
Subtotal	42.3	30.4	0
Total	87.2	87.2	37.5
Pumping Plants (No.)			
Main Aqueduct	5	5	6
Indian Delivery Line	0	2	0
Avra Valley Delivery Line	0	1	0
Recharge Pipelines	6	3	0
Total	11	11	6
Right-of-Way (Acres)			
Main Aqueduct			
Canal	2100	800	0
Pipe	125	290	575
Subtotal	2225	1090	575
Indian Delivery Line			
Canal	0	1/	0
Pipe	30		30
Subtotal	30		30
Avra Valley Delivery Line			
Canal	0	775	0
Pipe	0	135	0
Subtotal	0	910	0
Recharge Pipelines			
Canal	105	35	0
Pipe	0	25	0
Subtotal	105	60	0
Total	2360	2060	605
Power Requirements			
Main Aqueduct			
Load (MW)	33.3	38.3	52.0
Energy (GWH)	121.5	147.3	170.8
Indian Delivery Line			
Load (MW)	0	0	0
Energy (B&W)	0	0	0
Avra Valley Delivery Line			
Load (MW)	0	1.4	0
Energy (B&W)	0	3.6	0
Recharge Pipelines 2/			
Load (MW)	15.5	4.3	0
Energy (B&W)	38.4	31.9	0
Total			
Load (MW)	48.8	44.0	52.0
Energy (GWH)	159.9	182.8	170.8

1/ Included with Avra Valley delivery line.

2/ Includes pump located at the reservoir.

Table 20 [1]
Comparative Costs of
Alternatives Eliminated
(All Costs Are In Thousands Of Dollars)
(January 1985 Price Levels)

	West Side Recharge Plan	East Side Recharge Plan	West Side Modification Low Pressure Pipeline	West Side Plan With Tucson Treatment Plant
Aqueduct	182,105	208,182	375,943	213,813
Indian Delivery Line	1,845	[7]	1,845	1,064
Avra Valley Delivery Line	0	44,630	0	0
Storage Site, Diversion Works, Channel and Road Relocation	100,772	104,554		0
Recharge Aqueducts	147,121	92,326		0
Relocation	327	327		0
Effluent Bypass Pipeline	3,232	3,232		0
Water Treatment Plant and Distribution System [2]				60,081
Collection System	27,972	27,972		0
TOTAL FIELD COST	463,374	481,223	377,788	274,958
Noncontract (25%)	115,843	120,307	94,447	68,740
TOTAL CONSTRUCTION COST	579,217	601,530	472,235	343,698
Interest During Construction [3]	110,413	116,245	90,539	66,503
Mitigation - Biological [4]	8,833	7,284	1,727	4,169
- Cultural Resources [5]	1,000	1,000	1,000	1,000
TOTAL CAPITOL COST	699,463	726,059	565,501	415,370
(OM&R) - Aqueduct & Pumping Plants	1,586	1,155	1,307	1,934
- Indian Delivery Line	60	[7]	62	41
- Avra Valley Delivery Line	0	262	0	0
- Storage Site, Diversion Works, Channel, and waterway from aqueduct to reservoir	624	659	0	0
- Recharge Aqueducts	917	520	0	0
- Effluent Bypass Pipeline	18	18	0	0
- Water Treatment Plant and Distribution System	0	0	0	1,544
- Collection System	793	793	0	0
Energy - Aqueduct & Pumping Plants	8,110	8,783	6,864	6,700
- Indian Delivery Line	0	[7]	0	0
- Avra Valley Delivery Line	0	241	0	0
- Storage Site Pumping Plant	28	191	0	0
- Recharge Aqueducts	4,861	2,321	0	0
- Water Treatment Plant and Distribution System	0	0	0	0
- Collection System	4,991	4,991	0	0
TOTAL (OM&R) COST	21,988	19,934	8,233	10,219
ANNUAL EQUIVALENT OF CAPITAL COST [6]	53,368	55,397	43,147	31,692
Value of Water Loss Through Evaporation	[8]	[8]	0	524 [9]
Value of Floodwater	(3,237) [10]	(3,237) [10]		0
Value of Water Loss to Tucson Water	5,306 [11]	5,306 [11]		
TOTAL (O&R) COST	21,988	19,934	8,233	10,219
TOTAL ANNUAL COST	77,425	77,400	51,380	42,435

1/ Labels in this table relate to function and not to funding responsibility.

2/ Costs obtained from Tucson Water staff have been updated to 1985 price levels.

3/ Interest during construction is based on a 5-year construction period and an interest rate of 7.625 percent.

4/ Estimated mitigation expenditures.

5/ These numbers are estimates; maximum mitigation expenditure can be up to 1 percent of total construction costs.

6/ Formulated based on 100-year project life and an interest rate of 7.625 percent.

7/ Included in Avra Valley delivery line costs.

8/ Assumes no evaporation losses. However, evaporation losses would occur when water is released to the streambeds.

9/ Assumes value of water at $200 per acre-foot.

10/ Assumes 23,120 acre-feet per year of floodwater would be captured, 70% would be recovered after recharging at a value of $200 per acre-foot.

11/ This time represents the value of water loss to Tucson Water due to their inability to recover 100% of the amount of water recharged. Assumes Tucson Water would receive an average of 88,438 acre-feet per year from CAP, 70% would be recovered after recharging at a value of $200 per acre-foot.

(greater than or equal to 69-kV) installations have been constructed in congested urban areas, or as leads from generating plants or to substations. It is important to note that technological requirements for underground HV transmission lines are markedly dissimilar to those for lower-voltage distribution transmission lines. Undergrounding of HV transmission lines is vastly more complex and costly, primarily because of problems associated with dissipating cable heat.

Design parameters and thermal limitations prohibit the use and application of underground transmission cable systems for long-distance transmission. For these reasons alone, without consideration of the cost factor, with notable exceptions (submarine), there are few underground transmission systems in the United States at voltages 115-kV and above exceeding approximately 15 miles.

Of the underground transmission cable systems in service, or concepts under development, only two cable systems are feasible (or viable) for installations of approximately 15 miles. These are the high-pressure oil-filled pipe-type (HPOF) and low-pressure oil-filled self-contained (SCOF) cable systems. The preference in the United States for HPOF cable systems is based on their relative ruggedness, lower installation costs, reduced obstruction of vehicular and pedestrian traffic, and avoidance of congestion during installation.

The basic cost of undergrounding a 115-kV line using an HPOF cable system would be approximately $1.3 million per mile. In addition to the cable, pipe and oil, ancillary facilities (such as cable terminators, oil-pressurizing and pumping stations, and reactor stations) would be required to complete the underground system. Oil-pressurizing and pumping-plant facilities that would be required every 7 to 10 miles along the transmission route would cost approximately $233,000 per station (in 1981 dollars), and termination stations at each of the two substations would cost approximately $106,000 per station. In brief, total estimated costs for undergrounding a 115-kV transmission line would be roughly 8 to 10 times the cost of constructing an overhead system of comparable capability.

Technology is available for an underground 115-kV transmission line; however many problems exist. Among the adverse impacts associated are:

a. An above ground switchyard (50' x 50') would be required every few miles on the right-of-way and would have some adverse visual effects.

b. Any maintenance would require that the earth be redug to get to the oil-pressurized conduit which would insulate the line. Some leakage of oil can occur. We expect that new EPA regulations will regulate very small amounts of oil-spillage. Oil spills near drainages may contaminate water runoff and would damage wildlife resources.

Since revegetation of cleared areas may not occur in the life of the project, the clearing associated with an underground transmission line would produce an additional adverse impact to vegetation because it would require clearing an area approximately 150 to 200 feet wide. An overhead line on the other hand, only requires one pole every 450 feet along the right-of-way. Each pole location disturbs about a 6 foot area. The remaining area can stay vegetated for wildlife use, visual benefits, and soil erosion prevention.

Western plans to use existing roads, access roads, and the aqueduct right-of-way access roads wherever possible to reduce adverse impacts to the vegetation. Disturbances will be held to a minimum. Impacts would be similar for the roads for both underground and above ground transmission systems.

Considering the technical complications, economic and environmental costs, and accessibility, an underground HV system was rejected as an alternative transmission system.

III. AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

III. Affected Environment and Environmental Consequences

The area defined by the alternative aqueduct routes is typical of Sonoran desert in south-central Arizona and is characterized by desert mountain ranges gently sloping down to broad and nearly flat alluvial basins.

Interstate Highway 10 and the City of Tucson border the Phase B area to the east, with Avra Valley forming the western boundary. The Phase B area begins at I-10 near the town of Rillito and terminates on the south boundary of the San Xavier Indian Reservation.

The climate is characterized by long hot summers, short mild winters, sparse rainfall periods that occur twice a year in winter and late summer, low relative humidity, and high rates of evaporation. Average annual precipitation is about 11 inches. Vegetation is typical of the southwestern desert scrub formation, with creosote-bursage on the plains and lower slopes, the paloverde-mixed cacti on the coarse soils of the upper slopes, mesquite bosque along the major drainages and desert grassland in the southern half of the area.

Ground water pumped from the alluvial basins is the principal source of water in the study area, with most water being used for irrigated agriculture. Ground water withdrawal exceeds natural recharge (overdraft) and has resulted in extensive water table declines over the last 55 years.

The predominant land uses in the Phase B area are residential, farming, grazing and recreation. Most of the farmland is on the north end of the Phase B area. The grazing is primarily to the south on the San Xavier Indian Reservation. Residential development is concentrated in Tucson east of the Tucson Mountains but is increasing on the south and west slopes, especially in Avra Valley. There are two natural preserves in the Tucson Mountains area which represent major recreation resources, the Saguaro National Monument and the Tucson Mountain Park. Several large tracts of land in Avra Valley are retired farmland owned by the City of Tucson.

Within each environmental topic or area of interest, a common format has been generally followed. The existing conditions are first described, then the environmental impact analysis, followed by a comparative analysis of the six alternative routes. Indirect impacts and short-term and long-term effects are also addressed.

A. Biological Resources

In February 1981, the Bureau of Reclamation contracted with the Arizona Game and Fish Department (AGFD) to provide biological reconnaissance for the area of Tucson Aqueduct Phase B, Central Arizona Project. Two main objectives of this three year study were to provide the Bureau with adequate biological data to address environmental issues and to provide AGFD personnel with data to suggest reasonable and appropriate mitigation measures (AGFD 1983).

A project-specific report was written by the Fish and Wildlife Service (FWS) under the Fish and Wildlife Coordination Act (FWS 1984) which described the existing environment of the study area and the effects and possible mitigation for the various alternative alinements of the aqueduct.

The Phase B Proposed Action includes measures to mitigate the adverse effects of project construction on biological resources. These measures were developed in coordination with personnel from the AGFD and the FWS and are based in part on the recommendations of the Fish and Wildlife Coordination Act Report. These recommendations include wildlife fencing and crossings along the canal alinement, revegetation of disturbed areas, tortoise barriers in identified areas, modification of overchutes and road crossings to permit wildlife use, development of water sites away from the aqueduct, acquisition of a 4.25 square mile area for use as a wildlife movement corridor, limiting construction disturbance during critical periods in identified areas, monitoring right-of-way areas during construction to remove wildlife, raptor-proofing powerlines to prevent electrocution, and monitoring studies to determine if additional mitigation is needed for such species as the kit fox.

A plant survey of the West Side Plan alinement was conducted by the Non-Game Branch of the AGFD to determine if any State or Federally listed species were present. The Thornber's fishhook cactus (<u>Mammillaria thornberi</u>) and the Tumamoc globe-berry (<u>Tumamoca macdougalii</u>) were found on the alinement. The <u>Mammillaria thornberi</u> has been proposed as a Federally threatened species and the FWS has prepared a listing package for <u>Tumamoca macdougalii</u> and this plant may be proposed as a Federally endangered species in the near future. A third species, Sheer's strong-spined cory cactus (<u>Coryphantha scheeri</u> var. <u>robustispina</u>) was found at one location on the alinement. It is a Category One species which means that sufficient information is available to support proposing it for listing, although no listing is anticipated in the near future. Two other species, night-blooming cereus (<u>Peniocereus greggii</u>) and Pringle's lip fern (<u>Cheilanthes pringlei</u>), were also found. However, sufficient information is unavailable at this time to support Federal listing for these two species.

1. <u>Description of Conditions</u>

The study area lies within the Sonoran Desertscrub Regional Formation (Brown et al. 1979), also referred to as the Lower Sonoran Life Zone (Lowe 1964). The major plant communities in the area are the creosote-bursage community, the palo verde-mixed cacti community, the desert grassland community (predominantly shrub-scrub), much of it in disclimax due to long-term over-grazing, and the mesquite bosque community. In general, the creosote-bursage community occurs on the flatter areas that have fine alluvium soil, the paloverde-mixed cacti community occurs on the bajadas and foothills of the mountains where soils are more coarse, the desert grassland community occurs on the southern half of the Phase B area and the mesquite bosque community occurs along the major drainages.

a. <u>Vegetation</u>

Seven natural vegetative communities were classified within this study area (Figure 42): desert grassland (shrub-scrub disclimax and mixed grass scrub), creosote-bursage, paloverde-mixed cacti, eriogonum-agave, saltbush, mesquite bosque, and mixed riparian woodland. Two of these, the eriogonum-agave and saltbush communities, were found in limited areas. The mixed riparian woodland habitat is included with the mesquite bosque habitat in Figure 42.

Species composition, as determined on line-intercept transects, revealed that the paloverde-mixed cacti habitat had significantly more plant species than all other types. The next most diverse habitats were desert grassland and mixed-riparian woodland. Creosote-bursage and mesquite bosque were least diverse. The mean percent cover among the habitat types sampled was lowest in creosote-bursage (20 percent) and highest in mixed-riparian woodland (45 percent). Percent cover and biomass production was greatest in the two riparian habitats and lowest in the desert grassland.

(1) Desert Grassland

This semi-desert community is dominated by grasses and other herbaceous plants. Grasslands of two different climatic zones occur in the study area. A warm temperature grassland which is located on Wasson Peak is subjected to freezing temperatures of short duration in most years. This small area is dominated by mixed grasses and mixed scrub species. A few chaparral species also exist in the Wasson Peak desert grassland (Brown 1978).

The majority of desert grassland in the study area occurs in the sub-tropical climatic zone which has infrequent 24-hour periods of freezing temperatures. These sub-tropical grasslands are classified as shrub-scrub disclimax habitats. The disclimax state apparently resulted from long term overgrazing by livestock. Mesquite (Prosopis juliflora) is the dominant tree or scrub species. Burroweed (Haplopappus tenuisectus) and broom snakeweed (Gutierrezia sarothrae) are the main shrub species. Both shrub species are indicators of heavy grazing by livestock (Parker 1972).

(2) Creosote-Bursage

This habitat is one of the two principal biotic communities that evolved in the Sonoran Desertscrub biome (Lowe 1964). The sparsely vegetated creosote-bursage community is mainly composed of shrubs and half-shrubs. The dominant shrub is creosote (Larrea tridentata). Triangle bursage (Ambrosia deltoidea) is the dominant half-shrub of this habitat.

(3) Palo verde-Mixed Cacti

The second principle biotic community of the Sonoran Desertscrub biome is palo verde-mixed cacti. This vegetatively diverse community occurs on rock hills, bajadas, and coarse-soiled slopes. Within this study area, it encompasses the Tucson Mountains, Roskruge Mountains, and a large coarse-soiled section of the San Xavier Indian Reservation.
Palo verde trees (Cercidium microphyllum) and many species of cacti (Opuntia spp., Cyclindropuntia spp., Ferocactus spp., Echinocereus spp., and Mammillaria spp., and Carnegiea gigantea) best characterize this habitat, although it is often comprised of a diverse mixture of tree and shrub species. Most rocky slopes support stands of the tall saguaro cactus (Carnegiea gigantea) with the densest populations on the Saguaro National Monument. Jojoba (Simmondsia chinensis) associations often exist on northern slopes in the Tucson Mountains. On the lower slopes, palo verde-bursage and palo verde-creosote associations occur as the community intersperses with the creosote-bursage community.

(4) Eriogonum-Agave

This upland community in the Sonoran Desertscrub biome exists in a very limited area of this study area. Only one area, a steep north-facing slope on Wasson Peak, was mapped. This habitat is characterized by flattop buckwheat (*Eriogonum fasciculatum*), agave (*Agave* spp.), and infrequent mixed scrub species.

(5) Saltbush

The saltbush community, an upland habitat, occurs in valley bottomlands which have alkaline soils and periodic flooding. This habitat has a limited distribution along the Santa Cruz River, often situated between creosote and riparian communities. This community has a low species diversity and is often sparsely vegetated. The plant species that characterize this habitat are saltbush (*Atriplex* spp.) and mesquite. The desert saltbush (*Atriplex polycarpa*), wolfberry (*Lycium* spp.), and mesquite association exists in Brawley Wash.

(6) Mesquite Bosque

The mesquite bosque community contains three riparian plant associations. The two associations discussed in this section are collectively called mesquite bosque in the following sections. The mesquite-mixed narrow leaf tree association was classified as a different vegetative habitat and is described in the mixed-riparian woodland section. The mesquite bosque community is a wetland habitat along the Santa Cruz River and in Brawley Wash. Mesquite is the dominant species, although in Brawley Wash wolfberry and *Acacia* spp. are also frequently encountered.

Presently the actual mesquite bosque is limited to a few medium-sized trees which are restricted to the banks of the intermittently flowing Santa Cruz River. The area formerly occupied by an extensive forest-like bosque is now bare ground and dead trees, with a few small live mesquite trees.

The second association of mesquite bosque occupies Brawley Wash in Avra Valley. Brawley Wash is a broad floodplain which is dissected with several channels. This area is frequently flooded during summer and winter rains. The wash is interspersed with mesquite bosque, creosote-bursage, and desert grassland communities. Mesquite bosque occupies the area adjacent to the narrow channels and, in some locations, broad floodplains.

(7) Mixed Riparian Woodland

This association is located north of Tucson along the Santa Cruz River. Although classified as a "mesquite-mixed narrow leaf tree" association, it is treated as a separate vegetative community for the purpose of this EIS. The age of the vegetation is quite young and reflects a riparian community that is changing from a mesquite bosque to a true broadleaf riparian community. The section of the Santa Cruz River which is south of Tucson is an intermittently flowing waterway which is dependent upon seasonal rainfall. In the northern part of Tucson, the river becomes a perennial stream because of sewage effluent from the Tucson sewage treatment plant. As a result of permanent waterflow, broadleaf species (Poplar spp.) and narrow leaf species (Salix spp., Tamarix spp, desert willow (Chilopsis linearis) and Baccharis spp.) are the dominant plants. Mesquite is still a common species in some locations.

b. Wildlife

Intensive wildlife surveys, summarized below, were conducted by AGFD (1983) in the Phase B area.

(1) Big Game and Predators

The AGFD estimated a population size of between 200 and 400 mule deer (Odocoileus hemionus) and between 400 to 600 javelina (Tayassu tajacu) in the Phase B area. Mountain lions are present in low numbers.

Overall, coyotes (Canis latrans) were the most common predator in the study area. Coyotes were abundant in desert grassland, paloverde-mixed cacti, and mesquite bosque habitats. The lowest density was in creosote-bursage areas. Kit fox (Vulpes macrotis) were primarily found in creosote-bursage habitat. Gray fox (Urocyon cinereoargenteus) were most common in the paloverde-mixed cacti type but were also found in desert grassland and mixed riparian woodland. Bobcats (Lynx rufus) were also prevalent in paloverde-mixed cacti, and were also found in the desert grassland and mesquite bosque. All predators, except kit fox, utilized the creosote-bursage type least of all natural vegetation types.

Based on radio-telemetry data, all animals, except kit fox, showed strong preference for the paloverde-mixed cacti habitat and for mountainous terrain. Most preferred washes, foot of slopes, slopes, and ridge tops. Creosote flats were selected against by all animals except kit fox. All species showed strong preference for areas over 0.5 mile from residences and major man-made intrusions.

Radio tracking of big game animals and predators in the project area also documented extensive animal movements between the Tucson Mountains and Avra Valley agricultural fields, Brawley Wash, the Garcia Strip and Tumamoc Hill. Similar movement patterns exist between Black Mountain and the desert grassland on the San Xavier Indian Reservation.

(2) Small Mammals

A total of 20 species of small mammals representing 5 families (Leporidae, Sciuridae, Heteromyidae, Cricetidae and Geomyidae) were recorded. The most common rodents trapped were the woodrat (Neotoma albigula) and the kangaroo rat (Dipodomys merriami).

The palo verde-mixed cacti was the preferred habitat for small mammals. The creosote-bursage and the two riparian types were all close in species diversity indices, second to paloverde-mixed cacti. Desert grassland was lowest in numbers caught and in species diversity.

(3) Songbirds and Gamebirds

A total of 143 species of birds were observed in the Phase B area during the AGFD study. Although the dominant permanent residents varied by habitat types, some of the most common species throughout the study area were: Gambel's quail (Lophortyx gambelii), mourning dove (Zenaida macroura), common flicker (Colaptes auratus), verdin (Auriparus palvicieps), cactus wren (Campylorhynchus brunnelicapillus), northern mockingbird (Mimus polyglottos), curve-billed thrasher (Toxostoma curvirostre), black-tailed gnatcatcher (Polioptila melanuar), brown-headed cowbird (Molothrus ater), house finch (Carpodacus mexicanus), and black-throated sparrow (Amphispiza bilineata).

The mixed-riparian woodland river habitat consistently had both the greatest songbird density and the highest number of species. The creosote-bursage (bursage association) and palo verde-mixed cacti (palo verde association) habitat types were ranked second and third in density of individuals identified. The creosote-bursage (creosote association) was the lowest of all types sampled.

(4) Raptors

Nineteen species of raptors were found in the Phase B area by AGFD investigations.

The red-tailed hawk (Buteo jamaicensis) was the most common diurnal raptor. The mesquite bosque and retired agriculture lands were ranked first and second with nearly three times as many diurnal raptors as the next ranked vegetation type. Palo verde-mixed cacti (saguaro association) habitat had the lowest number of diurnal raptors observed on road transects.

During the diurnal raptor nest searches a total of 91 raptor nest structures were located. Red-tailed hawks were the most common raptors nesting in this area (60 percent of total). Golden eagles (Aquila chrysaetos), prairie falcons (Falco mexicanus), and Harris' hawks accounted for 20 percent of the breeding activity. Three main areas of breeding raptor concentrations occurred within the study area. The first included Safford and Panther Peaks in the northern section of the Saguaro National Monument, south along the western boundary of the monument, including the northwest portion of the Tucson Mountain Park. The second was along the western boundary of the study area, south of Mile Wide Road and north of Three Points. The third area was west of Black Mountain on the San Xavier Reservation.

The palo verde-mixed cacti habitat was the most productive habitat for owls. Few owls were recorded in the creosote-bursage habitat types. No owls were recorded on retired agriculture land. Overall the order of abundance was elf owl (Micrathene whitneyi), western screech owl (Otus kennicottii), great horned owl (Bubo virginianus), and barn owl (Tyto alba).

(5) Reptiles and Amphibians

A total of 39 species of reptiles and amphibians were recorded in the Phase B area. Data from the road transects indicate that frogs and toads were most common, comprising 63 percent of all observations.

Lizards and snakes accounted for 24 percent and 12 percent, respectively. The Colorado River toad (Bufo alvarius) was most frequently observed, followed by Couch's spadefoot toad (Scaphiopus couchi), and Great Plains toad (Bufo cognatus). The most abundant lizards were western whiptail (Cnemidophorus tigris) and zebra-tail lizard (Callisaurus draconoides). Snakes most frequently observed include Sonoran gopher snake (Pituophis melanoleucus), Mojave rattlesnake (Crotalus scutulatus), and western diamondback rattlesnake (Crotalus atrox).

When all survey methods are combined, palo verde-mixed cacti habitat proved to be the most valuable to reptiles and amphibians. Desert grassland was second in importance. Creosote-bursage had the lowest species diversity index of all habitat types surveyed.

Several areas high in tortoise densities were the basins within the Tucson Mountains, the upper San Joaquin Road area, and Black Mountain on the San Xavier Indian Reservation.

(6) Wildlife Habitat Value Summary

The palo verde-mixed cacti habitat was generally the highest value wildlife habitat and in composite was also the most valuable habitat in this study area. The mesquite bosque, which was an important habitat type for several species, was rated as the second most important habitat. Creosote-bursage was of limited value to most wildlife, with the notable exception of the kit fox.

c. Special Status Species

Several species of plants and animals occur on or near the Phase B area that are of special concern because of their legal protection under state or Federal regulations or because they are listed as sensitive or unique by one or more resource agencies.

There are 5 species listed under the Federal Endangered Species Act that may occur near the project area: the Sonoran pronghorn antelope (Antilocapra americana sonoriensis), peregrine falcon (Falco peregrinus), masked bobwhite quail (Colinus virginianus ridgwayi), Gila topminnow (Poeciliopsis occidentalis occidentalis) and Nichols Turks head cactus (Echinocactus horizonthalonius var. nicholii). Biological assessments on these species were prepared by AGFD for USBR. The assessments concluded that this project would have no effect on any of these listed species. The FWS has concurred with this conclusion.

In addition to Federally listed species, there are plant and animal species being considered for listing under the Endangered Species Act. These candidate species are grouped into categories to accurately reflect present evaluations of their status. Category 1 species are those for whom sufficient information exists to support their being listed under the Act. Category 2 species are those for whom the available information is not sufficient to support listing at this time. Candidate species that occur in the project area are Tumamoc globe-berry (Tumamoca macdougalii) and Sheer's strong-spined cory cactus (Coryphantha scheeri var. robustispina) (Category 1 plants); Pringle's lip fern (Cheilanthes pringlei) and night-blooming cereus (Peniocereus greggii), (Category 2 plants); ferruginous hawk (Buteo regalis), desert tortoise, and Gila monster (Category 2 animals). Thornber's fishhook cactus occurs in the project area and was proposed for listing as a threatened species in April, 1984.

The State of Arizona maintains a list of Threatened Native Wildlife in Arizona (AGFD 1982). Seven species on the list were recorded within the project area by AGFD studies (1983) or are documented as occuring in this area by Monson and Phillips (1981). The species are separated by the degree of threat to their continued existence. Group 2 species are those whose continued presence in Arizona is in jeopardy. Group 3 species are those whose continued existence in Arizona could be in jeopardy in the foreseeable future and Group 4 species are those presently faced with only minor threats which may in the future increase sufficiently to warrant Group 2 or 3 status. Group 3 species occurring in the Phase B area are the desert tortoise, peregrine falcon and the northern beardless tyrannulet (Camptostoma imberbe ridgewayi). Group 4 species recorded in the Phase B area are the black-bellied whistling duck (Dendrocygna autumnalis fulgens), black-crowned night heron (Nycticorax nycticorax hoactle), great egret (Casmirodius albus egretta) and snowy egret (Egretta thula brewsteri).

The Bureau of Land Management (BLM) maintains a list of sensitive wildlife and plant species that are found on BLM lands. Sensitive species are those species considered rare or have been made the object of special concern by an agency or department. Among species on the BLM list that occur in the Phase B area are kit fox, Harris' hawk and ferruginous hawk. The kit fox is also listed in Endangered and Unique Wildlife of the Southwestern National Forest (U.S.D.A. Forest Service, 1975).

2. Construction Impact Analysis

The effects of the construction, operation, and maintenance of any of the alternative alinements on the flora and fauna of the study area consist of habitat degradation and loss, severence of contiguous habitat and movement corridors, and direct loss of wildlife in open canal sections.

Habitat losses would vary between canal and pipeline sections both by amount and permanence of the loss. Canal construction would permanently remove all vegetation from a strip as wide as the canal and necessary access roads. Permanent habitat loss along a pipeline would be confined to the width of the access road. Over time, disturbed areas including pipeline corridors and flood retarding structures would revegetate, but full recovery of these disturbed areas may not occur within the life of the project even with revegetation efforts. Desert habitats are very susceptible to damage and re-establishment of some species is extremely slow and may require 30 years or more to recover (Grieve et al. 1978).

Based on observations along the Granite Reef Aqueduct, some desert vegetation downstream of the aqueduct would incur a loss or reduction of flood-flows due to interception or redirection of sheet flows by the aqueduct cross drainage protective structures (collective dikes). This would result in a loss of vigor and vitality of the vegetation along the washes and may eventually result in the loss of this vegetation. This situation would result in a direct negative effect on the wildlife. Desert vegetation upstream of the flood protection structures will have an increased vigor and vitality due to an increase in available moisture unless the water is impounded for an extended time (3 or 4 days) in which case the community species structure would eventually change to more mesophytic species such as mesquite and saltcedar. If the vigor of the plant communities is increased or if a mesophytic plant community is developed, certain plants and wildlife would probably be beneficially affected while others, such as cacti, will be negatively affected.

Impacts to terrestrial wildlife would result from separation of habitat caused by the open canal portions of the aqueduct alternatives. This is usually referred to as the barrier effect. Natural river courses form barriers to wildlife; however, this barrier effect is not usually permanent. Animals can cross rivers during low-flow periods, at natural fords, or by floating and swimming downstream until a suitable place to exit is found. The canal has no suitable places to cross and steep walls preclude all but a few species from exiting the canal. Canals would be permanent dividers of habitat whereas pipelines would only be barriers during construction.

The effects of barriers on terrestrial wildlife populations vary between species, depending on the size (number of individuals) of the population, the home range of the breeding populations, the location of the barrier within the home range, and the genetic diversity within the separated populations. In addition to interference with normal gene flow within a population, the division of the habitat into two or more parcels may affect the total number of animals that could be supported in each parcel versus the number of animals the entire habitat could support. Because usable or essential resources are not evenly spread throughout a habitat, the placement of an open canal through the habitat may unequally divide important resources in the resulting parcels. This division would also be critical if animals were blocked from a limited or seasonably used resource.

The number of radio-collared animals which crossed proposed canal routes strongly suggests that the majority of coyotes, deer, and bobcat along the route will be affected. Forty-five percent of the collared javelina and 38 percent of the collared gray fox crossed canal routes. While impacts may be more serious on coyote, bobcat, and mule deer populations, an open canal potentially could affect a sizable proportion of the gray fox and javelina populations along its route.

The AGFD studies estimated that as many as 175 mule deer (44% of total in area) and 146 javelina (24% of total in area) could be initially impacted by a west side open aqueduct route. Impacts would range from drowning losses (from completed canal) to avoidance of the area during construction depending upon the proximity of the animals home ranges to the aqueduct alinement (de Vos, et al. 1983). Over the life of the project, it is possible that the mule deer in the Tucson Mountains could be eliminated if no mitigation is provided.

Habitat separation would affect all mammals and reptiles in the area which use the habitat on both sides of the canal. The result of this would be a loss of wildlife which are separated from their sources of food, water, cover, and denning sites. Under the worst case, the result would be the loss of viability of the separated populations, with the eventual loss of those populations. With proper mitigation, this is not expected to be the case along any of the Tucson B aqueduct alternatives.

Because of the steep sidewalls of the canal section few, if any, wildlife species would be able to get out of the canal if they should fall or jump in. This would result in death by drowning or exposure. This problem would be especially significant with regard to deer along the west side of the Tucson Mountains. This area was identified as a primary use area based on telemetry studies by the AGFD (1983).

In the southwestern United States, the loss of deer due to drowning in canals has been documented along the Coachella and Wellton-Mohawk canals in California and southern Arizona. Over the last 20 years, over 1,000 deer have fallen into the Wellton-Mohawk canal. As many as 13 deer have died in a single day in this canal (AGFD, unpublished data). The measures proposed for the Tucson B aqueduct (fencing, crossings, land acquisition, alternative water sources) will prevent the losses seen in the Wellton-Mohawk and Coachella Canals.

Four special status species of wildlife and five special status species of plants may be affected by the plans under consideration. Areas of potential impact to the desert tortoise occur in the paloverde-mixed cacti vegetation west of the Tucson Mountains and near Black Mountain on the San Xavier Indian Reservation. Impacts to Gila monsters could be expected primarily in the desert grassland vegetation areas, especially on the San Xavier Indian Reservation and to a lesser extent in other habitat types. Kit fox are found in creosote flats in Avra Valley and on the San Xavier Indian Reservation. Harris' hawks nest in the palo verde-mixed cactus areas adjacent to the westside alinements. Desert tortoises and Gila monsters, because they are slow moving, small, and burrowing in nature, would be susceptible to losses during construction from earth moving equipment and harassment from construction personnel. These species would also be susceptible to drowning losses in open canals. Also of concern is the effect on kit fox, a species with a very localized distribution. Canal placement could cut off foraging areas from den sites or directly destroy dens. Since kit fox dens are critical areas not easily replaced or relocated, the destruction or isolation of dens could have serious detrimental effects on the local kit fox populations.

The most common effects of transmission lines on wildlife resources are from the construction and maintenance of permanent roads which destroy habitat for some forms of wildlife. Existing access roads will be used whenever possible. Transmission lines may create an electrocution hazard to raptors including Harris' hawks attempting to perch on the towers or poles. Powerpoles are favored hunting perches in treeless desert areas and AGFD researchers frequently observed raptors on existing powerlines in the project area. However, some powerline configurations are extremely dangerous to raptors if the bird can connect two wires, either with wings or feet. All transmission lines will be designed to preclude the possibility of raptor electrocution. A transmission line used by the Western Area Power Administration meets the accepted criteria established and approved by the U.S. Fish and Wildlife Service and the Bureau of Land Management for the protection and prevention of electrocution to raptors. Other bird species are too small for their wings to touch two conductors at the same time. Transmission lines rated at 115-kV and above do not present a problem to raptors since spacing between conductors is wider than the wingspan of most raptors.

A small cactus, known as Thornber's fishhook cactus (Mammillaria thornberi), occurs on the lands west of the Tucson Mountains. The cactus is being studied by the Endangered Species Office of the U.S. Fish and Wildlife Service (FWS) because it is believed to be declining in numbers. The West Side Plan would cut through Thornber's fishhook cactus habitat for several miles and destroy an estimated 19,000 cacti. Although this cactus occurs sparingly west onto the Papago Reservation, the area impacted by the West Side Plan contains some of the densest and healthiest known stands of this species. There also would be impacts to this cactus from the delivery lines to the Schuk Toak District, from the Avra Valley Irrigation District with the East Side Plan, and from portions of the Sandario, the Sandario-San Joaquin, and the Sanders-San Joaquin Modification Plans. The FWS proposed this species as Federally threatened in April 1984. The Tumamoc globe-berry (Tumamoca macdougalii) which occurs on the West Side route, may be proposed as a Federally endangered species in the near future and has had a listing package for it prepared by the FWS. The total known population of mature plants consists of 356 individuals. The West Side Plan could impact 81 of them and the other plans would probably impact some individuals of this species as well. One individual of Sheer's strong-spined cory cactus (Coryphanta scheeri var. robustispina) would be impacted by project construction. This is a Category 1 species, but a proposal for listing this species is not anticipated in the near future. Night-blooming cereus (Peniocereus greggii) would be impacted along several portions of the alinement, especially on the Papago Delivery Line and the Pringle's lip fern (Cheilanthes pringlei) would be impacted by pipeline construction in the Tucson Mountains. These latter two species are Category 2 plants, which means that there is insufficient information at this time to support their inclusion on the Federal threatened species list.

3. Mitigation Plan

The primary purpose of a mitigation plan is to reduce or eliminate adverse effects of an action. It is recognized that the construction of a canal through undeveloped desert lands, especially in desert foothill areas, would have some local adverse impacts which cannot be eliminated or even appreciably lessened.

The primary mitigation and conservation measures for all alternative routes include: 1) fencing to exclude wildlife, 2) wildlife crossing at sites where migratory corridors exist, 3) constructing a specified number of wildlife watering sites away from the route, 4) revegetation of all disturbed areas, and 5) constructing powerlines that will not electrocute raptors. In addition, for the West Side Plan and the Sandario Plan, land acquisition to maintain a wildlife movement corridor and as a conservation measure for Mammillaria thornberi impacts will be needed, and for the East Side, Sandario-San Joaquin, and the Sanders-San Joaquin Modification Plans land acquisition as a conservation measure to compensate for Mammillaria thornberi impacts may be needed (Table 21).

The mitigation and conservation plan would be carried out in two phases. The first would occur during construction of the aqueduct.

The second phase would include monitoring of wildlife and vegetation in the project area to determine whether further mitigation is necessary.

The mitigation measures for biological impacts and the conservation plan for proposed threatened and endangered species identified in this statement should adequately mitigate for all project impacts identified at this time, and will be implemented by the Bureau. These measures include wildlife barriers, bridges, water catchments, revegetation, and the acquisition of 2,530 acres of land for a wildlife movement corridor and compensation for habitat lost from construction, including a population of the proposed threatened Thornber's fishhook cactus.

Table 21
BIOLOGICAL MITIGATION MEASURES 1/

	Alternative					
	West Side	Sandario	Sandario-San Joaquin	Sanders-San Joaquin Modification	East Side	No Federal Action
Revegetation (acres)	2,380	2,107	1,701	2,340	2,389	1,391
Wildlife Crossing (No.)	13	9	2	3	6	0
Wildlife Fencing (Miles)	23	17	9	9	12	0
Tortoise Barrier (Miles)	8	8	0	0	0	0
Wildlife Water Sites (No.)	7	5	1	2	3	3
Land Acquisition (Acres)	2,530	2,530	640	640	640	0

1/ These are proposed measures based on available information. Changes could occur prior to final design.

Phase One

The first phase of the mitigation plan would include construction of wildlife crossings, along with the modification of vehicular bridges, flood water overchutes, and other crossings to permit use by wildlife. The anticipated numbers of wildlife crossings for the six alternatives are listed on Table 21 and their locations are shown on the location maps for each route. The locations of the wildlife crossings were determined by radio-tracking collared animals to determine their movement paths. The actual number and exact location of these crossings would be determined through consultation with the FWS and AGFD prior to final aqueduct design, so that their construction may take place as part of the general aqueduct construction.

The first phase of mitigation would also include acquisition of approximately 4 square miles of land between Tucson Mountain Park and the Shuk Toak district of the Papago Indian Reservation. Acquiring and managing this land would: 1) compensate for movement disruptions caused by aqueduct construction by providing a wildlife movement corridor between the Tucson Mountains and areas to the west, 2) preserve areas containing the Federally proposed threatened Thornber's fishbook cactus, to compensate for populations that will be impacted by project construction, and 3) compensate for other special status species and wildlife habitat lost due to aqueduct construction (kit fox, desert tortoise, Gila monster, Harris' hawk).

Wildlife movement across the aqueduct is necessary to permit bisected populations to maintain gene flow and to allow use of habitat on both sides of the aqueduct. An accepted technique used on other portions of CAP to enable wildlife movements to continue is to provide crossing bridges. However, in the situation that exists on the west side of the Tucson Mountains, such structures alone would not adequately mitigate for the barrier effect of the aqueduct. Available information suggests that urbanization west of the Tucson Mountains would not be rapid nor complete enough to cut off animal movements to and from the Tucson Mountains during the life of the project. However, the open aqueduct, even with fixed wildlife crossings, would create a barrier to animal movement if housing were developed near the crossings. Under present conditions, and future conditions without the project, if housing development would occur near a usual wildlife movement path, wildlife could shift their movements to avoid the development. With the project and its fixed crossings, wildlife would not have the option of shifting to another area to avoid the development and movement would be restricted. Since it is not possible to predict the exact location and type of development or to prevent zoning ordinances from changing, wildlife crossings could not be placed in areas guaranteed free of development.

The most effective way to insure that wildlife movements would continue after aqueduct construction would be to provide an open, undeveloped corridor across the aqueduct in an existing wildlife movement path. The AGFD has identified a parcel of land that would provide this type of corridor as well as providing wildlife and threatened cactus habitat to compensate for habitat lost due to aqueduct construction. The four sections of Arizona State Trust Land at T.14S.R.11E. Sections 10, 11, 14 and 15 and the privately owned Section 2 SW-1/4 contain palo verde-mixed cacti, mesquite and creosote-bursage habitat types which are extensively used by wildlife, and provide a well established wildlife movement corridor from the Saguaro National Monument and Tucson Mountain Park to the Garcia Strip of the Papago Indian Reservation and other points west and southwest of the Tucson Mountains. The parcel borders on both the Park and the Reservation, insuring a permanently open corridor in and out of the mountains regardless of future development patterns in the Avra Valley. This land will be turned over for management as a wildlife area to a state or county resource agency such as the Tucson Mountain Park.

Wildlife watering sites would also be included as Phase One mitigation, and would be constructed as part of the aqueduct construction prior to aqueduct completion. Watering sites away from the canal would be constructed to provide a source of water other than the canal. The approximate number of watering sites for each alternative route are listed in Table 21. The final number, location, and design of these watering structures will be determined through negotiation with U.S. Fish and Wildlife Service, the National Park Service, the Pima County Parks Department, the Papago Tribe, and Arizona Game and Fish prior to final design of the aqueduct.

Revegetation efforts would occur on all spoil areas, borrow areas, cut slopes, and protective dikes immediately after they are used or constructed to take advantage of the soil moisture resulting from the dust abatement program. This would result in quicker establishment of the vegetation than usually occurs when seeded after the prime contractor is completely finished and the soil has sealed. Seeding may be enhanced by the use of an imprinting machine (Dixon and Simanton 1980) to maximize the chances of vegetation success. The normal seed mix includes quail bush, desert saltbush, bursage, brittlebush, creosotebush, desert broom and grasses and forbs. This seed mix would be changed according to site specific requirements if necessary.

Procedures to be developed in coordination with the FWS will be used to minimize impacts to candidate plant species for the Federal threatened and endangered list. Techniques may include removal and transplanting, acquisition and preservation of additional plant habitat, construction of additional water overchutes to minimize flooding and downstream impacts, or fencing and diking to preserve the plants in place.

Wildlife-proof fencing with zero ground clearance would be used along all canal sections which present a significant drowning hazard. These areas would be mainly foothill areas and several areas of known wildlife movement. The primary purpose of this fence would be to keep larger mammals off the canal right-of-way and out of the canal. Final design of this fence would be determined after consultation with interested wildlife agencies.

To further prevent drowning losses, a suitable barrier would be placed along portions of the wildlife fence in areas known to support desert tortoise populations. Those portions of the alternative alinements where the need for a barrier has been established are shown on the location maps for each route. A field check of the right-of-way and removal of any tortoises found would also be included as Phase One mitigation. Construction disturbance would be minimized from January 1 to June 1 within one half mile of Harris' hawk nests. Construction along the East Side Route near Tumamoc Hill should be minimized from May 1 to October 1 to avoid interruption of wildlife movements to water sources.

The freeboard on the open aqueduct will be rough-broom finished to facilitate the escape of small animals from the canal.

To minimize impacts from transmission line construction disturbances to wildlife habitat, the disturbed sites will be revegetated. The construction of new maintenance roads would be minimized by use of the canal operation and maintenance roads along most of the transmission route, and by the use of existing roads, where possible, off the canal right-of-way. Insulator and crossarm lengths on transmission structures will be designed to minimize the likelihood of flashover between conductors, ground wires, and the structures. The standard 69-kV and 115-kV structures used are unlikely to cause electrocution of raptors because the conductor spacing and ground-to-conductor spacing on these structures are wider than the wingspan of the largest raptors found in the area. In addition, the position of the conductors and ground wires in relationship to each other makes it unlikely that a raptor would touch two wires while landing or taking off.

Phase Two

Phase Two of the mitigation would be carried out at the end of the construction period. Vegetation monitoring would be established and baseline data recorded to determine seeding success and whether or not additional efforts are needed. All wildlife crossings and watering sites would be monitored to determine use and insure that they are properly located. The entire length of the aqueduct would be monitored to determine if additional wildlife crossings or other mitigation measure are needed. Additional mitigation may be identified by telemetry studies requested by the AGFD which will determine if the kit fox displaced by the aqueduct can successfully relocate. Additional mitigation recommended by the FWS, AGFD, BLM, and others would be implemented as appropriate. All areas of construction disturbance would be revegetated and areas previously disturbed would be overseeded, if necessary.

Transmission lines would be monitored for electrocution of raptors. If adverse effects are discovered, appropriate modifications would be made.

The following recommendations are the result of the U.S. Fish and Wildlife Coordination Act Report and supplemental coordination letter and were submitted to the Bureau for consideration for implementation.

Recommendations

It is recommended that the following mitigation measures be implemented for Tucson Aqueduct Phase B.

1. Disturbed or cleared areas should be revegetated with native plant species immediately after construction. Best available methodology and necessary measures should be used to insure the effectiveness of this measure. Because of the difficulty of reestablishing native vegetation in disturbed soils, the area disturbed should be kept to a minimum.

2. Specified sections of open canal should be fenced with an approved design wildlife fence. Designs and placement sites should be evaluated by AGFD and FWS prior to placement.

3. A 2 feet high apron, extending out 1 foot from the fence on the ground and made of fine mesh fencing should be added to the fence in areas of desert tortoise and Gila monster populations.

4. Crossing structures should be provided at appropriate locations along the canal. Locations and number of crossings should be determined by AGFD based on results of their contract study. Design standards should conform to best available design information.

5. All overchutes and road crossings over the aqueduct should be modified to allow wildlife use.

6. Rehabilitation and/or establishment of wildlife watering sites in the Tucson Mountains and at off-canal oases should be accomplished. Placement and numbers will be determined by AGFD, Pima County Parks, NPS, FWS and USBR.

7. The 4 sections of Arizona State Trust Land at T.14S. R.11E. Sections 10, 11, 14 and 15 and the privately owned SW-½ of T. 14S. R.11E. section 2 should be acquired as replacement acreage for habitat losses due to canal and pipeline construction, a wildlife movement corridor, and to preserve 27,000 M. thornberi. No development, including construction of any public roads should be permitted on these lands. Wildlife fencing and crossings would be required for the open canal through this area.

8. A study should be done to more fully evaluate the effects of the aqueduct on kit fox and to suggest mitigation for those impacts.

9. Construction should be prohibited in the vicinity of known Harris' hawk nests from January 1 - June 1. In areas of high nesting raptor density, construction activites may continue through this period if construction begins prior to January 1.

10. Construction on the East Side Plan reach near Tumamoc Hill should be prohibited from May 1 to October 1 to permit animals to reach the water sources on Tumamoc Hill.

11. Where possible, the aqueduct should be re-routed to avoid areas containing special status plant species. Where this is not possible, measures such as dikes, protective fencing, etc., should be used to prevent damage to specimens of Tumamoca macdougalii and Coryphantha scheeri var. robustispina. Transplantation and/or salvage of any specimens of any special status plant should be considered only as a last resort to prevent destruction.

12. A daily check of all construction areas should be made to locate and remove trapped animals from the site.

13. All powerlines should be raptor-proofed to prevent accidental electrocution.

4. Comparative Analysis of Alinements

Construction of any of the alinements would result in serious impacts to wildlife without the mitigation measures in place. Both U.S. Fish and Wildlife Service and Arizona Game and Fish have indicated that mitigation measures committed to in this EIS would adequately reduce impacts to acceptable levels for all of the action alternative.

Western alinements would have greater biological impacts than would eastern alinements. Areas of high biological impact for sensitive animal and plant species are shown on Figures 43, 44, and 45. No map is provided for Tumamoc globe-berry to protect this species from vandalism or theft. Urban encroachment is much more prevalent on the eastern slopes of the Tucson Mountains. As a result of urbanization most wildlife migratory corridors to the east have already been severed, while many western migratory corridors are still utilized. With areas such as the Saguaro National

Monument and Tucson Mountain Park providing protection from urbanization, western areas will retain their value to wildlife. Mitigation measures on the East Side route will decrease the impacts to a greater degree than is possible for western routes.

Alinements utilizing buried pipe for most of the route would have less biological impacts than would alinements with predominately open aqueduct. Impacts from buried pipe are limited to disturbance during construction and a temporary loss of vegetation. Unmitigated open aqueducts create a drowning hazard, movement disruption, habitat separation and a greater amount of long-term temporary and permanent vegetation loss.

It is possible to compare the wildlife habitat losses that would result from the construction and operation of each of the alternative alinements. The acreages calculated in Table 21 assumed that all vegetation in the right-of-way would be initially destroyed. Permanent loss of habitat would occur where canals and operation and maintenance roads are constructed. While the remaining disturbed areas will be reseeded, vegetation success on previously constructed portions of the CAP aqueduct has been highly variable and 30 years or more may be required before the natural vegetation is fully reestablished on the disturbed and elevated soils along the canal right-of-way. Additional areas not impacted by construction may be subject to periodic inundation by water impounded behind dikes.

The agency proposed West Side Plan would have the highest biological losses and, having more miles of open canal, would be the least acceptable alternative for biological reasons. The Sandario Plan would have fewer habitat acres lost, would have less impact on wildlife movements from the Tucson Mountains and would be less damaging to wildlife than the West Side Plan. The East Side Plan, although a closed pipeline for most of its length, would have habitat losses and wildlife impacts on the west side from its Avra Valley delivery canal. The Sanders-San Joaquin Modification Plan would disrupt fewer wildlife movement areas but would have about the same amount of open canal as the Sandario Plan. The most acceptable alternatives from a biological standpoint would be the Sandario-San Joaquin Plan and the No Federal Action Plan. These mostly buried pipeline alternatives would have significantly fewer acres of habitat lost, would not be a permanent barrier to wildlife movement over much of their lengths and because of these factors are the preferred alternatives of the FWS and AGFD.

a. Impacts of West Side Plan (Agency Proposed Action)

Without mitigation measures in place, construction of this alinement would result in serious impacts to wildlife. In addition to the long-term temporary (20-30 years) loss of approximately 2,380 acres and permanent loss of 367 acres of wildlife habitat, the alinement would sever wildlife movements in and out of the Tucson Mountains and bisect kit fox, desert tortoise and Gila monster habitat. Habitat destruction could also impact about 19,000 individuals of *Mammillaria thornberi* and 81 *Tumamoca macdougalii* with this plan.

The northern canal sections would cross agricultural lands and areas of creosote-bursage habitat. In this area the open canal would prevent mule deer and coyotes in the Tucson Mountains from reaching the agricultural areas near Marana, eliminating these water and forage areas from use. Animals attempting to cross the open canal could drown. Kit fox foraging areas would be bisected by the open canal, eliminating access to areas on the other side of the canal from dens. If enough foraging area was reduced or eliminated and/or the canal was near enough to the den site to cause direct destruction or disturbance related abandonment, kit fox populations could be eliminated. Where the alinement crosses the Santa Cruz River there would be a small loss of riparian vegetation.

Where the canal would run south along the west flank of the Tucson Mountains, the alinement remains in the creosote-bursage habitat. Kit fox foraging areas could be bisected by the open canal, reducing foraging area available. Kit fox den destruction or abandonment may also occur. The open canal would prevent mule deer, javelina and coyotes from leaving or entering the Tucson Mountains, preventing access to water and forage in the Avra Valley and eliminating dispersal movements. The palo verde-mixed cacti habitat adjacent to the alinement in the Tucson Mountains supports high concentrations of nesting raptors including the Harris' hawk. Construction noise, dust and human presence along this reach from January to June could cause raptors to abandon their nests.

The reach between Mile Wide Road and San Joaquin Road would be in a palo verde-mixed cacti and palo verde-creosote transition type. The open canal would block an important movement corridor for mule deer, javelina and coyotes between the Tucson Mountains and Brawley Wash and the Papago Indian Reservation. Construction noise and disturbance could result in raptor nest abandonment. Desert tortoise and Gila monster habitat would be destroyed and individuals would be killed by construction activities.

Along the San Joaquin Road the canal would shift back into creosote-bursage habitat. Kit fox dens and foraging areas would be isolated or destroyed. The canal would impact Gila monster habitat here with resultant habitat loss and possible construction and drowning losses of individual animals. Mule deer and bobcat movements through this area would be prevented by the open canal. Drowning losses of these animals could occur.

From Ajo Road to the northern boundary of the San Xavier Indian Reservation, severence of coyote movements by the open canal would occur. Gila monsters would lose habitat as well as incurring construction and subsequent drowning mortality in the open canal. Impacts to all species from the pipeline would include construction mortality, habitat loss and temporary blockage of movement corridors.

The pipeline from the reservation boundary to south of Black Mountain would temporarily block mule deer, coyote and javelina movements from the western areas of the reservation to the water sources on Black Mountain. Habitat loss and construction mortality would effect both Gila monsters and desert tortoises.

The southernmost pipeline reach to the terminus would cross mostly desert grassland. Construction would temporarily block mule deer, javelina and coyote movements from the Black Mountain water sources. Desert tortoises and Gila monsters would incur construction losses.

The Indian Deliver Pipeline would cross creosote-bursage habitat. Kit fox dens and foraging areas could be disturbed during construction. Gila monster habitat would be lost and there may be construction related mortality.

The Tucson water treatment plant delivery line would cross palo verde-mixed cacti habitat. Temporary blockage of mule deer, javelina and coyote movements would occur. Construction in the area from January to June would disturb nesting raptors, causing nest abandonment. Desert tortoise would lose habitat and incur construction mortality. Several hundred Cheilanthes pringlei could be affected in this area.

b. Impacts of Sandario Plan

From the terminus of Phase A to the intersection of Twin Peaks and Sandario Roads, impacts to wildlife would be the same as in the West Side Plan. The pipeline on Sandario Road would go through creosote bursage, urban lands and paloverde-mixed cactus habitat types and would pass through or along 4.5 miles of the Saguaro National Monument. Loss of habitat, temporary habitat division and temporary blockage of mule deer, coyote and javelina movements between the Tucson Mountains and the Avra Valley would occur. Construction activities and human presence could cause den abandonment by kit fox and nest abandonment by raptors if construction were near den and nesting areas. Many raptors, including Harris' hawks, nest on and near the Saguaro National Monument. Up to 2,107 acres of wildlife habitat would be subject to long-term temporary loss or disturbance, 263 acres would be permanently lost, and several thousand Mammillaria thornberi and an undetermined number of Tumamoca macdougalii could be impacted with this plan.

Below the intersection of Sandario and Mile Wide Roads, the alinement would be identical to the West Side Plan and thus would have the same impacts on wildlife. Impacts from the Papago Indian Reservation and Tucson water treatment plant delivery line would also be the same as from the West Side Plan.

c. Impacts of Sandario - San Joaquin Plan

Wildlife impacts from this plan would be the same as the West Side Plan from the terminus of Phase A to the Intersection of Twin Peaks and Sandario Road and the same as the Sandario Plan to the intersection of Sandario and San Joaquin Roads. Approximately 1,701 acres of wildlife habitat could be temporarily impacted, 173 acres would be permanently lost, and a thousand or more Mammillaria thornberi and an undetermined number of Tumamoca macdougalii could be impacted with this plan.

The pipeline along San Joaquin Road crosses palo verde-mixed cacti and creosote bursage habitat. An important movement corridor for mule deer, coyote and bobcat would be temporarily disrupted by construction. Kit fox dens and raptor nests located near the alinement could be abandoned as a result of construction disturbance. Desert tortoise and Gila monsters may have construction induced mortality.

Below Ajo Road the pipeline would cross creosote bursage and desert grassland habitat ajacent to urbanizing lands. Coyote movements through this area would be temporarily interrupted by construction, and Gila monsters may have construction related mortalities. Impacts on wildlife would be identical to the West Side Plan impacts through the San Xavier Indian Reservation.

The Papago Indian Reservation delivery line would cross mostly creosote-bursage habitat. Kit fox dens may be disturbed by construction activities and there may be losses of Gila monsters to construction activities. The Tucson water treatment plant delivery line would cross palo verde-mixed cactus, creosote bursage and urbanized lands. Mortality of desert tortoise at construction sites and habitat loss are the impacts that can be expected along this delivery line. Raptor nest abandonment is possible near Cat Mountain where the pipeline crosses Tucson Mountain Park south of the proposed treatment plant site. As stated previously, construction activity and human presence could cause raptors to abandon their nests.

d. Impacts of Sanders-San Joaquin Modification Plan

With this plan approximately 2,340 acres of wildlife habitat would be temporarily impacted, 289 acres would be permanently lost, a thousand or more M. thornberi and an undetermined number of T. macdougalii would be impacted. Wildlife impacts from this plan would be the same as the West Side Plan from the terminus of Phase A to the Sandario pumping plant and about the same as the Sandario-San Joaquin Plan to the southeast corner of the proposed wildlife movement corridor with the following exception. The Sanders-San Joaquin Modification Plan would have pipeline one mile further west--at the west boundary of the Saguaro National Monument--than that of the Sandario-San Joaquin Plan and would have greater impacts to kit fox and less impact to desert tortoises. All other special status species impacts would be similar to those incurred from the Sandario-San Joaquin Plan.

From the southeast corner of the wildlife movement corridor to the beginning of the dike (about two miles west of the San Xavier pumping plant), the aqueduct remains in buried pipe for 2.75 miles and transects mainly creosote bursage habitat important to kit fox. From the beginning of the dike southward the impacts are identical to those from the West Side Plan. The impacts from the Papago Indian Reservation and the Tucson Water treatment plant would also be the same as from the West Side Plan.

e. Impacts of East Side Plan

Approximately 2,389 acres of wildlife habitat would be subject to long-term temporary (20-30 years) loss and 250 acres would be permanently lost. Over 10,000 Mammillaria thornberi and an undetermined number of Tumamoca macdougalii could be impacted with this plan, primarily from the Avra Valley delivery line. The initial canal section from Tangerine Road and Ina Road would extend through a disturbed palo verde-mixed cacti habitat area. Coyote movements across the area would be blocked by the open canal and habitat partitioning would affect small mammals, reptiles, and amphibians.

At Ina Road the aqueduct would be placed in a pipeline and would run along city streets. Localized construction impacts (noise, dust and vegetation removal) would be the major disturbances to wildlife. In the reach between Twin Hills and Tumamoc Hill, construction from May to October would block mule deer and javelina from important water sources on Tumamoc Hill. Construction near nesting raptors from January to June could result in nest abandonment. Desert tortoise mortality from construction activities would also occur. Some riparian vegetation would be lost where the pipeline would cross the Santa Cruz River. Beyond Ajo Road the impacts of this route would be the same as for the West Side Plan.

The Indian Delivery Line would go through palo verde-mixed cacti and creosote-bursage habitat. Kit fox foraging areas would be temporarily bisected and dens could be disturbed or abandoned as a result of adjacent construction. Desert tortoise and Gila monster habitat would be lost and individuals lost to construction. Large animal movements would be temporarily curtailed.

The Avra Valley delivery line would have very similar impacts to wildlife as the agency proposed West Side Plan since they both follow approximately the same route. These are significant impacts and are discussed in the evaluation of the West Side Plan. The extent and degree of impacts from the largely open canal West Side Plan are far more severe than the impacts from the closed pipe East Side Plan. However, if the impacts associated with the Avra Valley delivery line canal are combined with East Side Plan impacts, the gap between the two alinements narrows considerably.

f. Impacts of No Federal Action Plan

Approximately 1,391 acres of wildlife habitat would be subject to long-term temporary (20-30 years) loss and 135 acres would be permanently lost. It is not expected to significantly impact any special status species.

The initial canal section from Tangerine Road and Ina Road would extend through disturbed palo verde-mixed cacti habitat area. Coyote movements across the area would be blocked by the open canal and habitat partitioning would affect small mammals, reptiles, and amphibians.

The aqueduct may be placed in a pipeline at Ina Road and would run along city streets. Localized construction impacts (noise, dust, and vegetation removal) would be the major disturbances to wildlife.

In the reach between Twin Hills and Tumamoc Hill, construction from May to October would temporarily block mule deer and javelina from important water sources on Tumamoc Hill. Construction near nesting raptors from January to June could result in nest abandonment. Desert tortoise mortality from construction activities could also occur.

5. Indirect Impacts

The major indirect impacts associated with the aqueduct would be from the water distribution system. This system would consist of canals radiating from the main aqueduct to the water users within the service area. These canals would cause the typical impacts of habitat loss and wildlife and movement pattern severance associated with canals and would compound the impacts of the main aqueduct. Such canals constructed by Reclamation or with Reclamation (P.L. 84-984 or P.L. 84-130) loans will require further environmental analysis as part of the loan process. This analysis would require the development of mitigation measures as appropriate, and filing of the required NEPA documents.

Mitigation for these impacts would include revegetation of disturbed areas not required for operation and maintenance of the aqueduct. Protected native plants would be removed or transplanted. Fencing and escape ramps would be provided to prevent drowning losses. Crossing structures would be constructed as needed to minimize disruption of movement patterns. The entire water distribution system would be monitored for effectiveness of mitigation to insure compliance of commitments.

In addition, farmland may be created or maintained with the water from Phase B on the Shuk Toak and San Xavier Papago Indian Reservations and in Avra Valley. The area at the eastern end of the Garcia Strip of the Papago Indian Reservation may be converted from natural vegetative types to agriculture with CAP irrigation. Overall, 37,800 acre-feet of water may be used for development of new farm land on the Papago Indian Reservation. This would involve losses of creosote-bursage and mesquite bosque habitat types. These large area land alterations should not significantly affect wildlife movement patterns, and water in the fields may attract wildlife.

These impacts will be covered in greater detail in subsequent NEPA compliance documents to be prepared for Indian and non-Indian water distribution systems.

6. <u>Short-Term and Long-Term Impacts and Associated Mitigation</u>

Short term impacts (those which do not result in a loss of wildlife or habitat) would occur due to construction activity. These impacts would be mainly short period disturbances of wildlife caused by man's intrusion into the ecosystem. Impacts of this nature to wildlife would include disturbance and displacement due to construction activities such as movement of heavy equipment, noise, dust, or harassment (intentional or unintentional) of wildlife by construction personnel. The noise and human presence involved in aqueduct construction along the west flank of the Tucson Mountains would disturb raptor nesting. Most raptors are intolerant of human activity near thier nests and could abandon eggs or young if disturbances were near enough. In addition, pipeline construction with the East Side Plan between Tumamoc Hill and Twin Hills in the Tucson Mountains would temporarily block the water sources on Tumamoc Hill from mule deer and javelina. Pipeline construction through the wildlife movement corridor with the Sandario-San Joaquin and the Sanders-San Joaquin Modification Plans would also temporarily block access to water sources and fawning areas.

A search and removal of species along the right-of-way would be implemented prior to construction to prevent losses due to construction (Chapter IIIA.3.). Contractor crews would be discouraged from collecting or disturbing desert tortoise, Gila monsters, or raptor nests during construction and would be advised of AGFD and Federal Regulations pertaining to the protection of these species. Construction disturbance along the East Side alinement near Tumamoc Hill should be minimized from May 1 to October 1 (Chapter III.A.3.).

Canal construction would permanently remove all vegetation from a strip equal in width as the canal and necessary access and maintenance roads. Permanent habitat loss along a pipeline would be confined to the width of the access road. Over time, disturbed ground areas including pipeline corridors and flood retarding structures would revegetate, but full recovery to original conditions of these disturbed areas may not occur within the life of the project even with revegetation efforts. Desert habitats are very susceptible to damage and re-establishment of some species is extremely slow.

Removal or transplantation of protected native plants, when required, would be coordinated with the Arizona Commission of Agriculture and Horticulture in accordance with the Arizona Native Plant Law (ARS, Chapter 7, Article 1). Procedures to be developed in coordination with the FWS will be used to minimize impacts to candidate plant species for the Federal Threatened and Endangered Species List. Techniques may include removal and transplanting, preservation on site, construction of additional water overchutes to minimize flooding and downstream impacts, habitat acquisition, and fencing and diking to preserve the plants in place (Chapter III.A.3.).

Mitigation for destroyed habitat would consist of revegetation attempts on all construction disturbed areas not required for operation and maintenance of the aqueduct. Revegetation would be attempted on all spoil areas, borrow areas, and protective dikes immediately after they are used or constructed to take advantage of the soil moisture resulting from the dust abatement program. All areas of construction disturbance would be revegetated and areas previously disturbed would be overseeded, if necessary (Chapter III.A.3.).

Temporary but long term losses of existing vegetation include the loss of 2,389 acres for the East Side Plan, 2,380 acres for the West Side Plan, 2,340 acres for the Sanders-San Joaquin Modification Plan, 2,107 acres for the Sandario Plan, 1,701 acres for the Sandario-San Joaquin Plan, and 1,391 acres for the No Federal Action Plan. Long-term impacts would also result from drowning losses, habitat disturbance, and movement pattern severance. Partial mitigation which may prevent some wildlife drowning losses would consist of a rough, broom finish on the upper 5 feet of the canal lining (Chapter III.A.3.).

Wildlife-proof fencing would be used along canal sections which present a significant drowning hazard. Design of this fence would be determined after consultation with interested agencies (Chapter III.A.3.). This fence would include a small mesh barrier at the bottom through areas where desert tortoises and Gila monsters occur.

The first phase of the mitigation plan would include construction of single-purpose wildlife crossings, along with vehicular bridges, overchutes and other crossings which would also be modified for use by wildlife. The final number and location of these crossings would be determined through negotiation with the FWS and the AGFD prior to final aqueduct design, so that their construction may take place as part of the general aqueduct construction (Chapter III.A.3.).

Mitigation for movement severance would include the acquisition of a wildlife movement corridor (4.25 mi^2) in T. 14S. R.11E., Sections 10, 11, 14, and 15 and SW¼ of T.14S. R.11E Section 2 which would be turned over to a natural resource agency for management as wildlife habitat (Chapter III.A.3.).

Wildlife watering sites would also be included as first phase mitigation, and would be constructed as part of the aqueduct construction prior to aqueduct completion. The final number, location, and design of these watering structures would be determined through negotiation with interested wildlife agencies prior to final design of the aqueduct (Chapter III.A.3.).

Vegetation would be monitored and baseline data recorded. All wildlife crossings and watering sites would be monitored to determine use and to insure that they are properly located. The entire length of the aqueduct would be monitored to determine if additional wildlife crossings or other mitigation measures are needed (Chapter III A.3.).

A study to monitor kit fox populations and their response to the aqueduct will be implemented to delineate problems and suggest mitigation measures if needed (Chapter III.A.3.).

All stock tanks which are not in the construction right-of-way would be left undisturbed. Stock tanks which would be removed due to construction or dewatered due to placement of flood protection structures would be rebuilt in areas where floodflows can be intercepted (Chapter III.A.3.).

All powerline poles will be of a design that will prevent accidental electrocution of raptors. Construction disturbance will be minimized from January 1 to June 1 in areas of Harris hawk nesting populations.

The long term effects of each alternative includes the permanent loss of 367 acres of wildlife habitat for the West Side Plan, 289 acres for the Sanders-San Joaquin Plan, 263 acres for the Sandario Plan, 250 acres for the East Side Plan, 173 acres for the Sandario-San Joaquin Plan, and 135 acres for the No Federal Action Plan. All wildlife which require this habitat for their existence, primarily small mammals and some species of reptiles and amphibians would be lost as would their future production.

B. Water Resources

1. Surface Water

a. Description of Existing Conditions

The primary surface water features within the Phase B project area are the Santa Cruz River and its principle tributaries, Brawley Wash, Canada Del Oro Wash, and the Rillito River. These streams, with the exception of the Santa Cruz from Tucson to the vicinity of the Cortaro Marana Irrigation District, are all intermittent. Few if any direct uses are made of the limited surface water resources in the upper Santa Cruz River basin. The primary water source for mineral production, domestic, municipal, and agricultural uses is pumped ground water. The occasional surface flows infiltrate the normally dry stream courses to be lost to evapotranspiration or to recharge the underlying ground water aquifers.

The interaction between Phase B of the Tucson Aqueduct and the local surface water system will be very limited, confined to providing cross-drainage control and protection for the aqueduct.

Naturally occurring runoff along the alternative routes is typical of central Arizona, being highly erratic in rate and volume, usually sediment laden, and present only in direct response to local precipitation. No continuous records of surface water quality for the area's major streams are available due to the sporadic flow regime and the non-use of this very limited resource.

b. Construction Impact Analysis

Portions of Phase B of the Tucson Aqueduct would require cross-drainage protection to prevent flood damage to the aqueduct and allow local runoff to pass the aqueduct alinement without entering or mixing with project water supplies. Detailed cross-drainage plans will be prepared during the final design stage immediately before construction.

For the open canal portions of the aqueduct, cross-drainage protection is typically provided by floodwater retarding dikes, overchutes, or culverts. With the exception of floodwater retarding structures, these cross-drainage structures result in minimal, if any, disturbance to the natural drainage channels or alterations of natural runoff. More specific discussion of cross-drainage structures and influences can be found in the Salt-Gila Aqueduct Environmental Statement (Bureau of Reclamation 1979;44).

The pipeline portions of each route are of little concern to local drainage except during construction. Plans are to bury the pipe segments of the aqueduct which would neither obstruct nor significantly alter the natural terrain, obviating the need for cross-drainage structures. Normal construction methods are to open the trench in which the pipe is laid immediately ahead of the pipe installation area, and backfill the trench immediately behind. Therefore, the active construction area may be relatively small and continuously moving, reducing the construction time in any given area to weeks for small pre-cast pipe sizes up to several months for larger cast-in-place pipes.

Should local storms produce runoff in the construction area while the trench is open or before backfilling is complete, the most likely impact would be increased sediment concentrations in the runoff waters passing the site. Because surface waters are unused and normally high in suspended sediments, typical of desert rainfall-induced surface flows, increased sediment loads are of little consequence.

Open canal construction differs from pipeline construction both in the amount of surface disturbance and in the length of time over which disturbance occurs. Larger construction areas, up to several miles in length, and longer periods of surface disturbance, 1 to 2 years, increase the likelihood of construction activities impacting the area's surface water resources. However, the impact is again limited to the potential of increasing sediment concentrations, if and when runoff passes through the disturbed construction area. The typical sequence of open canal construction is removal of vegetation, prewetting, earth moving (excavation and fill) to create the canal prism, final shaping, concrete lining, clean up and revegetation. From the time earth moving begins until cross-drainage structures are complete and in service (usually prior to the canal lining phase), the area is relatively more exposed to producing high sediment loads than in its natural state. Again, however, increased sediment loads are of little consequence.

Power Transmission Facilities

None of the transmission line routes would impact water resources in terms of availability or quantity. If construction activities take place during periods when water is in the streambeds, there may be short-term impacts to water quality by increasing turbidity and sedimentation during construction. The problem will be eliminated or minimized by the careful selection of crossing locations and avoidance of sensitive areas. In addition, care will be exercised to avoid the spilling or discharge of contaminants (oils, gas, etc.) into stream channels during construction.

c. Comparative Analysis of Alinements

As indicated above, the primary difference in potential impacts on local surface water is related to whether the aqueduct is constructed as a pipeline or an open canal. In either case, however, surface water impacts should be limited to cross drainage and occasional increases in sediment concentrations during construction.

d. Indirect Impacts

Use of CAP water in the study area will have little if any affect on the nature, occurrence, frequency or magnitude of the area's surface waters. Because the Phase B area is totally dependent on ground water as its supply source and the surface and ground water systems are generally hydraulically independent, changes in the use of ground water related to CAP deliveries will not result in major changes to the surface water system.

Longstanding water ponds that may occur behind dikes or spoil banks will be monitored for vectors. County health authorities will implement vector control measures if necessary. Insecticides will only be applied to areas where it cannot enter the aqueduct water.

2. Ground Water

a. Description of Ground Water Occurrence and Quality in Project Area

The project area generally overlies the eastern portion of the Lower Santa Cruz and the northern portion of the Upper Santa Cruz Basins and the Avra Valley Basin (Laney et al. 1978). These basins are currently being overdrafted far in excess of natural recharge. Average annual overdrafts are reported to be 520,000 acre-feet in the Lower Santa Cruz Basin (AWC 1975:24), and, according to the Arizona Department of Water Resources (ADWR), the combined overdraft in the Upper Santa Cruz and Avra Valley basins in 1979 totaled 190,000 acre-feet. Depths to ground water in the project area in 1972 are depicted on Figure 46 (USGS 1973) and vary from less than 100 feet below ground surface under the Santa Cruz River Channel through Tucson to an excess of 700 feet below land surface at several mountain-front locations. New data, reflecting 1982 ground-water level data for the Upper Santa Cruz Basin and 1983 ground-water level data for the Lower Santa Cruz Basin, are available from the ADWR. Generally, these data reveal that the ground-water basins depicted on Figure 46 are continuing to be depleted in excess of the recharge rate. For example, depths to ground-water have increased in the Tucson Metropolitan area between 5 and 30 feet since 1972.

The long term historic trend for ground water levels in the service area shows a declining static level throughout most of the area. In recent years, increases in static ground-water levels have been observed in selected locations within the study area. In general, however, a comparison between current groundwater level data and historic data reveal a significant shift from an equilibrium condition to a serious overdraft situation. This overdraft situation which has caused severely lowered ground water elevations in certain areas, has also caused land subsidence and earth fissures. Subsidence occurs through compaction of sediments in and below dewatered zones. Earth fissures generally occur around the periphery of basins with ground-water declines and subsidence.

b. Water Quality

Quality of the ground water is shown on Figure 47 (USGS 1974) in terms of total dissolved solids (salinity). Most of the alluvial area is underlain by ground water of 1,000 milligrams per liter (mg/l) or less of dissolved solids. This water is generally suitable for most purposes including crop irrigation and drinking. The primary constituents of local ground waters which are of concern from a drinking water perspective are salinity, fluoride, nitrate, sulfate, hardness, and trichloroethylene (TCE). The Arizona Drinking Water Regulations (ADHS 1978) establish maximum contaminant levels (MCL) for various inorganic, organic, and microbiological contaminants. Flouride and nitrate (as N) concentrations in drinking water are limited by these regulations to 1.4 mg/l and 10.0 mg/l respectively. Hardness, salinity, and sulfate are listed as secondary contaminants for which no MCL's are established. TCE is not currently listed in the Federal or State Drinking Water Regulations.

Concentration of dissolved solids was addressed by the EPA National Interim Primary and Secondary Drinking Water Regulations which recommended salinity concentrations of no more than 500 mg/l primarily on the basis of taste, although more saline water is commonly used for public supplies if lower concentrations are unavailable.

Hardness is caused mainly by the calcium and magnesium content of water which reduces the effectiveness of soap and causes encrustation of pipes and appliances. Hardness is not known to be a health hazard and, therefore, no MCL has been set or limit recommended. Water with a hardness of less than 150 mg/l is not generally objectionable for domestic supplies.

Sulfate is included in the EPA's National Interim Primary and Secondary Drinking Water Regulations with a Secondary MCL set at 250 mg/l. Sulfate in the form of magnesium sulfate is known to have a purgative effect on individuals, with some individuals being more sensitive than others. The State of Arizona has set no MCL for this constituent.

Although no standard has been set by the State of Arizona for TCE, an "action level" of 5 parts per billion has been set by the ADHS at which time intensive studies focusing on cause and mitigation begin. TCE is a suspected carcinogen.

Most of the ground water in the project area meets both the Arizona Drinking Water Regulations and the U.S. Public Health Service 1962 recommended standards, the primary undesirable being excess hardness. Hardness can be reduced by use of a water-softening or deionizing system. Water softening does not reduce the dissolved solids concentration but exchanges calcium and magnesium for sodium, thereby reducing the hardness. The increased sodium content, however, is undesirable for persons with heart problems or otherwise medically restricted to low-salt (NaCl) diets.

Other constituents of concern are generally restricted to certain portions of the study area. Fluoride is predominant along the Santa Cruz River near Sahuarita. Excessive nitrate and sulfate levels occur in ground water along the Santa Cruz River between Cortaro and Jaynes and between Sahuarita and Continental. Also, excessive levels of TCE have been detected in ground water near the Tucson International Airport and in the Tucson area. Concentrations of nitrates near Marana in the Avra Valley basin is a continuing problem.

The U.S. Geological Survey has prepared maps covering the project area showing chemical quality of ground water for public supplies (USGS 1974a). More detailed or localized information on chemical quality of ground water can be obtained from the ADHS.

Impacts on the ground water resources of the project area due to construction of the preferred route or the alternative routes will be minimal. Water will be required during construction for soil-moisture control and dust control. This water will likely be acquired from local ground water sources and its use for construction may add to the overdraft. It is estimated that maximum water needs to construct Phase B of the Tucson Aqueduct would be less than 2,000 acre-feet. This compares to average annual ground water pumping of 900,000 acre-feet, 240,000 acre-feet, and 150,000 acre-feet in the Lower Santa Cruz, Upper Santa Cruz, and Avra Valley Basins, respectively (AWC 1975). The small increment of additional overdraft due to construction would result in no measurable amount of added ground water level declines.

Water applied during construction would not normally infiltrate to depth, so that ground water recharge and water quality would remain unchanged due to this application.

c. Comparative Analysis of Alinements

The impacts of construction on ground water will be negligible regardless of route. As previously described, construction uses of water will be very small in comparison to existing ground water uses in the area, resulting in no significant differences between alternative routes.

d. Indirect Impacts

Indirect impacts of significance are the reduction of groundwater overdraft commensurate with the use of CAP water and the importation of salts in Colorado River water with the potential for these salts to reach groundwater.

The use of CAP water, rather than ground water, will cause the water level to decline less rapidly or stabilize. This will decrease the amount of subsidence that will take place and decrease the occurrance of fissures. In areas where the water level is stabilized, subsidence will slow and gradually stop.

Potential users in the Phase B service area include irrigation districts, towns and cities, and mining operations. Water users that received CAP allocations are shown in Figure 2. Each of these users has decidedly different water uses and varying degrees of potential impact on groundwater. In each case, the primary constituent of interest in comparing the quality of Colorado River Water with Tucson area groundwater is salinity. Water at the intake to Havasu pumping plant has a salinity of approximately 750 mg/l TDS. The salinity of water delivered to the above mentioned users will be slightly higher due to the concentrating effects of evaporation during transit. The salinity of groundwater underlying the Tucson B service area varies from less than 500 mg/l TDS to more than 3000 mg/l TDS (Kister, 1974).

Under irrigated agriculture, a significant portion of applied water is consumed by evapotranspiration, leaving all of the dissolved constituents, i.e. salts, behind. The remaining water along with its concentrated salt burden has the potential to percolate to groundwater. The potential impact will depend on (1) volume of leachate, (2) salinity of leachate, (3) soil interactions (gain or loss of TDS), (4) degree of mixing with groundwater, and (5) existing quality of groundwater. These factors are generally site specific and there is no overall relationship that can be used to make area-wide predictions of impacts.

CAP water is generally comparable in quality to existing groundwater underlying irrigated crop land.

A mixture of CAP and pumped groundwater will be used for irrigation, municipal, and industrial purposes in the Tucson Phase B service area. The effect on groundwater quality is evaluated in Chapter III. B.4.

While salt loading due to the application of CAP water may be a concern, it is already a problem with current groundwater sources. As applied groundwater is consumed by evapotranspiration, all dissolved salts are retained in the remaining portion, creating saline leachate or return flow. The same situation would occur with CAP water and current farm practices such as overapplication to leach salts from the root zone would continue with CAP water.

The CAP water used by the mines is not expected to impact groundwater because of the comparatively small amount allocated. Municipal and industrial uses, primarily by the city of Tucson, are not expected to impact Tucson groundwater quality. All M&I water will be treated to drinking water standards before use. After use, wastewater will be collected by the city sewer system and treated before discharge to area water courses. The quality of that portion of treated effluent derived from CAP deliveries will be indistinguishable from current water sources. The quality of the composite treated effluent will be substantially the same as presently seen.

3. Colorado River Water

a. Availability

CAP will derive the major portion of its water supplies from Arizona's remaining, unused entitlements to the Colorado River. By decree of the United States Supreme Court in Arizona v. California, 1964, Arizona was upheld in its right to 2.8 million acre-feet per year of the first 7.5 million acre-feet of Colorado River water available for consumptive use by the States of the Lower Basin (California, Nevada, and Arizona). Additional project supplies may be developed from the Salt-Verde River system and/or the Gila River and Agua Fria River systems through the authorized storage features of CAP.

Reclamation has for many years analyzed future Colorado River runoff. The current procedure consists of 15 different runoff scenarios, all based on the recorded history of Colorado River runoff, beginning around the turn of the century. Each scenario, or runoff sequence, is different from the others in runoff patterns and long term averages, thus providing a broad spectrum of potential future conditions, each yielding a discrete CAP water supply that could occur in the future. What emerges from the multisequence studies is not a single water supply estimate, but a comprehensive picture of the probable ranges of future runoff and resultant supplies likely to occur. Each runoff scenario is tested against the CAP physical system of aqueducts, pumping plants, and reservoirs to determine the amounts of water deliverable to the prospective CAP water users based on water use allocations and priorities of use. The results are a number of possible annual water delivery schedules which are dependent on the framework of assumptions under which they were derived.

Table 22 summarizes the most recent analysis of CAP supplies from the Colorado River based on the 15 runoff sequences. The "best sequence" is the future runoff pattern for the Colorado River that produces the greatest average annual supply to the CAP. Conversely, the "worst sequence" is the runoff pattern producing the least average supply.

b. Water Quality

Quality of the Colorado River below Parker Dam (Lake Havasu) is measured and reported by the U.S. Geological Survey (USGS) annually. These records indicate that the water quality in the Colorado River varies from year to year. In this century, the salt content in the river has increased. Evaporation, salt seeps, and return flow from irrigation and other water uses increase the salinity level of the river as it flows toward Mexico. Despite the increasing salinity, the overall chemical, physical, and aesthetic quality of Colorado River water is suitable for drinking, irrigation, mining, and most industrial uses. Federal and State water quality standards require treatment of all surface waters used for human consumption. With standard treatment methods the Colorado River water meets all quality standards.

Without some type of regulating action, the salinity of Colorado River water in Lake Havasu, from which the CAP will pump its water, would continue to increase. Recognizing this problem, the seven Colorado River basin states joined the EPA in establishing salinity standards for the Colorado River and in securing passage of the Colorado River Basin Salinity

Table 22
Summary of the Central Arizona Project
Water Supply Available from the Colorado River 1/
(63 Year Period 1988 - 2050)
Tucson Aqueduct - Phase B

Lower Basin Water Supply Condition	Estimated Annual CAP Diversion from Colorado River 2/ (million acre-feet)	Probability of Annual Diversion in % of Years 1988-2010 Best Sequence	1988-2010 Worst Sequence	1988-2010 Avg. of 15 Sequence	2011-2050 Best Sequence	2011-2050 Worst Sequence	2011-2050 Avg. of 15 Sequence
Shortage	<1.0	0	0	0	0	37	19
Normal	1.0-1.7	26	100	75	63	63	63
Surplus	>1.7	74	0	25	37	0	18

63-Year Average Annuals (1988-2050)	Best Sequence (maf/yr.)	Worst Sequence (maf/yr.)	Average of 15 Sequence (maf/yr.)
Colorado River Supplies	1.64	1.28	1.50
Project Deliveries (After Losses) 3/			
With Full Regulatory Storage	1.67	1.24	1.49
With No Plan 6	1.51	1.19	1.37

1/ Based on Colorado River Basin operation study CRSM 12/84, prepared jointly by the Upper and Lower Colorado Regions, Bureau of Reclamation.

2/ Actual amounts divertable in any given year may vary depending on amount of CAP regulatory storage provided and on the surface-water conditions in central Arizona.

3/ CAP water deliveries from the Granite Reef, Salt-Gila, and Tucson Aqueducts and reservoirs to potential water users; after losses from the aqueduct and/or reservoir systems. Losses include evaporation, evapotranspiration, and seepage.

Control Act of June 1974. This act authorized four salinity control projects and provided for the continued investigation of 12 other units. These efforts are designed to reduce highly saline inflows into the river system.

In November 1975, the Arizona Water Quality Control Council adopted amendments to the Water Quality Standards for Surface Water of Arizona which established 1972 Colorado River salinity levels as the upper desirable limits. The maximum acceptable average annual salinity levels under these standards are 723 mg/l for water below Hoover Dam 747 mg/l below Parker Dam, and flows at Imperial Dam averaging 879 mg/l.

Since it is the intent of the United States and Arizona, in cooperation with the other basin states, to control the future salinity of the Colorado River at 1972 levels or below, diversions by CAP from Lake Havasu are expected to contain salinity concentrations which average about 747 mg/l. Recent unpublished Bureau studies indicate that the future salinity levels can be expected to range from less than 600 mg/l to more than 900 mg/l.

The average salinity of CAP water to be delivered to the Phase B area is expected to average approximately 760 mg/l. This average is dependent on the water diverted at Lake Havasu and to a lesser extent the mixing of Colorado River water with the Agua Fria River in the New Waddell Reservoir. This mixing in New Waddell Reservoir will produce a slightly lower salinity of the water returning to the aqueduct. However, the improvement will be small because the majority of the water in the reservoir will be Colorado River water. It should be noted that no numerical standard or limit exists for salinity in drinking water, on either the National or State level. However, EPA national Interim Primary and Secondary Drinking Water Regulations recommended that drinking water not exceed 500 mg/l if such source of water is available. This limit was primarily determined on the basis of taste. Many communities in the nited States and other countries use water containing 2000 to 4000 mg/l.

Bacterial levels of both the Colorado River and the Agua Fria River water have been determined to be treatable for domestic use by standard treatment techniques.

Representative samples of the Colorado River water near the point of CAP diversion and the established drinking water standards (State and Federal) are shown in Table 23. Corresponding water quality for ground water supplies in the Phase B area are shown in Table 24 as a comparison.

c. Impacts From Water Use

Initial deliveries of CAP water through Phase B are scheduled to begin in 1991. Before these deliveries begin, exclusive use of ground water will continue, causing an increase in the depth of ground water in most locations of the project area. Estimated annual declines average approximately 8 feet in the Lower Santa Cruz Basin, 5 feet in the Upper Santa Cruz Basin, and 4 feet in the Avra Valley Basin (AWC 1975).

Two major impacts of Colorado River water being delivered to the Phase B service area are expected. One is the reduction in use of ground water with a coincident reduction in the rate of decline of the area's ground water tables. Second is the change in water quality previously

Tucson Aqueduct - Phase B - Central Arizona Project

Constituents	Drinking Water Standards	6-3-73	11-4-74	5-5-75	1-15-76	3-10-77	6-12-78	8-9-79	4-10-80
		Typical Composition of Colorado River Below Parker, Date Sampled							
Arsenic	.05 1/ 2/	--	--	--	.004	.005	.004	.003	.002
Barium	1.0 1/ 2/	--	--	--	.1	.1	--	0	.2
Bicarbonate	--	168	149	166	159	159	160	150	--
Cadmium	.01 1/ 2/	--	--	--	0	.01	.002	.001	0
Calcium	--	88	82	87	88	84	81	81	85
Carbonate	--	0	--	0	0	0	0	0	--
Chloride	250. 3/	91	86	90	90	91	92	95	91
Chromium	.05 1/ 2/	--	--	--	.01	--	.005	0	0
Copper	1.0 1/ 3/	--	--	--	.01	.01	.005	.008	.004
Fluoride	1.4 4/	.5	.3	.4	.4	.3	.4	.3	.4
Hardness	--	350	320	350	350	330	330	330	340
Iron	.3 3/	.009	.01	.02	.01	.01	.01	.15	.16
Lead	.05 1/ 2/	--	--	--	.01	.01	.008	.003	.001
Magnesium	--	31	29	32	31	29	31	31	30
Manganese	.05 3/	--	--	--	.02	.02	.01	.02	.02
Mercury	.002 1/ 2/	--	--	--	0	0	0	.0001	.0
Nitrate-Nitrite	10. 2/	.38	.16	.24	.11	.14	.12	--	--
pH	6.5 - 8.5 3/	7.9	7.8	8.1	7.8	8.1	7.8	8.0	8.1
Potassium	--	4.8	5.7	5.3	5.0	5.1	5.5	6.0	5.1
Selenium	.01 1/ 2/	--	--	--	.003	.003	0	.003	.003
Silver	.05 1/ 2/	--	--	--	.01	.01	--	0	0
Sodium	--	110	100	100	100	110	100	110	110
Sulfate	250. 3/	310	280	300	290	290	280	300	300
Total Dissolved Solids (Salinity)	500. 3/	730	666	705	692	687	673	707	710
Zinc	5. 1/ 3/	--	--	--	.002	.001	.002	.02	.31

1/ ADHS, Rules and Regulations Title 9, Chapter 21, 1982. Untreated Surface Water, Maximum Allowable Limits.
2/ Code of Federal Regulation 40 CFR 141 and 143, 1980. ADHS, Rules and Regulations Title 9, Chapter 8, 1982. Treated Surface Water, Maximum Allowable Limits.
3/ Secondary Maximum Contaminant Levels, recommended limits only.
4/ Fluoride Maximum Allowable Limits range from 1.4mg/l to 2.4 mg.1 depending on annual average maximum air temperatures. Average maximum air temperatures for Phoenix (85.1°F) and Tucson (81.5°F) have a limit of 1.4mg/l.

Table 24

Chemical Composition of Selected Ground-Water Wells in Pima County
(mg/l)
Tucson-Aqueduct - Phase B

Constituent	Well: 1/ 2/ Location: Use:	D-12-10 33CDC Irrig. 2/	D-12-11 18-DAB Irrig. 2/	D-13-10 09DDD Irrig. 2/	D-13-12 01ABA Irrig. 2/	D-14-111 33DCC Irrig. 2/
Bicarbonate		163	175	166	288	161
Cadmium		0	0	0	0	0
Calcium		32	37	34	108	30
Chloride		0	36	30	100	30
Chromium		0	0	0.001	0	0.003
Copper		0	0	0	0	0
Floride		0.5	0.4	0.6	0.6	0.5
Hardness		Hard	Hard	Hard	V. Hard	Hard
Iron		0.03	0.026	0.013	0.078	0.03
Lead		0	0	0	0	0
Magnesium		4	7	5	13	11
Manganese		0	0	0	0	0
Nitrate - Nitrite		7	4	5	29	6
pH		7.8	7.9	7.9	7.6	7.9
Potassium		3.1	3.7	2.5	3.0	2.8
Sodium		50	65	43	92	55
Sulfate		20	52	20	160	60
Total Dissolved Solids (TDS)		200	260	200	720	200
Zinc		0.023	0	0.021	0.038	0

1/ Well numbers are based on the U.S. Geological Survey's state quadrant system of land subdivision.
2/ Data from Report 256, "The Quality of Arizona's Domestic, Agricultural, and Industrial Waters", by Dutt and McCready, Argicultural Experiment Station, University of Arizona, February 1970.

described. Based on Secretary Watt's March 24, 1983, CAP water allocations and recent Reclamation water studies, it is estimated that approximately 8.095 million acre-feet of CAP water will be delivered to water users in the Phase B service area over the 50-year repayment period. Of this total, 1.365 million acre-feet are estimated to be delivered to non-Indian agricultural users, and would result in equivalent reductions in ground water pumping.

Water quality differences between Colorado River water and local ground water are demonstrated in Tables 23 and 24. Notable differences occur in sodium and sulfate concentrations. However, the State of Arizona requires the treatment of all surface water used for drinking purposes and no treatment is required for ground water. Surface water treatment consists of filtration to remove suspended particles, and chlorination to remove microorganisms and bacteria. Recent findings of EPA indicates, however, that normal chlorination of surface water for drinking may produce trihalomethane (THM), a known cancer agent. Being high in organic content as a result of extensive upstream irrigation use, Colorado River water diverted by the CAP may be susceptible to THM production during chlorination. This factor should be considered in the design of water treatment plants utilizing CAP waters, although not currently a state or Federal requirement in the treatment of surface waters for drinking purposes.

Sulfate in combination with magnesium, as magnesium sulfate, may have a purgative effect on sensitive individuals and sulfate in combination with calcium, as calcium sulfate, may be moderately toxic in irrigation. Average individuals are affected by magnesium sulfate concentration of about 1,000 mg/l, while the EPA recommended sulfate limit of 250 mg/l is primarily to protect transients from laxative effects (University of Arizona 1970) (EPA 1976). Comparison of sulfate from the data tables show CAP water to be higher in sulfate than the existing water supply; however, the continual exposure to the CAP sulfate level would not pose a problem. Toxicity in irrigation water due to high sulfates, resulting from possible precipitation of calcium in plants, is not a typical problem for those irrigating with Colorado River water (University of Arizona 1970).

The potential harmful level of sodium in domestic waters is about 200 mg/l for persons with cardiac, renal, and circulatory diseases. Persons on salt-restricted diets can balance high-sodium intake in drinking water with the amount ingested from food and other sodium sources. The concentration of sodium in Colorado River water is about 100 mg/l and should present no particular problem to salt-restricted persons.

Losses from the aqueduct to evaporation and seepage will be relatively constant. Table 25 summarizes the losses expected to occur for the alternative routes. Water losses should be minimal in all pipe sections. Open canal sections, however, would lose water in two ways, by seepage through the canal sides and bottom, and by evaporation from the exposed water surface. Both of these potential losses are reduced by concrete lining. Concrete lining inhibits seepage and also provides a more efficient aqueduct section, exposing less surface area to evaporation than an unlined section of equal carrying capacity.

Evaporation losses are irrecoverable since the loss is in the form of water vapor to the atmosphere. Seepage losses may be recoverable in part, since seepage is to the soil and/or rock structures underlying the

Table 25

Estimated Evaporation and Seepage Losses[1/]
(units: Acre-feet/year)
Tucson Aqueduct - Phase B

	West Side Plan	Sandario Plan	Sandario - San Joaquin Plan	Sanders-San Joaquin Modification Plan	East Side Plan	No Federal Action
Aqueduct Evaporation	820	460	150	550	210	210
Aqueduct Seepage	3820	2160	720	2600	950	950
Total Losses	4640	2620	870	3150	1160	1160
Potential Ground Water Recharge [2/]	1910	1080	360	1300	475	475
Net Irretrievable Losses Short Term	4640	2620	870	3150	1160	1160
Net Irretrievable Losses Long Term	2730	1540	510	1850	685	685

1/ Based on an evaporation rate of 6.65 feet per acre per year and a seepage rate of .075 feet per square foot of wetted perimeter per day.
2/ Assumed to be approximately 50 percent of aqueduct seepage.

aqueduct, and may in time migrate downward to the water table and be available to pumps for future use.

Given that the open canal segments of the aqueduct will have normal water surface at below natural ground levels, that local soils are generally permeable and well-drained, and that the water table is located at considerable depth and declining, it appears most likely that seepage losses will migrate downward rather than laterally. This lessens the probability of seepage waters promoting vegetative growth along the aqueduct corridor.

Deliverable project water supplies would be larger by the amounts shown in Table 25 should the aqueduct be constructed totally in pipe. Trade-offs include substantially higher construction costs for pipe and increased use of pumping energy, or higher operating costs.

4. Short Term and Long Term Impacts

The Tucson Aqueduct would be capable of providing portions of southern Pinal County and eastern Pima County of Arizona with substantial amounts of Colorado River water over the life of the project.

The water currently used in the service area of Phase B of the Tucson Aqueduct is being pumped from ground water basins underlying the area, resulting in a severe overdrafting situation. This overdraft is currently causing earth fissuring and land subsidence in some areas and threatening similar effects in others. Construction of Phase B would have the effect of lessening this overdraft situation and slowing the rate of land subsidence and earth fissuring over the life of the project.

Importation of Colorado River water would result in generally poorer quality of water than is now being used from the local ground water sources (Tables 23 and 24). However, the ground water resources are being severely overtaxed. The effect of CAP deliveries on the ground water quality in the Phase B area (Tucson and Avra Valley Basins) is difficult to evaluate due to insufficient ground water quality data on historic trends, depth stratification or ground water movement. However, two analyses were performed using a simplistic mass and salt balance approach to estimate the effect of CAP deliveries on existing ground water quality. These analyses used the worst case approach by ignoring soil interactions and travel times that would have an effect on the TDS of the water remaining in the basins after 50 years. Therefore, the calculations are considered to be higher than actually expected.

The first analysis is for the Avra Valley Basin. All CAP deliveries to this basin are for agriculture. The assumptions, calculations, and results are presented in Table 26. The calculated water remaining in the basin after 50 years with and without CAP varies from 6.3 million acre feet (MAF) to 4.9 MAF respectively, for a difference of 1.4 MAF. The quality (TDS) of that remaining ground water increases by 28 mg/l with 50 years of CAP. The increase of ground water remaining in the basin due to CAP offsets the small increase in TDS; therefore, the effect of CAP deliveries on the ground water of the Avra Valley Basin is insignificant.

The second analysis is for the Tucson Basin. This analysis addresses the impacts on ground water quality from M&I deliveries of CAP

Table 26
Hypothetical Total Dissolved Solids Changes to Existing Ground Water
Avra Valley Basin
Tucson Aqueduct - Phase B

Assumptions:

* 1.43 MAF CAP delivery to water users within the Basin, 50 year total, sequence 10. [1/]
* 1.43 MAF substitute for ground water pumping in Basin, 50 year total, sequence 10. [1/]
* 760 mg/l average TDS of CAP water delivered.
* 325 mg/l average TDS of Avra Valley Basin wells. [2/]
* 32 percent recharge of applied Ag water. [4/]
* 7.5 MAF ground water withdrawals from Basin (50 year total @ 150 TAF/yr. [4/]
* .2 MAF natural recharge (50 year total @ 4 TAF/yr) [4/] Assume 250 mg/l TDS.
* 9.8 MAF of ground water in storage above 700 feet depth
* Assume for agriculture all salts remailn in the Basin. [4/]

General Equations:

1. Basin Storage - Withdrawals + Return Flows + Natural Recharge = Basin Water Remaining

2. Basin (Vol. x TDS) + Return Flows (Vol. x TDS) + Natural Recharge (Vol. x TDS) / Total Vol. = TDS of Basin Water Remaining

Calculations: units - water quantities in million acre-feet(MAF), water quality TDS in mg/l

Without 50 years of CAP

1. $9.8 - 7.5 + (7.5 \times 32\%) + .2 = \underline{4.9 \text{ MAF}}$

2. $(2.3 \times 325) + (2.4 \times 325 \times 1.25) + (.2 \times 250) / 4.9 = \underline{362 \text{ mg/l}}$

With 50 years of CAP

1. $9.8 - (7.5 - 1.43) + ((7.5 - 1.43) \times 32\%) + (1.43 \times 32\%) + .2 = \underline{6.33 \text{ MAF}}$

2. $(3.73 \times 325) + (1.94 \times 325 \times 1.25) + (.46 \times 760 \times 1.25) + (.2 \times 250) / 6.33 = \underline{390 \text{ mg/l}}$

1/ FEIS Water Allocations and Water Service Contracting, Central Arizona Project, USBR, 1982.

2/ Average of well data from "The Quality of Arizona's Domestic, Agricultural, and Industrial Waters" Report 256, University of Arizona, 1970.

3/ From Avra Valley Basin Table 12, AWC 1975 - Arizona State Water Plan, Summary Inventory of Resource and water. The assumptions, calculations, and results are presented in Table 27. The calculations show that an additional 3.7 MAF of ground water remains in the Tucson area after 50 years of CAP. The TDS of the water remaining with 50 years of CAP is calculated to be 51 mg/l higher than without the CAP deliveries. This increase in TDS of the ground water remaining is considered insignificant in light of the additional quantity.

Salt loading, as a result of suspended or dissolved chemicals remaining in agricultural soils, is already a problem in the area. Current farm management, including overapplication of water to leach salts from the root zone, should continue with CAP water.

Constructing CAP to divert Colorado River water to central Arizona is a commitment of water resources for the long term. Evaporation losses from Phase B of the Tucson Aqueduct (from 200 to 800 acre-feet per year) would be an irretrievable reduction in the water supply in the state. Seepage losses from the aqueduct in Phase B (from 900 to 3,700 acre-feet annually) would be lost for the short term, but, some of this seepage would reach the underlying water tables and be recoverable over the long term. The amount recoverable is unknown but should exceed 50 percent of the loss. Table 25 shows the impact of losses on the water resources from Phase B.

C. Air Quality

1. Description of Existing Air Quality in Project Area

The air quality in the project area is, in general, good. The air in sparsely inhabited regions lives up to its pristine reputation, while airsheds with cities frequently experience air pollution levels exceeding Federal health standards. The Tucson Metropolitan Area is no exception.

The Arizona Department of Health Services (ADHS) and the Pima County Air Quality Control District publish comprehensive air quality reports for the area. Concentrations of major pollutants vary from place to place in the Tucson Metropolitan Area. Ozone, the chief component of photochemical smog is normally highest northwest of downtown Tucson. Carbon monoxide levels are highest in the immediate vicinity of major intersections and congested streets. Particulates are highest near unpaved roads and heavily travelled paved roads. Because of prevailing southeasterly winds, the north central to north west region of the airshed has higher particulate levels than the south and south eastern regions. In general, particulates decrease with increasing elevation. Nitrogen dioxide and sulfur dioxide remain well below the primary and secondary standards throughout the area. Table 28 lists the National Ambient Air Quality Standards for total suspended particulates (TSP), carbon monoxide (CO), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), and non-methane hydrocarbons (NMHC) and present data for the latest 5 years for each constituent in the Tucson area. Also listed are the number of standards violations which occurred in this period.

2. Construction Impact Analysis

a. Aqueduct Facilities

An exhaustive air quality impact analysis was performed for the Tucson Aqueduct Phase A Environmental Impact Statement (USDI, 1982,

Table 27
Hypothetical Total Dissolved Solids Changes to Existing Ground Water
Tucson Basin
Tucson Aqueduct - Phase B

Assumptions:

* 47 MAF Ground water in storage above 1,200 feet below surface 1/
* 20.2 MAF Withdrawals from basin without CAP, 17.0 with CAP (50 yr totals) 2/
* 5.0 MAF CAP deliveries to basin, 50 yr. total 3/
* 2.4 MAF Natural Recharge (50 yr total @ 48,100 acre-feet/yr) 1/
* 4.7 MAF Surface inflow (50 yr total @ 94,400 acre-feet/yr) 1/
* 32 Percent recharge of withdrawn water 1/
* .5 MAF Ground water outflow (50 yr total @ 10,000 acre-feet/yr) 1/
* .86 MAF Surface water outflow (50 yr total @ 17,100 are-feet/yr) 1/
* 760 mg/l TDS of CAP water imported
* 323 mg/l TDS weighted average of Tucson interior well field 4/
* 413 mg/l TDS average of Santa Cruz River near Levean 5/

General Equations:

Water

1. Basin storage - withdrawal + returns + recharge + inflow - outflow = water remaining in basin

TDS

2. (Basin Vol. x TDS) + (inflows x TDS) - (outflows x TDS) / Vol. remaining in basin = TDS of remaining basin

Calculations: units - water quantities in million acre-feet (MAF)
units - water quality TDS in mg/l

Without 50 years of CAP

1. 47.0 - 20.2 + 6.5 + 2.4 + 4.7 - .5 - .86 = 39.0 MAF

2. (47 x 323) + (4.7 x 413) - (1.36 x 413) / 39.0 = 425 mg/l

With 50 year of CAP

1. 47.0 - 17.0 + 5.4 + 2.4 + 4.7 + 1.6 - .5 - .86 = 42.7 MAF

2. (47 x 323) + (4.7 x 413) + (5.0 x 760) - (1.36 x 413) / 42.7 = 476 mg/l

---

1/ "Components of the Water Budget on the Tucson Area", Arizona, 1970-1972, U.S. Geological Survey, compiled by S.G. Brown 1976.

2/ Projections of well pumpage utilized "Ten Year Water Capital Improvement Program 1984-1994", Tucson Water, 1983 growth predictions.

3/ FEIS Water Allocations and Water Service Contracting, Central Arizona Project, USBR, 1982.

4/ Based on samples of Tucson wells from 1950-1981. Received from Tucson Water by letter dated January 4, 1984.

5/ Numerical average for TDS at the Santa Cruz River near Levean, U.S. Geological Survey 1975-1981.

Table 28

Air Quality Trends, Standards, and Violations for Various Constituents
Tucson Metropolitan Area
Tucson Aqueduct - Phase B

TOTAL SUSPENDED PARTICULATES

State and Federal Standards		Annual Geometric Mean	24-hour Average
	Primary	75ug/m^3	260ug/m^3
	Secondary	60ug/m^3	150ug/m^3

	TSP Annual Geometric Mean - mg/m^3 Year					Violations in 5 year period of Annual Geometric Mean		Number of Exceedances of 24-hour Standards			
								Primary		Secondary	
Station	83	82	81	80	79	Primary	Secondary	82	83	82	83
Downtown	52	65	67	61	70	0	4	0	0	1	0
Prince Road	77	93	101	117	129	5	5	0	0	1	2
Border Patrol	48	52	58	61	69	0	2	0	0	0	0
Hughes Nogales	34	44	54	54	54	0	0	0	0	0	0
Orange Grove	78	86	108	108	109	5	5	0	0	3	2

CARBON MONOXIDE

State and Federal Standards	Maximum 1-hr Average	Maximum 8-hr Average
Primary and Secondary	40mg/m^3	10mg/m^3

	Downtown			22nd/Craycroft			22nd/Alvernon		
	Maximum		No.	Maximum		No.	Maximum		No.
Year	1-hr Avg.	8-hr Avg.	>8-hr Std.	1-hr Avg	8-hr Avg	>8-hr Std.	1-hr Avg	8-hr Avg	>8-hr Std.
1979	11.5	7.0	0	12.6	6.7	0	28.8	12.6	6
1980	16.0	7.4	0	18.9	7.0	0	28.4	14.0	5
1981	17.8	10.7	1	12.8	6.5	0	24.1	13.2	3
1982	17.8	10.4	0	13.7	6.9	0	30.9	12.6	5
1983	21.2	11.0	1	18.9	7.0	0	25.0	13.2	10

Table 28 Continued

Air Quality Trends, Standards, and Violations for Various Constituents
Tucson Metropolitan Area
Tucson Aqueduct - Phase B

NITROGEN DIOXIDE

State and Federal Standard	Annual Average	Violation of Standard in 5 year period
Primary and Secondary	100 ug/m^3	0

	DOWNTOWN			22ND/CRAYCROFT		
Year	Annual Average	Max. 1-Hr	Max. 24-Hr	Annual Average	Max. 1-Hr	Max. 24-Hr
1979	47*	263	91	29	132	71
1980	68*	413	240	43	319	110
1981	70	395	143	55	451	112
1982	68	508	208	39	263	109
1983	60	451	209	36	226	80

SULFUR DIOXIDE

State and Federal Standards	Annual Average	24-hr Average	3- hr Average	Violations of all Standards in 5 year Period
Primary	80 ug/m^3	365 ug/m^3	----	0
Secondary	---	---	1300 ug/m^3	0

	Downtown			22nd/Craycroft 1/			Tanque Verde Loop 1/		
Year	Annual Average	Max. 3-hr Average	Max. 24-hr Average	Annual Average	Max. 3-hr Average	Max. 24-hr Average	Annual Average	Max. 3-hr Average	Max. 24-hr Average
1979	4	114	31	5	210	48	1	97	29
1980	2	105	25	2	79	33	4*	157	55
1981	3*	131	34	8	333	64	5	349	70
1982	-	-	-	6*	157	49	4*	191	40
1983	-	-	-	3	341	210	5	79	79

1/ All monitors except Downtown are specific for SO_2. The Downtown monitor measured all sulfur compounds before discontinuation of monitoring in 1981.

Table 28 Continued

Air Quality Trends, Standards, and Violations for Various Constituents
Tucson Metropolitan Area
Tucson Aqueduct - Phase B

NON-METHANE HYDROCARBONS

State and Federal Standard Primary and Secondary	3-HR AVERAGE (6 - 9 a.m.) 1/ $160\ ug/m^3$

Year	Downtown Annual Average	Max. 3-Hr	2nd-High 3-Hr	Exceedances of Standard
1979	139*	545	525	104
1980	74	406	346	36
1981	138*	685	599	31
1982	142*	532	479	32
1983**	-	-	-	-

* Annual average based on limited number of samples.
** Non-methane hydrocarbon monitoring discontinued in February 1983.
1/ Federal Standard repealed February 1983.

INT-FES- 82-26). The results from this intensive Phase A air quality survey were used to determine the appropriate level of investigation for Phase B.

Although there are differences between the two phases of the Tucson Aqueduct, a rationalization of the differences led to the conclusion that the air quality study for Phase A was applicable to Phase B. In general, methods of construction and the characteristics of the construction zone for Phase B are similar to those assumed for the Phase A study. Two major characteristics of the Phase B plan which would tend to increase air pollutant emissions are the increased number of pumping plants and the increase in overall aqueduct mileage for the Phase B West Side Plan over the shorter Phase A route. However, capacities for all the Phase B structures have been significantly decreased. The pumping plants on Phase A ranged in size from 1200 to 750 cfs while the pumping plants on Phase B range from 600 to as low as 200 cfs. Aqueduct capacities show similar decreases in sizing for Phase B. Because these sizing limitations would decrease the scope of the construction effort needed to implement Phase B, the assumption was that this decrease would offset the increase in number of pumping plants and the increase in mileage for certain alternatives. Therefore, the air quality impacts obtained from the Phase A study are good estimates as to the potential air quality impacts associated with Phase B construction.

Table 24 in the Tucson Aqueduct Phase A Environmental Impact Statement (USDI, 1982, INT-FES 82-26) presents the estimated concentration increases resulting from construction emissions on Phase A for various air pollutants. This table was analyzed to determine which constituents would pose significant impacts in terms of additional standards violations for the Phase B study area. Table 29 is a summary of the worst case impact from the three studied Phase A routes as compared to various air quality standards.

By using Table 29 in conjunction with Table 28 the air pollutants of concern were identified for Phase B investigation. Lead was eliminated as a constituent of concern, as was done in the Phase A study, because the relatively small usage of leaded gasoline by the construction fleet would cause a negligible impact. Ozone was eliminated from the Phase B study because of the extremely complex photochemical process which is involved in producing this constituent. Instead, examination of project impacts on hydrocarbons and nitrogen oxides (as nitrogen dioxide), the two major components required to produce ozone, was deemed sufficient.

Impacts of five remaining constituents, TSP, CO, NO_2, SO_2, and NMHC, were quantified in terms of impacts on the various Federal and State Primary Standards and are shown in Table 29. As can be seen, the incremental increase caused by the Phase B construction project for sulfur dioxide and nitrogen dioxide are negligible compared to the primary standard. Also, the primary and secondary standards for these two pollutants have never been exceeded in the Tucson Metropolitan Area, and they are not perceived as a potential problem within the time frame of this construction project.

Carbon monoxide and hydrocarbons levels, although being a more serious problem in the Tucson Metropolitan Area, are shown to be insignificantly impacted by the construction activities for Phase B of the Tucson Aqueduct. The incremental increase shown for carbon monoxide could not be detected by typical air quality monitoring equipment. Similarly, the

Table 29

Worst Case Increase for Pollutant Concentrations Resulting from Construction Emissions on the Tucson Aqueduct Phase A Central Arizona Project

utant	Averaging Time	Primary Standard ug/m3	Worst Case Phase A Impact ug/m3 1/
spended Particulates (TSP)	Annual	75	10.4
	24-hour	260	17.2
ioxiode (SO_2)	Annual	80	0.17
	24-hour	365	0.29
onoxide (CO)	8-hour	10,000	7.6
	1-hour	40,000	30.5
bons (NMHC)	3-hour	160 2/	2.3
Dioxide (NO_2)	Annual	100	2.7
	1-hour	235	- 3/
	3-month	1.5	- 4/

odology for obtaining these figures is presented in the Tucson Aqueduct Phase A ental Impact Statement (USDI, 1982, INT-FES 82-26).

ral and State standard repealed in February 1983.

e is generated photochemically and estimates are not available.

relatively small usage of leaded gas by the construction fleet would indicate negligible impact of hydrocarbon emissions are small compared to the pre-1983 standard and actual quantification of any impacts on ozone production by small incremental increases in concentration is complicated by the photochemical processes involved. The overall impact on hydrocarbon levels was deemed insignificant.

The remaining constituent, total suspended particulates, was the primary parameter of concern in the Phase A study and remains so for Phase B. The Phase A study calculated a possible increase in the average concentration of TSP for a 24-hour period of 12.3 to 17.2 mg/m^3 and a possible increase in annual average TSP readings of 7.4 to 10.4 mg/m^3, depending on the route chosen. These figures, for reasons previously stated, have been assumed to be applicable to assess the impacts of Phase B construction on TSP concentrations.

Because of the defined particulate problem which will be attributable to the Phase B construction process, dust control will be a primary concern during construction. Construction specifications will require contractors to carry out proper and efficient measures to comply with local air pollution regulations and to reduce dust nuisances. Furthermore, all contractors will be required by the regulations of the Pima County Air Quality Control District to carry out proper and efficient measures to reduce dust nuisances. The contractors will be responsible for preventing any nuisance to persons or damage to crops, orchards, cultivated fields, or dwellings, resulting from dust generated by this operation. Such efforts may include, but are not limited to, prewetting of any excavation area, continued wetting of the areas after construction begins, requiring the use of hooding or other dust-collection equipment for concrete batching and aggregate crushing facilities, and wetting and application of dust palliatives to all construction access roads and other heavily traveled areas. Various forms of dust suppressant measures were assumed in the Phase A study to obtain the predicted maximum increases in particulate levels.

Power Transmission Facilities

Western Area Power Administration's construction activities would not involve extensive earth moving or vegetation clearing. Major increases in fugitive dust are not expected. Transmission line construction would not involve the use of large numbers of heavy, diesel-powered machinery so noxious emissions would be relatively insignificant. If fugitive dust becomes a problem, particularly on windy days near major transportation corridors and in residential areas, treatment of access roads would reduce the potential impacts to insignificant levels.

3. Comparative Analysis for Alinements

The impacts of Phase B construction emissions on background levels of lead, sulfur dioxide, nitrogen dioxide, carbon monoxide, and hydrocarbon are similar for all alinements and are essentially insignificant.

The impacts of the predicted maximum increase in TSP levels due to Phase B construction in terms of additional air quality standards violations vary greatly with alinement of each route. For purposes of discussion, all alternative routes will be grouped into two general categories. The first group consists of all west side plans which follow alinements on the west side of Saguaro National Monument and Tucson Mountain Park including the agency preferred West Side Plan, the Sandario Plan, the Sandario-San Joaquin Plan, and the Sanders-San Joaquin Modification Plan. The second group consists of the East Side Plan and the No Federal Action Plan which follow alinements on the east side of Saguaro National Monument and Tucson Mountain Park, skirting the west side of the City of Tucson.

Background TSP concentrations in the vicinity of the west side routes are low. The west side routes generally pass through rural areas of sparse population and little commercial or industrial development. Some agricultural lands of the Avra Valley Association lie to the west of the canal opposite the Saguaro National Monument. Annual geometric means for TSP's along the routes of the west side plans are less than 20 mg/m^3 over nearly their entire length (PCAQCD, 1984:11). The probability of Phase B construction TSP emissions causing additional violations of either annual or 24-hour TSP standards in this construction corridor is low. Prevailing southeasterly winds combined with distance and the orographic separation of the Tucson Mountains will keep the construction generated TSP's from impacting the usually higher concentrations in the Tucson Metropolitan Area.

Background TSP concentrations in the vicinity of the northern two-thirds of the East Side Plan and the entire length of the No Federal Action Plan are considerably higher than on the west side routes. These portions of the east side routes generally skirt the western border of the City of Tucson near the eastern edge of the Saguaro National Monument and the Tucson Mountain Park. Annual geometric means for TSP's fall between 50 and 75 mg/m^3 along certain portions of this Phase B construction corridor. The probability of Phase B construction TSP emissions causing additional violations of the 24-hour standard is high and there is also the risk of causing violations of the annual geometric mean standard for areas near the City of Tucson. Since neither of the east side routes are preferred alternatives, quantification of additional 24-hour violations was not attempted. For comparative purposes, recognizing that the air quality impacts of either of the east side routes are significantly greater than those associated with the preferred west side routes is deemed sufficient.

The southern one-third of the East Side Plan is similar to alinement of the west side plans and the possibility of additional standards violations in this area is low.

It must be noted that Reclamation can only enforce dust control for the project/construction area itself. Increased particulates generated from construction equipment traversing State or County roads to reach the construction area must be regulated by the responsible State or County agency.

4. <u>Indirect Impacts</u>

The delivery of water from Phase B of the Tucson Aqueduct would require construction of water distribution facilities to the irrigation districts and other users. These construction activities would involve the usual air quality impact of increased suspended particulates during the construction phase.

The Pima Association of Governments (PAG) has been informally contacted to determine the consistency of the Central Arizona Project with the assumptions used in the State Implementation Plan, the Nonattainment Area Plan, and the Regional Transportation Plan for Pima County. The PAG has determined that the CAP will have no significant impact on their current assumptions for population, emissions, and transportation.

Upon completion of the Tucson Aqueduct, normal maintenance activities would commence. These activities are not expected to have any significant impact on air quality.

5. Short and Long Term Impacts

a. Short Term Impacts

The major air quality impacts associated with Phase B of the Tucson Aqueduct will occur during the construction phase of the project. All construction impacts as previously described are short term impacts.

Another short term impact is specific to the desert southwest and is associated with coccidiomycosis spores which may become airborne in areas of soil disturbance. Persons in construction zones, where soil disturbance is significant, may be at a greater risk of acquiring a cocci infection (valley fever). Valley fever is a fungal disease which is endemic to the southwest desert regions and results from inhalation of the anthrospores of the fungus. The disease ordinarily manifests itself as a "flu-like" illness and causes no severe problems. However, valley fever is occasionally a serious and sometimes fatal illness. Aqueduct construction will be closely monitored to insure that effective dust abatement measures are carried out, thus reducing the likelihood of a significant increase in airborne Valley Fever spores.

b. Long Term Impacts

Upon completion of the aqueduct, post-construction activities would be relatively small air pollutant generators. Horseback riding and other recreational activities along the right-of-way, if permitted, may attract a number of people from urban areas. The introduction of additional vehicles for recreation, and maintenance of the aqueduct, should have a minimal impact on air quality.

D. Sound Quality

1. Description of Existing Sound Quality in Project Area

Sound level measurements taken by Bureau personnel along the potential aqueduct routes ranged from less than 30 decibels to more than 75 decibels. The higher sound levels were due to vehicles and aircraft, and a more representative ambient level would be approximately 45 decibels or less. Sound levels were also measured at specific sites where it is proposed that pumping plants be constructed, with similar results.

The sound levels for Southern Nevada Project pumping plants were taken as representative of those for Phase B. Tests were made at four different plants, one being located within a residential area. The highest reading on any plant was 77 dBA at a distance of 20-30 feet from the air conditioning units. One plant tested at a distance of 100, 500 and 1000 feet had readings of 54, 44, and 40 dBA, respectively. The plant located within the residential area recorded a high of 72 dBA within the service yard, and 40-48 dBA outside the fenced yard area, away from residences. On the residence side of the plant a reading of 55-57 dBA was recorded from house air conditioning units.

2. Construction Impact Analysis

Construction activities would result in acute, relatively short duration noise due to equipment operation, vehicle access, and blasting. Blasting is anticipated for various portions of any of the potential alternative alinements, but would be minimized to the extent feasible.

During construction, sound levels will be monitored by Bureau personnel to assure compliance with Federal, state, and local laws and regulations. Construction sound levels will neither exceed 75 decibels during nighttime operation, nor 80 decibels during daytime operation, as measured from points considered to be sound sensitive. Sound levels up to 114 decibels would be encountered by personnel working within right-of-way boundaries. Contractors and Bureau inspectors would insure that Occupational Safety and Health Administration (OSHA) safety regulations are observed.

3. Comparative Analysis for Alinements

Of the six alternatives under consideration, the East Side and No Federal Action Plans would require the most blasting. These eastern alinements would cross about 6.5 miles of probable rock cut, which is about 10 percent of total excavation. The proposed West Side alinement would cross about 0.3 miles of probable rock cut, which is less than 1 percent of total excavation. For the Sandario, Sandario-San Joaquin and Sanders-San Joaquin Modification Plans blasting requirements would be comparable with the West Side Plan.

Various types of effects have been attributed to transmission lines due to their electrical charge, including electrical and magnetic field effects, audible noise, radio and television interference, and the production of oxidants. The Phase B transmission line will be designed to meet Federal Communications Commission (FCC) and National Electrical Safety Code standards, which are set to minimize these electrical effects.

Radio and television interference, audible noise, and the production of oxidants result from a phenomenon called corona. When the natural insulating quality of the air around a conductor breaks down, an electrical discharge occurs. This breakdown can occur when the stress caused by the electrical field (a function of the operating voltage and the diameter, height, spacing, and geometric arrangement of the conductors) exceeds the breakdown gradient of air, which is a function of air density. Transmission lines are designed to comply with FCC standards to minimize corona; however, atmospheric conditions and foreign matter such as dust, insects, and raindrops can increase the voltage gradient by shortening the electrical distance, and produce a corona discharge.

The corona discharge produces an audible low level crackling or buzzing sound. The intensity of the noise level is dependent on weather conditions. In fair weather, the noise level is generally undetectable.

During foul weather conditions of rain or heavy fog, the noise level at the edge of the transmission line right-of-way (25 feet from transmission center line) would be 30 decibels (dbA), a level which is slightly audible and comparable to the noise level in a library.

Poorly contacting transmission line hardware with an oxidized film on their contact surfaces can cause radio interference known as gap-type noise. The oxidized film acts as an insulator to create a voltage distance between the two metallic objects, which results in the creation of microarcs. This gap-type noise is essentially constant regardless of frequency. Gap-type noise is generally not a problem with well-maintained tranmission lines; if it occurs, it is an obnormality which can be pinpointed and readily corrected.

4. Indirect Impacts

The delivery of CAP water from Phase B of the Tucson Aqueduct would require construction of distribution systems to the users. Short term construction noise, including blasting, would result from construction of these facilities. It is conceivable that sound levels due to the use of electric and diesel powered irrigation pumps would decrease as CAP replaces some portion of currently used ground water. However, this cannot be quantified and is not expected to be significant.

5. Short and Long Term Impacts

Construction noise and blasting along any of the alinements would temporarily disturb wildlife and annoy residents in the short term.

Long term increases in sound levels would be limited to intermittent, low level increases due to maintenance activities on the completed aqueduct and operation of pumping plants. Recently collected data indicate that sound levels along the proposed Tucson Phase B alternative routes and the proposed pumping plant sites are generally in the vicinity of 45 decibels or less, with intermittent sound levels of up to 75 decibels due to passing vehicles, aircraft, and other transitory events.

The operation of pumping plants will contribute to the sound levels in the adjacent areas. Sound level measurements of similar pumping plants indicate that sound produced by operational plants will be well within acceptable limits. For instance, the Hacienda Pumping Plant of the Southern Nevada Project near Las Vegas produces a sound level of about 48 decibels at the perimeter of the site. By comparison, people speaking in normal conversation generate 45 decibels. Measurements near homes in the area recorded values of 56 to 57 decibels due to passing cars, aircraft, and other normal activities. Since the plants on Phase B will be located in depressed areas and the right-of-way (R-O-W) will be 400-500 feet from the plant, the noise level at the edge of the R-O-W should be in the 40-50 dBA range. Operation of pumping plants is not expected to cause a noise nuisance for adjacent residents.

E. Visual Resources

1. Description of Existing Conditions

The U.S. Bureau of Land Management (BLM) has developed a program to assess and manage visual resources. The Visual Resource Management (VRM) System has served as a standard from which visual resources can be measured and has served as a model for tranmission line placement, highway placement, and a host of other development activities for more than 10 years. VRM is an analytical process that identifies, sets, and meets objectives for maintaining scenic values and visual quality. The system (fully described in BLM Manual 8400) is based on research that has produced ways of assessing aesthetic qualities of the landscape in objective terms. What has been considered extremely subjective (aesthetic judgment, particularly concerning the landscape) was found to have identifiable, consistent qualities that can be described and measured. Independent from the particular terrain (and observer), perception of visual quality in landscape seems to be based on several common principles:

- o Landscape character is primarily determined by the four basic visual elements of form, line, color, and texture. Although all four elements are present in every landscape, they exert varying degrees of influence.

- o The stronger the influence exerted by these elements, the more interesting the landscape.

- o The more visual variety in a landscape, the more aesthetically pleasing the landscape. Variety without harmony, however, is unattractive, particularly in terms of alterations that are made without care.

Using the basics of VRM, contiguous areas of similar visual quality can be identified as VRM Class 1, 2, 3, 4, or 5 to aid in impact considerations. Class 1 would indicate an area as having the greatest amount of scenic resources, e.g., the Grand Canyon. Under VRM methodology, Class 1 areas are established through legislation or policy. Class 5 indicates areas where human modifications have already disturbed the natural setting to a condition in need of rehabilitation. VRM classes (1, 2, 3, 4, or 5) are determined by rating three factors: Scenic Quality, Visual Sensitivity, and Distance Zone.

Scenic Quality is defined as the degree of harmony, contrast, and variety within a landscape. The Scenic Quality rating system is used first to evaluate areas within the proposed site according to basic landscape features (landform, vegetation, water, color, adjacent scenery, scarcity and cultural modifications) and compares them to other areas within the physiographic region (see Table 30 for rating factors and criteria).

Visual Sensitivity Level is an index to the degree of user interest in the scenic quality of an area and concern toward existing or proposed changes in the landscape features of that area. Visual Sensitivity levels (rated high, medium, and low, with "high" indicating the greatest sensitivity) are determined by evaluating both Use Volume and User Attitude. The determination for Use Volume is based on the amount of traffic or visitors (by road, trail, river) that frequent an area. The criteria to determine Use Volume is set forth in BLM Manual 8411 - Sensitivity Level. The User Attitude rating for each of the units is established by determining the amount of use of a particular area (for recreation, preservation, scenery, education, events, etc.) by the indigenous populations as well as by non-residents.

Table 30
SCENIC QUALITY EVALUATION FACTORS AND CRITERIA[1]
TUCSON AQUEDUCT - PHASE B
CENTRAL ARIZONA PROJECT

LANDFORM	VEGETATION	WATER	COLOR	ADJACENT SCENERY	SCARCITY	CULTUR MODIFI
High vertical relief such as prominent cliffs, spires or massive rock outcrops or severe surface variation or highly eroded formations including major badlands or dune systems; or detail features dominant and exceptionally striking and intriguing such as glaciers. 5	A variety of vegetative types in interesting forms, textures, and patterns. 5	Clear and clean appearing, still, or cascading white water, any of which are a dominant factor in the landscape. 5	Rich color combinations, variety or vivid color, or pleasing contrasts in the soil, rock vegetation, water or snow fields. 5	Adjacent scenery greatly enhances visual quality. 5	One of a kind; or unusually memorable; or very rare within region. Consistent chance for exceptional wildlife or wildflower viewing 6	Fr ca or si en ti to 2
Steep canyons, mesas, buttes, cinder cones and drumlins; or interesting erosional patterns or variety in size and shape of landforms; or detail features present and interesting though not dominant or exceptional. 3	Some variety of vegetation, but only one or two types. 3	Flowing or still, but not dominant in the landscape. 3	Some intensity or variety in colors and contrast of the soil, rock and vegetation, but not a dominant scenic element. 3	Adjacent scenery moderately enhances overall visual quality. 3	Distinctive, though somewhat similar to others within the region. 2	Sc so at ou no th ti mo li va ar 0
Low, rolling hills, foothills or flat valley bottoms. Interesting, detailed landscape features few or lacking. 1	Little or no variety or contrast in vegetation. 1	Absent, or not noticeable. 0	Subtle color variations, contrast or interest; generally muted tones. 1	Adjacent scenery has little or no influence on overall visual quality. 0	Interesting within its setting, but fairly common within the region. 1	Mo so sc ar or re -4

1. Bureau of Land Management Visual Resource Management Program.

NOTE: Values for each rating are maximum and minimum scores. It is also possible to assign within these ranges.

Scenic Quality Rating	Points Scored
A	19-23
B	12-18
C	0-11

Using results of the Use Volume and User Attitude ratings, the Visual Sensitivity of each area can be identified (see Table 31).

Distance Zones divided into foreground/middleground, background, and seldom-seen, take into account the proximity of the observer to the landscape. Areas that are closer have a greater effect on the observer and require more attention. Because of the ease of accessibility in the Tucson Aqueduct-Phase B study area, all areas were viewed as foreground.

Management Class To determine the Visual Resource Management Classes for the study area, the results of the Scenic Quality, Visual Sensitivity, and Distance Zones are applied to the Resource Management Class Matrix (see Table 32). The VRM classes provide a basis for determining the visual impact of a proposal, and mitigating measures needed to bring the activity within the acceptable limits of the VRM class.

VRM classes, their objectives, and recommended management practices are as follows:

> Class 1. This class provides primarily for natural ecological changes; however, it does not preclude very limited management activity. Any contrast created within the characteristic environment must not attract attention. It is applied to wilderness areas, some natural areas, wild portions of the wild and scenic rivers, and other similar situations where . . . activities are to be restricted.
>
> Class 2 Changes in any of the basic elements (form, line, color, texture) caused by an . . . activity should not be evident in the characteristic landscape. A contrast may be seen but should not attract attention.

Using the VRM methodology, the visual resources of the Tucson Aqueduct - Phase B study area were inventoried by an interdisciplinary team between June and August, 1982. Scenic quality of the area was evaluated in terms of land form, vegetation, color, presence or scarcity of water, adjacent scenery, and existing cultural modifications. The results of the scenic quality ratings are shown on Figure 48.

The Visual Sensitivity Level for the entire study area, based on Use Volume and User Attitude, was determined to be high (see Table 31). Due to ease of road access to all parts of the study area, all areas could be viewed as "foreground" in the Distance Zone criteria. Based on above measures, VRM classes for the study area were determined, and are shown on Figure 49. Saguaro National Monument is considered Class 1 based on its legal status. The remainder of the study area is classed as 2 or 3.

3. Impact Analysis

Phase B of the Tucson Aqueduct will pose two types of visual changes to the area surrounding the project -- short term disturbances due to construction, and the long-term changes due to the presence of the structures. Movement of construction equipment, dust, exhausts, and temporary structures would contribute to an unnatural appearance of the landscape and a degradation of visual quality. These construction activities would be temporary, however, and are not considered long-term or significant adverse impacts.

TABLE 31

VISUAL SENSITIVITY LEVELS 1/
TUCSON AQUEDUCT - Phase B
CENTRAL ARIZONA PROJECT

	USER ATTITUDE	QUANTITY OF USE
High Sensitivity	H	H
	H	M
	M	H
	H	L
Medium Sensitivity	L	H
	M	M
	M	L
Low Sensitivity	L	M
	L	L

1/ Bureau of Land Management Visual Resources Management Program

TABLE 32
VISUAL RESOURCE MANAGEMENT CLASS MATRIX 1/
TUCSON AQUEDUCT - PHASE B
CENTRAL ARIZONA PROJECT

VISUAL SENSITIVITY		HIGH			MEDIUM			LOW
SPECIAL AREAS		1	1	1	1	1	1	1
SCENIC QUALITY	A	2	2	2	2	2	2	2
	B	2	3	3	3	4	4	4
	C	3	4	4	4	4	4	4
DISTANCE ZONES 2/		FG MG	BG	SS	FG MG	BG	SS	SS

1/ Bureau of Land Management Visual Resources Management Program.
2/ FG- foreground
MG - middle ground
BG - background
SS - seldom seen

The implementation of any of the alinement alternatives would introduce open canals, earthen dikes, buried pipelines, pumping plants, surge protection structures, power transmission lines, and access roads into the area. The presence of these structures would impose long-term changes on the visual quality of the area. The nature and significance of these changes depend on many factors, including the location from which the structure is viewed, the number of viewers, scenic quality of the area involved, and the existing disturbance in the area due to man's activities.

The degree of visible change due to the presence of the Tucson Aqueduct-Phase B facilities would vary significantly according to whether the aqueduct is designed as buried pipeline or open canal. Buried pipeline may result in less visual impacts, since the only structures visible after construction would be power transmission lines, low profile pumping plants, operation and maintenance (O&M) roads, and surge protection structures along the pipeline. The design, number, and location of surge protection structures would be determined during final design, if a pipeline alternative was selected as the proposed action.

Open canals would have the potential for greater visual impact, depending on their visibility and the sensitivity of the areas through which they pass. Of particular concern is the visibility of the open canal of the West Side Plan as it passes near areas of high visual sensitivity such as the Arizona-Sonora Desert Museum, Saguaro National Monument, and Tucson Mountain Park. A specific analysis was made to determine the visibility of project features from these sensitive viewpoints. By comparing views of the completed CAP canal near Phoenix with viewpoints from the visually sensitive areas, it was determined that the open canal of the West Side Plan would not be visible from many areas due to topography and vegetative screening, and where visible, it would not be a dominant feature of the view. Studies from several vantage points in the Tucson Mountain Park and Saguaro National Monument indicate that the dike will be of sufficient height and distance away to hide the canal and service roads from view. The view from most other higher lookout points would be a line representation of the canal due to the distance involved. Nevertheless, views to the west from higher elevations within Saguaro National Monument would be degraded by the addition of the canal and associated structures to the landscape. These views are considered by the National Park Service as park resources, since they add to visitor enjoyment of the area. Figure 50 is a photo showing an existing segment of the CAP canal near Phoenix. The view of the canal in the photo is an excellent representation of how the Tucson Aqueduct would appear from the Arizona-Sonoran Desert Museum, since the distance (about 2 miles), topography and vegetation are similar.

The dikes on the upslope side of the canal would not be constructed as visual mitigation features, but rather would be necessary to provide cross drainage protection to the canal from natural storm runoff. They would however, function to conceal the canal from most of the more visually sensitive vantage points to the east. We have evaluated the concept of coloring the canal concrete to help blend the structure into the surrounding landscape. We have concluded that coloring the entire concrete surface of the canal is not justified. Once operational the canal will remain filled with water, except on rare occasions when maintenance may require temporary dry-ups. Because of this, and because the dike will be of adequate height to provide some visual relief, we have concluded that the additional cost is not justified. However, we believe that painting or staining highly visible canal structures, such as bridges pipe and flume overchutes is a valid technique for reducing visual impact.

In order to reduce visual impact, the tall surge tanks at Brawley, Black Mountain, Snyder Hill, and San Xavier Pumping Plants have been eliminated. The decision has been made to use air chambers at these four pumping plants. Surge protection will still need to be provided at some point along the delivery pipeline from the Snyder Hill Pumping Plant to the Tucson Water delivery point. This protection could be provided by a short surge tank (about 15 feet high), air chamber structure, or other means determined during final design. We will coordinate with Tucson Mountain Park during final design to arrive at an acceptable configuration for this structure.

During final design of the aqueduct features, measures will be included to reduce the visual impact of the aqueduct, dikes, pumping plants, and access roads. A landscape architect will specify landscaping measures to be included at each of the pumping plants, and review construction specifications for other aqueduct features to insure adequate consideration of visual impacts. Specifically, the following measures will be incorporated into the proposed action to reduce visual impacts:

- inclusion of landscaping measures for each pumping plant and, if appropriate, aqueduct reaches to reduce visual impact;

- removal and stockpiling of sufficient numbers of saguaros and other cactus from the construction zone to be transplanted at pumping plants or along the aqueduct at specific areas as landscaping;

- dikes and cut slopes will be benched, terraced or furrowed to reduce erosion and aid in revegetation;

- seeding of native and/or xeric adapted perennial-plants and grasses on construction-disturbed areas. The revegetation program may include the use of a land-surface imprinter or other techniques to encourage revegetative success. Revegetation efforts will be coordinated with interested local agencies and input will be sought in developing a final vegetation plan;

- the use of cobble or gravel cover or placement of landscape stone on cut slopes or dike side slopes will be considered as a means to reduce erosion, and enhance revegetative success, thus reducing visual impacts;

- paint metal canal structures, such as pipe over-chutes, with a color chosen to reduce visibility;

- concrete canal structures such as bridges and flume overchutes shall receive a surface treatment to reduce visual contrast to the adjoining desert;

- chain link security fencing options such as of the PVC-coated type to reduce reflective glare, with fence posts and fabric of a color chosen to reduce visibility; or, if such material is determined unsuitable for desert climates, the galvanized fence with a dull-coat solution to reduce glare will be considered;

- prior to the canal excavation and construction, right-of-way fences will be erected, and vegetation clearing limits will be delineated in the construction specifications. Construction activities would be confined to these delineated areas within the R-O-W to reduce vegetation clearing and visual impact; and

- construction specifications will specify designated use areas for contractor construction yards and other needed construction areas. These use areas would be selected based in part on their visibility from sensitive areas, and other environmental considerations. Other construction use areas would require specific approval of the contracting officer.

Figure 51 shows the typical structures used for 69-kv and 115-kV transmission lines. Visual impacts of the line would vary with structure type (single or double pole), structure height, distance from viewers, context (industrial, residential, rural) and placement in relation to concentrations of people. To a great extent the viewer's attitudes toward man-made structures and transmission lines, in particular, determine the degree of impact. Non-specular conductors will be used along the entire length of the transmission line in order to reduce visual impacts.

Of concern is the potential for adverse visual impacts on the Saguaro National Monument and Tucson Mountain Park from the West Side alinements. The proposed alinement comes to within one-half mile of the Monument boundary but is over 1.5 miles from Kinney Road scenic route. The line would not parallel well-traveled roads and would barely be visible from scenic overlooks. The line would have less effect on Tucson Mountain Park because it is located further from scenic areas.

Of greatest concern along the East Side alinement is the proximity to residential areas. Transmission lines have adverse impacts on visual quality in residential areas. For the most part, visual impacts of transmission lines will be moderate to insignificant when viewed from distances greater than 0.33 mile. This distance may be shorter if the line is screened from view by vegetation or topography, or greater if the structures are silhouetted against the skyline or contrast sharply with the background. Generally, even a silhouetted line with structures of the types considered for this project would not be dominant features of the landscape at distances greater than approximately 0.5 mile. Impacts will be greater in residential areas.

To reduce the visual impact of the overhead lines, Western took the following steps in selection of transmission line routes:

- When feasible, considered routes which used existing utility corridors or transportation corridors which do not traverse areas with high or moderate scenic qualities.

- Avoided routes through the Saguaro National Monument.

- Paralled the right-of-way of the water delivery system through areas of low to moderate scenic quality, if the course was relatively straight.

- Where the water delivery system route made several sharp bends, the line routes deviate from a parallel course in order to avoid several sharp changes in direction which result in adverse impacts.

- Considered alternative routes and structure designs which minimized impacts in residential areas.

The choice between double-pole structures and single-pole structures involves trade-offs between the height and number of poles per mile of line and the overall structure profile. In general, double pole H-frame structures present a broader, more massive profile, require 6 to 7 fewer structures per mile, and are five to ten feet taller than single pole structures. Past experience indicates that the public finds single pole structures less objectionable than double pole.

Table 33 presents the miles of each transmission line route in each of the visual resource management Classes (I, II, III) and Scenic Quality ratings (A, B, C). The use of scenery classification assists in comparison of the relative scenic value of scenic resources in the study area by disinterested observers. Broad categories permit comparison of the relative total impact of each route. It is important to note, however, that the impacts on residential areas, as perceived by the inhabitants, are not necessarily less severe because the Scenic Quality rating of their area is classified as C. For this reason, reasonable routes which minimize impacts to residential areas have been included whenever possible, regardless of the classification.

For all alinements on the west side only short sections of the routes traverse anything but Class C scenery; no Class A scenery would be involved. The Saguaro National Monument is the only Class 1 management area in the study area and is avoided by all routes.

Of the five miles of Class B scenery crossed by the proposed West Side alinement, 2.5 miles are residential, making this alinement the one with the least overall impacts to visual resources and to residential areas.

The eastside alinements have greater overall impacts on visual resources due to a combination of three factors. First, the routes would be located in densely inhabited areas which increases the numbers of viewers which would be adversely affected. Second, the visual resources are of generally higher quality, including 1.5 miles of Class A scenic quality. Third, the relative impacts to residential areas would be greater because more residential areas are included in the impact zone.

TABLE 33

VISUAL RESOURCES

Miles of transmission line routes in each visual resource management class and scen quality rating group.

Route	Management Class I	Management Class II	Management Class III	Scenic Quality Rating A	Scenic Quality Rating B	Scenic Quality Rating C
West Side	0.0	5.0	28.0	0.0	5.0	28.0
Sandario	0.0	5.0	28.0	0.0	5.0	28.0
Sandario-San Joaquin	0.0	6.8	26.2	0.0	6.8	26.2
Sanders-San Joaquin Modification	0.0	5.0	29.0	0.0	5.0	29.0
East Side	0.0	6.5	25.5	1.5	5.0	25.5
No Federal Action	0.0	3.0	16.0	0.0	3.0	16.0

3. Comparative Analysis for Alinements

Table 34 compares each of the six alternative plans by length of open canal, pipeline, and power transmission lines and by visual resource management class.

Based on this comparison, any of the pipeline routes would be preferable to any of the canal routes, because the buried pipeline would not be highly visible after construction. However, all pipeline routes do traverse the Class I Saguaro National Monument area, and thus would have more significant adverse effects during the construction phase. Moreover, because the need for surge protection structures is based on lengths of pressure pipline, the pipeline routes would also require surge protection structures at regular intervals. It is possible such surge protection could be provided by low-profile air chamber structures, but this determination would be made during final design if a pipeline route is selected as the proposed action. The decision has been made to use air chambers at four of the pumping plants for the West Side Plan, the agency proposed action.

In a summary comparison of net, adverse impacts from least preferable to most preferable, the alternatives would be ranked as follows: West Side Plan, East Side Plan (based on transmission line impacts to residential areas), No Federal Action, Sandario Plan, Sandario-San Joaquin Plan (based on crossing through the National Monument) and the Sanders-San Joaquin Modification Plan. The long term visual impact of the West Side Plan is considered to be moderate; all other plans low.

4. Indirect Impacts

Use of CAP water from Phase B of the Tucson Aqueduct would require construction of distribution systems to irrigation districts and municipalities. For the most part, these distribution systems would be constructed as buried pipelines, so additional visual impacts would be minimal. Such distribution systems requiring Federal funding or loans would be subject to NEPA compliance prior to construction. Further visual impact analysis would be required as appropriate as part of the environmental analysis. The actual use of CAP water is not expected to affect the visual quality of the service area.

5. Short and Long Term Impacts

Construction activites would create visual intrusions having their greatest impacts in the short term. Revegetation and landscaping would lessen visual impact and achieve improved compatibility with preconstruction conditions, but a residual long-term visual impact would result from the imposition of the man-made structures onto the natural desert landscape. Continued cultural modification of the project area through residential and other development would lessen the visual impacts of the project in the long-term.

F. Lands

1. Project Right of Way Requirements

All the right-of-way required for Phase B of the Tucson

Table 34
Comparison of Alternatives by VRM Class
Tucson Aqueduct - Phase B
Central Arizona Project

Alternative	Visual Resource Management Class					Approximate Length (Mile)
	Class 1	Class 2	Class 3	Class 4	Class 5	
West Side Plan	0			0	0	
Canal		4.0	24.0			28.0
Pipeline		6.4	13.0			19.4
Transmission Lines		5.0	28.0			33.0
Sandario Road Plan				0	0	
Canal	0	3.0	13.9			16.9
Pipeline	2.5	7.0	18.4			27.9
Transmission Lines	0	5.0	28.0			33.0
Sandario-San Joaquin Road Plan				0	0	
Canal	0	0	4.8			4.8
Pipeline	2.5	14.0	23.5			39.8
Transmission Lines	0	6.8	26.2			33.0
Sanders-San Joaquin Modification Plan				0	0	
Canal	0	0.5	18.7			19.2
Pipeline	2.0	12.0	14.0			28.0
Transmission Lines	0	5.0	29.0			34.0
East Side Plan	0			0	0	
Canal		4.0	2.6			6.6
Pipeline		11.0	19.2			30.2
Transmission Lines		6.5	25.5			32.0
No Federal Action Plan	0					
Canal		4.0	2.6	0	0	6.6
Pipeline		8.5	5.0			13.5
Transmission Lines		3.0	16.0			19.0

Aqueduct would be located in Pima County. Depending on the route selected, the right-of-way requirements for Phase B could range from about 637 to 2,187 acres. The six routes and their estimated right-of-way requirements are listed in Table 35.

The right-of-way requirements vary both with the length of the route and whether the delivery system is an open canal or an underground pipe or a combination of both. Pipeline portions of the alternative route would normally require about 100 feet of right-of-way. For open canal sections, the right-of-way could range from 445 feet to about 615 feet.

In addition to the right-of-way estimates listed above, additional lands may be needed for borrow areas, aggregate sources, haul roads, and transmission lines. Transmission lines generally require about a 100 foot right-of-way.

All lands needed for the construction, operation, and maintenance of the aqueduct would be acquired in fee unless it is determined at the time of acquisition to be in the best interests of the Government to acquire a lesser interest in specific parcels. The lands to be obtained would be acquired in a manner consistent with the laws and regulations pertaining to the Federal acquisition of land as set forth in the "Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970" (P.L. 91-646, 89 Stat. 1984) and as provided in Parts 211.1.6 and 211.1.7 of the Bureau instructions. Specific land acquisition procedures have been detailed in previous CAP EIS's (see U.S.B.R. 1979:17-18) and are not repeated here.

2. Land Use

a. Description of Existing Land Use in Project Area

The land uses along the alternative routes for Phase B of the Tucson Aqueduct vary from desert grazing and irrigated cropland to rural, residential, commercial and industrial. Figure 52 depicts the land use along the alternative routes, and Tables 35 and 36 respectively, list the acreage and miles crossed by aqueduct and transmission line facilities.

b. Construction Impact Analysis

West Side Plan (Agency Proposed Action): Since much of the private land along this alinement is as yet undeveloped, this plan presents a minor impact to residential areas. Some disruption to grazing and agricultural land uses would occur.

Sandario-San Joaquin Plan: This alinement would have substantially the same construction impacts as the West Side Plan. Fewer disruptions to existing land use would occur where buried pipeline replaces open canal.

Sandario Plan: This alinement would have substantially the same construction impacts as the Sandario-San Joaquin Plan.

Sanders-San Joaquin Modification Plan: This alinement would have impacts very similar to those of the Sandario-San Joaquin Plan.

Table 35
Estimated Right-of Way Requirements
Tucson Aqueduct - Phase B
Central Arizona Project

Route	Desert	Agricultural	Residential	Commercial	Industrial
West Side	1,983	96	108	0	0
Sandario	1,517	96	95	0	0
Sandario-San Joaquin	862	96	107	0	0
Sanders-San Joaquin Modification	1,808	96	120	0	0
East Side	1,367	123	340	3	16
No Federal Action	447	0	176	0	14

TABLE 36
LAND USE - TRANSMSSION LINE ROUTES

Miles of land use categories crossed by the transmission line for each route.

Route	Residential	Industrial	Cultivated	Floodplain	Undeveloped
West Side	6.0	0.0	0.7	0.2	25.8
Sandario	7.6	0.0	0.7	0.2	24.5
Sandario-San Joaquin	11.8	0.0	0.7	0.2	21.3
Sanders-San Joaquin Modification					
East Side	9.3	3.0	0.6	0.6	18.0

East Side Plan: This alinement presents impacts to private property, which, in terms of mileage are approximately the same as those alinements situated on the west side of the Tucson Mountains. In terms of impact, however, the severity on the east side is greater because many landowners have constructed houses and made other improvements.

No Federal Action Plan: Impacts would be very similar to that of the East Side Plan since it has been assumed that this plan would be similar in route to the East Side Plan from the terminus of Phase A to Tucson. However, it would cross half as much residential land and no agricultural land.

c. Comparative Analysis for Alinements

As indicated in the previous section, the impact upon land use caused by the construction of any of the alternatives would be similar to a large extent. The East Side and No Federal Action alinements would have the most severe impact on private property due to the degree of development along those alinements. Any of the alinements on the west side of the Tucson Mountains would pose some problems to cattle grazing in that movement of animals would be restricted.

d. Indirect Impact

Construction of the aqueduct along any of the alternatives would alter cross drainage and water discharge patterns creating temporary impoundments which would affect land use. Lands within impoundments may attain more vegetation which could provide more browse for grazing. Land downstream of the aqueduct will become less susceptable to flooding, which may make them more attractive to development.

e. Short and Long Term Impacts

During construction, disruptions of grazing patterns, relocation of powerlines, roads, and annoyance to nearby restaurants would occur along any of the alternative routes. In the long term, some agricultural and grazing lands would be lost, and construction of the aqueduct would preclude future development of some private lands.

3. Land Ownership

a. Description of Existing Land Ownership

State, private, and Indian ownership accounts for approximately 98 percent of the Phase B land (See Figure 53). Federal and county ownership accounts for the remainder. Table 37 shows estimated acreage by land ownership for the aqueduct alinements and Table 38 shows miles of land ownership for each transmission route.

b. Construction Impact Analysis

For land now in state ownership, the state would be permitted to select "in lieu" lands from BLM holdings in return for most of the state lands acquired. Acquisition of these lands would have some adverse impact on state leasees since it may cause them to curtail some of their

Table 37

Estimated Acreage by Land Ownership
Tucson Aqueduct - Phase B
Central Arizona Project

Route	Federal	State	Private	County	Indian	Total
	Land Status					
West Side	35	1,222	712	4	214	2,187
Sandario	30	786	674	4	214	1,708
Sandario-San Joaquin	47	489	319	4	206	1,065
Sanders-San Joaquin Modification	35	1,047	724	4	214	2,024
East Side	34	703	902	4	206	1,849
No Federal Action	0	116	521	0	0	637

TABLE 38
LAND OWNERSHIP - TRANSMISSION LINE ROUTES

Miles of land ownership categories crossed by the transmission line for each route

ROUTE	PRIVATE	COUNTY	STATE	FEDERAL	INDIAN
West Side	17.9	0.0	9.2	5.1	0.5
Sandario	15.8	0.0	10.0	6.7	0.0
Sandario-San Joaquin	17.1	0.0	9.1	5.6	1.2
Sanders-San Joaquin Modification	17.1	0.0	10.1	5.6	1.2
East Side	24.7	0.7	3.8	1.0	1.3

farming and ranching operations. Since some of the land is in private ownership, acquisition by the Federal Government would result in some loss of tax revenue. In addition, the project could restrict access to certain areas, thereby affecting property values.

c. Comparative Analysis

There is no substantial difference among alternatives regarding impacts on land ownership with the exception of residential impacts on the East Side and No Federal Action Plans as discussed above.

d. Indirect Impacts

Construction of Phase B of the Tucson Aqueduct would make additional water available to the Tucson area. It would also make possible the construction of facilities to deliver water to adjacent users. The availability of additional water to these areas could have a positive influence on land values. The presence of the aqueduct could restrict access from rural residences, which in turn may have some effect on development of the area and its real estate values.

e. Short and Long Term Impacts

The only identified short and long term effects resulting from the acquisition lands in Phase B are the loss of tax revenues and private use of 319 to 902 acres of private land.

G. Geology

1. Introduction

The proposed Tucson Aqueduct-Phase B alternatives are located near the eastern edge of the Basin and Range Physiographic Province. The basins are broad and nearly flat, but rise gently toward the adjacent mountains. Numerous elongate, isolated mountain ranges composed of granitic, volcanic and metamorphic rocks (Tortolita and Tucson Mountains) separate the basins (Wilson et al, 1960; Damon et al, 1968). Figure 54 shows the proposed Tucson Aqueduct-Phase B alternatives in relation to the basins and mountains.

The great thicknesses of alluvial and lacustrine deposits that fill the basins have been subjected to subsidence by the overdraft of ground water during the past 55 years in this area. This has resulted in land subsidence and earth fissuring in parts of the region.

Based on historical seismic data, earthquake damage to the aqueduct is considered to be a possibility (DuBois and Smith, 1980). Forty-five earthquakes with epicentral intensities of V or greater on the Modified Mercalli Scale have been recorded since 1852 within 200 miles of the aqueduct.

The most significant mineral resource in the Phase B area is copper. Three large open pit copper mines are located just south of the area. South of Rillito, near the beginning of the proposed alinement, there is an active limestone quarry. The Tucson Mountains and the shallowly buried bedrock shoulder to the west of the mountain front are thought to have good potential for mineral development (Vuich and Peirce, 1973). There is evidence of small scale mining throughout the area.

Geologic hazards such as earth fissures, land subsidence, seismicity, liquefaction and flow of mine tailings, and adverse soil conditions such as expansive clays, low density soils, and dispersive clays would be fully considered in the design, construction, and operations of the aqueduct.

The short term geologic impact of the aqueduct is positive because it reduces the rate of overdraft of ground water. The rate of occurrence of land subsidence and earth fissures, which are the primary responses to overdraft, would diminish.

2. <u>Surface Water and Ground Water</u>

The Tucson Basin is drained by the Santa Cruz River and its tributaries, but the mean annual flow of 10,000 to 20,000 acre-feet occurs mainly in floods of short duration that are too intermittent to constitute a reliable water supply. The only place where streamflow leaves the basin is along the Santa Cruz River at Rillito.

The Avra Valley is drained by Brawley Wash and its tributaries. All of the flow is intermittent, and flow from the mountain washes reaches the main drainage only during times of heavy rainfall. Brawley Wash flows into the Santa Cruz River northwest of the Tucson Mountains.

The aquifer that underlies the Tucson Basin consists of the Pantano Formation and Tinaja beds of Tertiary age and the Fort Lowell Formation and surficial deposits of Quaternary age (Davidson, 1973). These three units are more than 2,000 feet thick and are composed mostly of loose to moderately cemented silty sand to silty gravel (Davidson, 1973). Depths to water in the Tucson Basin range from 21 to 332 feet (USGS, 1981). Mean annual pumpage increased from about 50,000 acre-feet in 1940 to about 177,000 acre-feet in 1965 (White et al, 1966). Water levels have declined between 6 and 31 feet between 1975 and 1980 (USGS, 1981).

The ground water in the Tucson Basin contains less than 500 milligrams per liter (mg/l) of dissolved solids to depths of greater than 1,000 feet. The U.S. Public Health Service (White et al, 1966) has set 500 mg/l as the upper limit of dissolved solids acceptable in drinking water. In the northeastern part of the basin dissolved solids are generally less than 300 mg/l whereas to the southwest dissolved solids increase to between 300 mg/l and 500 mg/l. Locally, concentrations of dissolved solids are as great as 3,000 mg/l (White et al., 1966).

Other constituents of concern for ground water are generally restricted to certain portions of the study area. Fluoride is predominant along the Santa Cruz River near Sahuarita. Excessive nitrate and sulfate levels occur in ground water along the Santa Cruz River between Cortaro and Jaynes and between Sahuarita and Continental. Also, excessive levels of TCE have been detected in ground water near the Tucson International Airport and in the Tucson area. Concentrations of nitrates near Marana in the Avra Valley basin is a continuing problem.

The Avra Valley is underlain by alluvial fill to depths of as much as 2,000 feet (White et al., 1966). The alluvial fill is composed of interfingering layers of clay, silt, sand, and gravel. The sands and gravels are coarse, permeable, and capable of storing and yielding large amounts of ground water.

Depths to the water table in the Avra Valley range from 140 feet to 500 feet (Reeter and Cady, 1981). Development of irrigation wells in the Avra Valley began in 1943 with the drilling of six wells. From the end of World War II to the present time numerous wells have been drilled in the valley. Water levels have declined as much as 76 feet in the northern end of the valley (Reeter and Cady, 1981).

The ground water of the Avra Valley contains from 195 to 851 mg/l of dissolved solids (Reeter and Cady, 1981) and there is no correlation between the amount of dissolved solids and depth (White et al., 1966).

The U.S. Geological Survey and the Arizona Department of Water Resources (ADWR) have developed separate models of the ground water system for the Tucson water supply. The results from the ADWR model are available in published form.

3. Land Subsidence

Potential for land subsidence is suspected in Phase B of the Tucson Aqueduct due to water-level declines that are expected to continue in the future. Land subsidence is the lowering of the elevation of the land surface with respect to sea level or to the surrounding mountains caused by the lowering of ground water levels. This phenomenon results from the compaction of unconsolidated sediments in basins that are bounded on the sides and the subsurface by relatively impermeable hard rock. Subsidence is well documented elsewhere in Arizona (Schumann and Poland, 1970; Laney et al, 1978), in California (Poland et al., 1975), in the Houston-Galveston region of Texas (Gabrysch and Bonnet, 1975) and elsewhere (Viets et al., 1979).

The Phase B routes cross two such basins. The West Side Route and associated alternatives are for the most part in Avra Valley, a topographic basin that corresponds to a fault bounded basin (see Oppenheimer and Sumner, 1980).

Avra Valley is bounded on the east by the Tucson and Tortolita Mountains and as shown on Figure 55 water-level declines have in places exceeded 150 feet west of the Tucson Mountains. Leveling along the Southern Pacific Railroad showed 2.1 feet of subsidence from 1948 to 1980 near Red Rock, diminishing to zero southeast of Rillito. Although no recent level measurements have been made, subsidence has probably taken place in the areas of large decline to the south as well.

The East Side and No Federal Action routes cross another similar complex geologic basin located on the east side of the Tucson Mountains. This basin corresponds roughly to the topographic basin that extends southward along the Santa Cruz River from near the town of Rillito and contains the city of Tucson (Davidson, 1973). Water-level declines exceeding 150 feet have occurred within this basin (City of Tucson, 1981) as shown on Figure 55. Maximum subsidence from 1954 to 1980 measured by the National Geodetic Survey was about 0.43 foot in an area where water-level declines were greater than 100 feet, and 1979-1980 data indicate subsidence rates of 0.05 to 0.07 foot per year. Near the end of the Phase B alinements along Highway 93 subsidence was about 0.3 foot, where the rate was less than 0.02 foot per year (Strange, 1983, p 17).

Water levels in both basins are expected to decline further which will result in increased subsidence. Experience has shown that the amount of subsidence per unit of water-level decline increases substantially after about 100 feet of decline has been reached (Schumann and Poland, 1970; Holzer, 1981). Therefore, the areas which have experienced the greatest water-level declines are likely to be the areas where future subsidence will be greatest if water-level declines continue. These areas are the northern part of Avra Valley, central Tucson, and the Sahuarita area south of Tucson.

4. Earth Fissures

Earth fissures or cracks usually form around the margins of subsiding basins which have had large water-level declines and are common in Arizona (Laney et al., 1978). Earth fissures have occurred in the basins crossed by the alinement of the Salt-Gila Aqueduct and the Phase A portion of the Tucson Aqueduct (U.S. Bureau of Reclamation, 1979, and U.S. Bureau of Reclamation, 1981). Because water levels have declined substantially in the Phase B area, and are expected to continue declining, earth fissures are likely to form there as well. Investigations by the U.S. Bureau of Reclamation and the U.S. Geological Survey along the Salt-Gila Aqueduct and the Phase A part of the Tucson Aqueduct indicate that earth fissures form where compressible basin sediments thicken abruptly over shallowly buried rock ridges or benches. Fissures may also form at abrupt facies changes between compressible and incompressible sediments such as between clay and gravel.

Four earth fissures have been reported in the Phase B area. They are in the NE¼SE¼NW¼ section 20, T. 12 S., R. 11 E., along the north of section 31, T. 14 S., R. 12 E., along Snyder Hill Road along the north of section 2, T. 15 S., R. 11 E., and the SW¼ section 16, T. 15 S., R. 11 E. These fissures are in the vicinity of the West Side Route. The closest is along Bopp Road about midway between the Sandario-San Joaquin alinement and the West Side alinement, about 0.5 miles from each alinement. The other reported fissures are more than a mile from any alternative. Earth fissures may form in other places in the future.

Subsidence in the future could cause a sag in the canal or pipeline. If large enough the sag could cause the water to flow over the canal banks or reduce the flow in a pipeline. Subsidence could also change the lifts at pumping plants.

Earth fissures could cause leakage from the canal or pipeline and damage foundations in pumping plants.

Overflow of canals can be prevented by raising the lining. A joint investigation between the Bureau of Reclamation and the U.S. Geological Survey has undertaken studies to estimate the amount of subsidence that will take place along the alinements so that the canals and pumping plants will be properly designed and that pipelines will have the proper gradients.

The joint investigation has also developed methods to identify and locate conditions that allow the formation of earth fissures. Investigations using these methods will be made along the selected alinement so that unfavorable conditions can be avoided, or the lining of canals can be reinforced or pipelines reinforced where conditions favorable to the formation of earth fissures must be crossed. In addition, the Bureau of Reclamation has been conducting experiments with designs that will further prevent or limit damage to the aqueduct by earth fissures.

5. Foundation Conditions

Loose and caliche-cemented alluvial fan and basin fill deposits will constitute most of the foundation for the proposed alinements. About 6.5 miles of the proposed East Side and No Federal Action alinements, and an as yet undetermined length of the proposed West Side alinement, would be founded on limestone and/or volcanic rock. A description of surface geology and geologic units is on Figure 56.

The sediments crossed by the proposed alinements are typically silt and clay fines and sands with lenses of gravel. Materials change abruptly both vertically and laterally. Auger holes drilled in the area (AP-1A-TAB through AP-32-TAB) encountered unconsolidated to caliche-cemented sandy silt and silty sand locally interbedded with poorly graded sand. These holes were drilled to a depth of 35 to 40 feet. Clay layers are also present. Where the alinement passes close to exposed bedrock, the materials contain higher percentages of coarse gravel, cobbles, and boulders.

Information obtained from the auger holes indicates that the foundation materials should not present any unusual design problems as far as grain size, plasticity, permeability, strength, or shrink-swell potential is concerned. The auger hole logs can be obtained from the Arizona Project Office, Phoenix, Arizona. Desert soils are typically low density because there is insufficient moisture to naturally compact them. Where low-density soils are encountered it will be necessary to over excavate or compact them. The compacting would be done by hydraulic and mechanical processes. Highly expansive clays and dispersive clays may be locally encountered and may require over-excavation. Preconstruction explorations will delineate most problem areas. If enough soils are unusable, a borrow site for embankment material will be located. Unusable soil would be disposed of in the vicinity of the aqueduct.

Disturbance of the soil by construction could increase soil erosion. Seldom is the moisture content suitable to keep the soil from becoming airborne under windy conditions. During construction, the soil will be watered to reduce erosion and minimize dusty conditions. After completion of the facilities erosion would be reduced by the construction of dikes and the scarification and reclamation of distured areas. All of the pumping plant foundation sites would be excavated in alluvial materials except Twin Peaks.

Approximately 6.5 miles of the East Side and No Federal Action alinements would be excavated in Cretaceous or Tertiary volcanic rocks. This will require a certain amount of blasting.

6. Construction Materials

In addition to aggregate requirements, borrow sources may be needed for areas where low-density cohesionless soils and oversize materials are present. These materials are present within the alluvial fan deposits where the alinement traverses close to the base of the Tucson Mountains. Borrow material may be required for areas where caliche cemented soils, dispersive or expansive clays are encountered.

Much of the material can probably be obtained from borrow areas delineated by investigations adjacent to the canal alinements. Due to the presence of dispersive clays, borrow materials require extensive testing to define nondispersive soils. Some of the riprap and rockfill could be supplied from rock-cut intervals of canals and siphons or from local quarries. Water for use in construction can be supplied from existing wells near Marana and Tucson or from the Santa Cruz (USBR 1968). Additional wells may be needed in certain areas to reduce the hauling distance, though the quantity of water required is not great enough to impact the ground water system. Investigations for aggregate sources would be conducted prior to design of the chosen route. Commericial sources of aggregate are available nearby.

7. Mining

The most significant mineral resource in the Phase B area is copper. Three large open pit copper mines are located just south of the southern terminus of the alinement. These are the Pima, Mission, and Esperanza mines. There could be a conflict between project construction and future mine expansion in this area. Abandonment of the tailings ponds adjacent to the mines could pose a maintenance problem for the aqueduct. Therefore, the decision was made to place the aqueduct in pipeline from the Black Mountain pumping plant to the terminus.

South of Rillito, near the beginning of the alinement, the Escabrosa Limestone and the Naco Group have been quarried for use in the manufacture of cement. The Arizona Portland Cement Company has an active plant near the quarry (Arizona Bureau of Mines, 1969). This plant is not expected to interfere with any proposed construction, nor will construction and maintenance of the aqueduct interfere with operation of the plant.

The Tucson Mountains and the shallowly buried bedrock shoulders to the west of the mountain front are considered to have good potential for mineral development (Vuich and Peirce, 1973). A portion of the proposed West Side alinement would be located above this bedrock shoulder. If commercial deposits are discovered in the bedrock below the alinement, their ultimate development would have to be congruent with the overlying aqueduct. Most of the land in the Tucson Mountains is presently closed to mineral entry because of Saguaro National Monument and Tucson Mountain County Park which occupy about 80 percent of the area. The remainder of the Tucson Mountains consists of private, state, and Bureau of Land Management lands. Mining would not be permitted in the aqueduct right-of-way, but development of mineral deposits adjacent to the right-of-way would be possible.

There are numerous sand and gravel pits near the Santa Cruz River channel. Sand and gravel deposits contained within the proposed aqueduct rights-of-way are negligible when compared to the deposits available in adjacent areas. Therefore, restricting the development of sand and gravel resources would not be a significant impact.

8. Seismicity

The Phase B area has a low rate of tectonic activity. Ertec Western (1982) states that a 5.5 magnitude earthquake (Richter Scale) is postulated to be capable of occurring anywhere within the Phase B area but at a depth of more than 3 miles. DuBois and Smith (1980) state that the Sonoran Earthquake of 1887, with an intensity of VIII to IX on the Modified Mercalli Scale, is a close approximation of the maximum credible earthquake for Arizona.

There have been no deaths or injuries resulting from recorded earthquakes in the state (USGS, 1970). The epicenter of the first damaging earthquake recorded in Arizona was centered in Sonora, Mexico, in 1887. It was recorded as having an intensity of VIII-IX on the Modified Mercalli Scale at the epcicenter in Sonora. In Tucson, it was recorded at an intensity of VII-VIII. The Sonoran earthquake is a close approximation of the maximum credible earthquake for Arizona (Dubois and Smith, 1980). Accoridng to reports, it caused considerble damage to buildings but not deaths or injuries (Dubois and Smith, 1980). The San Xavier Mission in Avra Valley was also damaged (Dubois and Smith, 1980). In many valleys where the water table was near the surface and unconsolidated alluvial material was very thick, liquefaction occurred creating surface settlement, earthquake fountains, soil lurching and fissures (Dubois and Smith, 1980). The earthquake also had an effect on regional hydrology including creation of new springs, disappearance of former lakes and springs, and charges in well levels (Dubois and Smith, 1980). The ground vibration caused numerous rockslides including areas near Tucson and Phoenix (Dubois and Smith, 1980).

There have been at least 45 earthquakes (excluding aftershocks) with intensities of V or greater on the Modified Mercalli Scale within a 200-mile radius of the Phase B area (Table 39.). However, only four of these earthquakes have their epicenters within a 100-mile radius of the area and none are within 50 miles. The most recent earthquake located in Arizona had an intensity of VI and occurred in the Chino Valley, about 174 miles from the Phase B area. Three earthquakes of intensity VIII to X have occurred within 200 miles of the site. The most recent of these was approximately IX-X on the Modified Mercalli Scale and centered in Sonora, Mexico, in 1934. This earthquake was recorded at intensity V in Tucson and intensity IV in Phoenix. Earthquakes of intensity VII-IX were recorded in 1852 at Fort Yuma, on the Arizona-California border, and in 1887 in Sonora, Mexico.

Seismic hazard maps prepared by Algermissen et al. (1982) indicate that the area has a 2 percent probability of exceeding a value of 10 percent of gravity for horizontal acceleration on bedrock in a period of 50 years. Ten percent of gravity is the level of acceleration generally considered strong enough to produce some degree of damage to a weak construction. Based on this information, plus historical records and geological evidence, there is a possibility that a damaging earthquake could occur in the Phase B area. If an earthquake does occur it could be strong enough to damage some of the proposed project features (DuBois and Smith,

TABLE 39
EARTHQUAKES WITHIN A 200-MILE RADIUS OF
PROPOSED CONSTRUCTION PROJECTS
TUCSON AQUEDUCT-PHASE B
(FROM NOAA, 1982)

Year	Locality	N. Lat.	N. Long.	Modified Mercalli Intensity	Approximate Distance of Epicenter from Construction Project (Miles)
1852	Near Fort Yuma, AZ	33	114.5	VIII-IX	195
1887	Sonora, Mexico	31	109	VII-IX	139
1906	Flagstaff, AZ	35.2	111.7	VII	194
1916	Eastern AZ	34	110	V	127
1931	Eastern AZ	34	110.5	V	115
1931	Cottonwood, AZ	35	112	V	182
1934	Silver City, NM	32.7	108.2	V	171
1934	Sonora, Mexico	31	114	IX-X	194
1935	Wellton, AZ	32.8	114.2	VI	179
1938	AZ-NM border	33.2	108.6	VI	150
1941	Sonora, Mexico	31	114	VII-VIII	194
1945	Sonora, Mexico	31	114	VI-VII	194
1945	Sonora, Mexico	31.5	114	V-VIII	173
1949	Sonora, Mexico	32.1	113.9	V	158
1950	Southwest AZ	32	113	V	111
1951	Southwest AZ	32	113	V	111
1952	Sonora, Mexico	31.5	113.6	VI-VIII	150
1953	Central AZ	34.8	111	V	158
1956	Near Sells	32	112	VI-VIII	58
1957	Sonora, Mexico	32	114	V	164
1958	Southwest AZ	32.5	113.5	V	154
1959	Flagstaff, AZ	35.2	111.7	V	194
1960	Sonora, Mexico	31.5	113	V	173
1961	Southwest AZ	32.2	112.5	V	79
1963	Southwest AZ	32.4	113.7	V	146
1963	Southwest AZ	33.2	110.7	V	72
1963	Sonora, Mexico	30.7	113.8	VI-VII	181
1963	Sonora, Mexico	32	113.3	V	125
1964	Sonora, Mexico	32	113.9	V	158
1964	Sonora, Mexico	31.8	114.1	VI-VII	174
1964	Sonora, Mexico	31.8	113.6	V	144
1964	Sonora, Mexico	31.7	113.7	V	153
1964	Sonora, Mexico	31.6	114.1	V	177
1964	Sonora, Mexico	31.6	113.6	V	149
1964	Sonora, Mexico	31.5	114.2	V	185
1964	Sonora, Mexico	31.3	114.1	V	182
1964	Sonora, Mexico	31.5	113.7	V	158
1964	Southwest AZ	32.3	113.7	V	146
1966	Sonora, Mexico	31.8	114.5	VI	195
1966	Sonora, Mexico	31.2	113.3	VI-VIII	142
1969	Sonora, Mexico	31.3	114.1	VI-VIII	177
1969	Near Globe, AZ	33.4	110.6	VI-VII	75
1975	AZ-NM border	32.8	108.7	VI-VII	142
1976	Near Prescott, AZ	34.7	112.5	VI	174

COMPARISON OF RICHTER-GUTENBERG AND MODIFIED
MERCALLI SCALES (GUTENBERG AND RICHTER, 1956)

Magnitude	2	3	4	5	6	7	8	8.5
Intensity	I-II	III	V	VI-VII	VII-VIII	IX-X	XI	XII

1980). Holzer (1979) theorized that unloading of the earth's crust by removal of large amounts of groundwater may induce earthquakes.

Reports of liquefaction in southern Arizona occurred after the 1887 Sonoran earthquake. These reports mostly concerned the alluvial valleys trending northward from the epicenter. At that time, however, the water table was within a few meters of the surface.

Following this event there were reports of rock falls in the mountains as far north as Phoenix. Steep slopes adjacent to the aqueduct and pumping plants would be examined to locate areas of potential rock falls or landslides. However, this is not expected to be a problem in the vicinity of the Tucson Mountains. There may be potential for earthflows or tailings material in the tailing pond near the end of the aqueduct.

9. Construction Impact Analysis

Although there has been little measurable subsidence in the Phase B area, portions of the proposed alinements are in areas where future subsidence is suspected. The affected portions of the alinements could require special design and/or maintenance to maintain desired gradients.

If post-construction subsidence occurred along the aqueduct it would locally change the invert gradient of the canal causing local sags and allowing water to overflow. Design and construction practices have been developed in subsiding areas to overcome the affect of subsidence and prevent overflow. These, in effect, deepen the canal (add freeboard) so that the water surface will always have the desired gradient, regardless of the gradient of the canal bottom. The operating water levels in the canal in the areas of greatest suspected future subsidence would be placed several feet below the natural ground surface. This would provide for a like amount of future subsidence. Also, additional freeboard in the form of higher canal lining can be added to the canal wherever and whenever additional subsidence may occur. Since deep subsidence is a gradual phenomenon and dependent on the amount of future ground water decline, the greatest economy may be to provide freeboard for only part of the maximum subsidence during construction and to raise the lining later as needed.

Although there are no known earth fissures along any of the proposed alinements there is some potential for future earth fissuring in and near the areas of greatest predicted subsidence, such as the northern part of the Avra Valley, the central Tucson area and the irrigated lands along the Santa Cruz River near Sahuarita. Detailed geophysical surveys and core drilling will be conducted along portions of the selected alinement that cross any of these areas. If it is determined that a significant potential for future earth fissuring exists, special considerations can be incorporated into the design of the canal. These would include such measures as special universal joints to accomodate differential subsidence and vertical shift, extra reinforcement, and strategic location of check structures. There would also be additional surveillance during operation and maintenance.

No significant impacts to geological resources can be attributed to construction of the transmission system along these routes. Mountain soils would be disturbed along the edges of the Tucson Mountains. Erosional impacts would be mitigated so no significant adverse impacts would occur. If existing mining claims are crossed, some minerals may be unrecoverable for the life of the project. Negotiations with each leasee would mitigate this impact.

10. Comparative Analysis of Alinements

Table 40 shows comparative analyses for the Tucson Aqueduct-Phase B alternatives in terms of subsidence and earth fissure occurrence, mineral potential, materials availability, excavation conditions, engineering characteristics, ground water problems and seismicity. Those routes which cross areas of predicted future subsidence and/or earth fissuring would require special designs.

11. Indirect Impacts

Initially, the impact of the Tucson Aqueduct-Phase B water deliveries on the geologic conditions of the area would be positive, because it would substantially reduce, or at least slow, the local overdraft of ground water subsidence and earth fissuring in the area.

Without CAP water importation, water levels in the area would continue to decline. Subsidence, resulting from overdraft, would probably occur and this could result in the formation of earth fissures. Damage to wells and structures in subsiding or fissured areas would probably occur, and urban areas near Tucson could be affected. Direct results of water level decline include higher costs to pump ground water from greater depths, and decrease in water quality with depth.

12. Short Term and Long Term Impacts

In the short term (10 to 15 years following initial water delivery), delivery of water to the Tucson Aqueduct service area would significantly lessen the amount of ground water withdrawn from the basins (AWC, 1978) and slow the rate of subsidence and earth fissure. If the amount of water that is pumped from the basins continues to increase, the addition of aqueduct water would not have long term effect on subsidence and earth fissuring in the Phase B area.

Commercial mineral deposits that might be discovered in bedrock shoulders beneath the proposed West Side alinement could become uneconomic to develop as a result of the proposed action.

H. Cultural Resources

The proposed project areas have never been systematically studied or inventoried for cultural resources. Because of this, Reclamation, in accordance with its Reclamation Instructions, "Identification and Administration of Cultural Resources" (Series 350, Part 376.11), has negotiated a contract for a series of studies designed to identify cultural resources in the area, analyze impacts of alternative plans, and prepare a plan for avoiding or mitigating adverse effects of the project upon significant cultural resources. These studies were designed to mesh with the planning of the Tucson Aqueduct and were begun with the earliest planning phases. The studies were general in nature early in the planning process but became more focused and specific as the aqueduct design became more detailed.

TABLE 40
COMPARISON OF ALTERNATIVES

	West Side Alternatives	East Side and No Federal Action Alternatives
Seismicity	------------------ Moderate seismic risk hazard zone ------------------	
Ground-water Problems	Below excavation; perched water may be encountered.	Generally below excavation; flooding of Santa Cruz River may cause rise in water table; perched water may be encountered.
Engineering Characteristics	In alluvium prewetting necessary, little special foundation preparation.	In alluvium; prewetting necessary, little special foundation preparation. In rock; suitable backfill will be needed.
Excavation Conditions	99% common, 1% rock.	75% common, 25% rock
Materials Availability		
Embankment and retention dikes	--------------- Obtained from required excavation and side borrows within right-of-way ---------------	
Selected backfill in areas of rock cut	Available from nearby required excavation.	Borrow pits must be located
Concrete Aggregate	Commercial sources located within twenty miles. New sources may be developed.	Adequate commercial sources nearby
Mineral Potential	Moderate	Low
Subsidence Potential	Moderate to high likelihood	Low to moderate likelihood
Earth Fissure Potential	Moderate to high likelihood	Low to moderate likelihood

Reclamation employs a tripartite hierachy of data collection and interpretation. The first phase of study is complete. It consisted of Class I (overview) inventories of about 1,666 square miles (Figure 57) encompassing the entire Tucson Aqueduct Phase A and B project areas (Westfall 1979; McCarthy and Sires 1981). These studies summarized and evaluated previous research in the area and developed a model of cultural resource sensitivity zones for initial evaluation of alternative aqueduct alinements.

The second phase of study is a Class II (sample) survey. In this case, a large enough survey sample (about 18 percent) was already present in existing data files within a more refined project area of about 392 square miles to preclude the need for additional field survey. Instead, we opted for an indepth review of current data within the study area rather than collection of new data which would likely duplicate the existing data base. This second phase of study has been completed (Czaplicki and Mayberry 1983). The major goals of the study were to assess the resource potential and to rank the alternatives from least to most severe impact. Over 300 cultural resources had been identified within the study area. Results from other nearby non-CAP surveys allowed us to develop additional models of site density and sensitivity from which our earliest estimates of impacts and mitigation were derived.

The third study phase is a Class III survey which consists of an intensive on-the-ground examination of all areas to be affected by the project. Class III surveys are designed to: i) inventory all cultural resources within the project area; ii) evaluate the significance of the cultural resources that may be affected; and iii) provide information for developing plans to avoid, minimize, or mitigate adverse effects upon significant cultural resources discovered within the areas of direct impact. A Class III survey has been completed for the proposed West Side route.

A separate study of the secondary impacts resulting from delivery and use of water by municipal and industrial entities has also been completed (Dames & Moore 1979). Although the final allocation of water to be delivered through the Tucson Aqueduct - Phase B has not been made, this study uses the current estimates to predict the relative level of potential impacts upon cultural resources that could result from the construction of delivery systems as well as from projected changes in land use attributable to the delivery of CAP water.

The completed and ongoing studies will provide documentation for consultation with the Arizona State Historic Preservation Officer, the Keeper of the National Register of Historic Places, the Advisory Council on Historic Preservation, and other interested local groups as stipulated in the National Historic Preservation Act of 1966, as amended in 1980. These consultations have been initiated under provisions of a Programmatic Memorandum of Agreement signed between Reclamation and the ACHP and Arizona SHPO. These consultations will be pursued to insure that the Tucson Aqueduct surveys and the avoidance/mitigation plans are adequate and appropriate.

After the final environmental statement is prepared and construction of Phase B is authorized, the avoidance/mitigation plan will be implemented. Nonreimbursable funding will be made available in accordance with the Historical and Archeological Data Preservation Act of 1974 (88 Stat. 174).

1. Description of Existing Cultural Resources

Although previous cultural resource surveys in the study area are limited, they do indicate that numerous types of archeological and historical sites are present and that they vary considerably in composition and distribution. Current information indicates the area has been occupied since about 10,000 B.C., however, most of the prehistoric archeological sites date to the Hohokam era which lasted from about 300 B.C. to A.D. 1450. The historic record of occupation within the study area suggests that sites dating from the Spanish Colonial (A.D. 1692-1821), Mexican (1821-1853) and American (1853 - ca. 1930) eras are present including missions, mines, battle sites, forts, ranches, homesteads, villages, and travel routes (roads and railroads).

The Class I survey identified 539 prehistoric and historic archeological sites recorded within the 1666 square mile study area. Of these 17 are currently listed on the National Register of Historic Places (Table 41). Two other sites are listed on the Arizona State Register and an additional 26 are listed on the State Inventory. Although a significant portion of the study area has been surveyed for cultural resources the total number of sites present and, more importantly, site densities are undoubtedly much higher.

For the Phase B Class II survey a 392 square mile area was defined as the survey area (Czaplicki and Mayberry 1983). Of that total, approximately 18 percent, or 71 square miles, had been previously intensively surveyed for other various non-CAP projects. Therefore, it was decided to concentrate the Class II study on an in-depth review of the existing data base rather than survey a random sample of the area with little hope of enhancing the existing data base. In addition, useful predictive results were available from nearby Class III surveys for the Tucson Aqueduct - Phase A (Czaplicki 1984), Vekol Wash (Marmaduke and Bostwick 1982), Ak Chin (Marmaduke et al., 1983) and Chui Chu (Marmaduke and Robinson 1983) Projects. Site densities for these surveys range from 4.7 sites per square mile for the Ak Chin survey to over 14 sites per square mile for the Vekol Wash survey; this provides a collective average of 6.1 sites per square mile. These results suggest that about 2,400 sites could be located within the 392 square mile study area. These figures were used for comparison during plan formulation.

The Class III survey identified 33 prehistoric archaeological sites within the proposed West Side alternative impact zone. One site has been destroyed by farming activity; the remaining 32 sites are defined by site type on Table 42.

Actual site density for the West Side plan impact area (5,189 acres) is about 4.2 sites per square mile, a figure somewhat lower than expected.

2. Construction Impact Analysis

Potential impacts upon cultural resources from the proposed construction of Phase B of the Tucson Aqueduct would be both direct and indirect. Both types of impacts would be adverse to the extent that significant, intact sites are destroyed or altered.

Table 41

Number of Properties Listed

National Register of Historic Places

Within The Tucson Aqueduct - Phase B

Class I Survey Study Area

	Site	District	Multiple Resource District
Prehistoric		1	
Historic	12	3	1

Table 42
SUMMARY LISTING OF TUCSON AQUEDUCT - PHASE B ARCHAEOLOGICAL SITES
WEST SIDE PLAN

Site Type	Date	Area (Acres)	Location (Reach)	Predicted Impacts
Hohokam Villages				
AZ AA:12:384 (Fast Times)	Late Colonial Hohokam	45	4	major direct
AA:16:94 (Water World)	Late Colonial Hohokam	51	5	major direct
Hohokam Farmstead/ Fieldhouses				
AA:16:97	Late Colonial Hohokam	10	5	major direct
AA:16:104	Sedentary Hohokam	<1	6	major direct
AA:16:161	Sedentary Hohokam	<1	5	major direct
Limited Activity (Hohokam)				
AA:12:484	Pioneer Hohokam	<1	4	minor flooding
AA:12:125	Sedentary Hohokam	8	4	major direct
AA:16:129	Sedentary Hohokam	5	6	minor flooding
AA:11:29	Classic Hohokam	2	4	major direct
AA:12:465	Classic Hohokam	<1	4	major direct
AA:12:482	Classic Hohokam	2	4	major direct
AA:16:150	Classic Hohokam	<1	6	major direct
AA:16:162	Classic Hohokam	1	5	major direct
Limited Activity (Sobaipuri)				
AA:11:26	Protohistoric Sobaipuri	25	4	major direct
AA:16:159	Protohistoric Sobaipuri	<1	5	major direct
Limited Activity (Unknown)				
AA:12:383	?	3	4	minor flooding
AA:12:385	?	<1	4	major direct
AA:12:452	?	<1	4	major direct
AA:12:456	?	<1	4	major direct
AA:12:457	?	2	4	major direct
AA:12:458	?	<1	4	minor flooding
AA:12:483	?	<1	4	minor flooding
AA:12:485	?	1	4	minor flooding
AA:16:148	?	<1	6	major direct
AA:16:158	?	2	5	major direct
AA:16:160	?	2	5	major direct
AA:16:163	?	1	5	minor flooding
AA:16:165	?	<1	5	major direct
Quarry				
AA:16:95	?	2	5	major direct
AA:16:96	?	1	5	major direct
AA:16:157	?	5	5	major direct
AA:16:175	?	2	5	major direct

Direct impact would result from actual construction activities. Sites lying at pumping plant locations and within the path of open canals and pipelines would be partially or completely destroyed; the only difference in the extent of impacts would stem from the fact that pipeline corridors would be narrower than canal corridors and thus may destroy smaller areas of specific sites. Another type of direct impact would result from the increased flooding that would occur to any sites located within detention basins behind the dikes that would have to be constructed to prevent flood damage to open-canal segments. Sites situated on the low end of such detention basins could be substantially affected, while sites located at higher elevations would be inundated only infrequently and, therefore, minimally affected. Since the detention basins would be fenced, the sites located near the upper ends might, in fact, be more protected than under current conditions.

Two major types of secondary impacts are possible. Damage to archeological and historical sites could result from inadvertent recreational activities or intentional vandalism as the result of construction of new access roads into currently remote areas. Another type of secondary impact would result from the use of water delivered through the system. Entities receiving allocations would have to construct delivery systems, and any sites within the path of such construction would be adversely affected. Secondary adverse effects resulting from these types of terrain-modifying activities will be mitigated only if Federal funds are used or Federal licences are required for any of this development. (Impact on Indian lands will be considered by separate environmental analyses.)

Transmission line construction will also cause both direct and indirect impacts to cultural resources. They can be either physical or visual in nature. Direct physical impacts occur if the context of the resource is disturbed by construction activities. Direct visual impacts from transmission lines obscure a resource's relationship with its surroundings. Sites with notable architectural value are most susceptible to visual intrusions. The construction and operation of transmission lines can also impact cultural resources indirectly by creating new public access to areas containing archaeological sites.

Contrary to the situation posed by many other types of development, avoiding direct impacts to some cultural resources is a viable alternative within the planning and design of a transmission line. After alternative corridors have been evaluated for relative magnitude of effects, design modifications can be made which facilitate avoidance prior to and during final construction of the line. There is suitable existing access along all of the alternatives. The threat of damage from off-raod vehicles should not change from current status as a result of this development.

3. Comparative Analysis of Alinements

The Tucson Aqueduct Class I survey (Westfall 1979) and supplemental Class I survey (McCarthy and Sires 1981) predicted that the density of archeological sites would vary in accordance with natural vegetation zones. The Tucson Aqueduct-Phase A Class II survey tested this model and found that there are no statistically significant differences among site densities within vegetation zones (McCarthy 1982). In other words, site densities are consistent for this part of Arizona and the Phase B study area. Impact predictions for each of the alternatives are based directly on the acreage that would be disturbed by each plan. A comparative analysis of the alternative alinements is presented in Table 43.

Results of the Class III survey for the proposed West Side Plan indicate that 32 prehistoric archaeological sites would be affected (see Table 44). Impacts caused by the other west side construction scenarios are estimates, although large portions of these alternatives coincide with the proposed plan, and thus have been intensively surveyed for cultural resources. Site types range from large Hohokam villages to much smaller and more common temporary camps. No significant historic sites were identified by the Class III survey; historic sites which may be affected by the other alternatives would probably date from the turn of the century or later and would be related to ranching, farming, mining or transportation activities. None of the sites listed on the National or State Registers would be affected by any of the proposed plans. Impacts to cultural resources by a No Federal Action plan should be lower than those caused by any of the proposed action alternatives. Areal impacts are estimated to be less than 1300 acres and the comparison shown on Table 43 shows an estimated 12 sites will be impacted by the No Federal Action Plan. Only two archaeological sites are known to occur within that impact area.

4. Indirect Impacts

The extent of secondary impacts is much more difficult to estimate, because there is no estimate of the amount of terrain that would be disturbed by such impacts. Therefore, the level of secondary impacts can be rated only in relative terms. The level of secondary impacts is not expected to vary significantly among the alternative routes.

Construction of new access roads into currently remote areas has the potential for increasing impacts in the form of increased damage to archeological and historical sites through inadvertent recreational activity or intentional vandalism. However, the areas traversed by all the alinements are currently accessible by numerous roads and trails, and construction along any alternative route would not significantly increase access. Therefore, these types of secondary impacts upon archeological and historical sites are predicted to be low.

The impacts due to construction of delivery systems to water users in the Phase B service area are expected to be relatively low in areas where the distribution routes are located on agricultural or other developed lands. However, where distribution systems cross natural desert areas, effects on cultural resources would be much more severe.

Potential secondary adverse impacts will be mitigated only if Federal funds are used or Federal licenses are required for any of this development. It is anticipated that there will be substantial Federal involvement in the construction of delivery systems. Our commitment to mitigate impacts to cultural resources resulting from construction of the distribution systems has been addressed in the Water Allocations and Water Service Contracting EIS (1982). Briefly, Reclamation will insure that impacts are dealt with through avoidance or mitigation as is appropriate.

Table 43

Comparison of Project Directed Impacts Upon
Cultural Resources Tucson Aqueduct - Phase B
Central Arizona Project

Route	Direct Construction		Detention Basins		Total		Actual
	Acreage Required	Estimated No. of sites	Acreage Required	Estimated No. of sites	Acreage Required 2/	Estimated No. of sites	No. of Sites
West Side	1860	18 ± 6	3329	32 ± 11	5189	50 ± 17	32 3/
Sandario Road	1493	14 ± 5	2372	23 ± 8	3865	37 ± 13	24 4/
Sandario - San Joaquin	973	9 ± 3	1638	16 ± 6	2611	25 ± 9	10 4/
Sanders-San Joaquin Modification	1400	13 ± 4	2478	24 ± 9	3878	37 ± 13	26 4/
East Side	1620	15 ± 5	2730	26 ± 9	4350	41 ± 14	7 4/
No Federal Action	783	7 ± 3	480	5 ± 2	1263	12 ± 4	2 5/

1/ Several Class III surveys conducted in the vicinity of the Tucson Aqueduct - Phase B indicate a site density of 6.1 sites per square mile. This figure represents a fairly accurate statistical estimate and should be viewed in that light. The actual site density could range from 4.0 to 8.2 sites per square mile (± 2.1 sites per square mile) at a 90 percent confidence interval.

2/ These estimates do not include estimates for aggregate sources, haul and access roads, construction staging areas, or transmission line right-of-ways which may require some additional acreage.

3/ Based on Class III survey.

4/ Based on combination of Class II and III surveys.

5/ Based on Class II survey.

Table 44

Sites Recorded by the Tucson Aqueduct - Phase B Class III Survey Within Proposed Alternatives

Site No.	Site Type	West Side	Sandario-San Joaquin	Sandario	Sanders-San Joaquin	East Side 1/	No Federal Action
AZ AA:12:384	Hohokam Village	x		x	x		
16:94	Hohokam Village	x		x	x		
16:97·	Hohokam Farmstead/Fieldhouse	x		x			
16:98	Hohokam Fieldhouse/Farmstead		x				
16:104	Hohokam Farmstead/Fieldhouse	x	x	x	x	x	
16:161	Hohokam Farmstead/Fieldhouse	x		x	x		
12:484	Hohokam Limited Activity	x			x		
12:125	Hohokam Limited Activity	x	x	x	x		
16:129	Hohokam Limited Activity	x	x	x	x	x	
11:29	Hohokam Limited Activity	x			x		
12:465	Hohokam Limited Activity	x			x		
12:482	Hohokam Limited Activity	x		x	x		
16:150	Hohokam Limited Activity	x	x	x	x	x	
16:162	Hohokam Limited Activity	x		x	x		
11:26	Sobaipuri Limited Activity	x			x		
16:159	Sobaipuri Limited Activity	x		x	x		
12:383	Undated Limited Activity	x			x		
12:385	Undated Limited Activity	x	x	x	x		
12:452	Undated Limited Activity	x					
12:456	Undated Limited Activity	x	x	x	x		
12:457	Undated Limited Activity	x	x	x	x		
12:458	Undated Limited Activity	x	x	x	x		
12:483	Undated Limited Activity	x			x		
12:485	Undated Limited Activity	x			x		
16:148	Undated Limited Activity	x	x	x	x	x	
16:158	Undated Limited Activity	x		x	x		
16:160	Undated Limited Activity	x		x	x		
16:163	Undated Limited Activity	x		x	x		
16:165	Undated Limited Activity	x		x	x		
16:95	Quarry	x		x			
16:96	Quarry	x		x			
16:157	Quarry	x		x			
16:175	Quarry	x		x			
	Total	32	10	24	26	4	0

5. Duration of Impacts

Cultural resources are nonrenewable and, even if they are studied prior to disturbance and destruction, the loss of sites represents an irretrievable data set. Data recovery studies are able to mitigate this loss only to the extent of current research capabilities. Given the nature of the resources to be affected and the predicted level of direct impact upon the regional resource base, it is possible that a program of data recovery could compensate for the destruction of sites to the extent that the loss may be classified as acceptable. Secondary impacts are much less easily quantified and would certainly contribute to the ongoing attrition of the cultural resource data base of the project area.

I. Recreation

1. Description of Existing Conditions

Current recreation activities in the Tucson Aqueduct-Phase B study area are concentrated in the Tucson area. Within the urban setting of Tucson, outdoor recreation activities are primarily centered around neighborhood parks, schools, city parks, and county parks. On the outskirts of Tucson a variety of dispersed activities take place. Dispersed recreation in the form of hiking, nature study, sightseeing, and horseback riding are prominent in areas such as the Saguaro National Monument and the Tucson Mountain Park (TMP). In addition to dispersed recreation, which usually requires little or no facility development, both the TMP and the Saguaro National Monument have developed areas such as campgrounds, picnic areas, and a variety of other recreational areas.

Estimates of existing recreation activity participation in the study area are not available from the local land management agencies, however the 1977 Arizona Statewide Comprehensive Outdoor Recreation Plan (SCORP) and the 1983 Arizona SCORP Update prepared by the Arizona Outdoor Recreation Coordinating Commission identify those recreational activities which are in demand and are facility/area deficient. Both documents identify a variety of trail activities, such as bicycling, hiking , horseback riding, and pleasure walking/running, which are ranked high in the need for facility and area development and use. In addition, nature study areas, open space activities, and camping facilities were also determined to be in high demand.

In addition recreation problems identified for Pima County by the 1977 SCORP are encroachment of development, apathy, and lack of funding.

2. Construction Impact Analysis

The primary impacts of project construction on current recreational use could be that of the inconvenience of rerouting trail access to aqueduct crossings, particularly in the Avra Valley area. Based on general alinement maps it may appear that certain alinements might provide additional access into the Saguaro National Monument and Tucson Mountain Park. However, existing roads and the open desert area currently provide sufficient access. Currently the O&M roads along the CAP open aqueduct are not available for public use. A multi-use trail is being designed for the upslope side of the CAP right-of-way. The development of this trail is being coordinated with the Pima County Parks and Recreation Department (PCPRD) and is contingent upon a local municipal agency, such as PCPRD, entering into a Land Use Agreement with Reclamation and agreeing to manage the trail. Without the construction of the Tucson Aqueduct, recreational patterns will continue as they currently exist until development limits or excludes open desert access and users revert to public roads or trails for access to the Tucson Mountain Park and Saguaro National Monument areas.

Assuming that Phase B of the Tucson Aqueduct is constructed, it is anticipated that some level of recreational use impact will result. This impact is anticipated to be in the form of access inconvenience and the severity of the impact will be determined largely by the route selected and length of construction time. Open canal portions will require permanent crossings at all access road and trail intersections, while canal portions in pipe will require aqueduct crossings primarily during construction.

Mitigative measures to alleviate the potential reduced recreational access will include the provision of aqueduct crossings wherever aqueduct alinements and access roads or trails intersect. For those portions of the alinement in pipe, these crossings would be needed primarily during the project construction.

3. Comparative Analysis of Alinements

Various local agencies have expressed interest in the recreation potential along the Tucson Aqueduct. The recreation potential is in the form of a multi-purpose trail along the entire length of the CAP and potential day-use facilities and areas in flood detention basins on the upslope side of open canal portions. The establishment of the proposed CAP trail is being coordinated by Reclamation and the Arizona Hiking and Equestrian Committee. The potential for day-use development in the flood detention basins, along open canal portions, is largely dependent upon a willingness of local municipal agencies being willing to manage these areas.

The relative desirability of the various alinements for recreational development is based on several factors. These factors are the current and future management of the land adjacent to the canal, type of aqueduct (open versus closed), diversity of the terrain, quality of the scenery, and opportunity for continuous trail segments.

Potential recreation opportunities for the No Federal Action Plan would be totally dependent upon the local agency interests who might select to extend the CAP aqueduct from the end of Phase A to a water treatment plant. It is anticipated that the recreation opportunities available with this alternative will be of a low to moderate level. This is based primarily on the number of miles and location of open canal, which could provide trail recreation opportunities and related dispersed activities. The portion of aqueduct in pipe, between I-10 and the treatment plant, may not be available for recreation uses if it is placed under or adjacent to road right-of-ways, which is likely.

However, should the local interests funding this alternative choose, the aqueduct alinement could provide a moderate level of recreation should lands be acquired, developed, and managed for trail-related recreation activities. It is probably more likely that only portions of the alinement would be available for public recreation use which would result in a low level of recreation opportunities.

Using these factors, the relative desirability for recreational development along the alinements is displayed below:

Plan	Potential
West Side	Good
Sandario-San Joaquin	Moderate
Sandario	Moderate
Sanders-San Joaquin Modification	Moderate
East Side	Low to None
No Federal Action	Low to Moderate

4. Indirect Impacts

Construction of Phase B of the Tucson Aqueduct will not significantly change the current recreation trends or future-use patterns that would occur without the project. Trails developed along the route selected would not cause a major redistribution of recreation patterns as much of this area is currently open desert. It is also anticipated that any day-use areas opened for public use would be established as the adjacent areas become more developed, thereby accommodating the demand rather than generating demand.

5. Short and Long Term Impacts

Any of the proposed alternatives could result in minor pedestrian and vehicular access inconvenience to recreational users, in the vicinity of the Saguaro National Monument (west) and the Tucson Mountain Park. Detours to aqueduct crossing points would be required. Those portions of routes in pipeline would require these detours primarily during construction, however the need for some permanent accessible crossings may also be necessary depending upon the fencing and management of the aqueduct. Open canal portions require permanent accessible crossings for public recreation users. While it is anticipated that all the routes would require crossings for some duration, it is noted that those routes consisting of open canal will require more of these crossings. However, in the open canal areas, road crossings will be constructed with bridges to accomodate both vehicular and trail use, thereby limiting the negative impacts.

The Pima County Parks and Recreation Department have officially indicated their sponsorship of a multi-purpose trail along the CAP canal in Pima County and are working with Reclamation to establish the trail, trail-related facilities and recreation areas within the flood detention basins which are conducive to recreational development and use.

Under the Federal Water Project Recreation Act of 1965 (Public Law 89-72) Reclamation may enter into 50-50 cost-sharing grants with local municipalities for the development of recreational areas and facilities on project lands. The Recreation and Public Purposes Act authorizes the Secretary of Interior to lease project lands to the State or local municipalities for recreational purposes without requiring that recreational facilities be developed. These recreational areas, with or without facility development, must be open for public use and managed by the local entity.

J. Social

1. Description of Existing Conditions

The majority of the entities to be supplied by Phase B are in Pima County. Tucson, the second largest city in Arizona, is the economic center of the Phase B Service area. The area is one of rapid growth; the population of the county grew from 407,500 in 1972 to 567,900 in 1982, an increase of approximately 40%. The 1982 population is presented below.

Pima County	567,900
Tucson	354,400
Green Valley Continental (1981)	8,296
Nogales (Santa Cruz Co.)	17,449

Median family income for Pima County was $23,975 in 1982, essentially equivalent to the state of Arizona at $24,000. The small community of Avra is located to the west of the Tucson Mountains. The community is comprised of retirees and people who commute to Tucson to work. It is a fairly new community with most residents having lived there from 2 to 10 years.

2. Short Term Impacts

Construction of the aqueduct is not expected to impact the population of Pima County measurably. A study conducted by the Bureau on the Granite Reef Aqueduct of the CAP indicates that approximately 75 percent of the workforce are local workers. A peak construction workforce of approximately 250 workers is anticipated for on-site employment. If 25 percent are non-local, 65 workers would not be from the area. Due to the proximity of the major metropolitan area of Tucson this increase would not be noticeable.

When compared with the No Federal Action alternative, changes in the study area's social conditions as a result of the Proposed Action or Alternatives would be minimal. Population changes as a result of the Proposed Action are expected to be negligible. In turn, demands for additional housing and community services and facilities as a result of the Proposed Action are expected to be minimal, and only a small number of individuals in the study area would be affected.

Changes in the study area's economic conditions as a result of the Proposed Action or Alternatives are likely to be minimal. Construction and operation crews are expected to be drawn from the metropolitan labor force, so that income and employment changes would be considered positive, although insignificant in the context of total study area income and employment.

Because population changes due to the Proposed Action and alternatives would be negligible, the additional demand for public sector expenditures is expected to be equally insignificant.

With the selection of the West Side Plan as the proposed action, some of the residents living in the Avra Valley have organized with the objective of having the aqueduct placed in pipe on the west side. The main concerns are preservation of the Sonoran Desert, visual impacts, wildlife impacts, and safety of an open aqueduct on the fringes of a populated area.

Selection of the West Side Plan has caused distress for these residents. Some residents have stated that they chose Avra Valley as their home for its unique desert setting and that construction of the aqueduct will destroy the very qualities that attracted them to that particular location. They are distressed by what they perceive as the lack of considertion of their views in the decision making process. They sense the loss of control concerning the environment in which they have made their homes.

3. Comparative Analysis of Alternatives

Relocations will be few with any of the alinements under consideration. The East Side Plan and No Federal Action would require the most, approximately 35 families. The West Side Plan would require about 15 relocations and the Sandario Plan and the Sandario-San Joaquin Plan would each require 10 relocations. The Sanders-San Joaquin Modification Plan would require about 7 relocations. Families relocated would experience stress associated with having to move involuntarily. However, most relocated families would be able to adapt to relocation without significant difficulty because of their ability to maintain their lifestyle, their independence, and their self-reliance by staying in the area. All persons required to relocate will receive benefits of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (P.L. 91-646, 89 Stat. 1984). In the Sanders-San Joaquin Modification Plan, residents of Sanders Road may experience short-term inconvenience during the construction period because of construction activities and possible temporary traffic through their front yards.

The presence of an above ground transmission line should not disrupt the lives of anyone living or working in the vicinity of the transmission lines. Noise is not considered to be a problem (see Sound Quality discussion).

Corona discharges act as miniature spark transmitters to cause radio interference. This interference is dependent on the same factors wich cause corona, such as line voltage, atmospheric conditions, and spacing of the conductors; plus other factors including the distance between the transmission line and the point of interference, and the electrical frequency of the equipment being interfered with. Corona noise is generally not a problem when the transmission line voltage is below 130-kV. AM radios are most susceptible to radio interference while FM and TV frequencies (above 10 Mhz) are negligibly affected.

Electric and magnetic fields (measured in units of kilovolts per meter and Gauss, respectively) are responsible for induced voltages and currents in conductive bodies.

Voltages can be induced in ungrounded metal objects located in an electric field, such as under a transmission line. These metal objects can, inturn, produce an electrical shock in a person who touches them and provides a path for the current to ground. Typical types of ungrounded objects are wire fences having dry wood posts, vehicles with rubber tires, and wooden barns with large metal roofs. The electrostatic voltages induced on an ungrounded metal object are dependent upon the surface area of the object, the distance of the metal surface from the transmission line conductors, and the height of the object above ground. The magnitude of the discharged currents from these induced voltages depend on the transmission line voltage, the object size and shape, and the impedance of the current's path through the person touching the object to the ground (which varies according to the individual and manner in which the person is grounded). The threshold of shock recognition in most people is between 0.9 and 2.5 Milliampers (ma).

The transmission line would be designed to meet or exceed the safety requirements of the National Electrical Safety Code (NESC). The NESC states that the design of the line shall be such that "the electric field, or the effects thereof, shall be reduced..., as required, to limit the current due to electrostatic effects to 5.0 ma, if the largest anticipated truck, vehicle, or equipment under the line were short-circuited to ground." The 5.0 ma current is commonly acknowledged to be the "let-go" threshold for a small child.

A field of 25 kV/m is necessary to produce a 5 ma tough current from an ungrounded automobile through a normally dressed person under average conditions. The field maximum from the proposed transmission line is substantially less than 25 kV/m and therefore would not cause problems of this nature.

Fuel ignition and interference with cardiac pacemakers are other areas of concern associated with electric fields. Field strengths from the proposed transmission line are well below the field levels required to cause a spark of sufficient energy to cause fuel ignition. The conclusion drawn from available research on possible field effects on pacemakers is that the overall risk to pacemaker wearers from transmission lines is minimal. The threshold for interference to the most sensitive pacemakers is estimated to be 3.4 kV/m. Reversion of pacemakers is the most substantial effect noted to wearers of pacemakers and is not considered a serious problem. To date, no evidence that a transmission line has caused a serious problem to the wearer of a pacemaker has been found (Bracken, 1982).

Biological effects resulting from long-term exposure to electrical and magnetic fields generated by a 115-kV transmission line have not been reported. Research addressing the existence and implications of possible long-term effects is being conducted with humans and animals. In the past several years, several independent reviews of the research literature on effects of exposure to power-frequency electric fields have been performed. It is generally concluded from these reviews that there is no apparent hazard to human health from exposure to electric fields found under transmission lines. This is especially true for fields of less than 10 kV/m. Long-term exposure to magnetic fields generated by transmission lines has received less attention, but this is due to the fields being of a very low magnitude.

Exposures in the home from applicances are comparable to or greater than those from transmission lines (Bracken, 1982). Based upon the very low levels of electrical and magnetic fields expected to be generated by the 115-kV transmission line, and upon its proposed location, which would be away from occupied residences, it appears highly unlikely that long-term biological effects would occur.

4. Water Supply

Impacts of supplying water are described in the Central Arizona Project Final Environmental Statement (FES 72-35) and the Final Environmental Impact Statement, Water Allocations and Water Service Contracting, Central Arizona Project. Construction of Phase B will permit a wider dispersion of the population growth within Pima County by providing an assured water supply for Green Valley. However, the overall growth of the county as presented below is not expected to change, because of the assumption in the future without the project that City of Tucson would receive all M&I water allocated to Pima County. The City of Tucson has an established policy of acquiring farm land in Avra Valley from willing sellers in order to obtain associated water.

Phase B of the Tucson Aqueduct permits delivery of water to the San Xavier Indian Reservation and the Schuk Toak District of the Papago Indian Reservation. If the 37,800 acre feet delivered to these communities under the Southern Arizona Water Rights Settlement Act is used to develop agriculture to maximize Indian employment, approximately 70 jobs would be created. The Pascua Yaqui will receive about 500 acre-feet of water which they plan to use for agriculture; this will diversify their economic base.

Eastern Pima County has a diversified economy. The principal industries of Pima County are copper mining, manufacturing, tourism, education, and government. Over the last five years, employment in manufacturing has grown steadily, while employment in the mining industry peaked in 1981 at 7,900 and declined to 3,700 in 1983.

K. Potential Safety Hazards

As on other features of the CAP, appropriate fencing would be provided around structures and along right-of-way boundaries to prevent access by the public. Various types of fences and their use are discussed in the EIS for the Salt-Gila Aqueduct (Water and Power 1979: 18-19).

Safety ladders for human escape would be installed opposite each other at 750-foot intervals on each side of the aqueduct and immediately upstream of pumping plant forebays, siphons, and checks.

Other escape devices would be installed across the aqueduct at various locations, especially upstream of such structures as the pumping plants and siphons. These may include safety nets strung across the aqueduct extending below the water surface, and suspended cables with tracers or droplines extending to the water surface.

The top portion of the side slopes of the canal lining extending 5 feet vertically below the top of the lining would receive a nonskid, longitudinally-brushed finish to facilitate exit by small animals which may fall in.

No potentially dangerous impoundment of floodwaters is expected along the aqueduct route. Protective dikes, overchutes, and flumes would be designed to convey floodwaters across the aqueduct and to route floodflows to natural drainages with adequate capacity to convey those flows below the aqueduct.

A breach in the aqueduct embankment and lining could occur due to a seismic event or as the result of fissuring across the canal alinement, causing the discharge of aqueduct water in areas where the aqueduct is above normal ground surface. Although an event of this type is expected rarely, the aqueduct would be remotely monitored at all times. Should a breach of the aqueduct be detected, check gates would be closed by remote control or by hand, thus isolating sections of the aqueduct to minimize discharge of water from the damaged section.

L. Conflicts with Other Agency Programs, Plans or Policies

1. Biological Resources - U.S. Department of the Interior

a. National Park Service

All alternatives except the No Federal Action Plan will affect wildlife on the National Monument that are dependent, during parts of the year, on resources located in areas west of the Monument. Construction of a pipeline in this area would temporarily disrupt this movement while an open canal would permanently disrupt it as well as creating a drowning hazard. The Sandario Plan and the Sandario-San Joaquin Plan would be constructed in, or adjacent to, the Monument for 4.5 miles and could cause a long-term loss of some natural vegetation adjacent to the road and short-term construction disturbance to wildlife in the Monument. Mitigation for these impacts is discussed in Chapter III.A.3.

Significant opposition to the Sandario and Sandario-San Joaquin Plans has been expressed by the National Park Service (NPS). Because these alternatives traverse a portion of the Saguaro National Monument, NPS stated that construction of either the Sandario or Sandario-San Joaquin Plan conflicts with legislated management policies for areas of the National Park Service in relation to the protection and perpetuation of their character and composition. Further, 36 CFR, Chapter I, part 14, section 14.10 prohibits such projects without the specific approval of Congress.

b. U.S. Fish and Wildlife Service (FWS)

The Endangered Species Office has a candidate plant species (*Tumamoca macdougalii*) that is being considered for immediate proposal as a Federally endangered species and a species of plant (*Mammillaria thornberi*) that is proposed for the threatened list that will both be impacted by all of the project alternatives. If actually listed, consultation will be required with FWS to determine if project construction will jeopardize the existence of these species. Possible methods of minimizing impacts to these species are discussed in Chapter III.A.3.

2. Biological Resources - State of Arizona

All project alternatives pass through Game Management Area 37-C which is administered by the AGFD. Wildlife game species in this unit would be impacted by an open aqueduct in this area from drowning losses, movement disruption, habitat loss, and construction disturbance. Non-game management responsibilities have also been assigned to the AGFD and impacts to non-game species of wildlife impacted by project construction would also be in conflict with AGFD programs. Mitigation for these impacts is discussed in Chapter III.A.3.

3. Biological Resources - Pima County

All alternatives except the No Federal Action Plan will affect wildlife in the Tucson Mountain Park that are dependent, during a part of the year, on resources located in areas west of the park. Any construction between these two areas would disrupt wildlife movements, destroy habitat and if in open canal, create a drowning loss to wildlife moving between these two areas. In addition, the construction of the Tucson pipeline passing through the Tucson Mountain Park would cause temporary disturbance and the loss of vegetation. Mitigation for these impacts is discussed in Chapter III.A.3.

M. Compliance with Other Environmental Statutes

Project compliance with other environmental statues is summarized on Table 45.

N. Irretrievable and Irreversible Commitment of Resources

The construction and operation of the West Side Plan would irreversibly and irretrievably commit physical and environmental resources to the project. An irreversible commitment of these resources is considered the permanent loss of the resource.

1. Biological Resources

Biological resources permanently lost as a result of the West Side Plan include 367 acres of wildlife habitat, the plants, mammals, birds, reptiles, and amphibians dependent upon this habitat, and those animals which will drown in the canal or be cut off from resources necessary to their survival, and the loss of future production from these animals.

2. Water Resources

The 161,900 acre feet of Colorado River which will be delivered through the Tucson Aqueduct will be committed to Tucson area and will be unavailable for use elsewhere.

3. Electrical Energy

The 174 gigawatt hours used each year to operate the Tucson Aqueduct will be unavailable for use elsewhere.

Table 45

Status of West Side Plan Compliance with other Environmental Statutes

Affected Resource	Statute	Requirements	West Side Plan Compliance Status
Wild & Scenic Rivers	Wild and Scenic Rivers Act of 1968 (PL 90-542)	Section 7 prohibits federal agencies from assisting or licensing water resource projects on or affecting any river designated for study as a potential component of the national wild and scenic river system. Section 5 requires consideration of wild and scenic rivers in planning water resource projects.	Full compliance. The only river in the route of the West Side Plan is the Santa Cruz River, which is an ephemeral stream. The Santa Cruz River is not listed, nor is it eligible for listing, in the Wild & Scenic Rivers System.
Air Quality	Clean Air Act of 1963, as amended 1970, Public Law 88-206.	Provides for the improvement, strengthening, and acceleration of program for the prevention and abatement of air pollution.	Construction specifications will require the contractor to carry out proper and efficient measures to comply with local air pollution regulations, or to reduce dust nuisances. The contractor would be responsible for preventing any nuisance to persons or damage to crops, orchards, cultivated fields, or dwellings, resulting from dust generated by this project.
Water Quality	Federal Water Pollution Control Act of 1972 (PL 92-500)/Section 404, Clean Water Act of 1977/Section 1424(e) of the Safe Drinking Water Act.	Requires a Corps of Engineers permit for the discharge of dredged or fill material into navigable waterways. An individual permit is not required if conditions of a Nationwide Permit apply. The West Side Plan complies with the conditions for Nationwide Permits (see Appendix D. Requires EPA review if a Federally assisted project would affect an aquifer which the Administrator of EPA has determined to be a sole source of drinking water for a community or area, and that contamination of such an aquifer would create a significant hazard to public health. The Administrator of EPA has determined that the Upper Santa Cruz and Avra-Altar Basins are sole source drinking water supplies for the Tucson Active Management Area.	Full Compliance. A Section 404 evaluation is included as Appendix D of this report. This evaluation satisfies the requirement for Reclamation compliance with Section 404. CAP is not subject to review under Section 1424(e) of the Safe Drinking Water Act. While authority exists for Federal assistance in construction of distribution systems through the Distribution System Loans Act (PL 84-130), the current plan is to provide the necessary systems by direct Federal construction under a validated repayment contract. Therefore, there is no Federally assisted action associated with the CAP subject to EPA review under Section 1424(e).
Recreational Resources	Federal Water Project Recreation Act, 16 USC 4601.	Provides for outdoor recreational and fish and wildlife enhancement for federal water projects, in coordination with existing and planned recreational developments.	Compliance is ongoing. Local agencies are interested in the formation of a multi-purpose trail along the entire length of the CAP and the formation of day-use facilities in flood detention basins on the upslope side of open canal portions. The feasibility of a CAP trail is being investigated by Reclamation and the Arizona Hiking and Equestrian Committee. The potential for day-use development in flood detention basins is dependent upon local municipal agency being willing to manage these areas. Recreation is discussed in Chapter III, I.

Table 45 Continued

Status of West Side Plan Compliance with other Environmental Statutes

Affected Resource	Statute	Requirements	Plan Compliance Status West Side
Biological Resources	Fish and Wildlife Coordination Act (PL 85-624)	Requires coordination with federal and state wildlife agencies (Fish & Wildlife Service and Arizona Game & Fish Department) for the purpose of mitigating and compensating for project-caused losses to wildlife resources.	Full Compliance. A Fish and Wildlife Coordination Act Report is on file at Reclamation and FWS.
Prime and Unique Farmland	Council on Environmental Quality Memorandum, Analysis of Impacts on Prime and Unique Farmlands, August 30, 1976.	Requires that federal agencies analyze the effects of their actions on prime and unique farmland, document these effects in an EIS where appropriate, and develop alternatives and/or mitigation measures.	Of the 96 acres of farmland to be used in the construction of the West Side Plan, none is classified as prime or unique. No further compliance required.
Floodplains & Wetlands	Executive Order 11988, Avoid Impacts Associated with Occupancy Modification of Floodplains, May 24, 1977 / Executive Order 11990, Avoid Adverse Impacts to Wetlands, May 24, 1977.	Agencies must determine whether their actions will affect floodplains and wetlands, consider alternatives, and include all practical measures to minimize impacts.	Full compliance. The Santa Cruz River contains a wetland area. The limited amount of riparian vegetation lost by construction will be reestablished. Wetlands outside the route will not be affected. Impacts to floodplains have been addressed in Appendix C of this report.
Endangered Species	Endangered Species Act of 1973, as amended. (PL 93-205).	Section 7 required consultation with the U.S. Fish & Wildlife Service to determine if federal project actions will affect threatened or endangered wildlife species, and to insure that any action authorized, funded, or carried out does not jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of habitat which is determined to be critical.	Compliance Ongoing. Thornber's Fishhook Cactus is proposed for the Threatened Species list and the Tumamoc Globeberry is being considered as an endangered species for proposal. Bureau is conferring with the U.S. Fish & Wildlife Service on Thornber's Fishhook Cactus and will implement any reasonable and prudent alternatives proposed by the F&WLS if they determine that the West Side Plan will jeopardize the continued existence of these species.
Cultural Resources	National Historic Preservation Act of 1966, as amended, Executive Order 11593, Protection and Enhancement of Cultural Environment, May 13, 1971 and implementing regulations under the Historical and Archaeological Data Preservation Act of 1974 (PL 92-291).	Federal agencies are responsible for the identification, protection, management, and nomination to the National Register of Historic Places resources which are located on federal lands and/or which would be affected by federal actions. Consultation with the Advisory Council on Historic Preservations and the State Historic Preservation Officer (SHPO) is required when a federal action may affect cultural resources on or eligible for inclusion on the National Register (Section 106 of the National Historic Preservation Act).	Compliance Ongoing. Reclamation has negotiated contracts for a series of studies to identify cultural resources in the area, analyze impacts of alternative plans, and prepare plans for avoiding or mitigating adverse effects of the project upon significant cultural resources. The completed and ongoing studies will provide documentation for consultation with the ArizonaState Historic Preservation Officer, the Keeper of the National Register of Historic Places, and the Advisory Council on Historic Preservation. These consultations have been initiated and will be pursued to insure that surveys and avoidance/mitigation plans are adequate.

4. Cultural Resources

The Class III survey indicates that 32 sites would be impacted as a result of the West Side Plan. No currently listed National Register sites would be affected.

5. Economics

Economic resources committed to the construction and operation of the West Side Plan would not be available for other uses.

6. Aesthetics

There would be irreversible changes in the aesthetic quality of the West Side alinement. These changes would result from the construction of the canal, pumping plants, and electrical transmission lines.

7. Geology/Soils

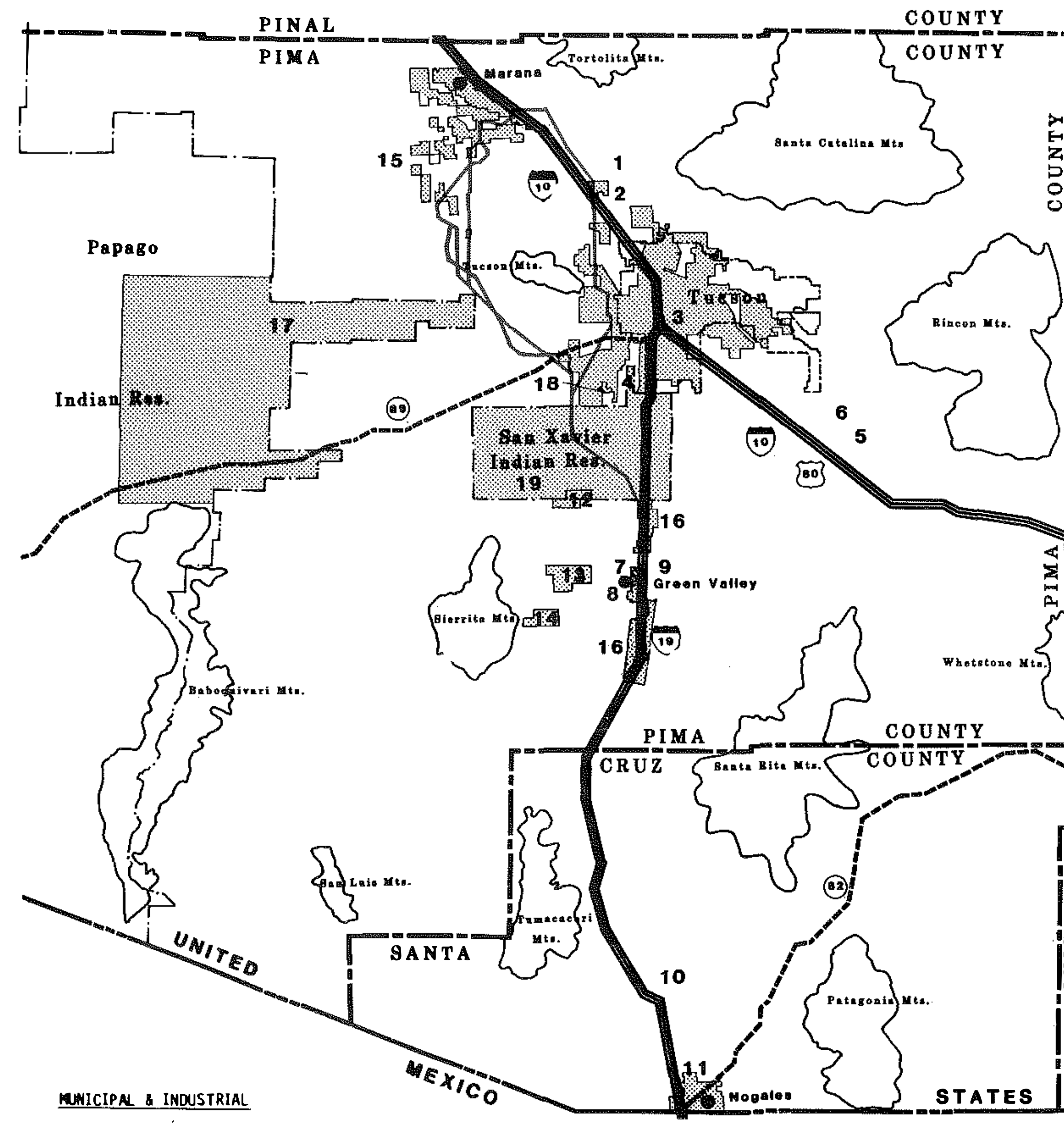
Sand, gravel and other soil fill material will be committed to the construction of the canal. Concrete will be committed to line the canals and fashion the buried pipeline. These material will be taken from borrow areas near the alinement or will be purchased from commercial sources. These materials will be unavailable for use elsewhere.

8. Land Resources

Land required for all project features, including canal and pipe alinement, access roads, transmission lines, and mitigation features, would be irreversibly committed to the project and would be unavailable for other uses.

IV. FIGURES

POTENTIAL TUCSON AQUEDUCT - PHASE B WATER USERS



MUNICIPAL & INDUSTRIAL

1. Foothills Water Co.
2. Flowing Wells Irrigation District
3. Tucson
4. Midvale Farms Water Co.
5. Ranch Lands Water Co.
6. Del Lago Water Co.
7. Green Valley Water Co.
8. Community Water Co. (Green Valley)
9. New Pueblo
10. Rio Rico (Citizens Utility Co.)
11. Nogales
12. Asarco Mission
13. Cyprus-Pima
14. Duval

NON-INDIAN AGRICULTURE

15. Avra Valley Irrigation District
16. Farmers Investment Co.

INDIAN COMMUNITIES

17. Schuk Toak (Papago Indian Res.)
18. Pasqua Yaqui Indian Reservation
19. San Xavier Indian Reservation

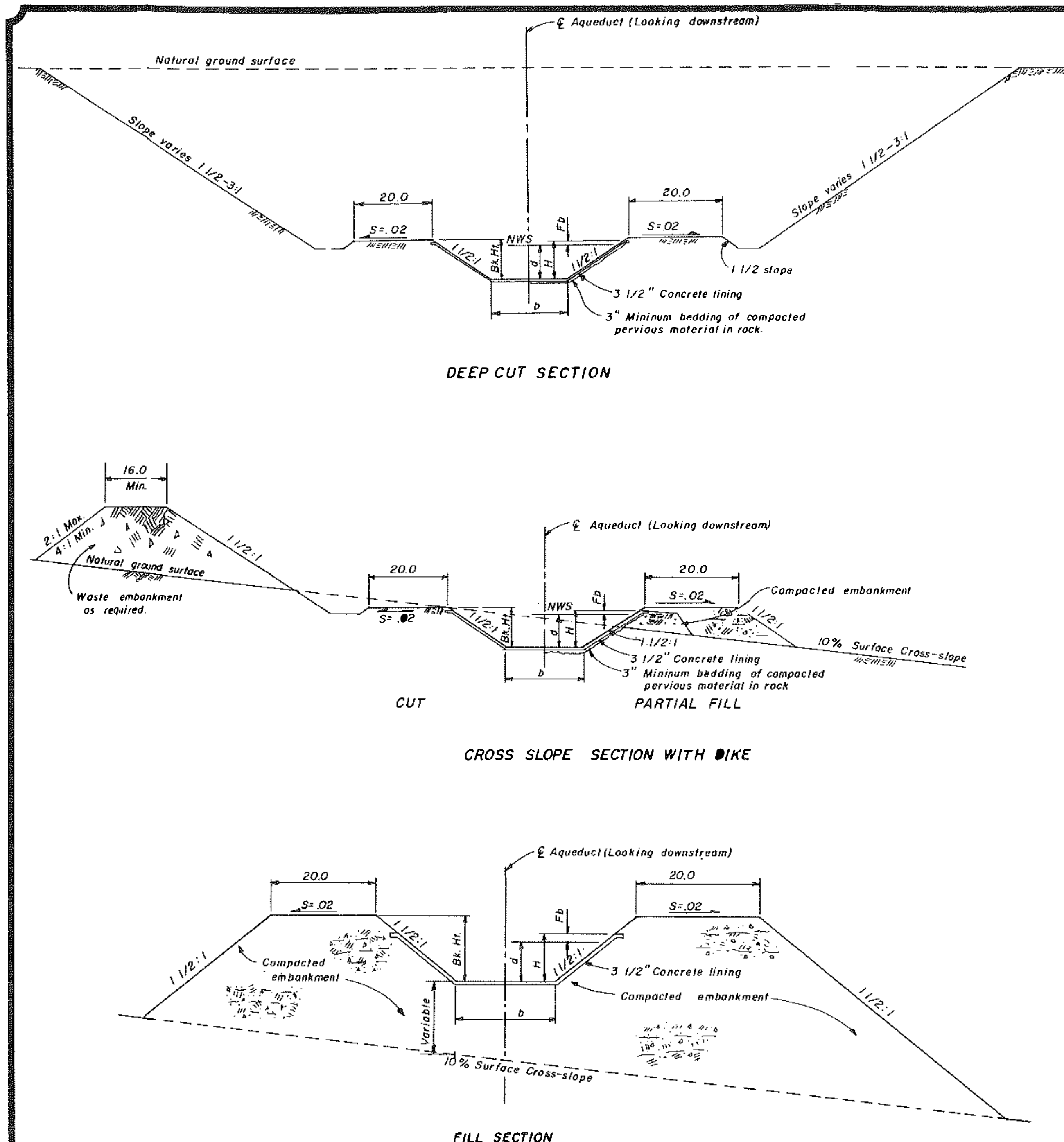
CENTRAL ARIZONA PROJECT

TUCSON AQUEDUCT - PHASE B

Dwn: RMM, PM

Figure 2
REV. MARCH 1985

344-330-4784



HYDRAULIC PROPERTIES

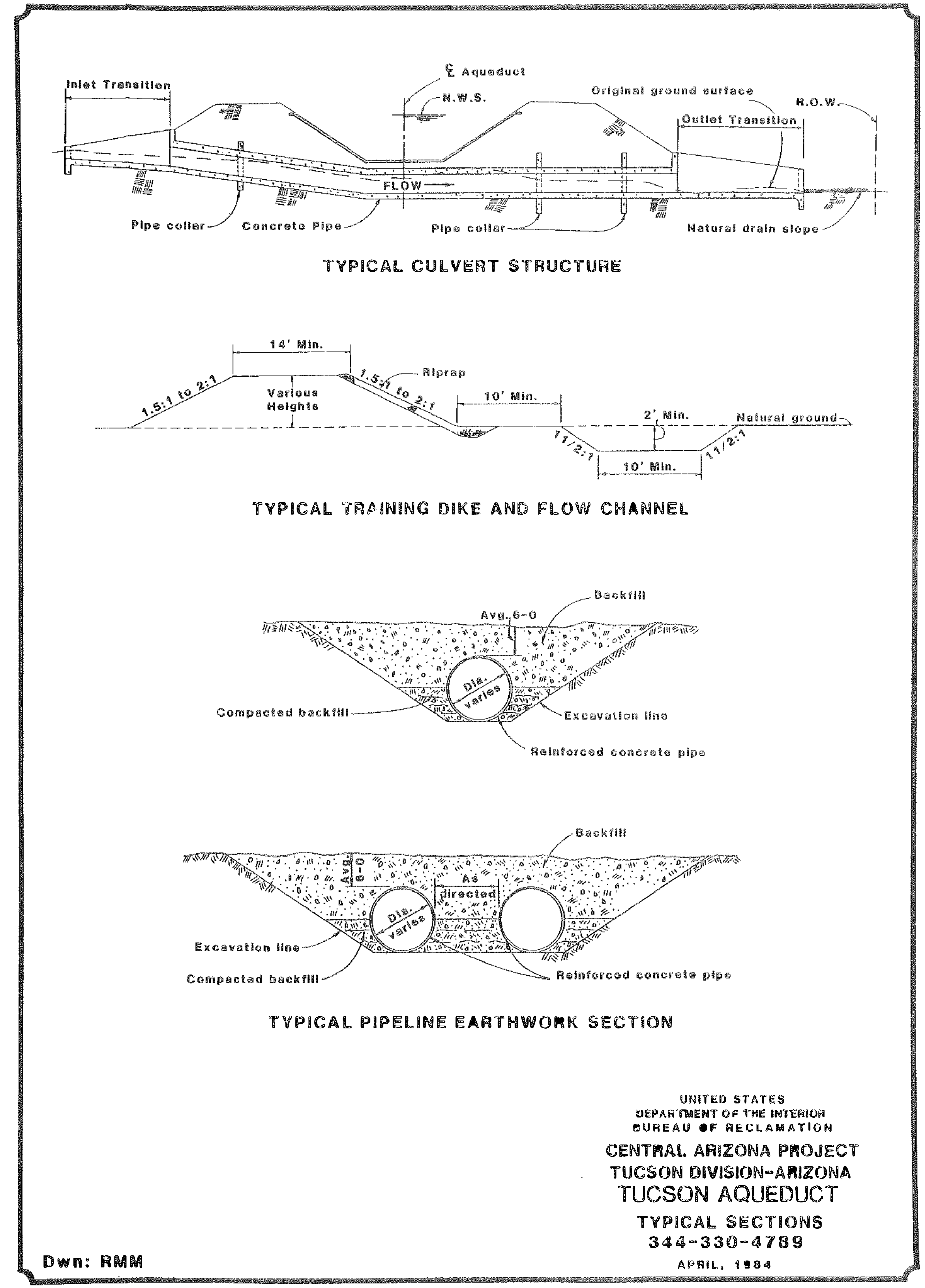
Q	b	d	A	V	n	s	Lining Fb	H	Bank Ht.	s:s
650	12	9.30	241.3	2.69	.015	.00008	1.40	10.7	12.5	1 1/2:1
575	12	8.76	220.2	2.61	.015	.00008	1.34	10.1	11.9	
550	12	8.58	213.4	2.58	.015	.00008	1.32	9.9	11.7	
525	11	8.36	196.8	2.67	.015	.00009	1.34	9.7	11.4	
200	7.5	5.18	79.1	2.53	.014	.00013	0.92	6.1	7.6	

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

CENTRAL ARIZONA PROJECT
TUCSON DIVISION-ARIZONA
TUCSON AQUEDUCT
TYPICAL SECTIONS
344-330-4790
APRIL, 1984

Dwn: RMM

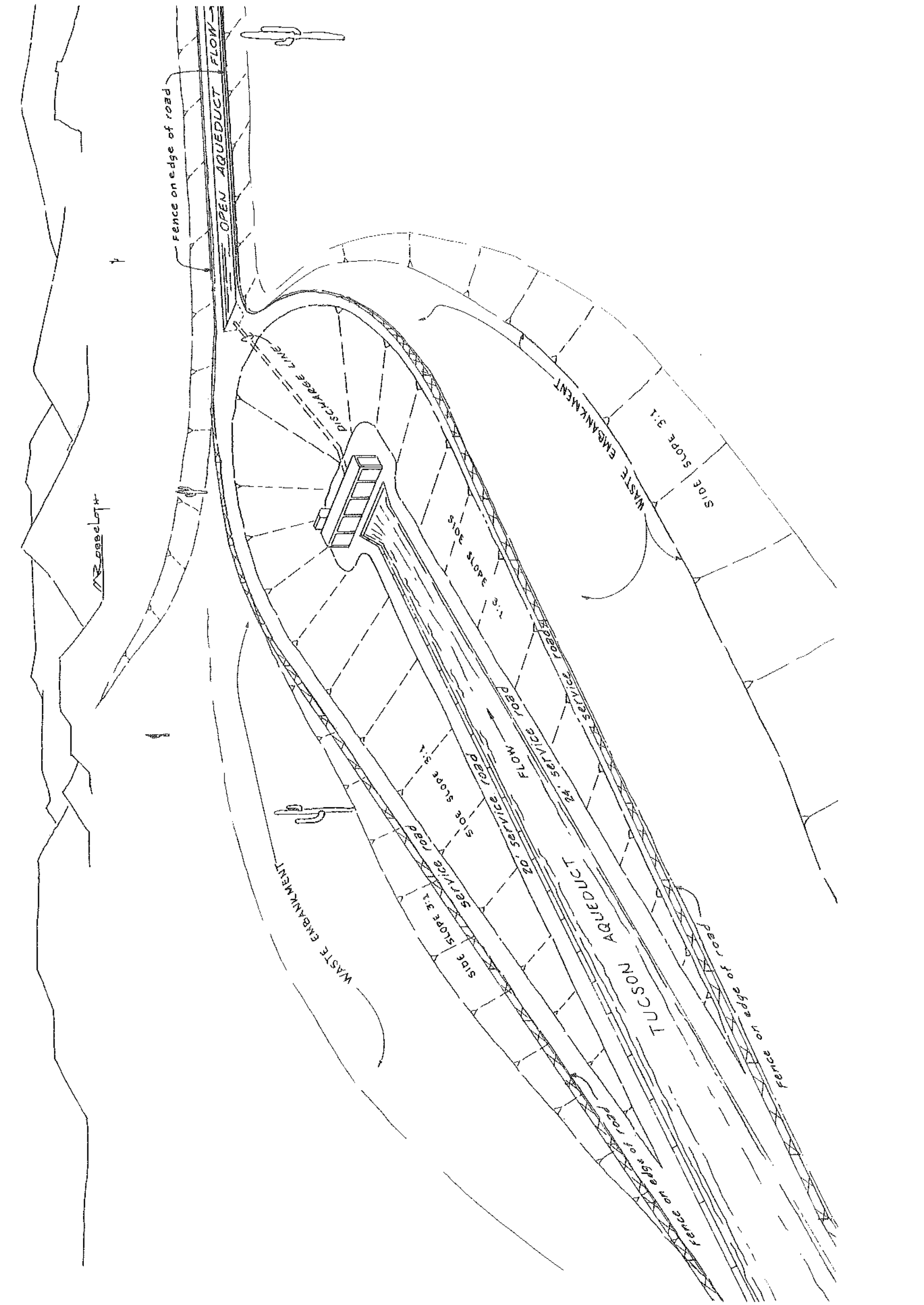
Figure 3



Inlet Transition
℄ Aqueduct
N.W.S.
Original ground surface
R.O.W.
Outlet Transition
FLOW
Pipe collar
Concrete Pipe
Pipe collar
Natural drain slope
TYPICAL CULVERT STRUCTURE
14' Min.
Riprap
1.5:1 to 2:1
Various Heights
1.5:1 to 2:1
10' Min.
2' Min.
Natural ground
1 1/2:1
10' Min.
1 1/2:1
TYPICAL TRAINING DIKE AND FLOW CHANNEL
Backfill
Avg. 6-0
Dia. varies
Compacted backfill
Excavation line
Reinforced concrete pipe
Backfill
Avg. 6-0
As directed
Dia. varies
Excavation line
Compacted backfill
Reinforced concrete pipe
TYPICAL PIPELINE EARTHWORK SECTION
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CENTRAL ARIZONA PROJECT
TUCSON DIVISION-ARIZONA
TUCSON AQUEDUCT
TYPICAL SECTIONS
344-330-4789
APRIL, 1984
Dwn: RMM

Figure 4

Artist's Concept
DEEP CUT APPROACH TO PUMPING PLANT



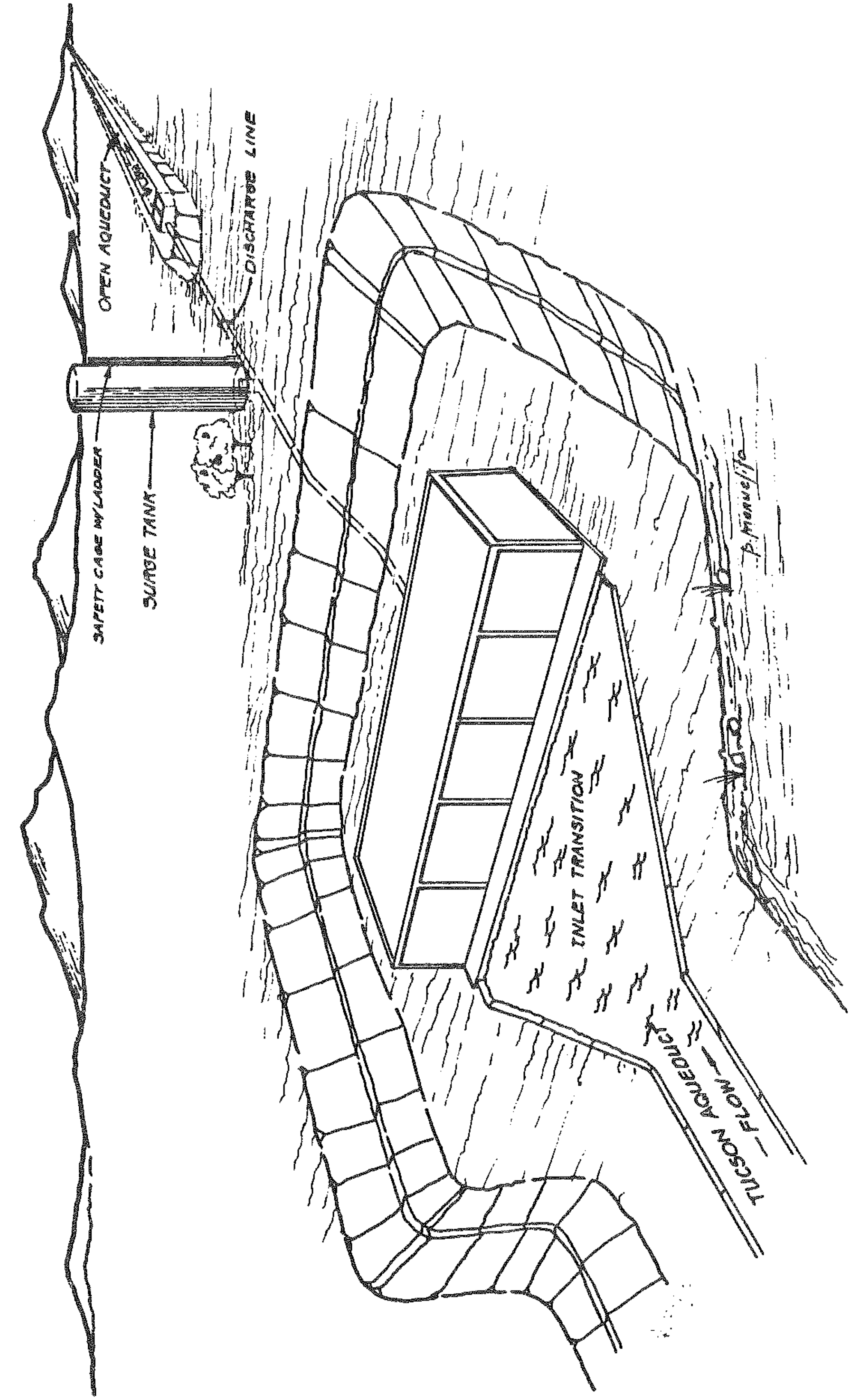
CENTRAL ARIZONA PROJECT

TUCSON AQUEDUCT-PHASE B

344-330-4803

Figure 5

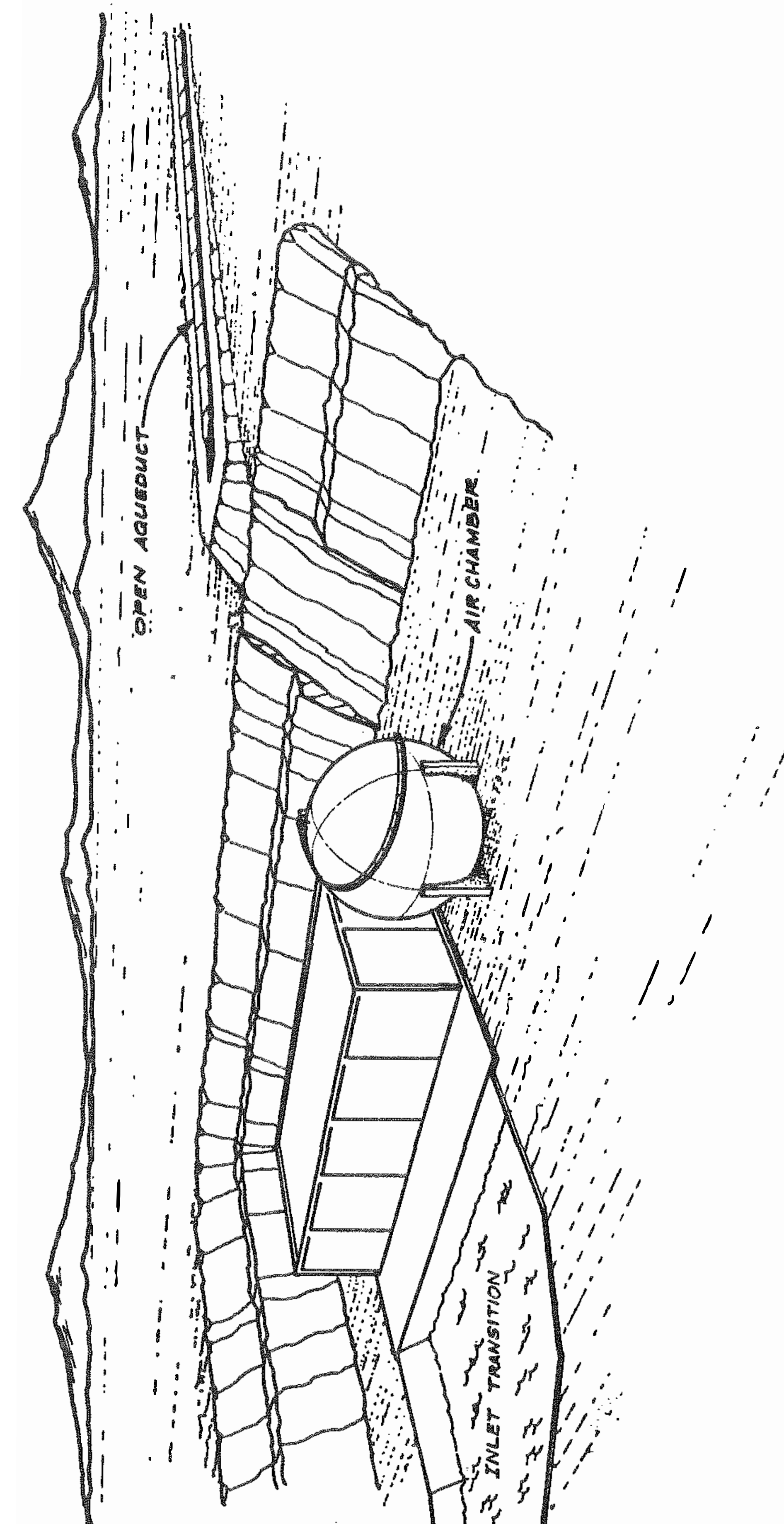
Artist's Concept
VIEW OF SURGE TANK



CENTRAL ARIZONA PROJECT

TUCSON AQUEDUCT PHASE-B
344-330-8275 Figure 6

Artist's Concept
VIEW OF AIR CHAMBER



CENTRAL ARIZONA PROJECT TUCSON AQUEDUCT-PHASE B
344-330-8276 Figure 7

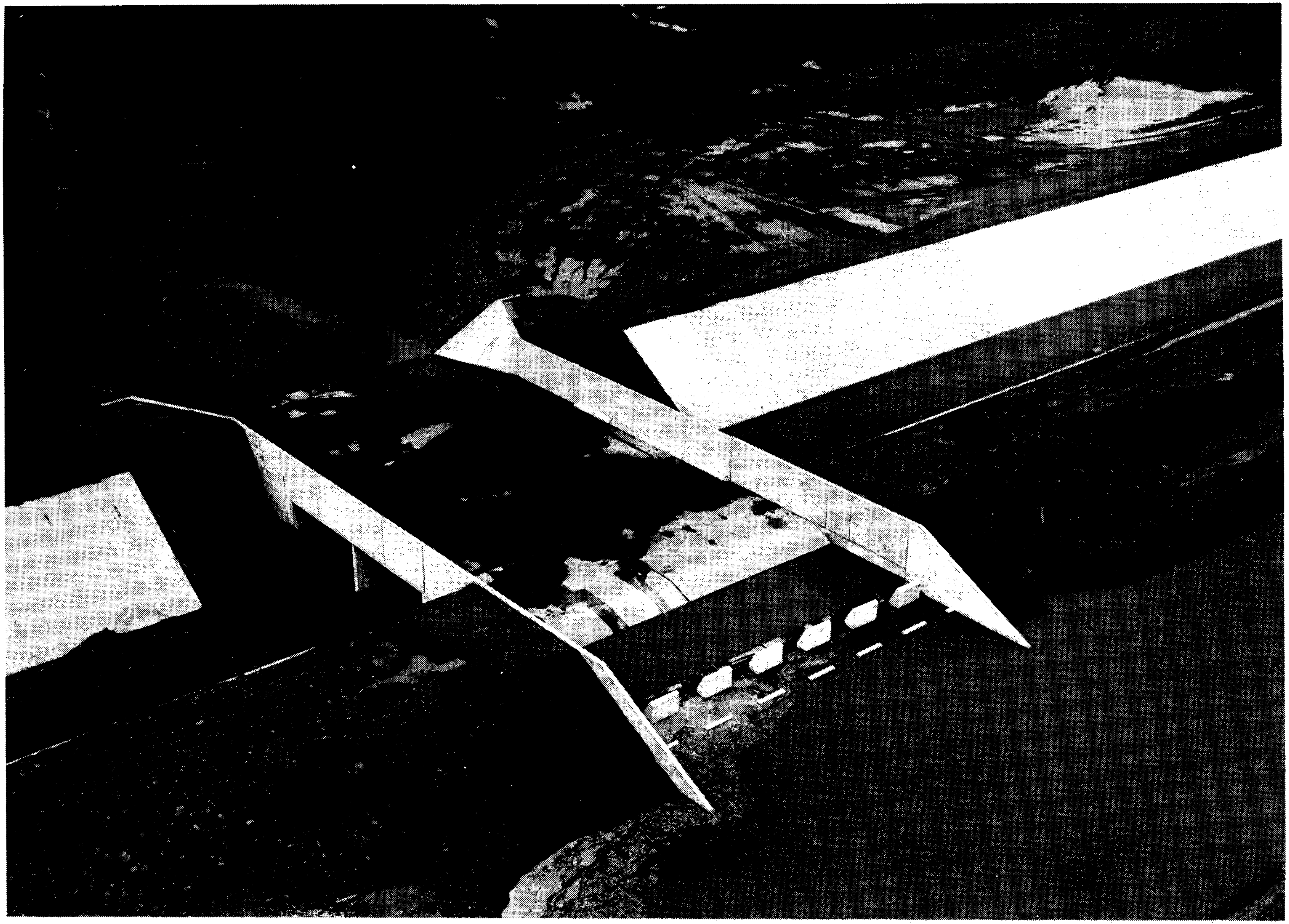


Figure 8. Box Flume Overchute--Granite Reef Aqueduct--Central Arizona Project. Aerial view showing a typical box flume overchute with hydraulic energy dissipators on the downstream side. This structure is similar to those that would be constructed on the Tucson Aqueduct. Photograph No. P344-300-02426

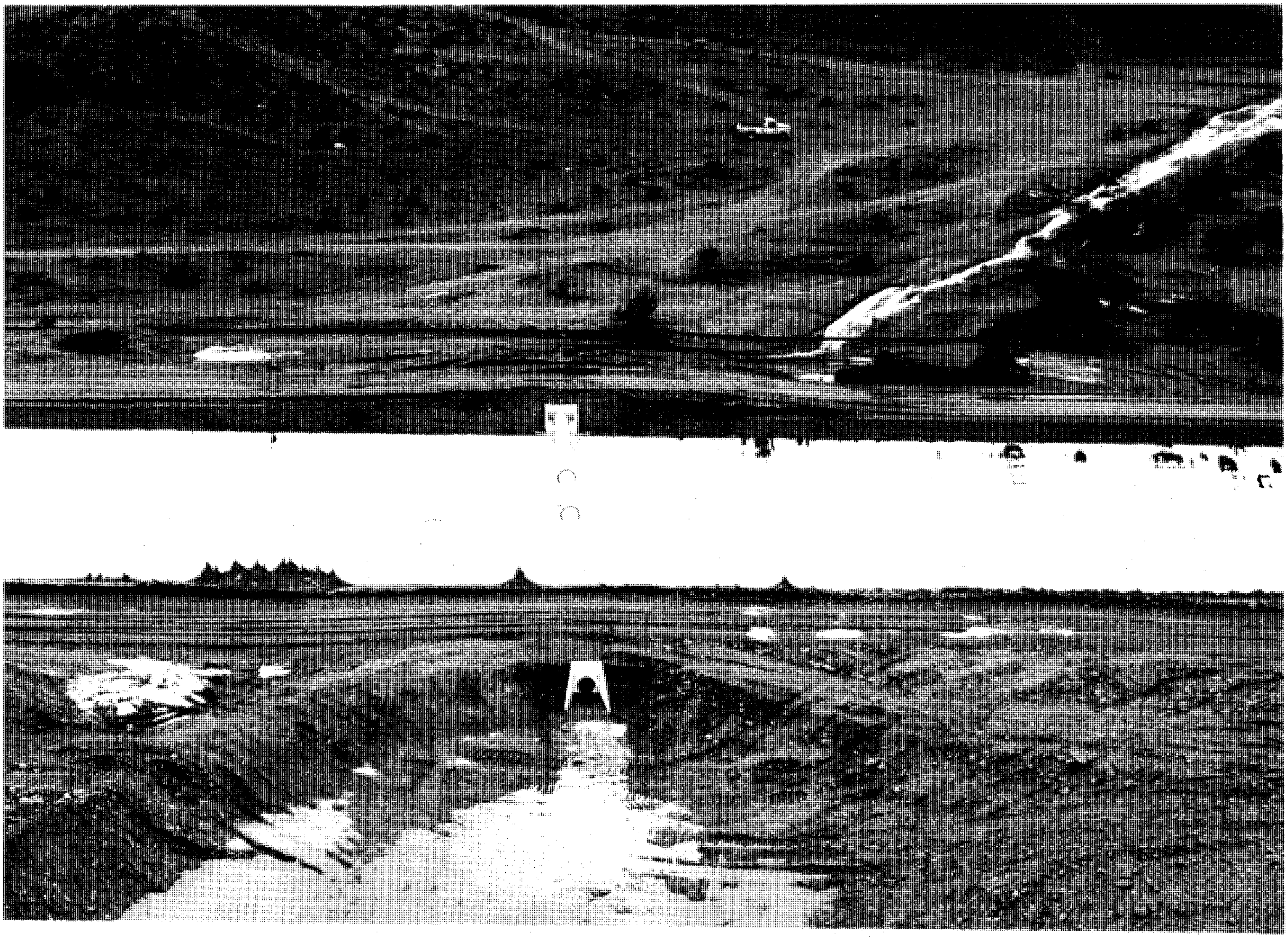


Figure 9. Pipe Overchute--Granite Reef Aqueduct--Central Arizona Project. Aerial view of a typical pipe overchute similar to those that would be constructed on the Tucson Aqueduct. Photograph No. P344-300-02424

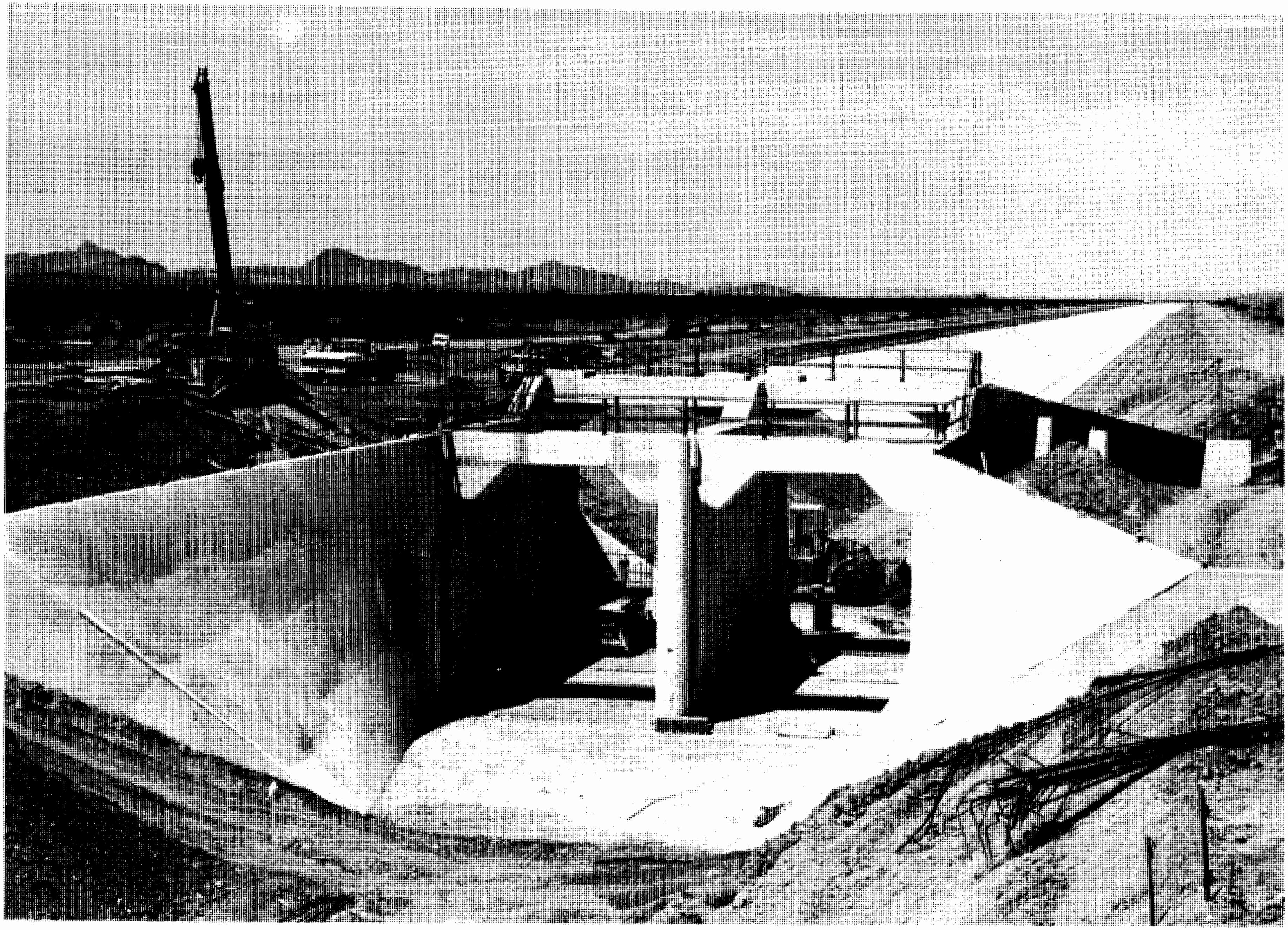
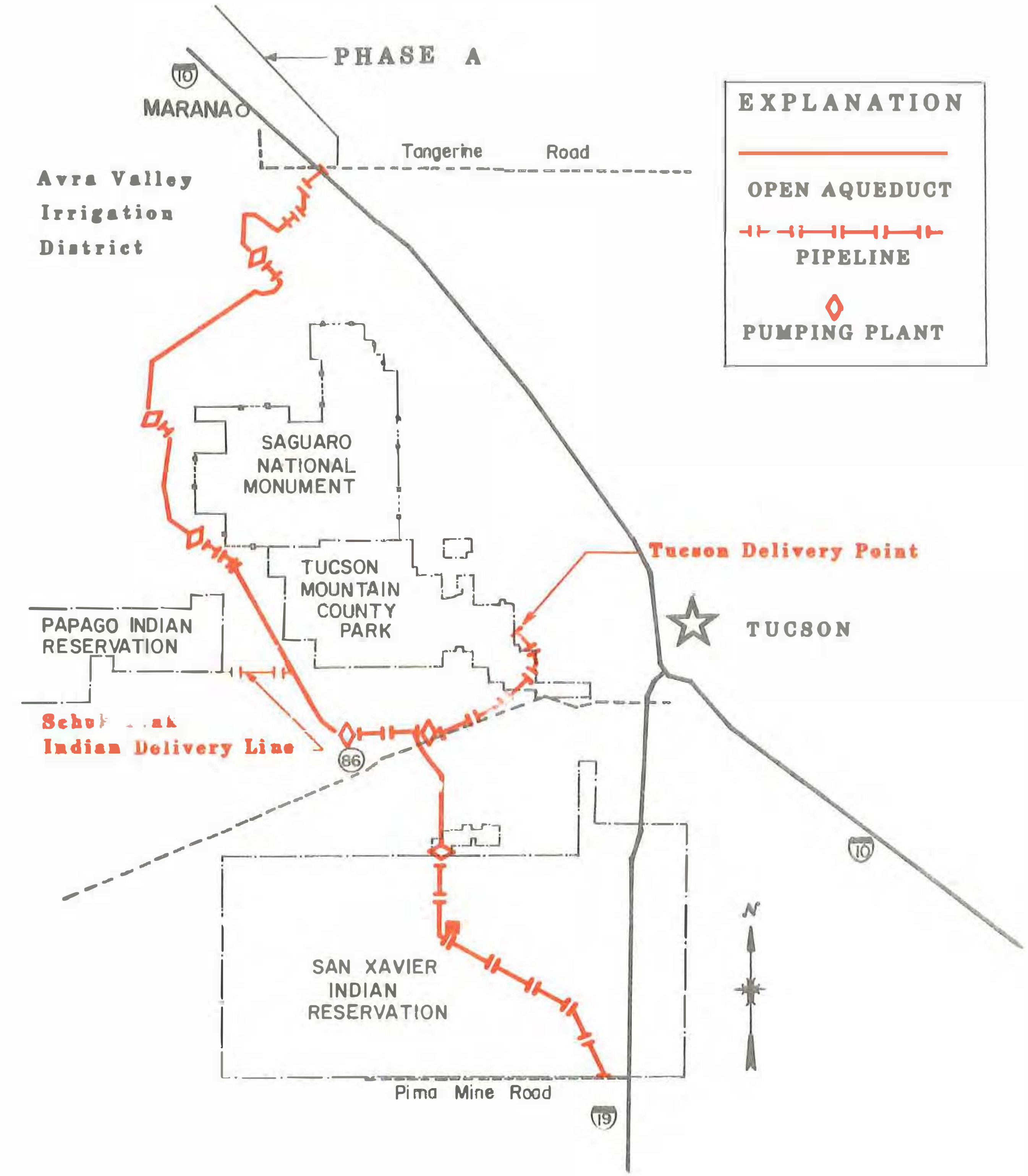


Figure 10. Check Structure Under Construction--Granite Reef Aqueduct--Central Arizona Project. A typical check structure similar to the type planned for the Tucson Aqueduct. Photograph No. P344-300-02196



344-330-5041
REV. MARCH 1985

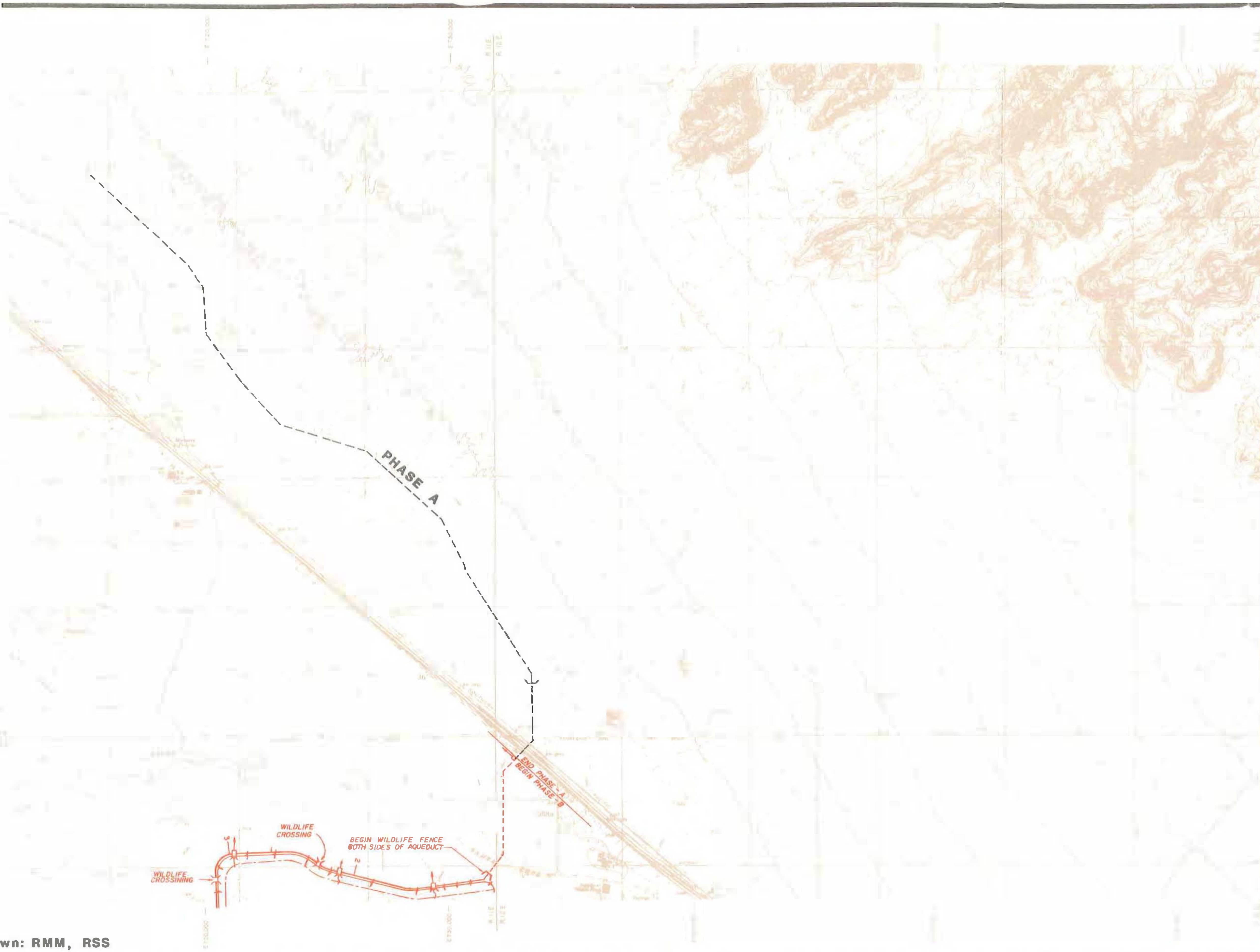
Dwn: RMM

WEST SIDE PLAN

CENTRAL ARIZONA PROJECT

TUCSON AQUEDUCT-PHASE B

Figure 1.1a



LEGEND

- OPEN AQUEDUCT
- PIPELINE
- PUMPING PLANT
- MILE MARKER
- TRANSMISSION LINE
- DIKE
- FLOOD DETENTION AREA
- CHECK STRUCTURE
- BRIDGE
- OVERCHUTE
- TURNOUT
- SPOIL AREA
- SIPHON

SHEET INDEX

4101 4102 4103 4104 4105 4106

2000 0 2000 4000 6000

SCALE OF FEET
CONTOUR INTERVAL VARIES

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

CENTRAL ARIZONA PROJECT
TUCSON DIVISION-ARIZONA

TUCSON AQUEDUCT-PHASE B
WEST SIDE ROUTE
AGENCY PROPOSED ACTION
344-330-4101

NOVEMBER 1984
REV. MARCH 1985

wn: RMM, RSS

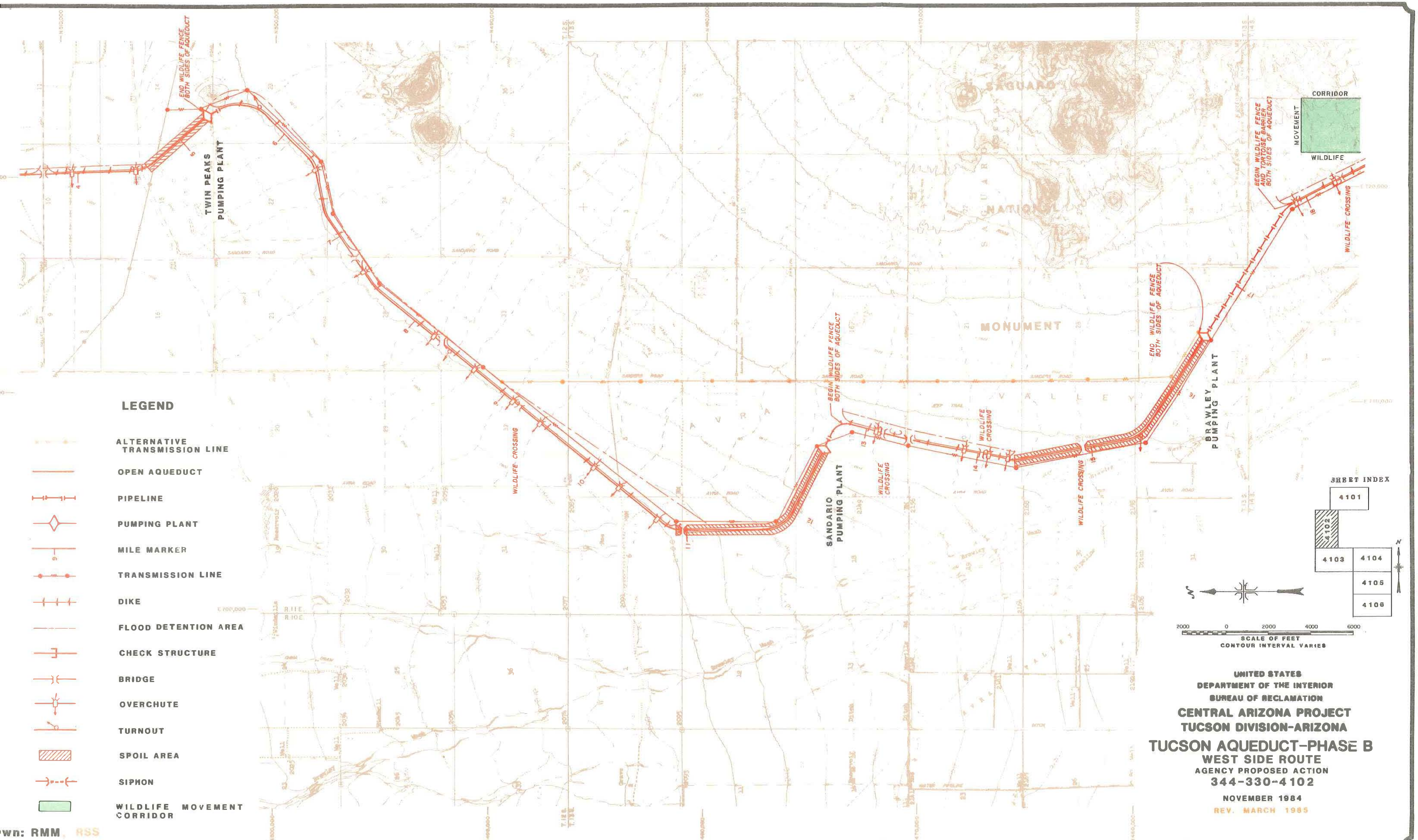

LEGEND
ALTERNATIVE TRANSMISSION LINE
OPEN AQUEDUCT
PIPELINE
PUMPING PLANT
MILE MARKER
TRANSMISSION LINE
DIKE
FLOOD DETENTION AREA
CHECK STRUCTURE
BRIDGE
OVERCHUTE
TURNOUT
SPOIL AREA
SIPHON
WILDLIFE MOVEMENT CORRIDOR
END WILDLIFE FENCE BOTH SIDES OF AQUEDUCT
TWIN PEAKS PUMPING PLANT
SAGUARO
NATIONAL
MONUMENT
AVRA
VALLEY
WILDLIFE CROSSING
BEGIN WILDLIFE FENCE BOTH SIDES OF AQUEDUCT
SANDARIO PUMPING PLANT
BRAWLEY PUMPING PLANT
BEGIN WILDLIFE FENCE AND TORTOISE BARRIER BOTH SIDES OF AQUEDUCT
CORRIDOR
MOVEMENT
WILDLIFE
SHEET INDEX
4101
4102
4103
4104
4105
4106
2000 0 2000 4000 6000
SCALE OF FEET
CONTOUR INTERVAL VARIES
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CENTRAL ARIZONA PROJECT
TUCSON DIVISION-ARIZONA
TUCSON AQUEDUCT-PHASE B
WEST SIDE ROUTE
AGENCY PROPOSED ACTION
344-330-4102
NOVEMBER 1984
REV. MARCH 1985
wn: RMM, RSS

Figure 12

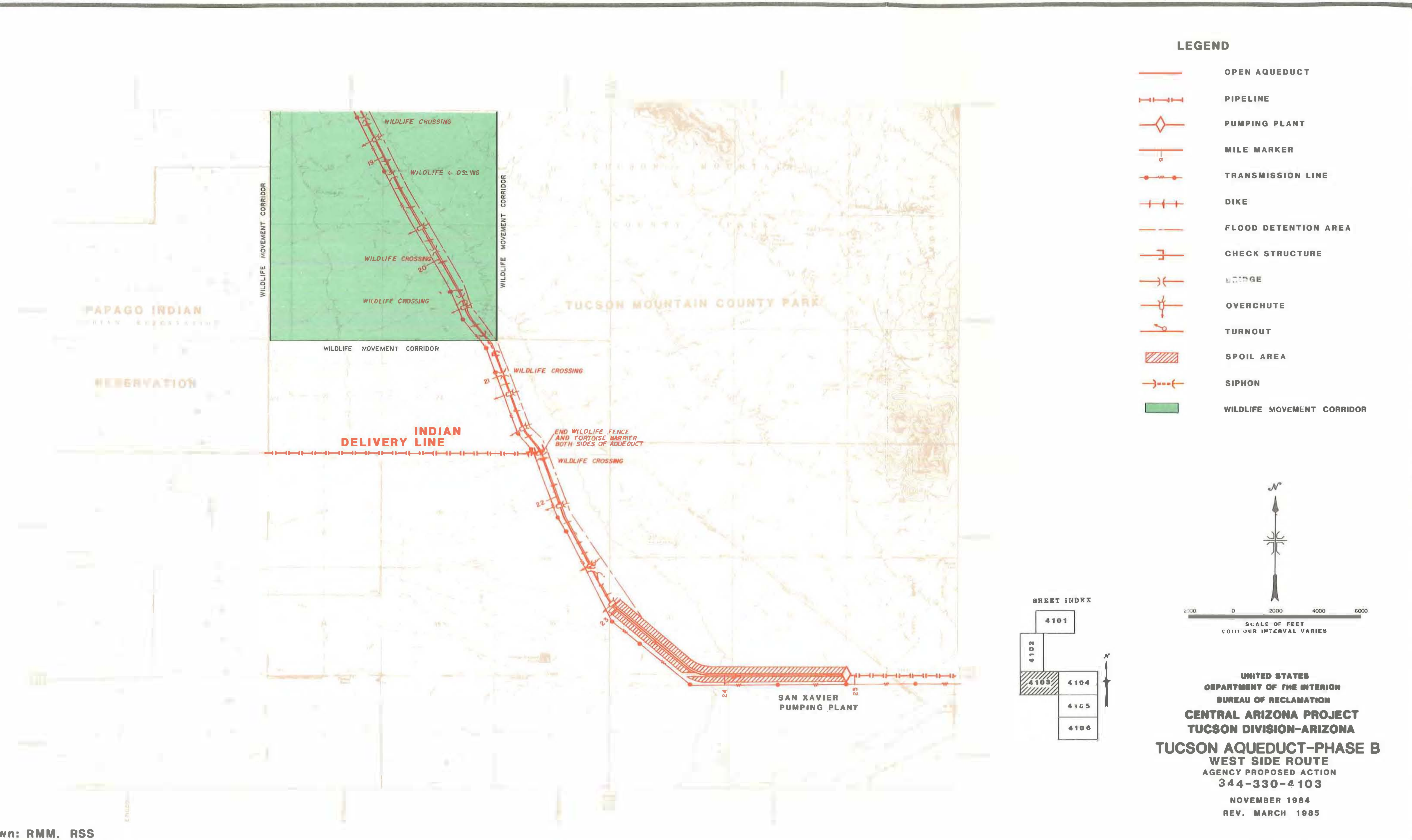
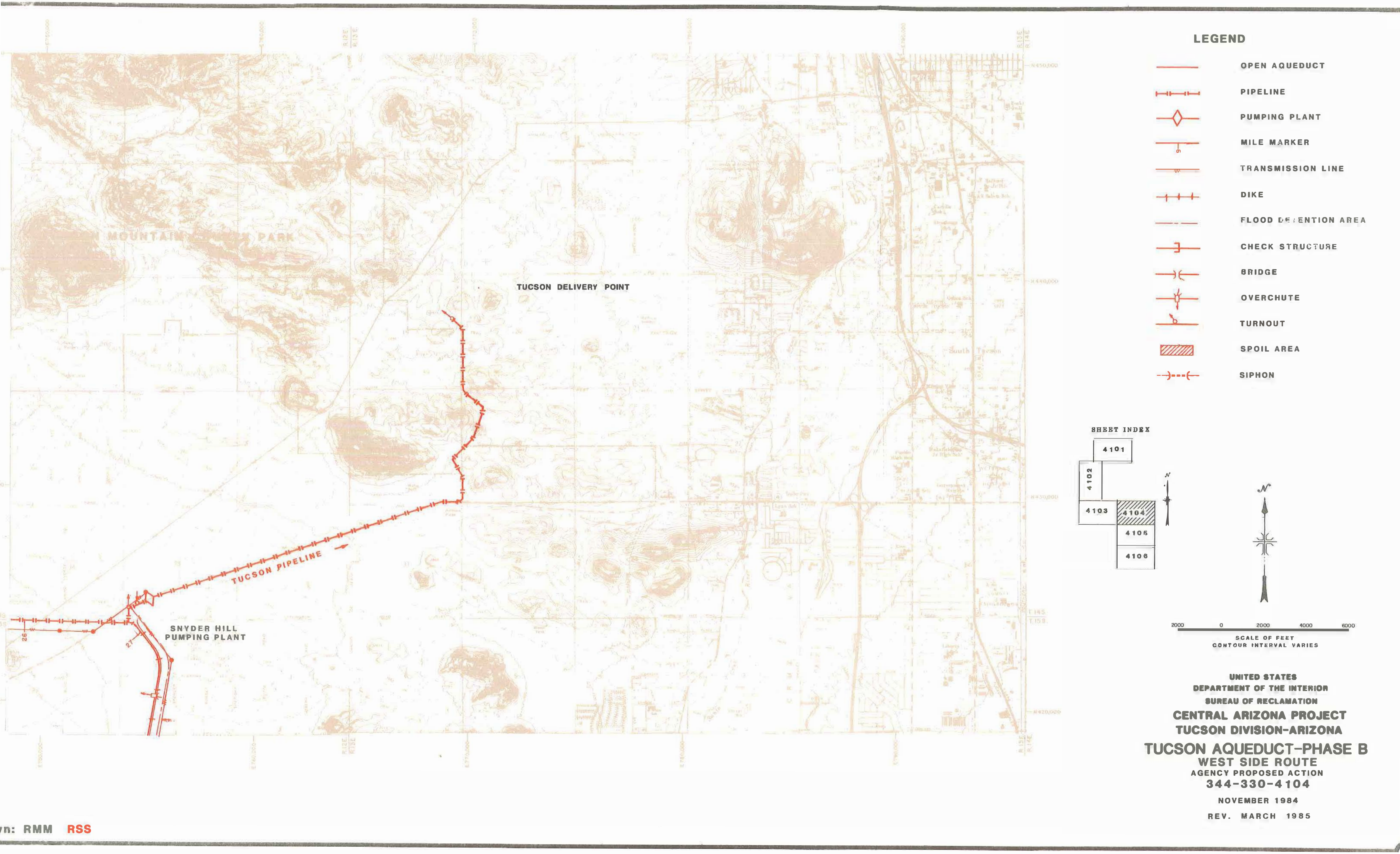
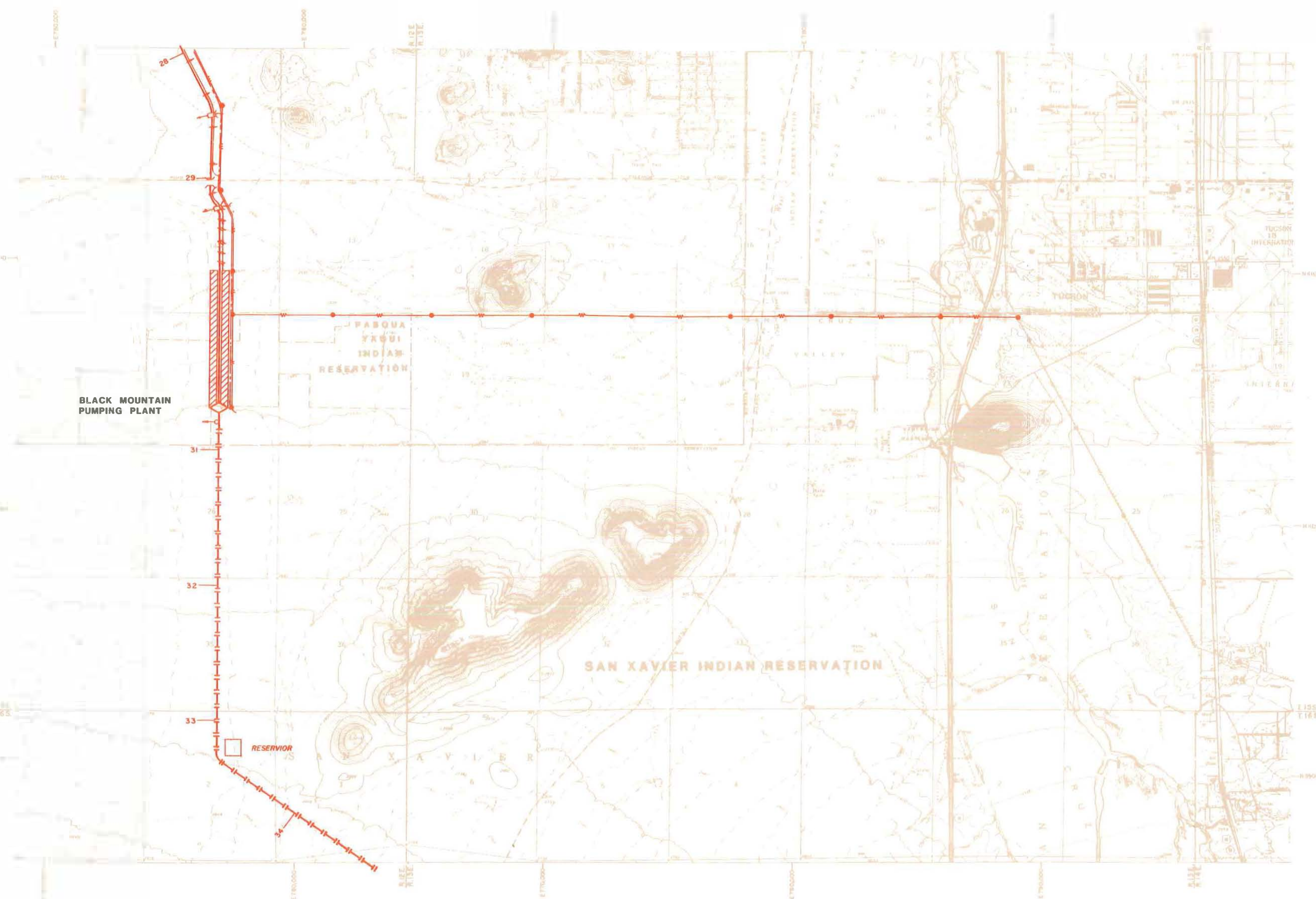

LEGEND
OPEN AQUEDUCT
PIPELINE
PUMPING PLANT
MILE MARKER
TRANSMISSION LINE
DIKE
FLOOD DETENTION AREA
CHECK STRUCTURE
BRIDGE
OVERCHUTE
TURNOUT
SPOIL AREA
SIPHON
WILDLIFE MOVEMENT CORRIDOR
WILDLIFE CROSSING
WILDLIFE CROSSING
WILDLIFE CROSSING
WILDLIFE CROSSING
WILDLIFE MOVEMENT CORRIDOR
WILDLIFE MOVEMENT CORRIDOR
WILDLIFE MOVEMENT CORRIDOR
PAPAGO INDIAN
RESERVATION
TUCSON MOUNTAIN COUNTY PARK
WILDLIFE CROSSING
INDIAN
DELIVERY LINE
END WILDLIFE FENCE
AND TORTOISE BARRIER
BOTH SIDES OF AQUEDUCT
WILDLIFE CROSSING
19
20
21
22
23
24
25
SAN XAVIER
PUMPING PLANT
SHEET INDEX
4101
4102
4103
4104
4105
4106
N
2000 0 2000 4000 6000
SCALE OF FEET
CONTOUR INTERVAL VARIES
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CENTRAL ARIZONA PROJECT
TUCSON DIVISION-ARIZONA
TUCSON AQUEDUCT-PHASE B
WEST SIDE ROUTE
AGENCY PROPOSED ACTION
344-330-4103
NOVEMBER 1984
REV. MARCH 1985
wn: RMM. RSS

Figure 13



MOUNTAIN PARK
TUCSON DELIVERY POINT
TUCSON PIPELINE
SNYDER HILL
PUMPING PLANT
South Tucson
LEGEND
OPEN AQUEDUCT
PIPELINE
PUMPING PLANT
MILE MARKER
TRANSMISSION LINE
DIKE
FLOOD DETENTION AREA
CHECK STRUCTURE
BRIDGE
OVERCHUTE
TURNOUT
SPOIL AREA
SIPHON
SHEET INDEX
4101
4102
4103
4104
4105
4106
2000 0 2000 4000 6000
SCALE OF FEET
CONTOUR INTERVAL VARIES
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CENTRAL ARIZONA PROJECT
TUCSON DIVISION-ARIZONA
TUCSON AQUEDUCT-PHASE B
WEST SIDE ROUTE
AGENCY PROPOSED ACTION
344-330-4104
NOVEMBER 1984
REV. MARCH 1985
wn: RMM RSS

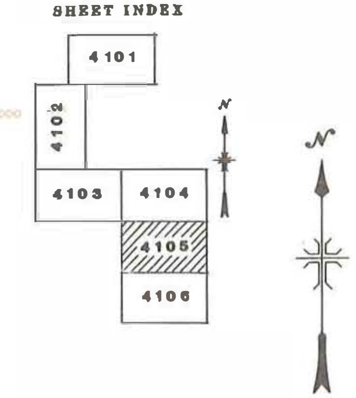
Figure 14



LEGEND

- OPEN AQUEDUCT
- PIPELINE
- PUMPING PLANT
- MILE MARKER
- TRANSMISSION LINE
- DIKE
- FLOOD DETENTION AREA
- CHECK STRUCTURE
- BRIDGE
- OVERCHUTE
- TURNOUT
- SPOIL AREA
- SIPHON

SHEET INDEX



2000 0 2000 4000 6000
SCALE OF FEET
CONTOUR INTERVAL VARIES

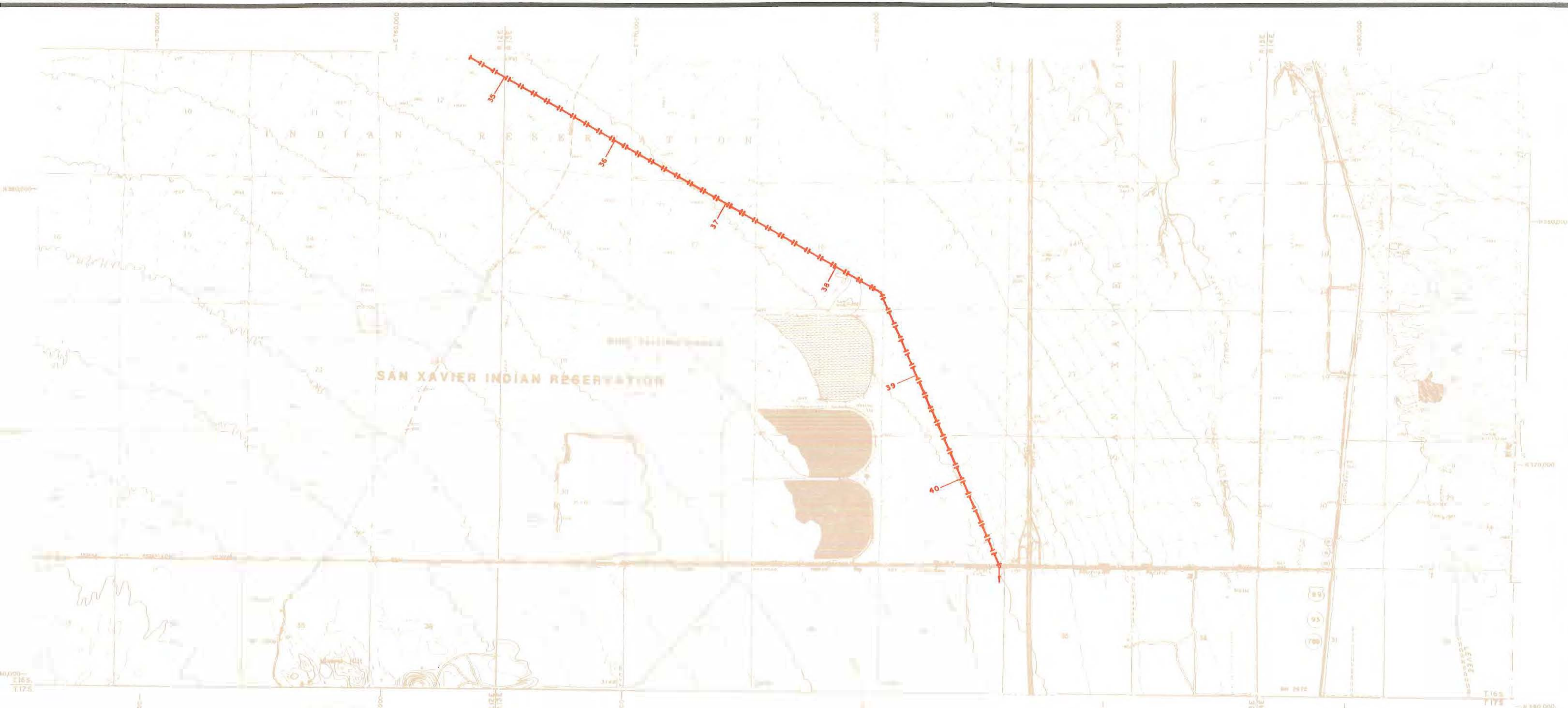
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CENTRAL ARIZONA PROJECT
TUCSON DIVISION-ARIZONA

TUCSON AQUEDUCT-PHASE B
WEST SIDE ROUTE
AGENCY PROPOSED ACTION
344-330-4105

NOVEMBER 1984
REV. MARCH 1985

vn: RMM, RSS

Figure 15



LEGEND

OPEN AQUEDUCT
PIPELINE
PUMPING PLANT
MILE MARKER
TRANSMISSION LINE
DIKE
SIPHON
FLOOD DETENTION AREA
CHECK STRUCTURE
BRIDGE
OVERCHUTE
TURNOUT
SPOIL AREA

SHEET INDEX

4101
4102
4103 4104
4105
4106

2000 0 2000 4000 6000
SCALE OF FEET
CONTOUR INTERVAL VARIES

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

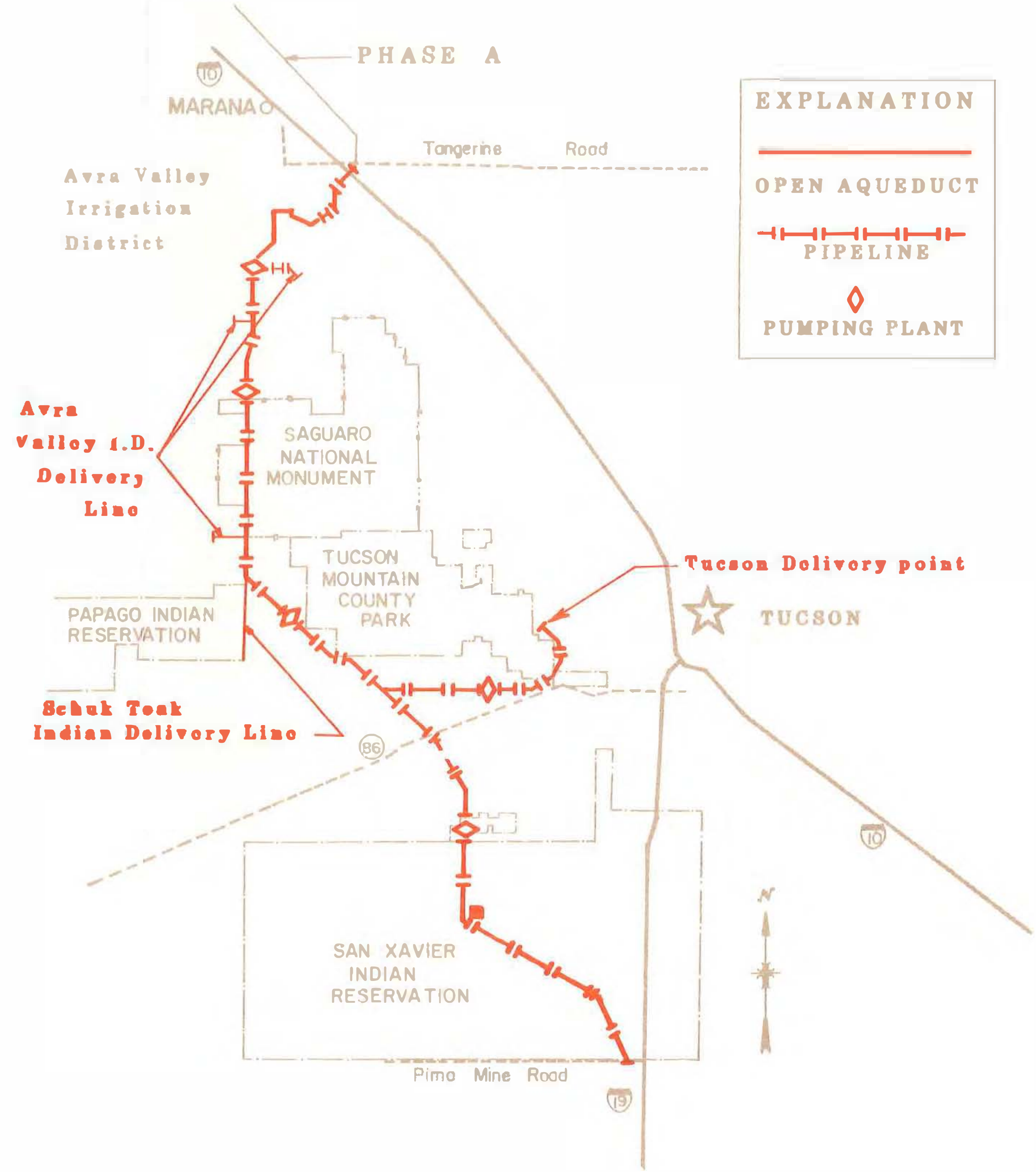
CENTRAL ARIZONA PROJECT
TUCSON DIVISION-ARIZONA

TUCSON AQUEDUCT-PHASE B
WEST SIDE ROUTE
AGENCY PROPOSED ACTION
344-330-4106

NOVEMBER 198
REV. MARCH 1985

n: RMM, RSS

Figure 16



344-330-6043
REV. MARCH 1985

SANDARIO-SAN JOAQUIN PLAN
CENTRAL ARIZONA PROJECT
TUCSON AQUEDUCT-PHASE B

Figure 17a

Dwn: RMM

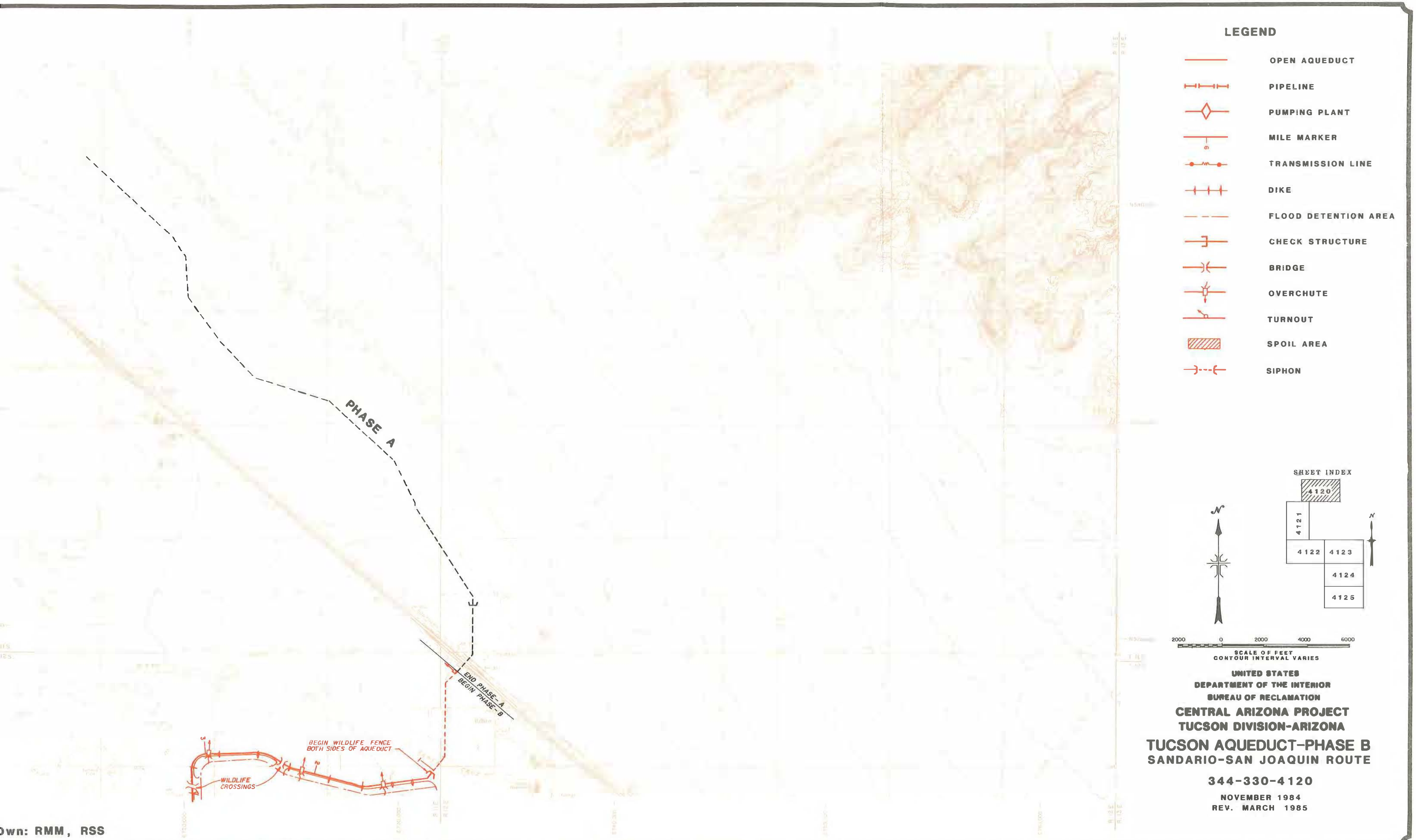

PHASE A
END PHASE-A
BEGIN PHASE-B
BEGIN WILDLIFE FENCE
BOTH SIDES OF AQUEDUCT
WILDLIFE
CROSSINGS
LEGEND
OPEN AQUEDUCT
PIPELINE
PUMPING PLANT
MILE MARKER
TRANSMISSION LINE
DIKE
FLOOD DETENTION AREA
CHECK STRUCTURE
BRIDGE
OVERCHUTE
TURNOUT
SPOIL AREA
SIPHON
SHEET INDEX
4120
4121
4122
4123
4124
4125
2000
0
2000
4000
6000
SCALE OF FEET
CONTOUR INTERVAL VARIES
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CENTRAL ARIZONA PROJECT
TUCSON DIVISION-ARIZONA
TUCSON AQUEDUCT-PHASE B
SANDARIO-SAN JOAQUIN ROUTE
344-330-4120
NOVEMBER 1984
REV. MARCH 1985
Dwn: RMM, RSS

Figure 17

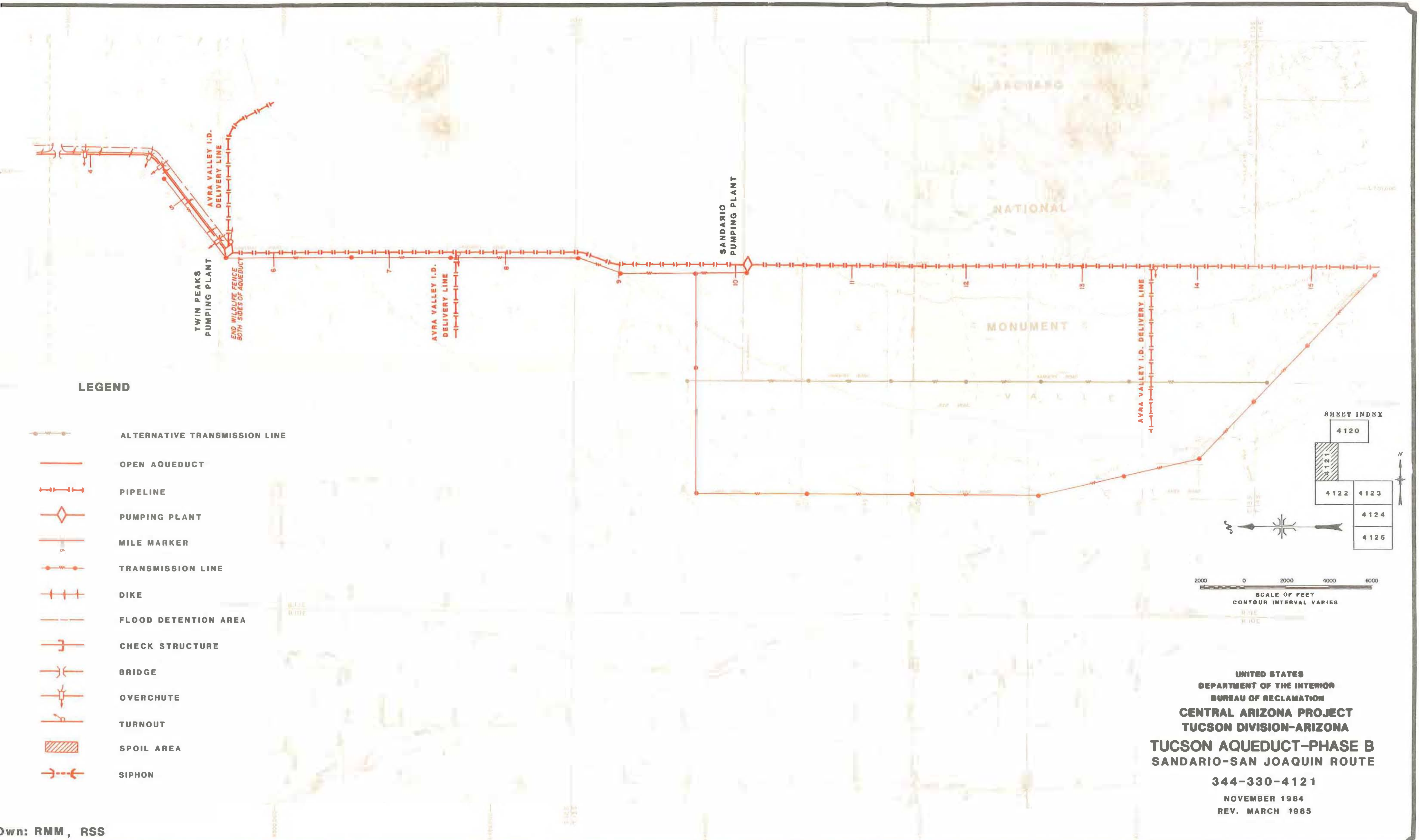
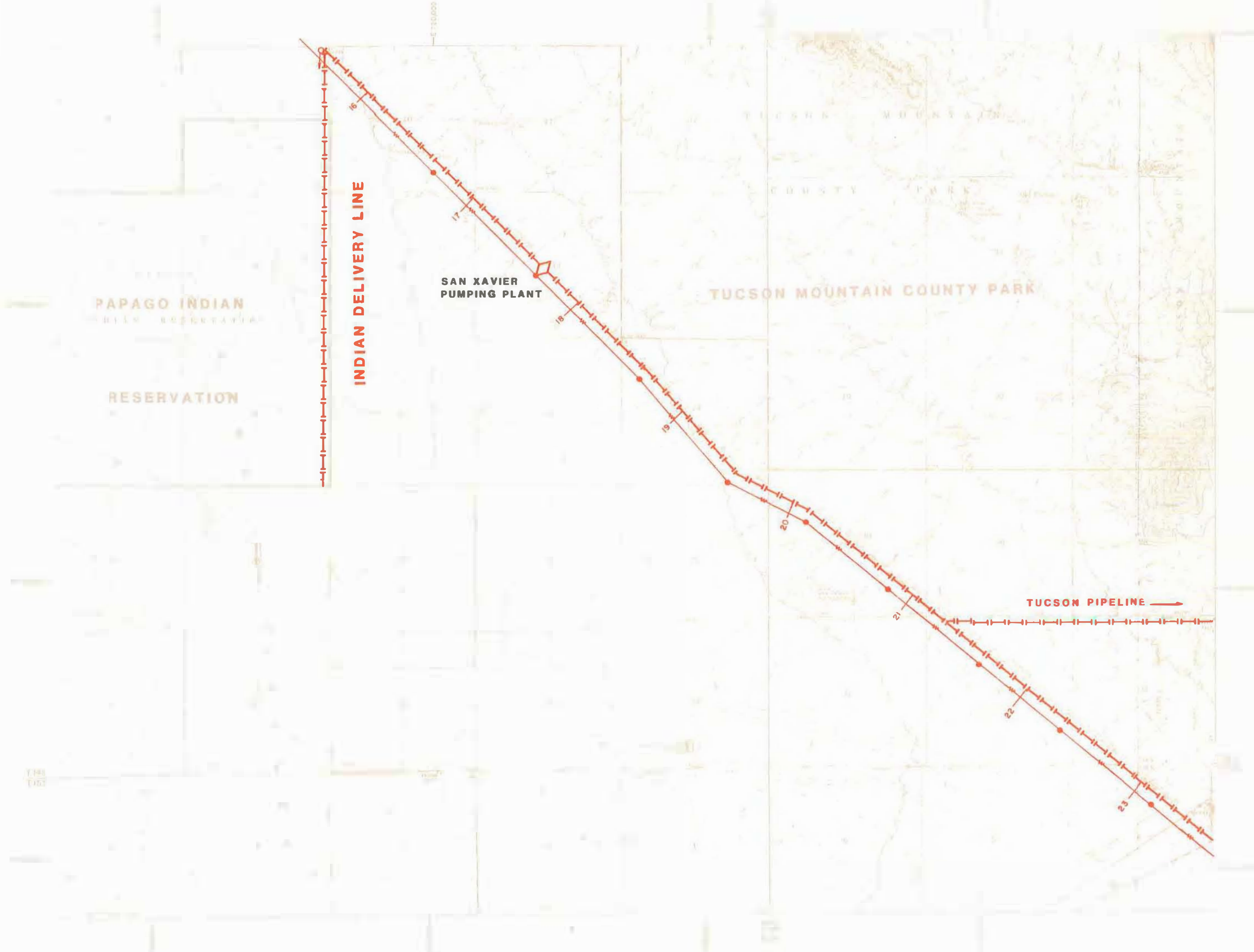
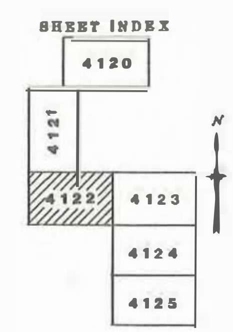

AVRA VALLEY I.D. DELIVERY LINE
TWIN PEAKS PUMPING PLANT
END WILDLIFE FENCE BOTH SIDES OF AQUEDUCT
AVRA VALLEY I.D. DELIVERY LINE
SANDARIO PUMPING PLANT
AVRA VALLEY I.D. DELIVERY LINE
SAGUARO
NATIONAL
MONUMENT
LEGEND
ALTERNATIVE TRANSMISSION LINE
OPEN AQUEDUCT
PIPELINE
PUMPING PLANT
MILE MARKER
TRANSMISSION LINE
DIKE
FLOOD DETENTION AREA
CHECK STRUCTURE
BRIDGE
OVERCHUTE
TURNOUT
SPOIL AREA
SIPHON
SHEET INDEX
4120
4121
4122
4123
4124
4125
SCALE OF FEET
CONTOUR INTERVAL VARIES
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CENTRAL ARIZONA PROJECT
TUCSON DIVISION-ARIZONA
TUCSON AQUEDUCT-PHASE B
SANDARIO-SAN JOAQUIN ROUTE
344-330-4121
NOVEMBER 1984
REV. MARCH 1985
Own: RMM, RSS

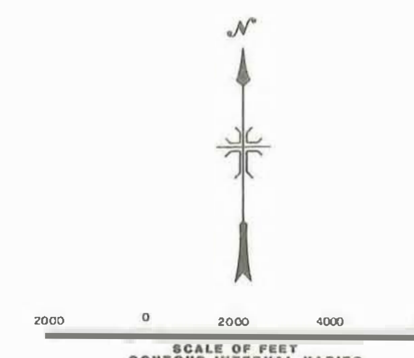
Figure 18



LEGEND

- OPEN AQUEDUCT
- PIPELINE
- PUMPING PLANT
- MILE MARKER
- TRANSMISSION LINE
- DIKE
- FLOOD DETENTION AREA
- CHECK STRUCTURE
- BRIDGE
- OVERCHUTE
- TURNOUT
- SPOIL AREA
- SIPHON





UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

CENTRAL ARIZONA PROJECT
TUCSON DIVISION-ARIZONA

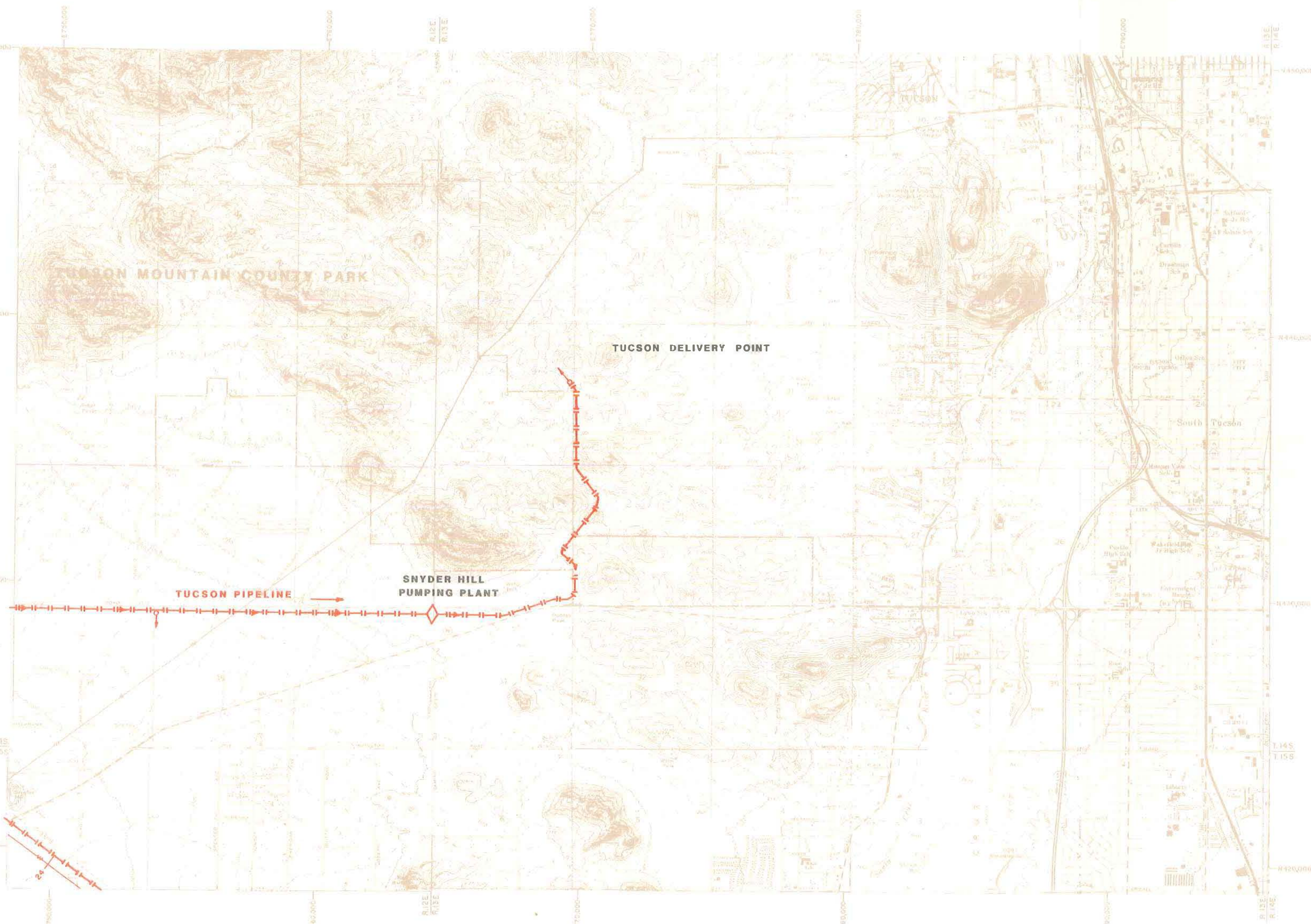
TUCSON AQUEDUCT-PHASE B
SANDARIO-SAN JOAQUIN ROUTE

344-330-4122

NOVEMBER 1984
REV. MARCH 1985

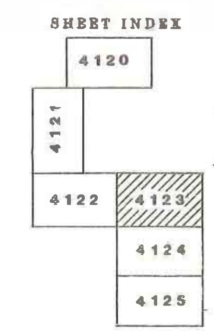
Own: RMM, RSS

Figure 19



LEGEND

- OPEN AQUEDUCT
- PIPELINE
- PUMPING PLANT
- MILE MARKER
- TRANSMISSION LINE
- DIKE
- FLOOD DETENTION AREA
- CHECK STRUCTURE
- BRIDGE
- OVERCHUTE
- TURNOUT
- SPOIL AREA
- SIPHON



2000 0 2000 4000 6000

SCALE OF FEET

CONTOUR INTERVAL VARIES

UNITED STATES

DEPARTMENT OF THE INTERIOR

BUREAU OF RECLAMATION

CENTRAL ARIZONA PROJECT

TUCSON DIVISION-ARIZONA

TUCSON AQUEDUCT-PHASE B

SANDARIO-SAN JOAQUIN ROUTE

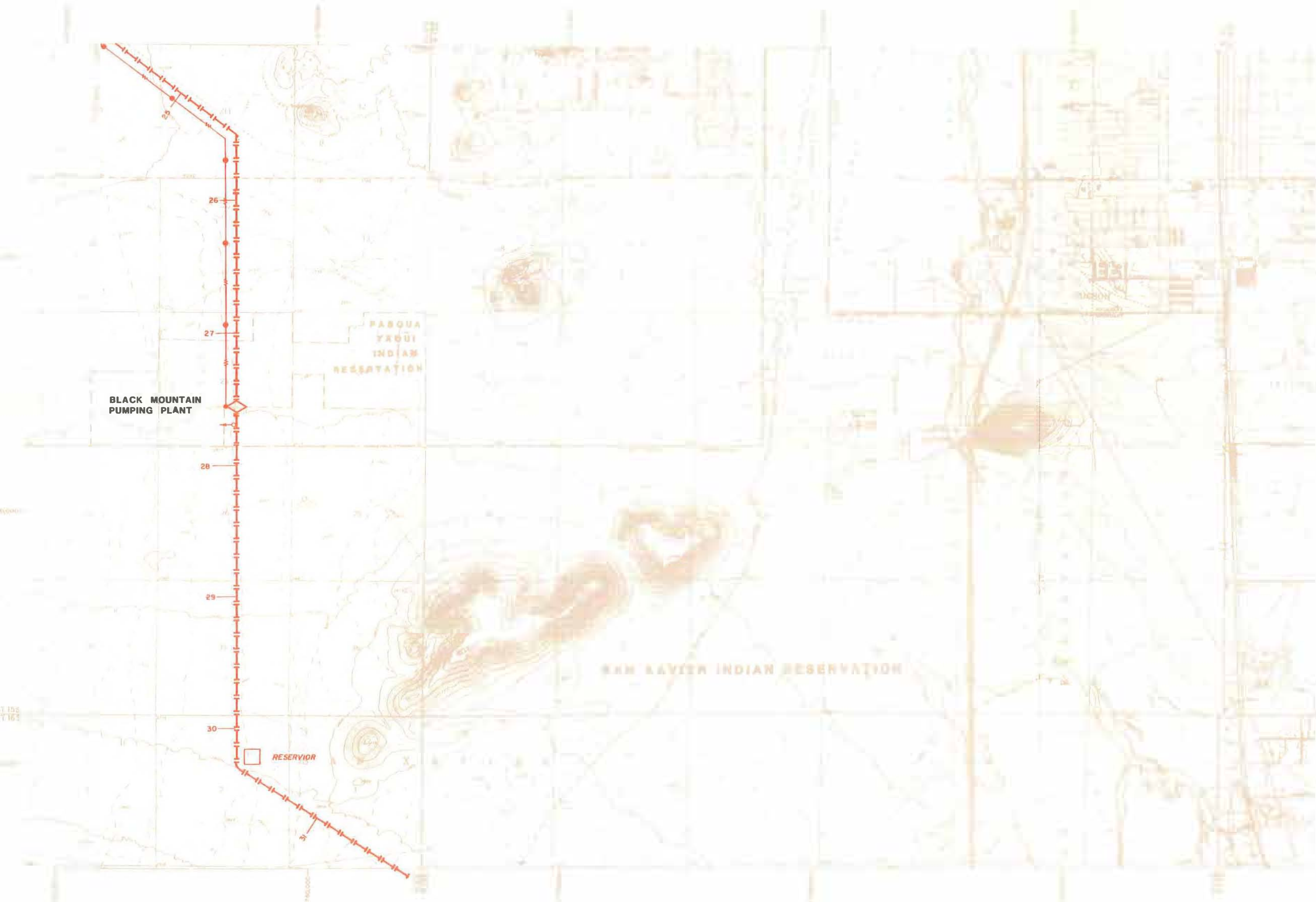
344-330-4123

NOVEMBER 1984

REV. MARCH 1985

Dwn: RMM, RSS

Figure 20



LEGEND

OPEN AQUEDUCT
PIPELINE
PUMPING PLANT
MILE MARKER
TRANSMISSION LINE
DIKE
FLOOD DETENTION AREA
CHECK STRUCTURE
BRIDGE
OVERCHUTE
TURNOUT
SPOIL AREA
SIPHON

SHEET INDEX

4120
4121
4122
4123
4124
4125

2000 0 2000 4000 6000

SCALE OF FEET
CONTOUR INTERVAL VARIES

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

CENTRAL ARIZONA PROJECT
TUCSON DIVISION-ARIZONA

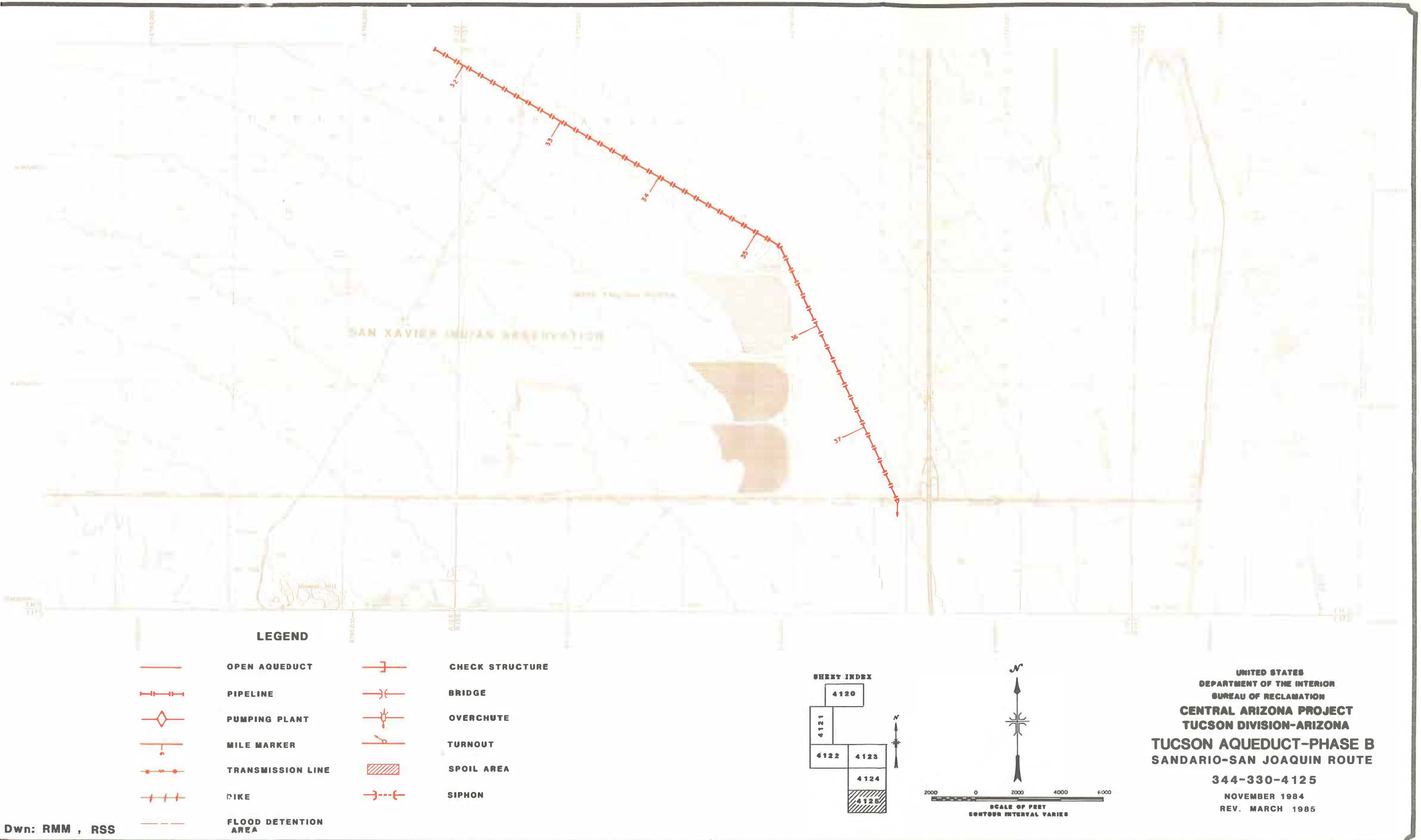
TUCSON AQUEDUCT-PHASE B
SANDARIO-SAN JOAQUIN ROUTE

344-330-4124

NOVEMBER 1984
REV. MARCH 1965

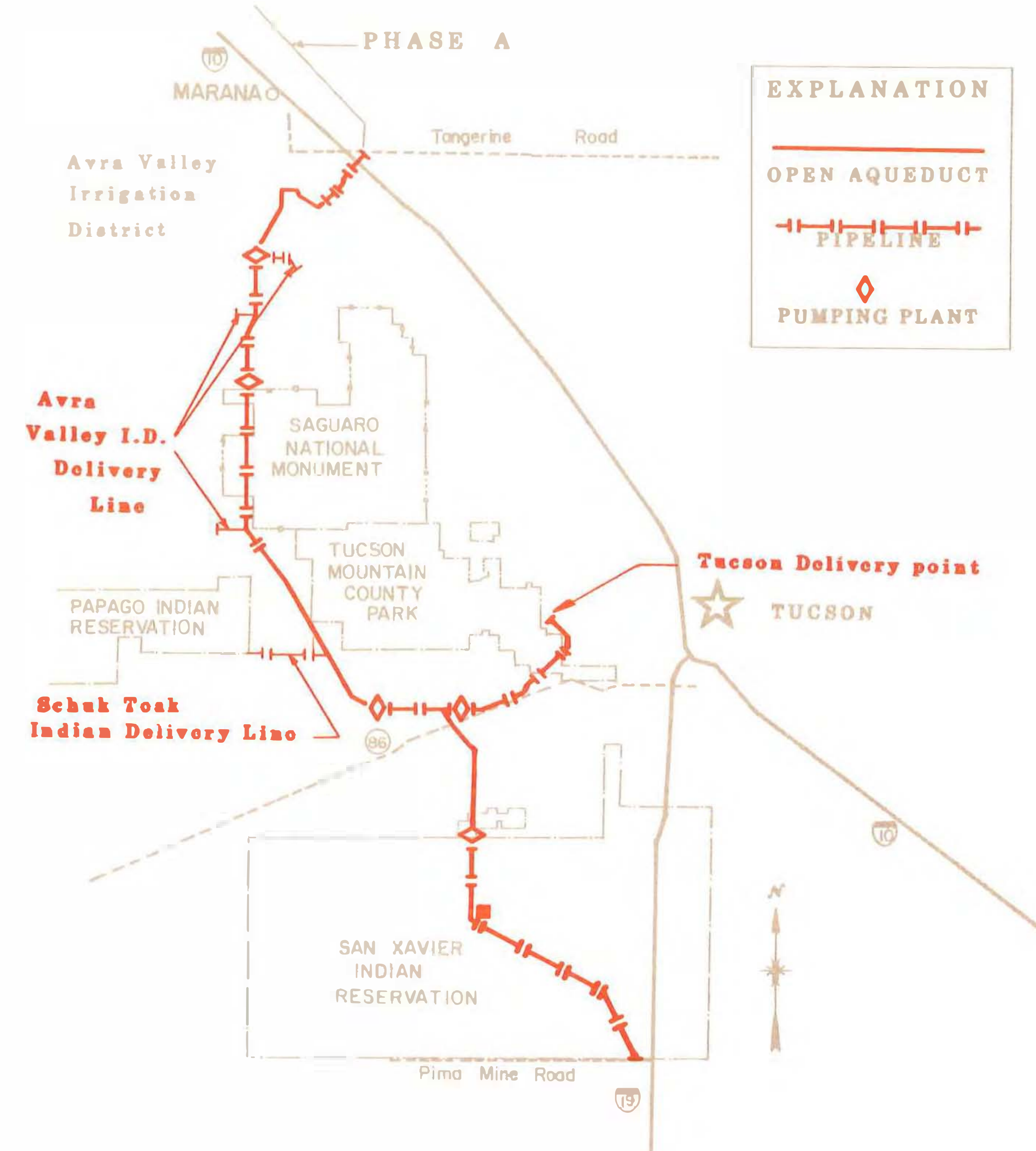
Dwn: RMM, RSS

Figure 21



32
33
34
35
36
37
SAN XAVIER INDIAN RESERVATION
LEGEND
OPEN AQUEDUCT
PIPELINE
PUMPING PLANT
MILE MARKER
TRANSMISSION LINE
DIKE
FLOOD DETENTION AREA
CHECK STRUCTURE
BRIDGE
OVERCHUTE
TURNOUT
SPOIL AREA
SIPHON
SHEET INDEX
4120
4121
4122
4123
4124
4125
N
2000 0 2000 4000 6000
SCALE OF FEET
CONTOUR INTERVAL VARIES
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CENTRAL ARIZONA PROJECT
TUCSON DIVISION-ARIZONA
TUCSON AQUEDUCT-PHASE B
SANDARIO-SAN JOAQUIN ROUTE
344-330-4125
NOVEMBER 1984
REV. MARCH 1985
Dwn: RMM , RSS

Figure 22

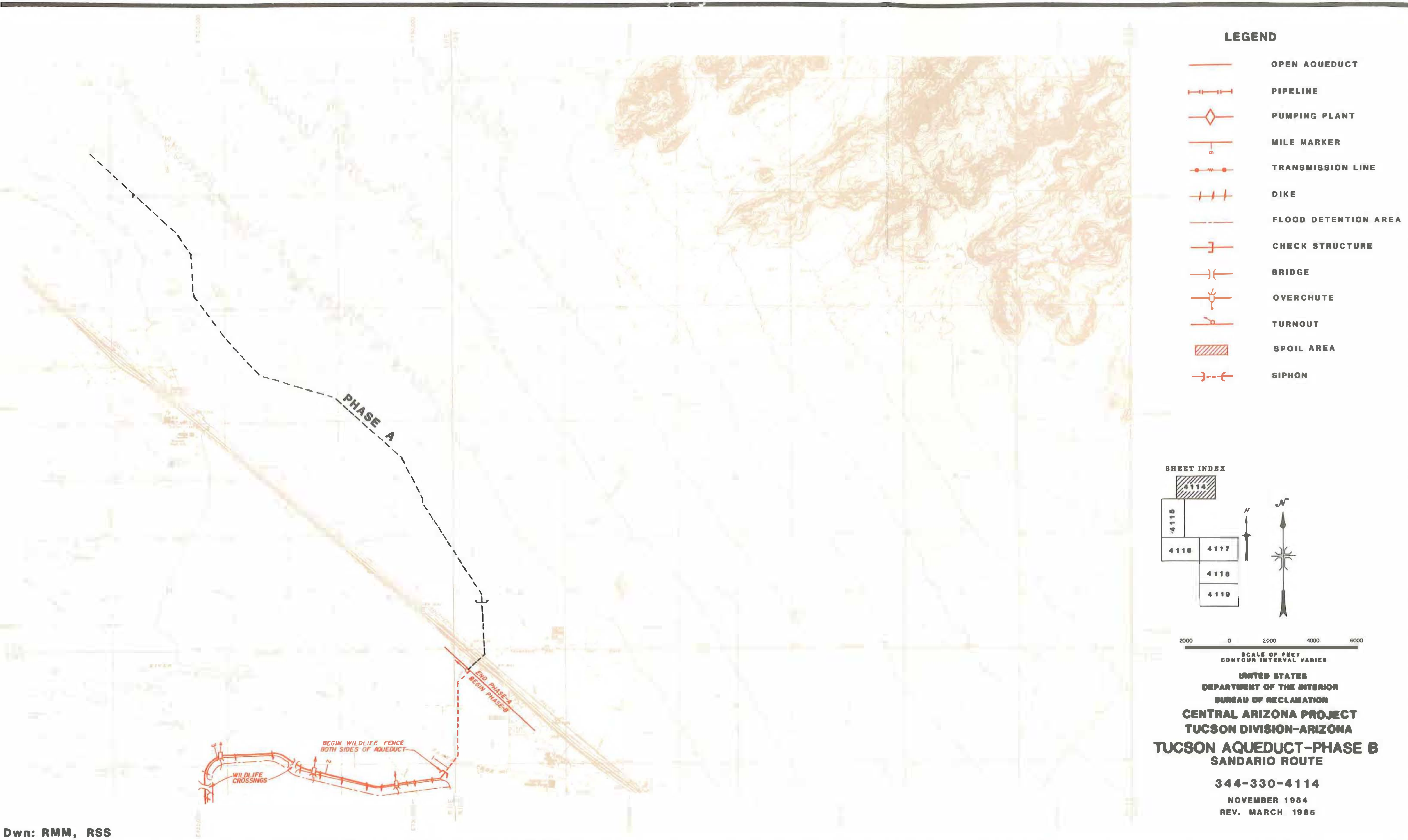


344-330-6044
REV. MARCH 1985

SANDARIO PLAN
CENTRAL ARIZONA PROJECT
TUCSON AQUEDUCT-PHASE B

Figure 23a

Dwn: RMM



LEGEND
OPEN AQUEDUCT
PIPELINE
PUMPING PLANT
MILE MARKER
TRANSMISSION LINE
DIKE
FLOOD DETENTION AREA
CHECK STRUCTURE
BRIDGE
OVERCHUTE
TURNOUT
SPOIL AREA
SIPHON
PHASE A
END PHASE-A
BEGIN PHASE-B
BEGIN WILDLIFE FENCE
BOTH SIDES OF AQUEDUCT
WILDLIFE CROSSINGS
SHEET INDEX
4114
4115
4116
4117
4118
4119
2000
0
2000
4000
6000
SCALE OF FEET
CONTOUR INTERVAL VARIES
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CENTRAL ARIZONA PROJECT
TUCSON DIVISION-ARIZONA
TUCSON AQUEDUCT-PHASE B
SANDARIO ROUTE
344-330-4114
NOVEMBER 1984
REV. MARCH 1985
Dwn: RMM, RSS

Figure 23

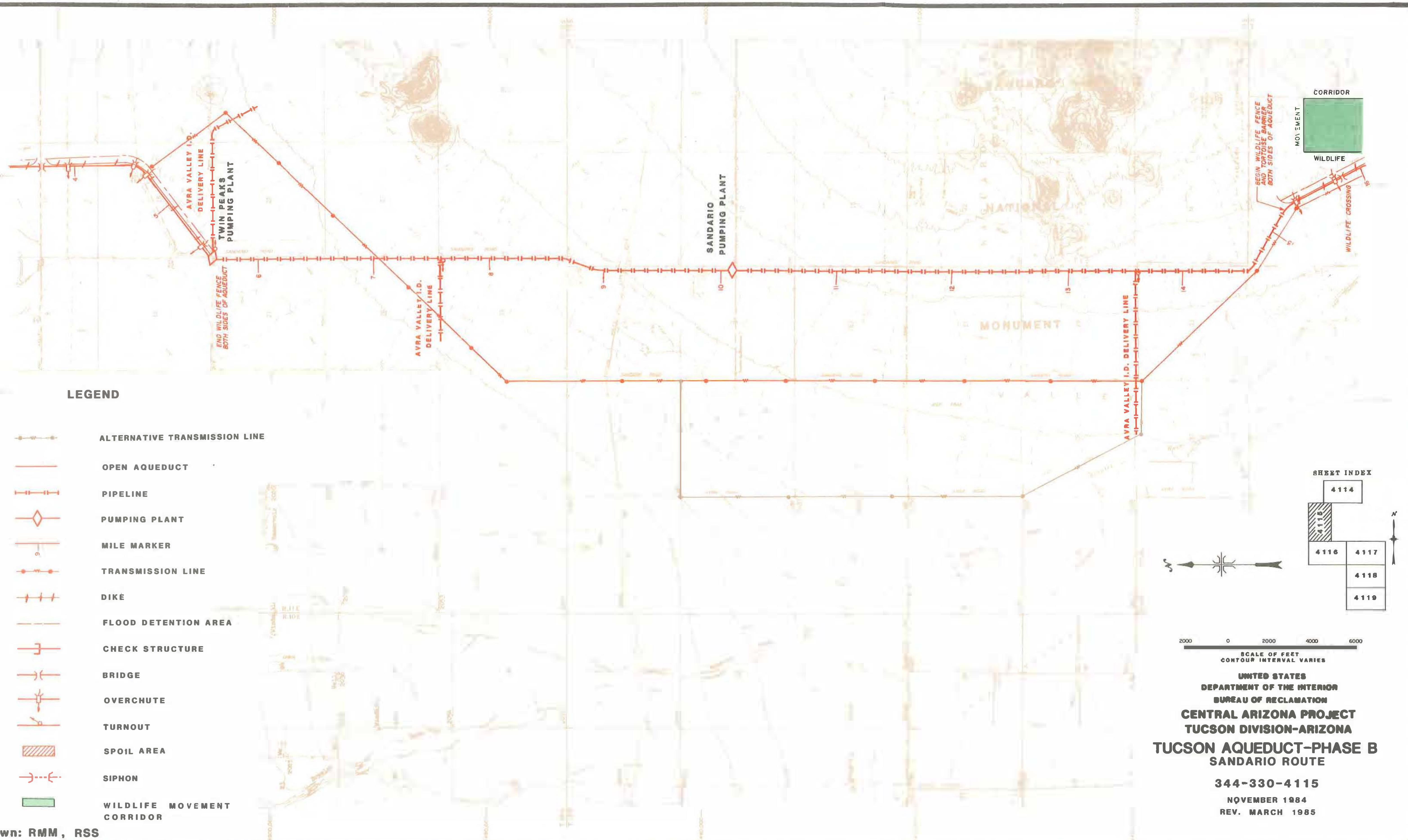

CORRIDOR
MOVEMENT
WILDLIFE
BEGIN WILDLIFE FENCE AND TORTOISE BARRIER BOTH SIDES OF AQUEDUCT
WILDLIFE CROSSING
AVRA VALLEY I.D. DELIVERY LINE
TWIN PEAKS PUMPING PLANT
SANDARIO PUMPING PLANT
END WILDLIFE FENCE BOTH SIDES OF AQUEDUCT
AVRA VALLEY I.D. DELIVERY LINE
AVRA VALLEY I.D. DELIVERY LINE
NATIONAL
MONUMENT
LEGEND
ALTERNATIVE TRANSMISSION LINE
OPEN AQUEDUCT
PIPELINE
PUMPING PLANT
MILE MARKER
TRANSMISSION LINE
DIKE
FLOOD DETENTION AREA
CHECK STRUCTURE
BRIDGE
OVERCHUTE
TURNOUT
SPOIL AREA
SIPHON
WILDLIFE MOVEMENT CORRIDOR
wn: RMM, RSS
SHEET INDEX
4114
4115
4116
4117
4118
4119
2000 0 2000 4000 6000
SCALE OF FEET
CONTOUR INTERVAL VARIES
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CENTRAL ARIZONA PROJECT
TUCSON DIVISION-ARIZONA
TUCSON AQUEDUCT-PHASE B
SANDARIO ROUTE
344-330-4115
NOVEMBER 1984
REV. MARCH 1985

Figure 24

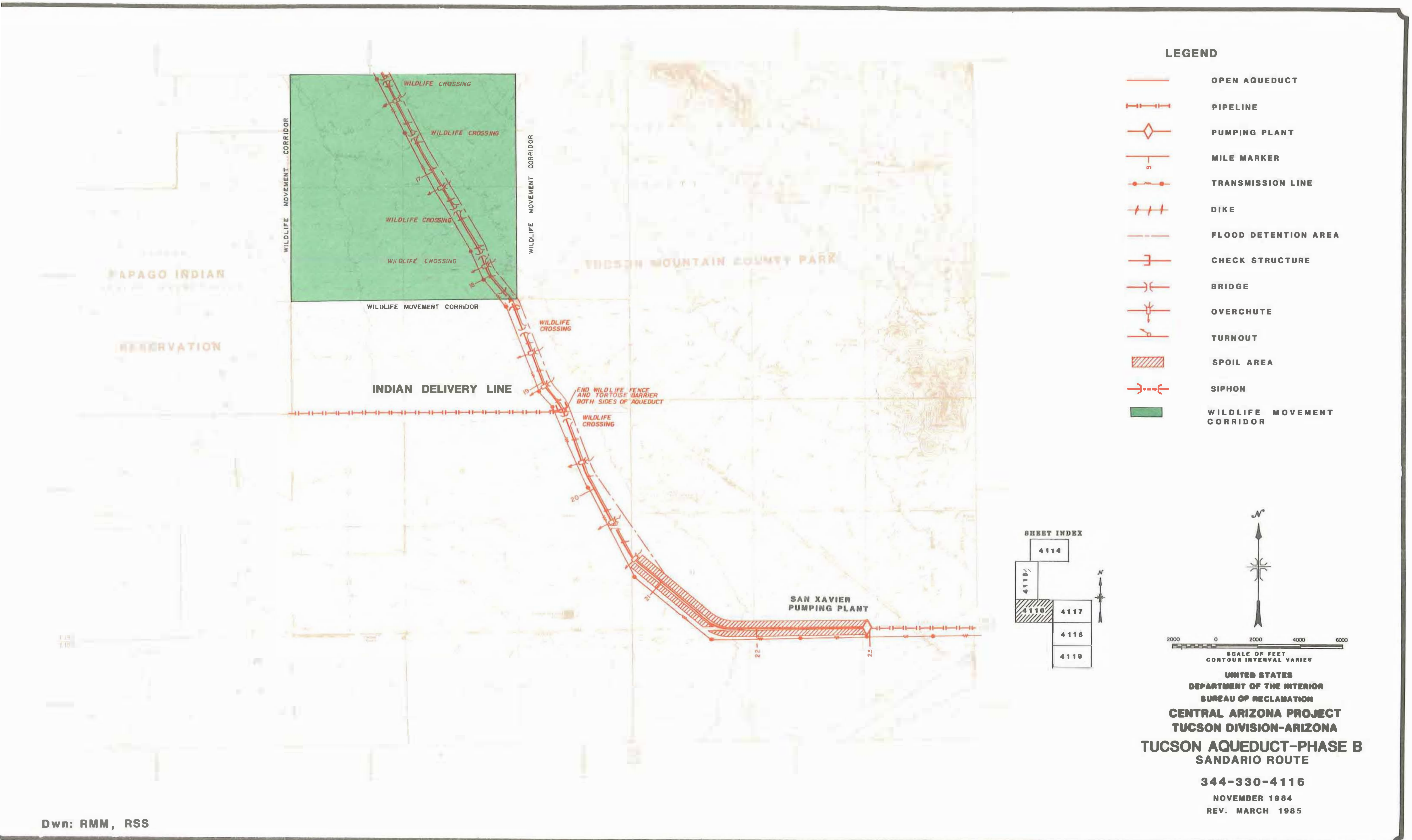
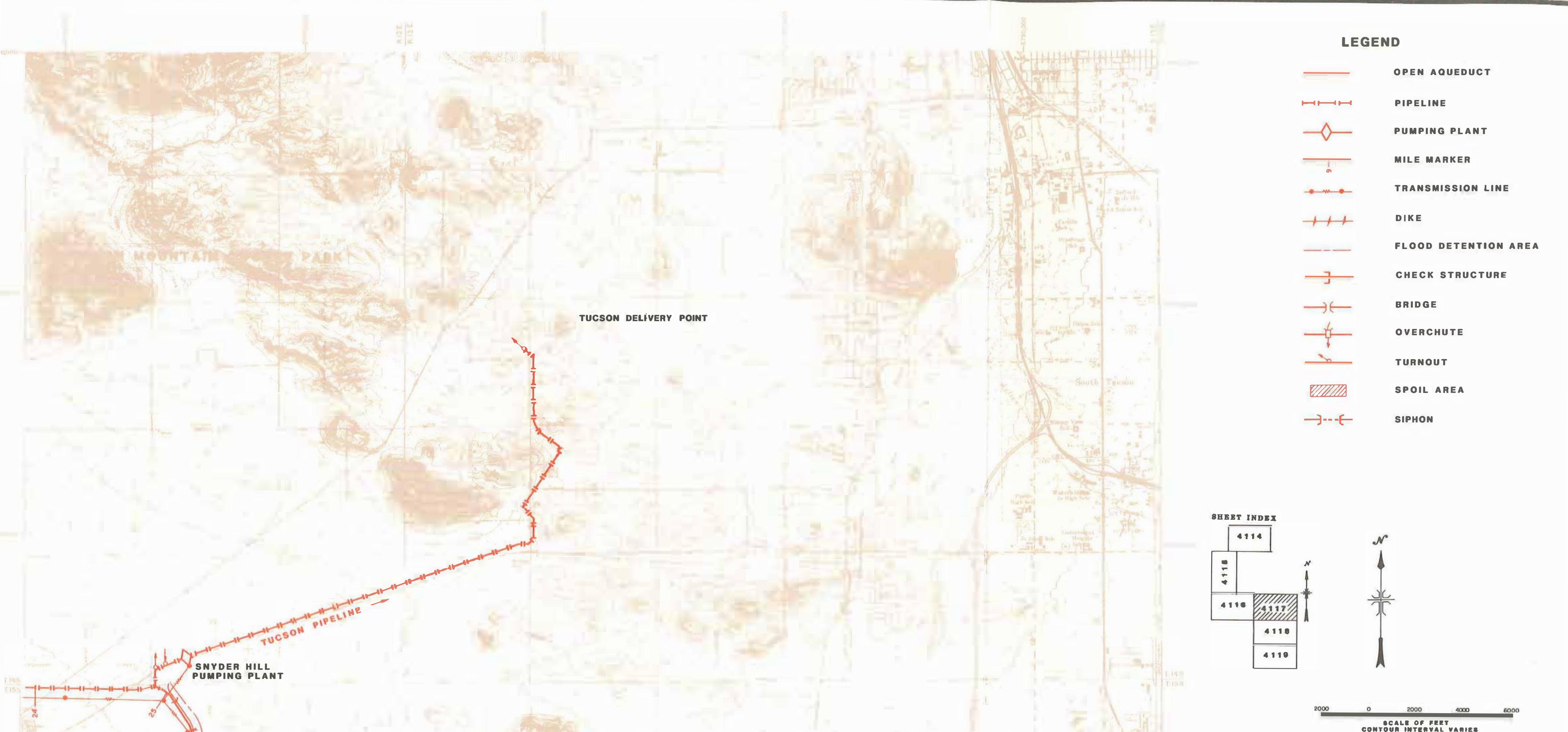

LEGEND
OPEN AQUEDUCT
PIPELINE
PUMPING PLANT
MILE MARKER
TRANSMISSION LINE
DIKE
FLOOD DETENTION AREA
CHECK STRUCTURE
BRIDGE
OVERCHUTE
TURNOUT
SPOIL AREA
SIPHON
WILDLIFE MOVEMENT CORRIDOR
WILDLIFE CROSSING
WILDLIFE CROSSING
WILDLIFE CROSSING
WILDLIFE CROSSING
WILDLIFE MOVEMENT CORRIDOR
WILDLIFE MOVEMENT CORRIDOR
WILDLIFE MOVEMENT CORRIDOR
WILDLIFE CROSSING
INDIAN DELIVERY LINE
END WILDLIFE FENCE AND TORTOISE BARRIER BOTH SIDES OF AQUEDUCT
WILDLIFE CROSSING
PAPAGO INDIAN
RESERVATION
TUCSON MOUNTAIN COUNTY PARK
SAN XAVIER PUMPING PLANT
SHEET INDEX
4114
4115
4116
4117
4118
4119
SCALE OF FEET
CONTOUR INTERVAL VARIES
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CENTRAL ARIZONA PROJECT
TUCSON DIVISION-ARIZONA
TUCSON AQUEDUCT-PHASE B
SANDARIO ROUTE
344-330-4116
NOVEMBER 1984
REV. MARCH 1985
Dwn: RMM, RSS

Figure 25



UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

CENTRAL ARIZONA PROJECT
TUCSON DIVISION-ARIZONA

TUCSON AQUEDUCT-PHASE B
SANDARIO ROUTE

344-330-4117

NOVEMBER 1984
REV. MARCH 1985

Dwn: RMM, RSS

Figure 26


LEGEND
OPEN AQUEDUCT
PIPELINE
PUMPING PLANT
MILE MARKER
TRANSMISSION LINE
DIKE
FLOOD DETENTION AREA
CHECK STRUCTURE
BRIDGE
OVERCHUTE
TURNOUT
SPOIL AREA
SIPHON
BLACK MOUNTAIN PUMPING PLANT
PASQUA YAQUI INDIAN RESERVATION
SAN XAVIER INDIAN RESERVATION
RESERVIOR
27
28
29
30
31
32
SHEET INDEX
4114
4115
4116
4117
4118
4119
N
2000 0 2000 4000 6000
SCALE OF FEET
CONTOUR INTERVAL VARIES
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CENTRAL ARIZONA PROJECT
TUCSON DIVISION-ARIZONA
TUCSON AQUEDUCT-PHASE B
SANDARIO ROUTE
344-330-4118
NOVEMBER 1984
REV. MARCH 1985
Dwn: RMM, RSS

Figure 27

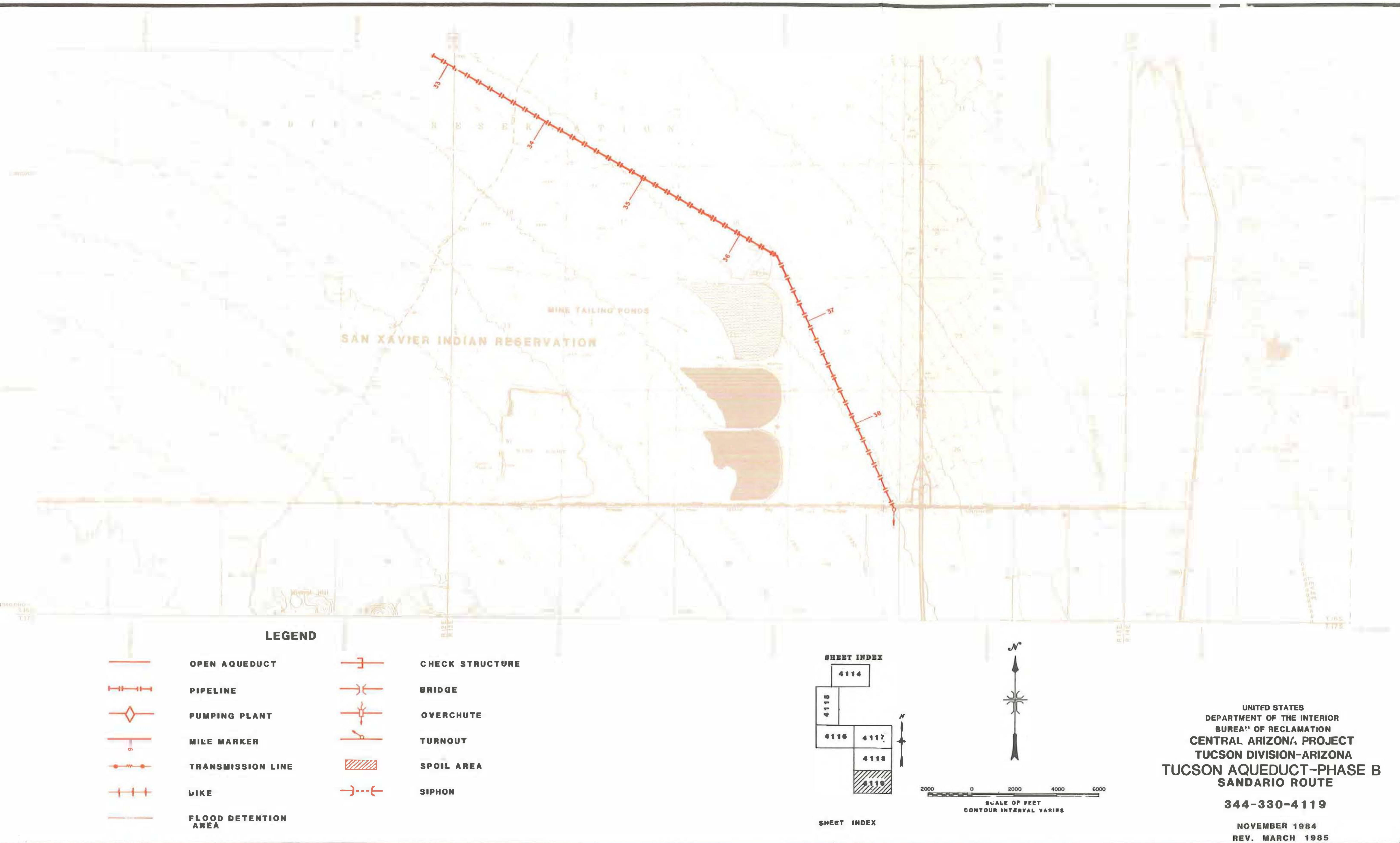
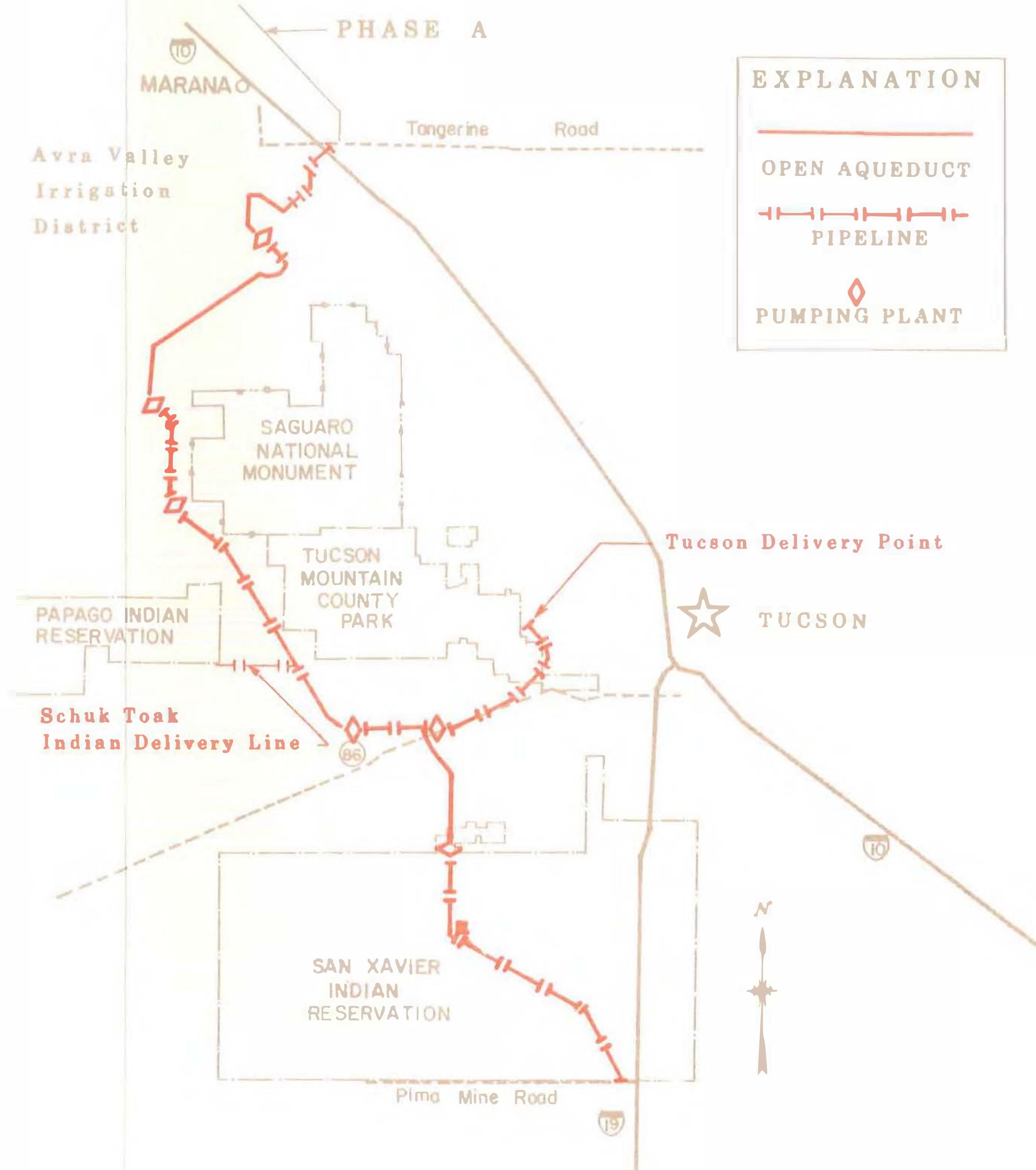

SAN XAVIER INDIAN RESERVATION
MINE TAILING PONDS
33
34
35
36
37
38
LEGEND
OPEN AQUEDUCT
PIPELINE
PUMPING PLANT
MILE MARKER
TRANSMISSION LINE
DIKE
FLOOD DETENTION AREA
CHECK STRUCTURE
BRIDGE
OVERCHUTE
TURNOUT
SPOIL AREA
SIPHON
SHEET INDEX
4114
4115
4116
4117
4118
4119
SHEET INDEX
N
2000 0 2000 4000 6000
SCALE OF FEET
CONTOUR INTERVAL VARIES
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CENTRAL ARIZONA PROJECT
TUCSON DIVISION-ARIZONA
TUCSON AQUEDUCT-PHASE B
SANDARIO ROUTE
344-330-4119
NOVEMBER 1984
REV. MARCH 1985

Figure 28



SANDERS-SAN JOAQUIN MODIFICATION PLAN

CENTRAL ARIZONA PROJECT

TUCSON AQUEDUCT-PHASE B

Figure 29a

344-330-8278

Dwn: PM

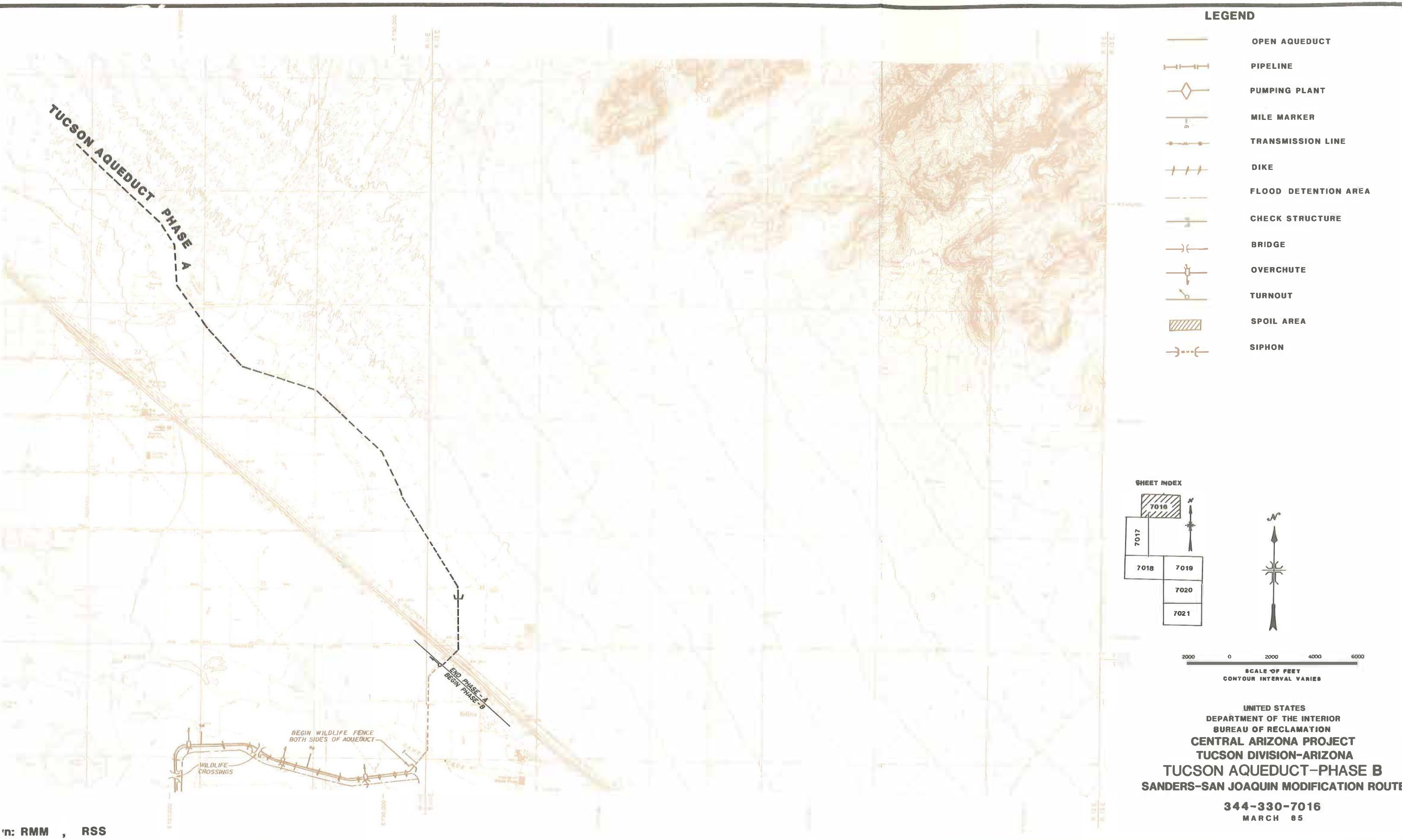
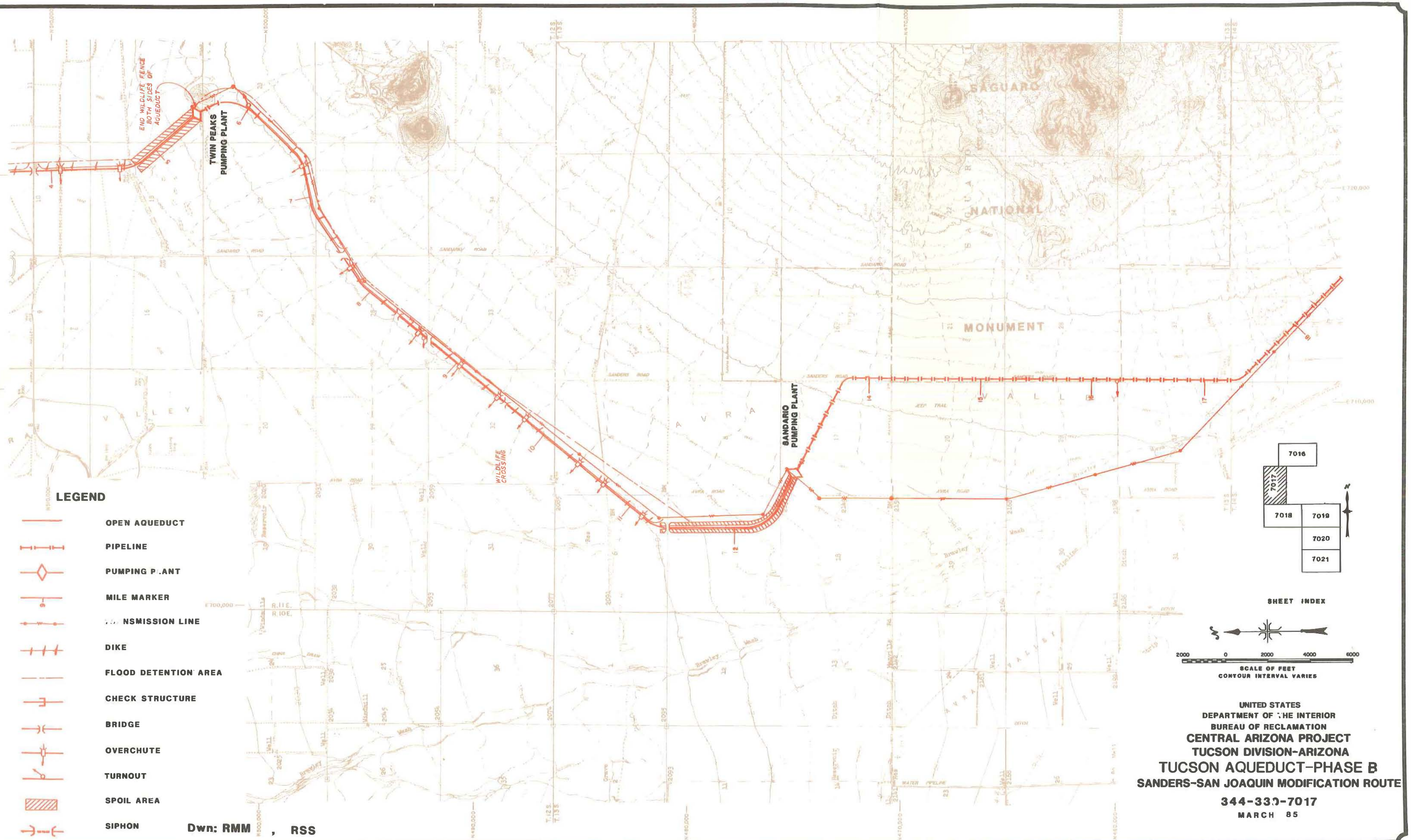
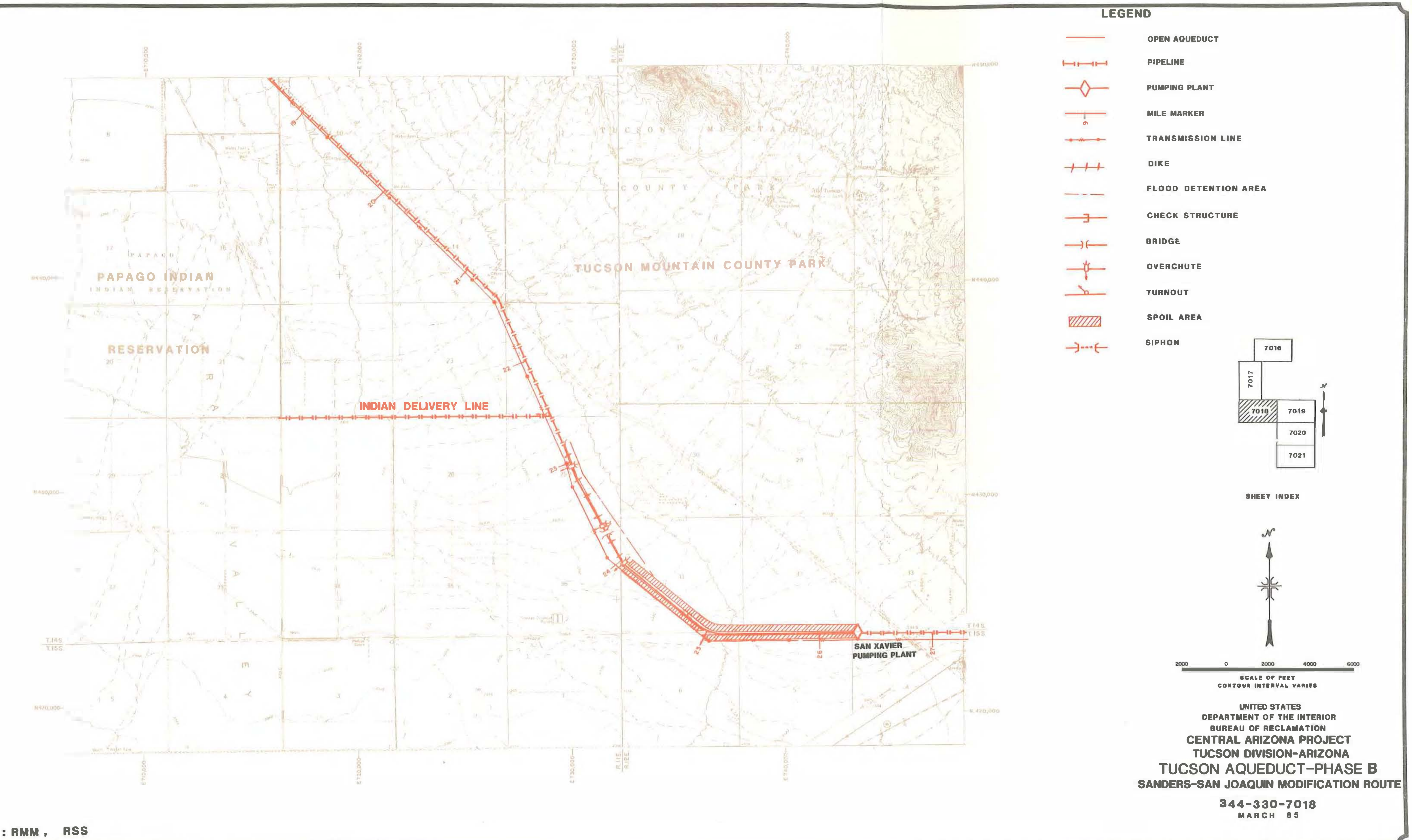

TUCSON AQUEDUCT PHASE A
END PHASE-A
BEGIN PHASE-B
BEGIN WILDLIFE FENCE BOTH SIDES OF AQUEDUCT
WILDLIFE CROSSINGS
LEGEND
OPEN AQUEDUCT
PIPELINE
PUMPING PLANT
MILE MARKER
TRANSMISSION LINE
DIKE
FLOOD DETENTION AREA
CHECK STRUCTURE
BRIDGE
OVERCHUTE
TURNOUT
SPOIL AREA
SIPHON
SHEET INDEX
7016
7017
7018
7019
7020
7021
N
2000 0 2000 4000 6000
SCALE OF FEET
CONTOUR INTERVAL VARIES
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CENTRAL ARIZONA PROJECT
TUCSON DIVISION-ARIZONA
TUCSON AQUEDUCT-PHASE B
SANDERS-SAN JOAQUIN MODIFICATION ROUTE
344-330-7016
MARCH 85
'n: RMM , RSS

FIGURE 29



END WILDLIFE FENCE BOTH SIDES OF AQUEDUCT
TWIN PEAKS PUMPING PLANT
SAGUARO
NATIONAL
MONUMENT
SANDARIO ROAD
SANDERS ROAD
AVRA ROAD
JEEP TRAIL
WILDLIFE CROSSING
SANDARIO PUMPING PLANT
V A L L E Y
A V R A
Brawley Wash
LEGEND
OPEN AQUEDUCT
PIPELINE
PUMPING PLANT
MILE MARKER
TRANSMISSION LINE
DIKE
FLOOD DETENTION AREA
CHECK STRUCTURE
BRIDGE
OVERCHUTE
TURNOUT
SPOIL AREA
SIPHON
Dwn: RMM , RSS
7016
7017
7018
7019
7020
7021
SHEET INDEX
2000 0 2000 4000 6000
SCALE OF FEET
CONTOUR INTERVAL VARIES
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CENTRAL ARIZONA PROJECT
TUCSON DIVISION-ARIZONA
TUCSON AQUEDUCT-PHASE B
SANDERS-SAN JOAQUIN MODIFICATION ROUTE
344-330-7017
MARCH 85

FIGURE 30



LEGEND
OPEN AQUEDUCT
PIPELINE
PUMPING PLANT
MILE MARKER
TRANSMISSION LINE
DIKE
FLOOD DETENTION AREA
CHECK STRUCTURE
BRIDGE
OVERCHUTE
TURNOUT
SPOIL AREA
SIPHON
PAPAGO INDIAN
RESERVATION
TUCSON MOUNTAIN COUNTY PARK
INDIAN DELIVERY LINE
SAN XAVIER
PUMPING PLANT
T.14S
T.15S
R.11E
R.12E
7016
7017
7018
7019
7020
7021
SHEET INDEX
2000 0 2000 4000 6000
SCALE OF FEET
CONTOUR INTERVAL VARIES
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CENTRAL ARIZONA PROJECT
TUCSON DIVISION-ARIZONA
TUCSON AQUEDUCT-PHASE B
SANDERS-SAN JOAQUIN MODIFICATION ROUTE
344-330-7018
MARCH 85
: RMM , RSS

FIGURE 31

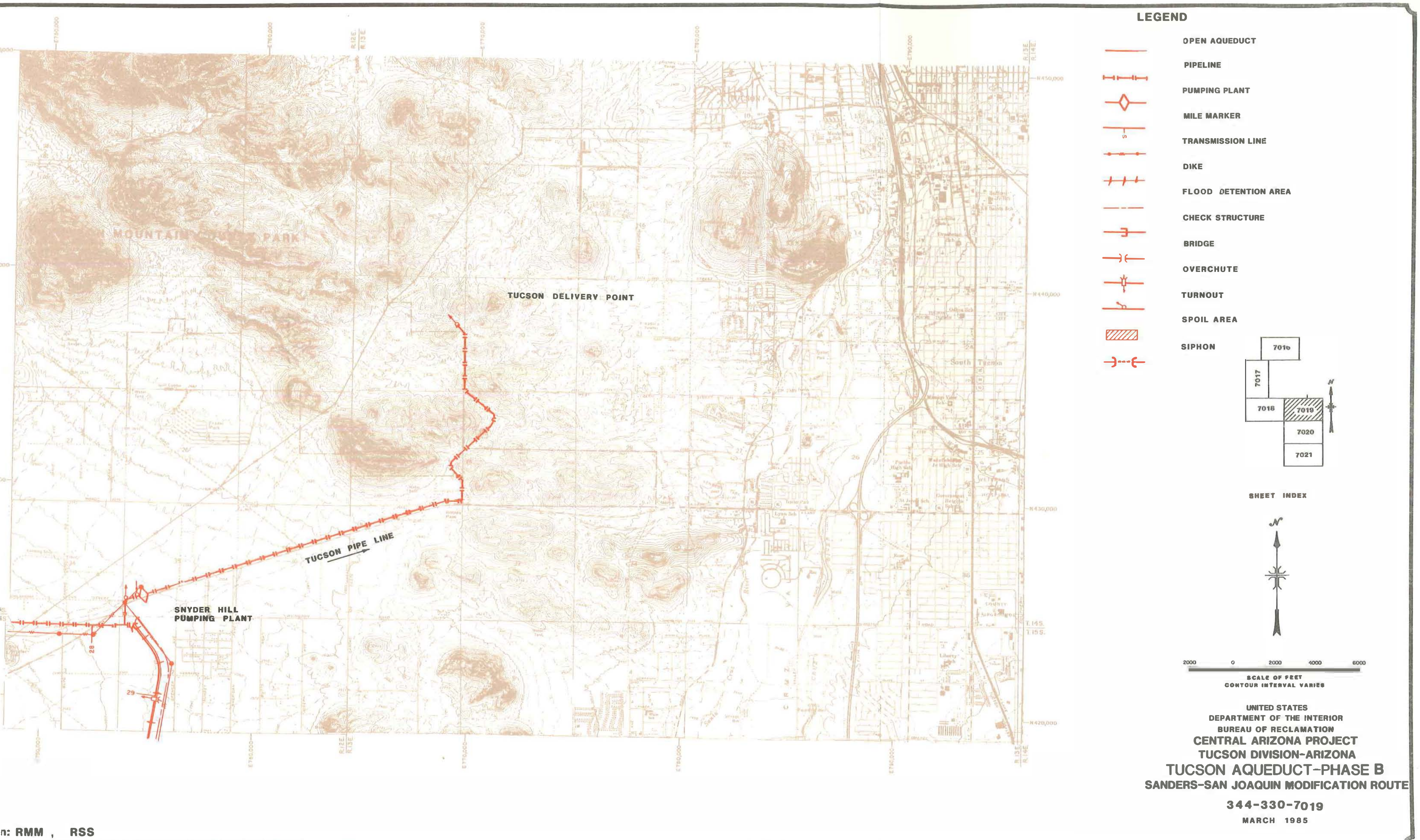

LEGEND
OPEN AQUEDUCT
PIPELINE
PUMPING PLANT
MILE MARKER
TRANSMISSION LINE
DIKE
FLOOD DETENTION AREA
CHECK STRUCTURE
BRIDGE
OVERCHUTE
TURNOUT
SPOIL AREA
SIPHON
TUCSON DELIVERY POINT
TUCSON PIPE LINE
SNYDER HILL PUMPING PLANT
MOUNTAIN PARK
South Tucson
7016
7017
7018
7019
7020
7021
SHEET INDEX
2000 0 2000 4000 6000
SCALE OF FEET
CONTOUR INTERVAL VARIES
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CENTRAL ARIZONA PROJECT
TUCSON DIVISION-ARIZONA
TUCSON AQUEDUCT-PHASE B
SANDERS-SAN JOAQUIN MODIFICATION ROUTE
344-330-7019
MARCH 1985
n: RMM , RSS

FIGURE 32

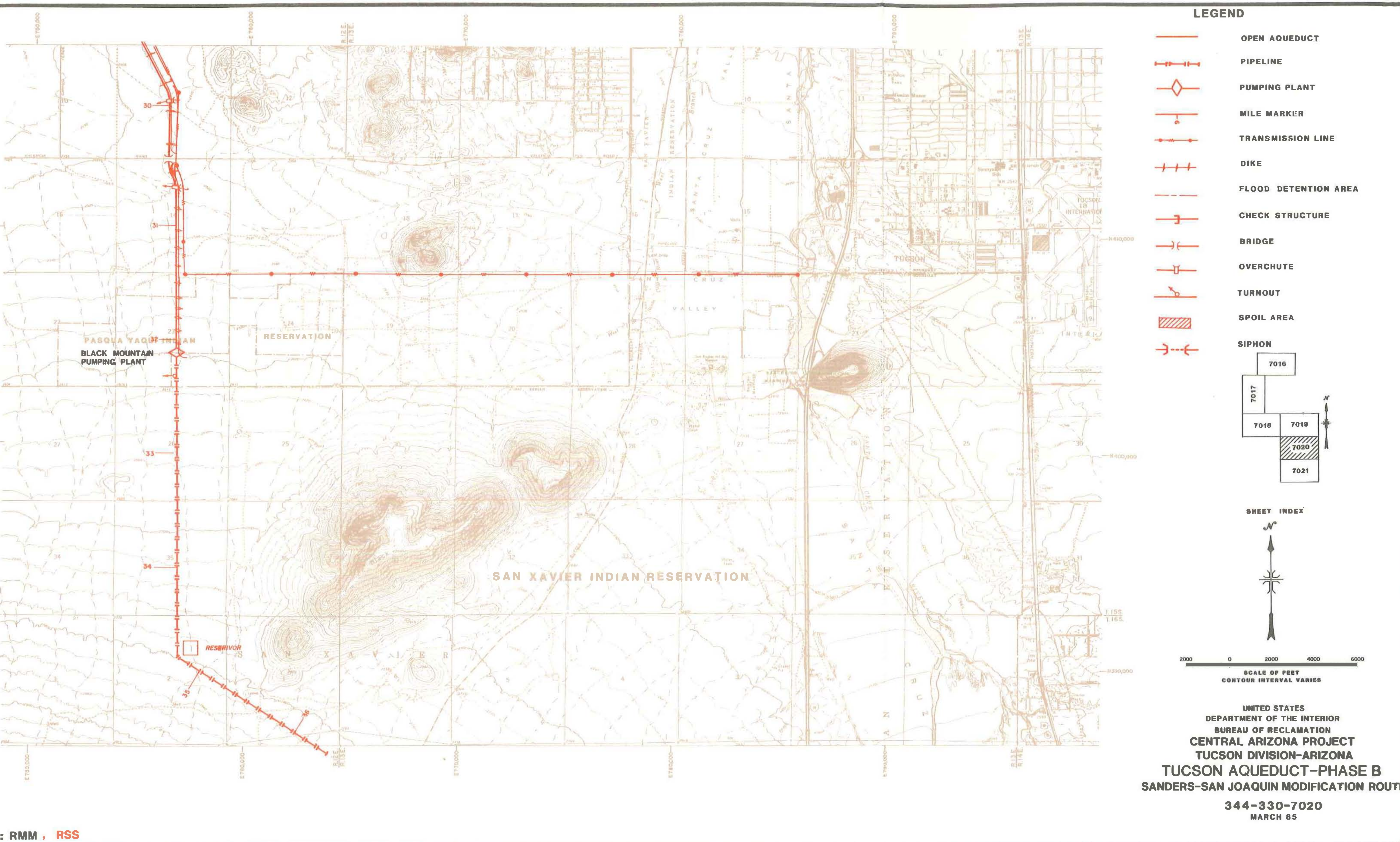
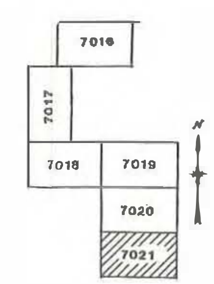

LEGEND
OPEN AQUEDUCT
PIPELINE
PUMPING PLANT
MILE MARKER
TRANSMISSION LINE
DIKE
FLOOD DETENTION AREA
CHECK STRUCTURE
BRIDGE
OVERCHUTE
TURNOUT
SPOIL AREA
SIPHON
7016
7017
7018
7019
7020
7021
SHEET INDEX
N
2000 0 2000 4000 6000
SCALE OF FEET
CONTOUR INTERVAL VARIES
BLACK MOUNTAIN PUMPING PLANT
PASQUA YAQUI INDIAN
RESERVATION
SAN XAVIER INDIAN RESERVATION
SANTA CRUZ VALLEY
RESERVOIR
TUCSON
30
31
33
34
35
36
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CENTRAL ARIZONA PROJECT
TUCSON DIVISION-ARIZONA
TUCSON AQUEDUCT-PHASE B
SANDERS-SAN JOAQUIN MODIFICATION ROUTE
344-330-7020
MARCH 85
: RMM , RSS

FIGURE 33

LEGEND

OPEN AQUEDUCT	SIPHON
PIPELINE	FLOOD DETENTION AREA
PUMPING PLANT	CHECK STRUCTURE
MILE MARKER	BRIDGE
TRANSMISSION LINE	OVERCHUTE
DIKE	TURNOUT
	SPOIL AREA

Dwn: RMM, RSS



SHEET INDEX

2000 0 2000 4000 6000

SCALE OF FEET

CONTOUR INTERVAL VARIES

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

CENTRAL ARIZONA PROJECT
TUCSON DIVISION-ARIZONA

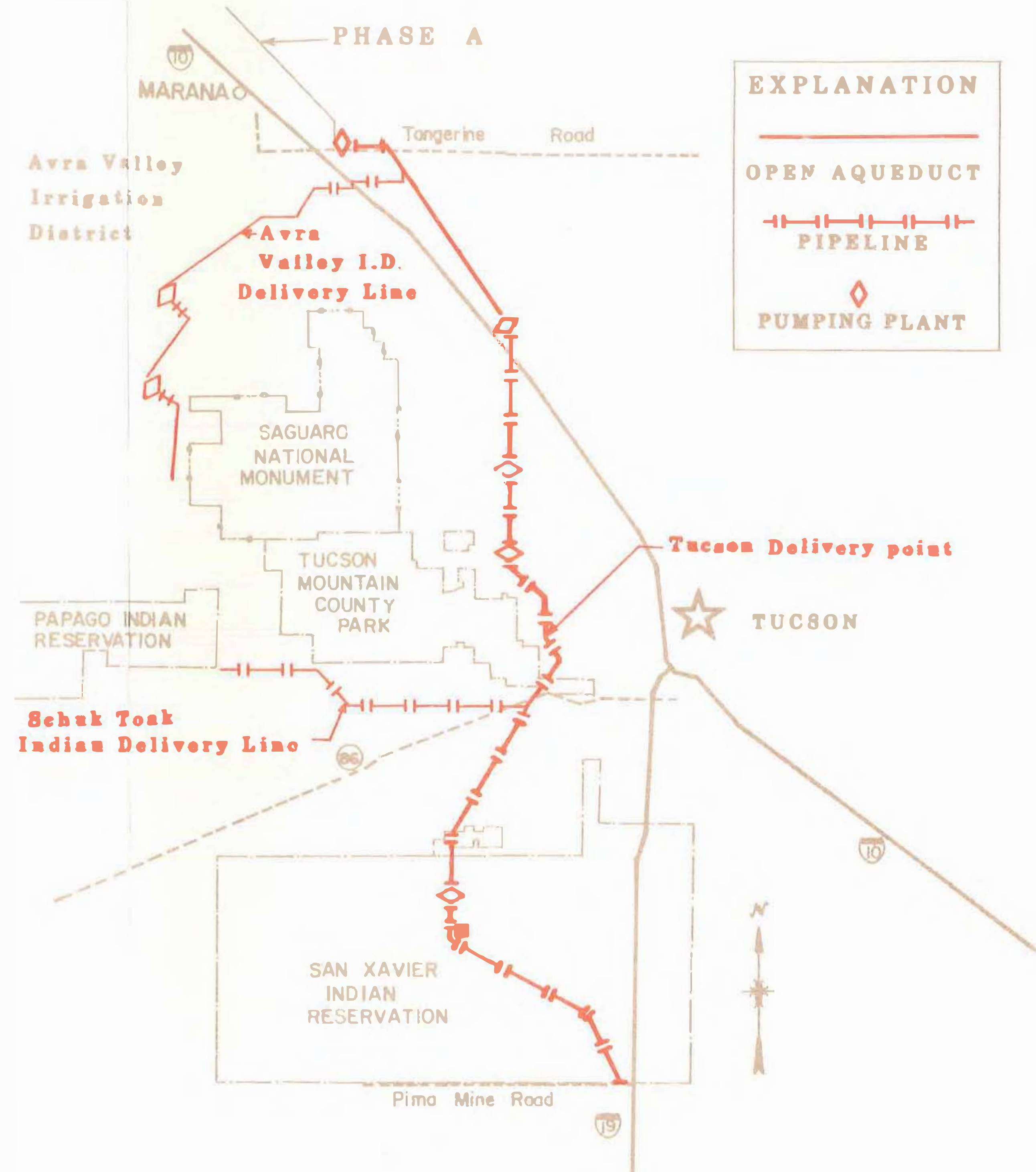
TUCSON AQUEDUCT-PHASE B

SANDERS-SAN JOAQUIN MODIFICATION ROUTE

344-330-7021

MARCH 85

FIGURE 34



EAST SIDE PLAN

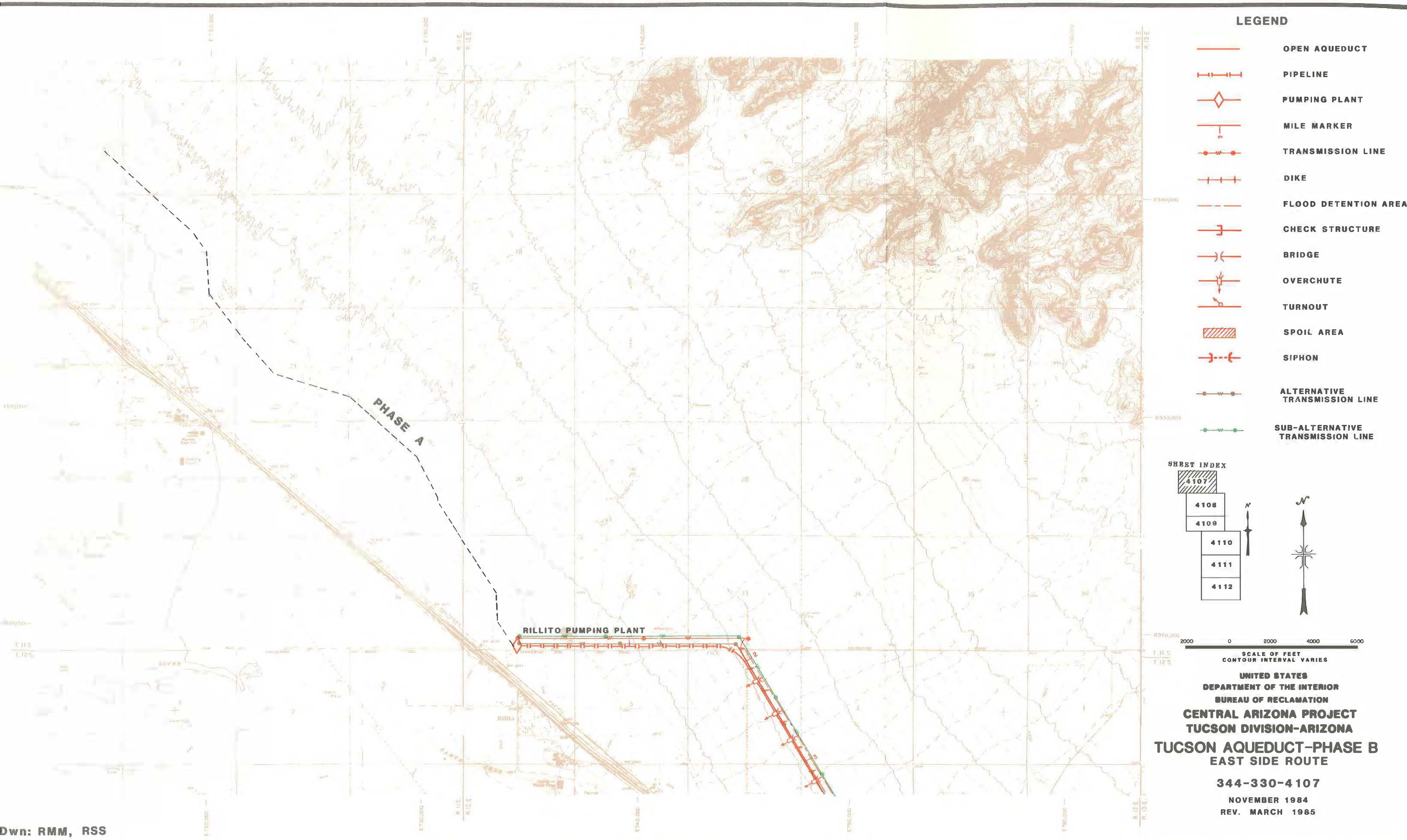
CENTRAL ARIZONA PROJECT

TUCSON AQUEDUCT–PHASE B

Figure 35a

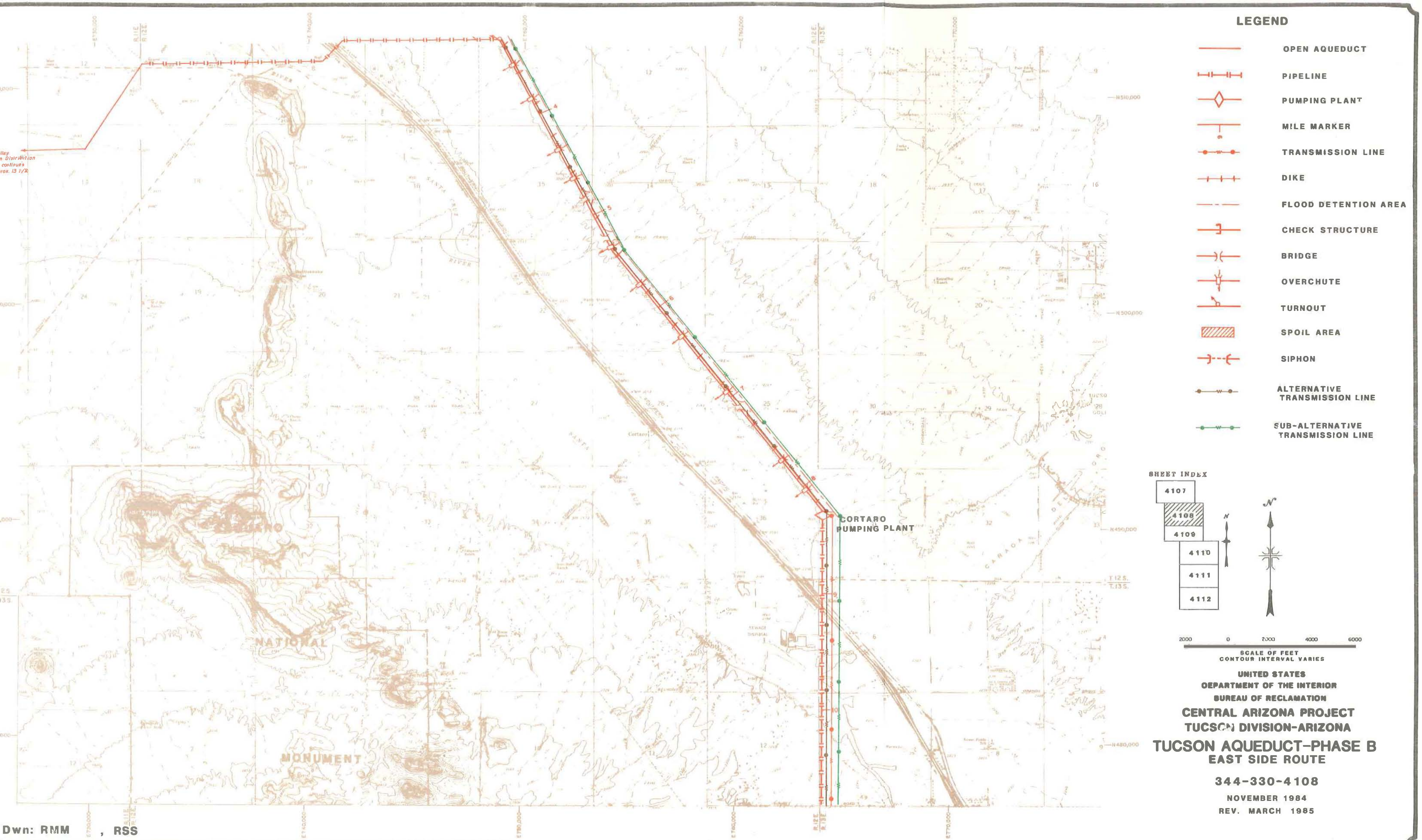
544-330-5042
REV. MARCH 1985

Dwn: RMM



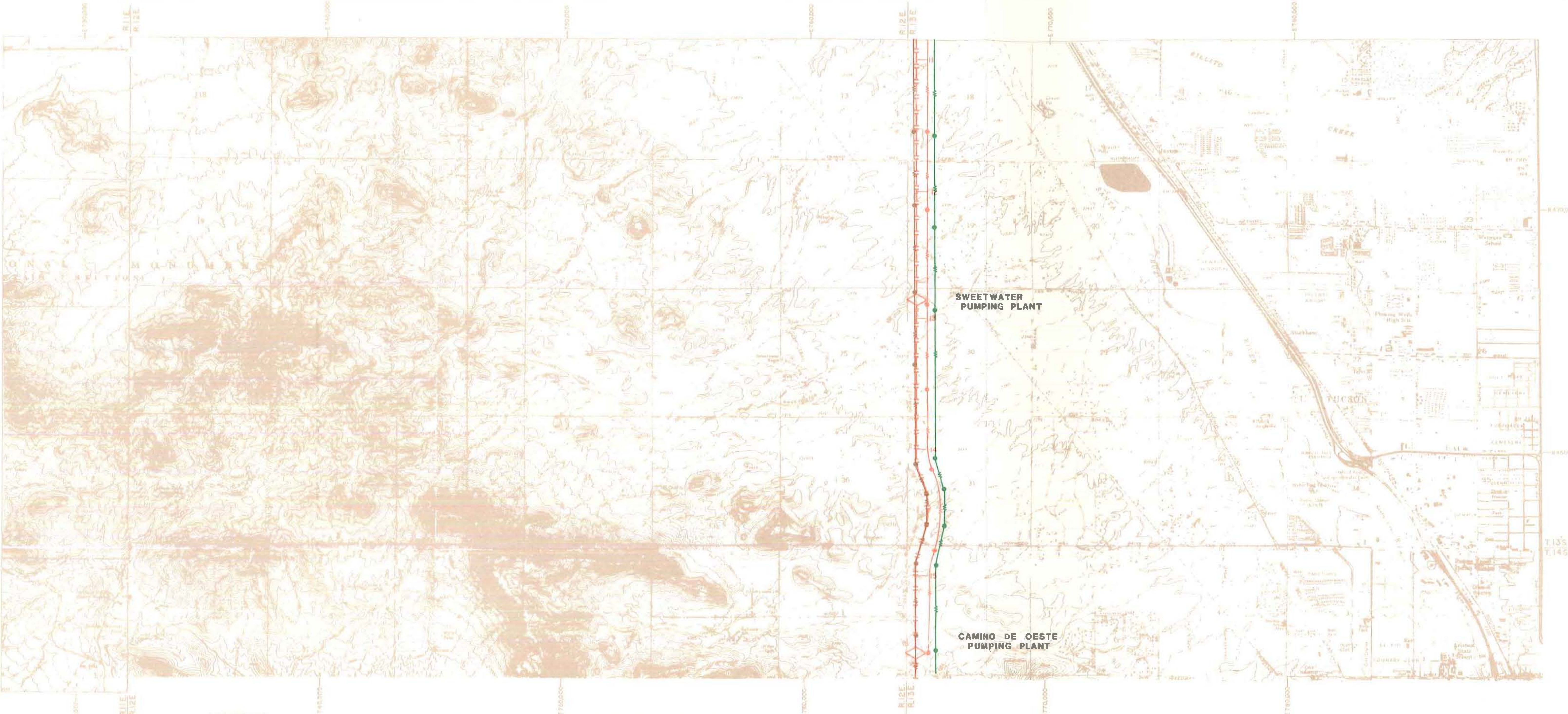
LEGEND
OPEN AQUEDUCT
PIPELINE
PUMPING PLANT
MILE MARKER
TRANSMISSION LINE
DIKE
FLOOD DETENTION AREA
CHECK STRUCTURE
BRIDGE
OVERCHUTE
TURNOUT
SPOIL AREA
SIPHON
ALTERNATIVE TRANSMISSION LINE
SUB-ALTERNATIVE TRANSMISSION LINE
SHEET INDEX
4107
4108
4109
4110
4111
4112
2000 0 2000 4000 6000
SCALE OF FEET
CONTOUR INTERVAL VARIES
PHASE A
RILLITO PUMPING PLANT
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CENTRAL ARIZONA PROJECT
TUCSON DIVISION-ARIZONA
TUCSON AQUEDUCT-PHASE B
EAST SIDE ROUTE
344-330-4107
NOVEMBER 1984
REV. MARCH 1985
Dwn: RMM, RSS

Figure 35



UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CENTRAL ARIZONA PROJECT
TUCSON DIVISION-ARIZONA
TUCSON AQUEDUCT-PHASE B
EAST SIDE ROUTE
344-330-4108
NOVEMBER 1984
REV. MARCH 1985

Figure 36



LEGEND

- OPEN AQUEDUCT
- PIPELINE
- PUMPING PLANT
- MILE MARKER
- TRANSMISSION LINE
- DIKE
- ALTERNATIVE TRANSMISSION LINE
- SUB-ALTERNATIVE TRANSMISSION LINE
- FLOOD DETENTION AREA
- CHECK STRUCTURE
- BRIDGE
- OVERCHUTE
- TURNOUT
- SPOIL AREA
- SIPHON

SHEET INDEX

4107
4108
4109
4110
4111
4112

2000 0 2000 4000 6000
SCALE OF FEET
CONTOUR INTERVAL VARIES

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CENTRAL ARIZONA PROJECT
TUCSON DIVISION-ARIZONA
TUCSON AQUEDUCT-PHASE B
EAST SIDE ROUTE
344-330-4109
NOVEMBER 1984
REV. MARCH 1985

Drawn: RMM, RSS

Figure 37

LEGEND

- OPEN AQUEDUCT
- PIPELINE
- PUMPING PLANT
- MILE MARKER
- TRANSMISSION LINE
- DIKE
- FLOOD DETENTION AREA
- CHECK STRUCTURE
- BRIDGE
- OVERCHUTE
- TURNOUT
- SPOIL AREA
- SIPHON
- ALTERNATIVE TRANSMISSION LINE
- SUB-ALTERNATIVE TRANSMISSION LINE

SHEET INDEX

4107
4108
4109
4110
4111
4112

2000 0 2000 4000 6000

SCALE OF FEET
CONTOUR INTERVAL VARIES

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

CENTRAL ARIZONA PROJECT
TUCSON DIVISION-ARIZONA

TUCSON AQUEDUCT-PHASE B
EAST SIDE ROUTE

344-330-4110

NOVEMBER 1984
REV. MARCH 1985

wn: RMM, RSS

Figure 38

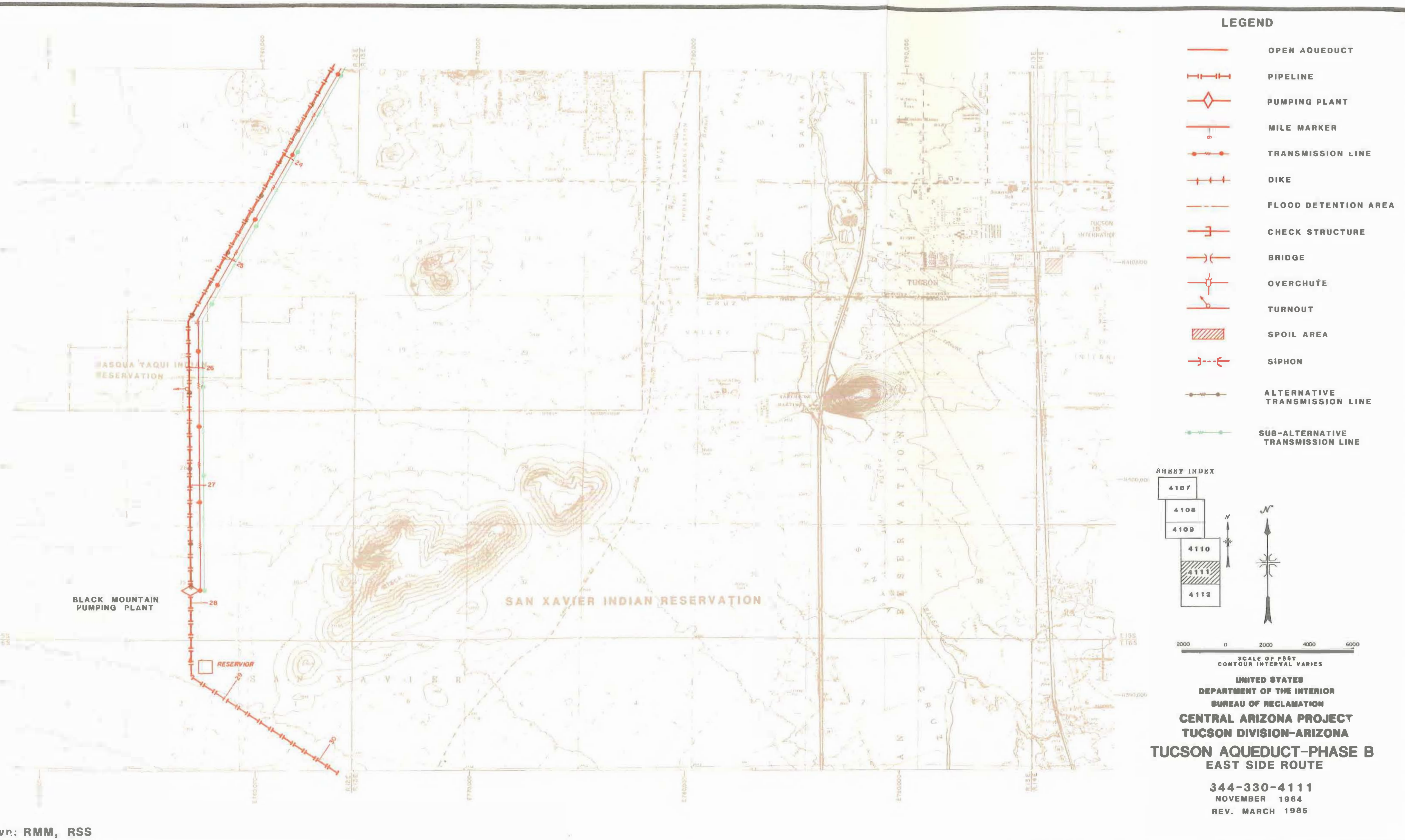
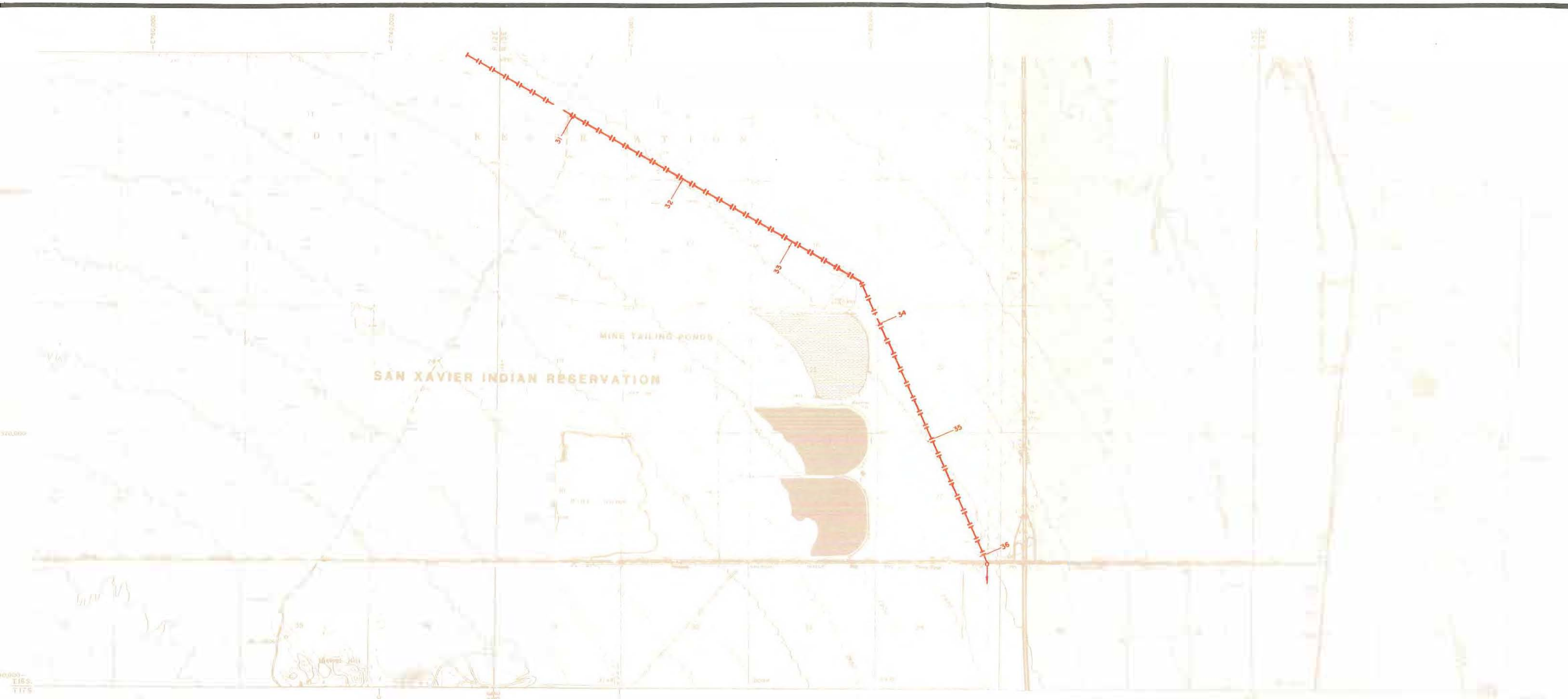

LEGEND
OPEN AQUEDUCT
PIPELINE
PUMPING PLANT
MILE MARKER
TRANSMISSION LINE
DIKE
FLOOD DETENTION AREA
CHECK STRUCTURE
BRIDGE
OVERCHUTE
TURNOUT
SPOIL AREA
SIPHON
ALTERNATIVE TRANSMISSION LINE
SUB-ALTERNATIVE TRANSMISSION LINE
SHEET INDEX
4107
4108
4109
4110
4111
4112
SCALE OF FEET
CONTOUR INTERVAL VARIES
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CENTRAL ARIZONA PROJECT
TUCSON DIVISION-ARIZONA
TUCSON AQUEDUCT-PHASE B
EAST SIDE ROUTE
344-330-4111
NOVEMBER 1984
REV. MARCH 1985
BLACK MOUNTAIN PUMPING PLANT
RESERVIOR
PASQUA YAQUI INDIAN RESERVATION
SAN XAVIER INDIAN RESERVATION
TUCSON
SANTA CRUZ VALLEY
RMM, RSS

Figure 39



LEGEND

	OPEN AQUEDUCT		FLOOD DETENTION AREA
	PIPELINE		CHECK STRUCTURE
	PUMPING PLANT		BRIDGE
	MILE MARKER		OVERCHUTE
	TRANSMISSION LINE		TURNOUT
	DIKE		SPOIL AREA
			SIPHON

wn: RMM, RSS

SHEET INDEX

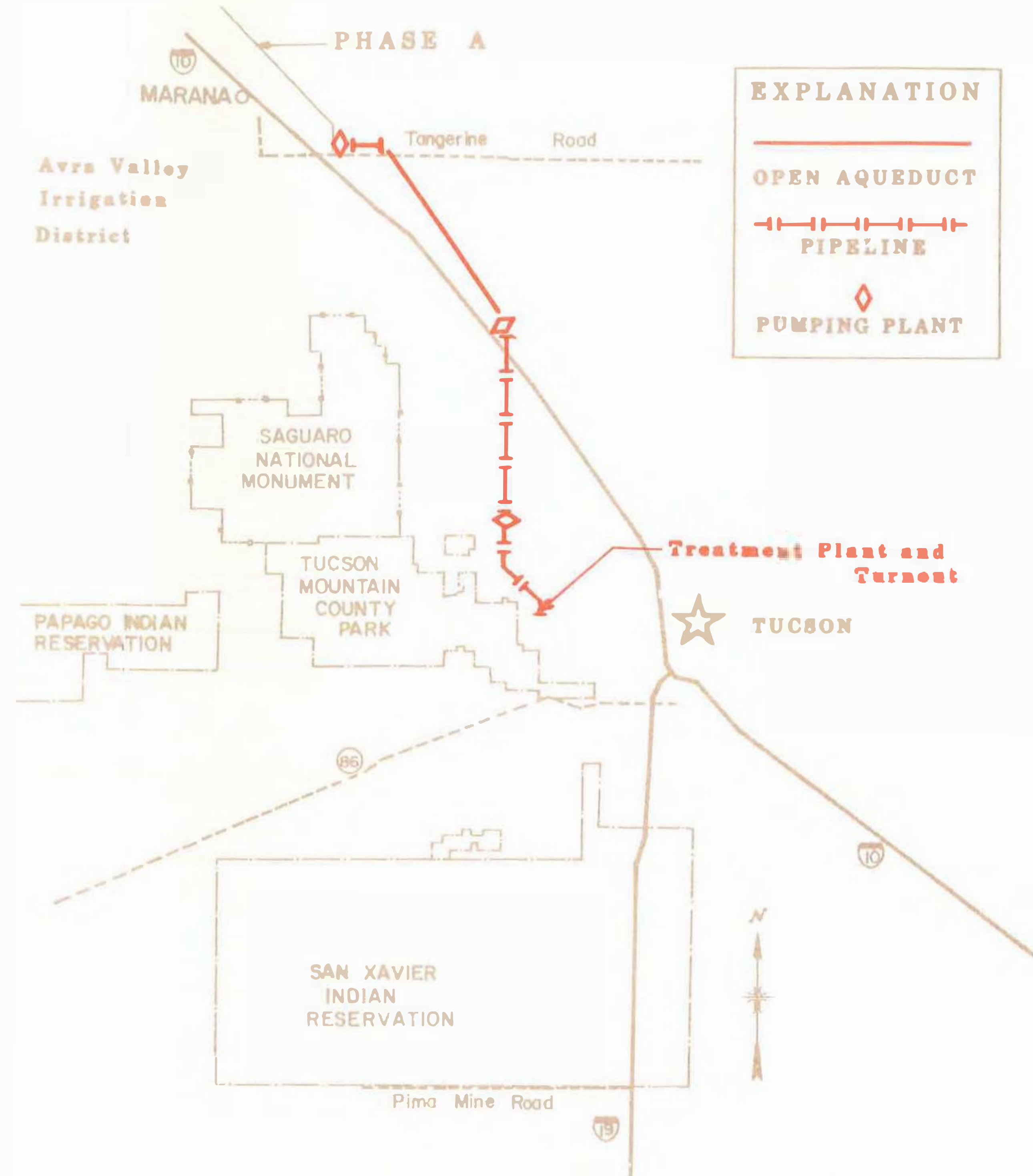
4107
4108
4109
4110
4111
4112

N

2000 0 2000 4000 6000
SCALE OF FEET
CONTOUR INTERVAL VARIES

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CENTRAL ARIZONA PROJECT
TUCSON DIVISION-ARIZONA
TUCSON AQUEDUCT-PHASE B
EAST SIDE ROUTE
344-330-4112
NOVEMBER 1984
REV. MARCH 1985

Figure 40



NO FEDERAL ACTION PLAN

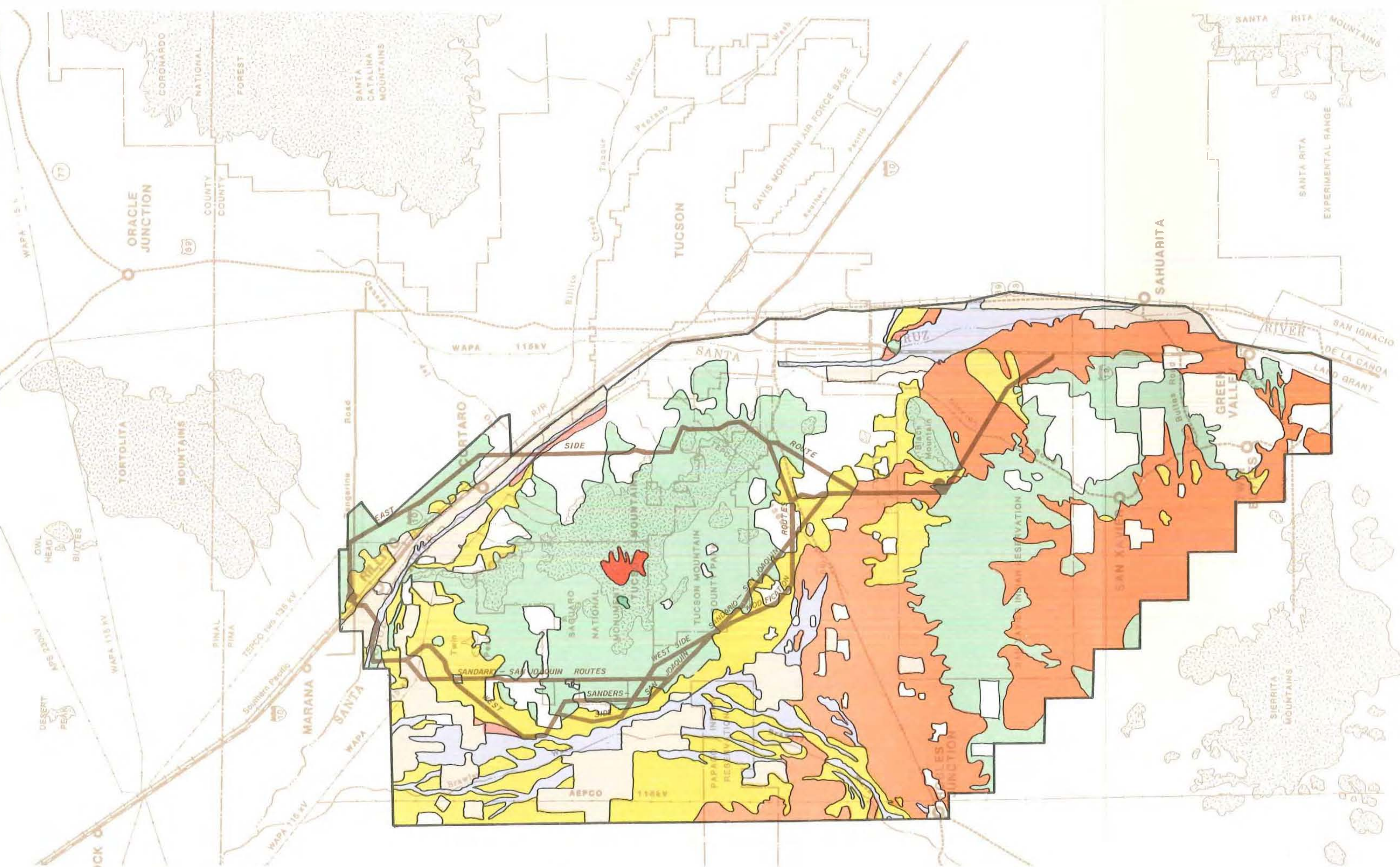
CENTRAL ARIZONA PROJECT

TUCSON AQUEDUCT-PHASE B

344-330-5046

Figure 41

Dwn: RMM



EXPLANATION

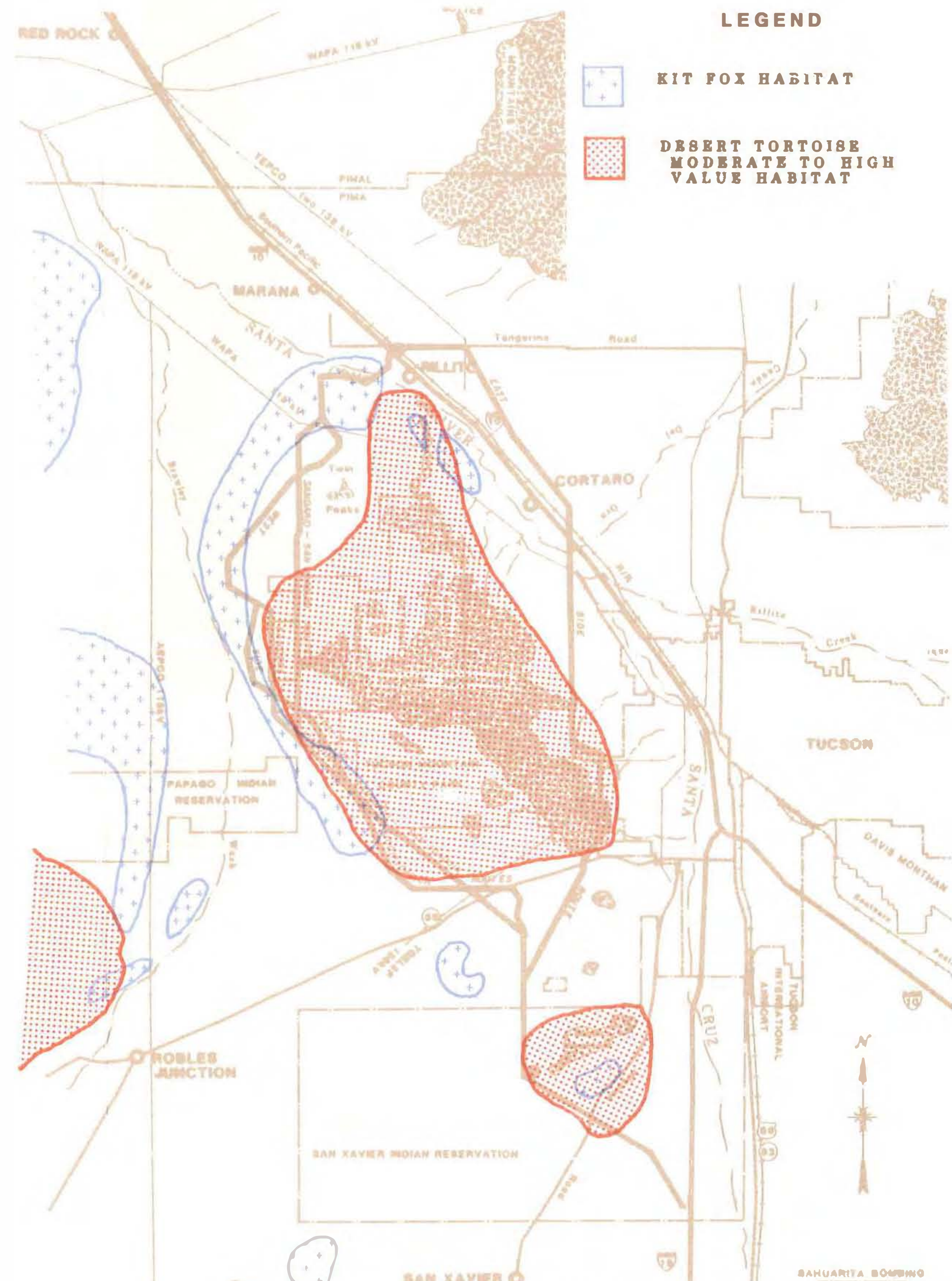
- Palo Verde-Mixed Cacti Community
- Shrub-Scrub Disclimax Community
- Creosote-Bursage Community
- Mesquite Bosque Community
- Saltbush Community
- Mixed Grass-Scrub Community
- Eriogonum-Agave Community
- Agricultural Land
- Developed Land

SCALE OF FEET
CONTOUR INTERVAL 20 FEET WITH INTERPOLATED 10 FOOT CONTOURS

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CENTRAL ARIZONA PROJECT
TUCSON DIVISION-ARIZONA
TUCSON AQUEDUCT-PHASE B
Vegetation Map
344-330-3512
Sept. 1983
REV. MARCH 1985

wn: RMM

Figure 42

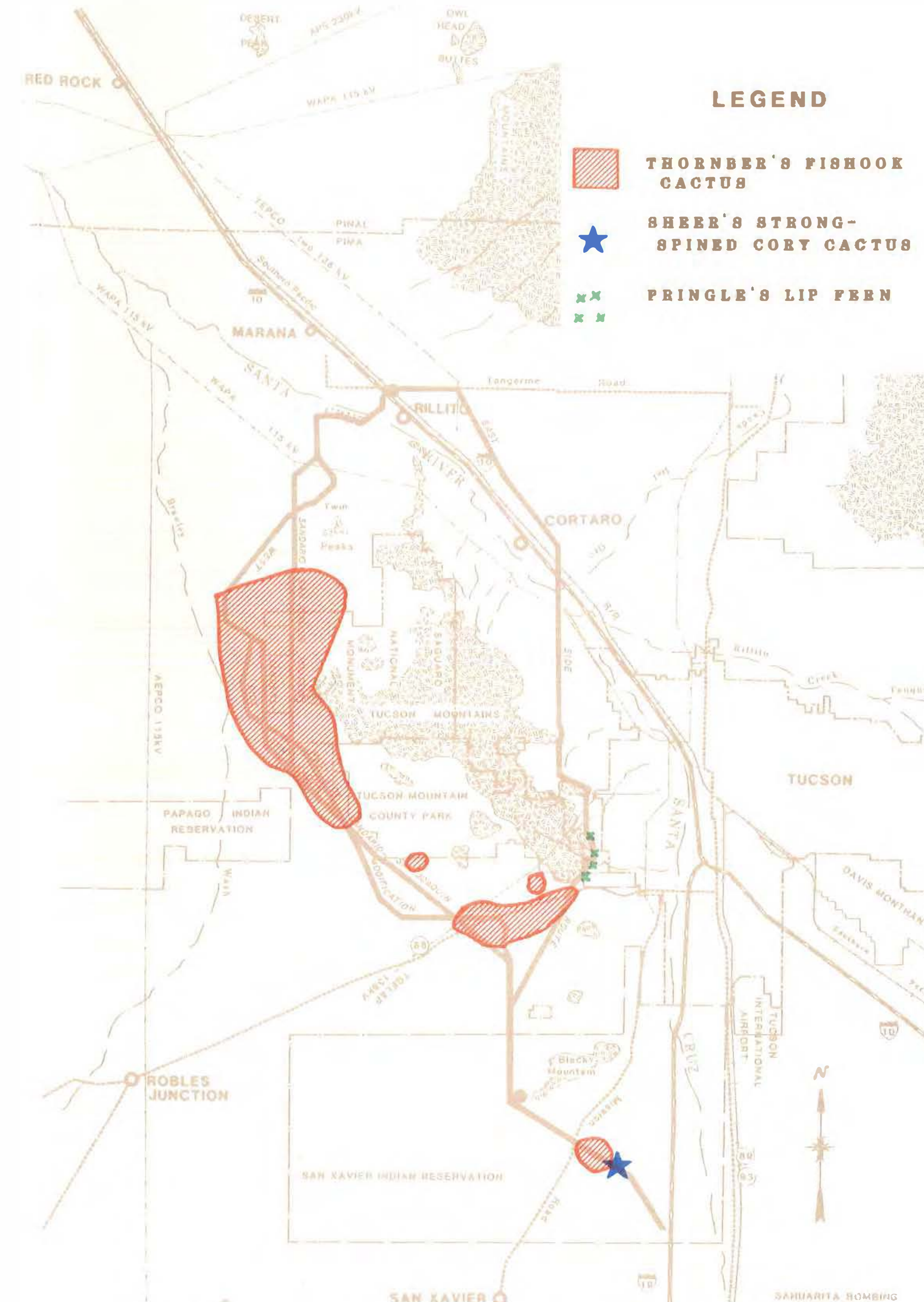


AREAS OF HIGH BIOLOGICAL IMPACT

TUCSON AQUEDUCT-PHASE B CENTRAL ARIZONA PROJECT

Dwn: RMM,PM   Figure 43   344-330-4781

REV. MARCH 1985



AREAS OF HIGH BIOLOGICAL IMPACT

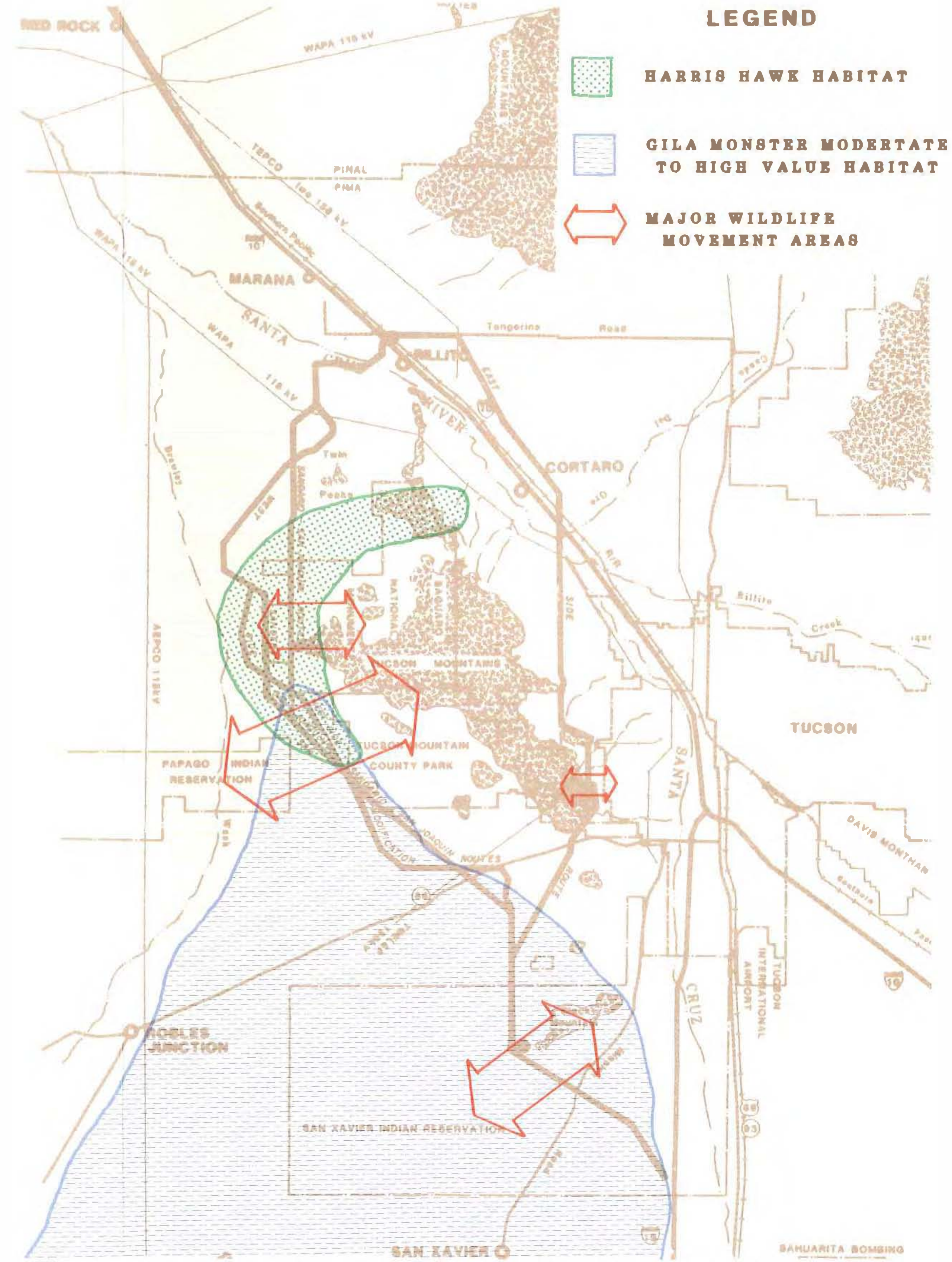
TUCSON AQUEDUCT-PHASE B CENTRAL ARIZONA PROJECT

Dwn: RMM,PM

Figure 44

344-330-4782

REV. MARCH 1985



AREAS OF HIGH BIOLOGICAL IMPACT

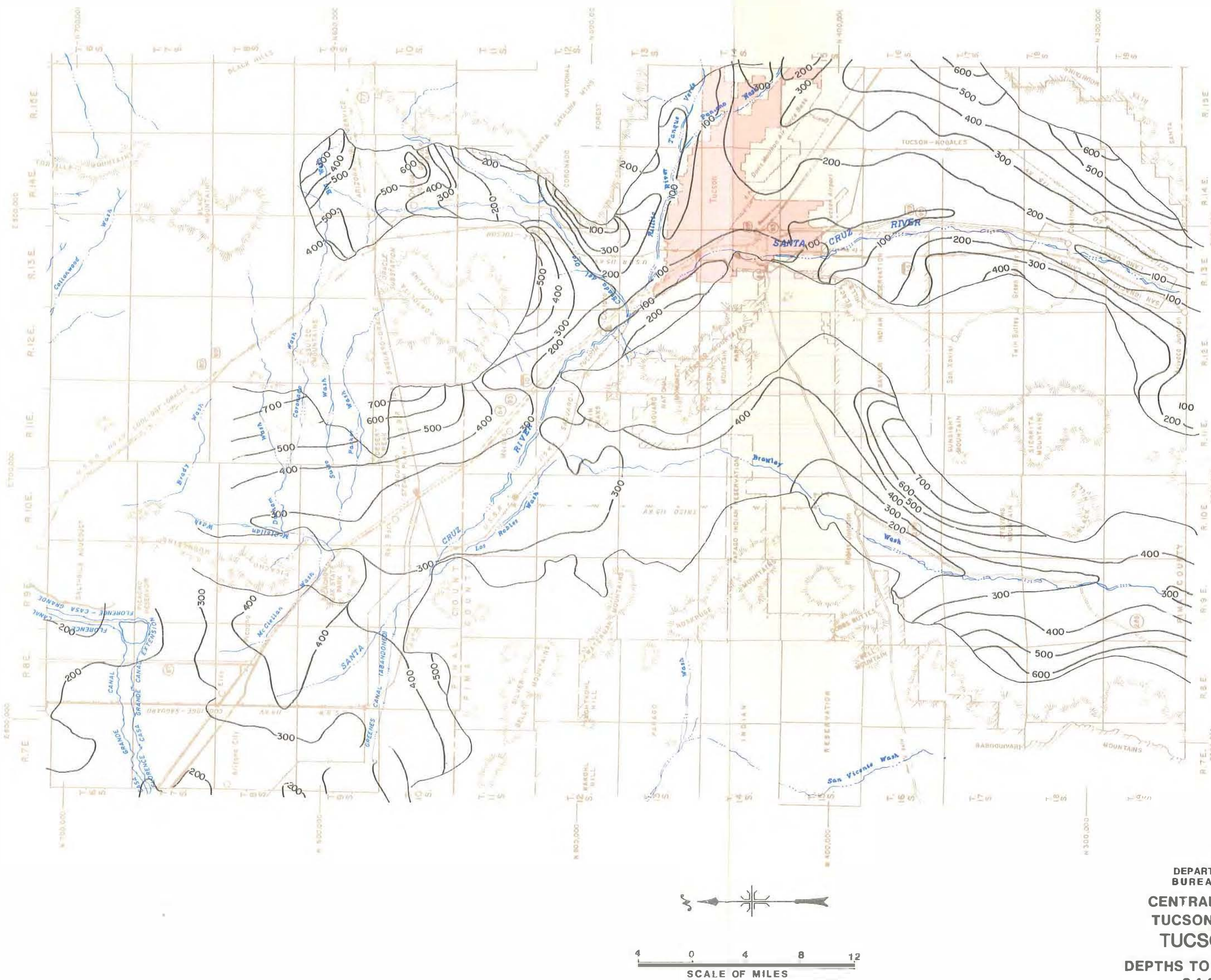
TUCSON AQUEDUCT-PHASE B CENTRAL ARIZONA PROJECT

Dwn: RMM, PM

Figure 45

344-330-4783

REV. MARCH 1985

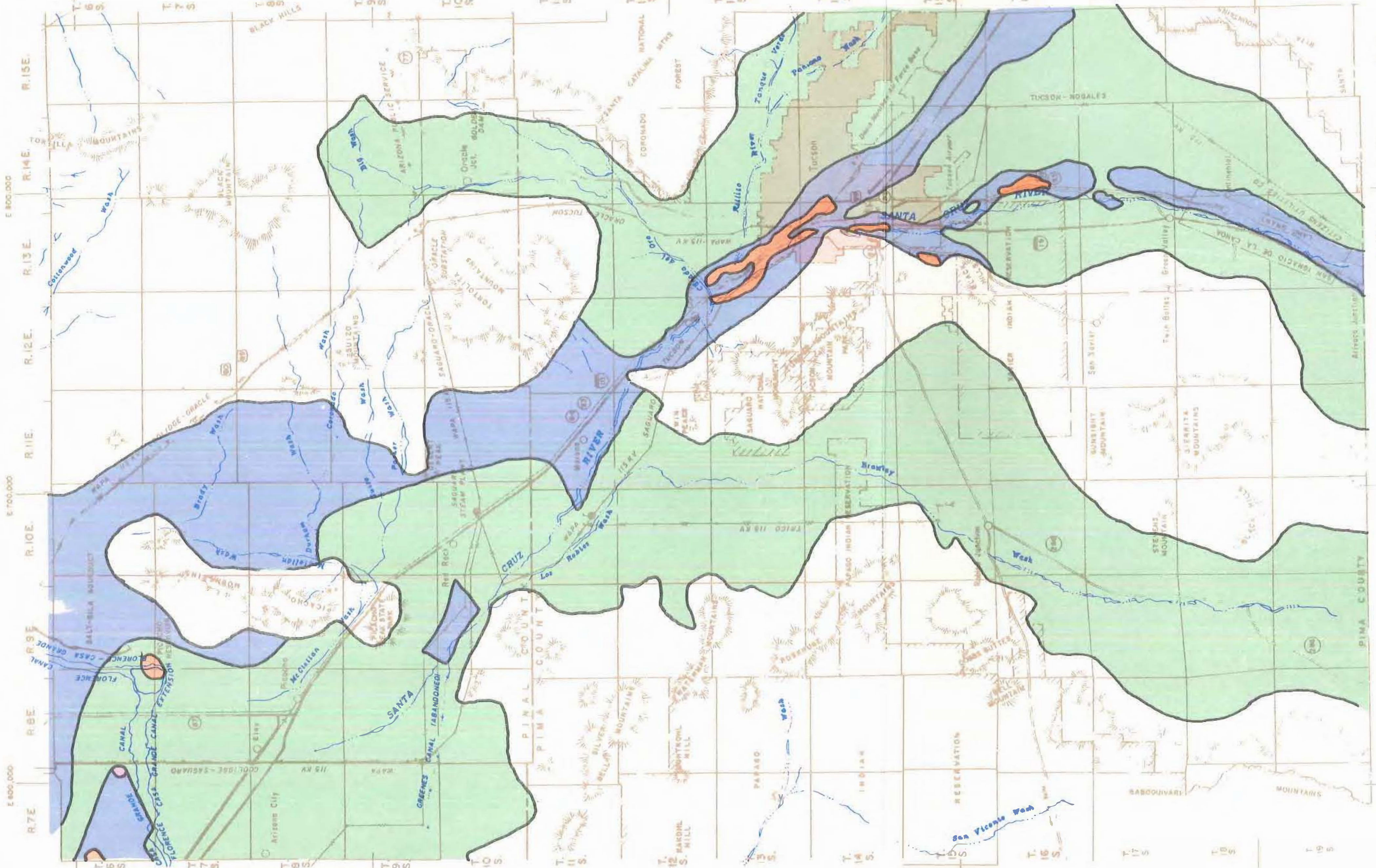


UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

CENTRAL ARIZONA PROJECT
TUCSON DIVISION-ARIZONA
TUCSON AQUEDUCT

DEPTHS TO GROUND WATER 1972
344-330-4785
APRIL, 1984

Dwn: RMM



NOTE

Dissolved-Solids Content Areas taken from U.S.G.S. Map I-844-I, Dissolved-Solids Content of Ground Water Tucson, Arizona: and Map I-845-G Dissolved-Solids Content of Ground Water, Phoenix, Arizona: by L.R. Kister, 1974

EXPLANATION

- Less than 500 mg/l.
- 500 to 1,000 mg/l.
- 1,000 to 3,000 mg/l.
- More than 3,000 mg/l.

4 0 4 8 12

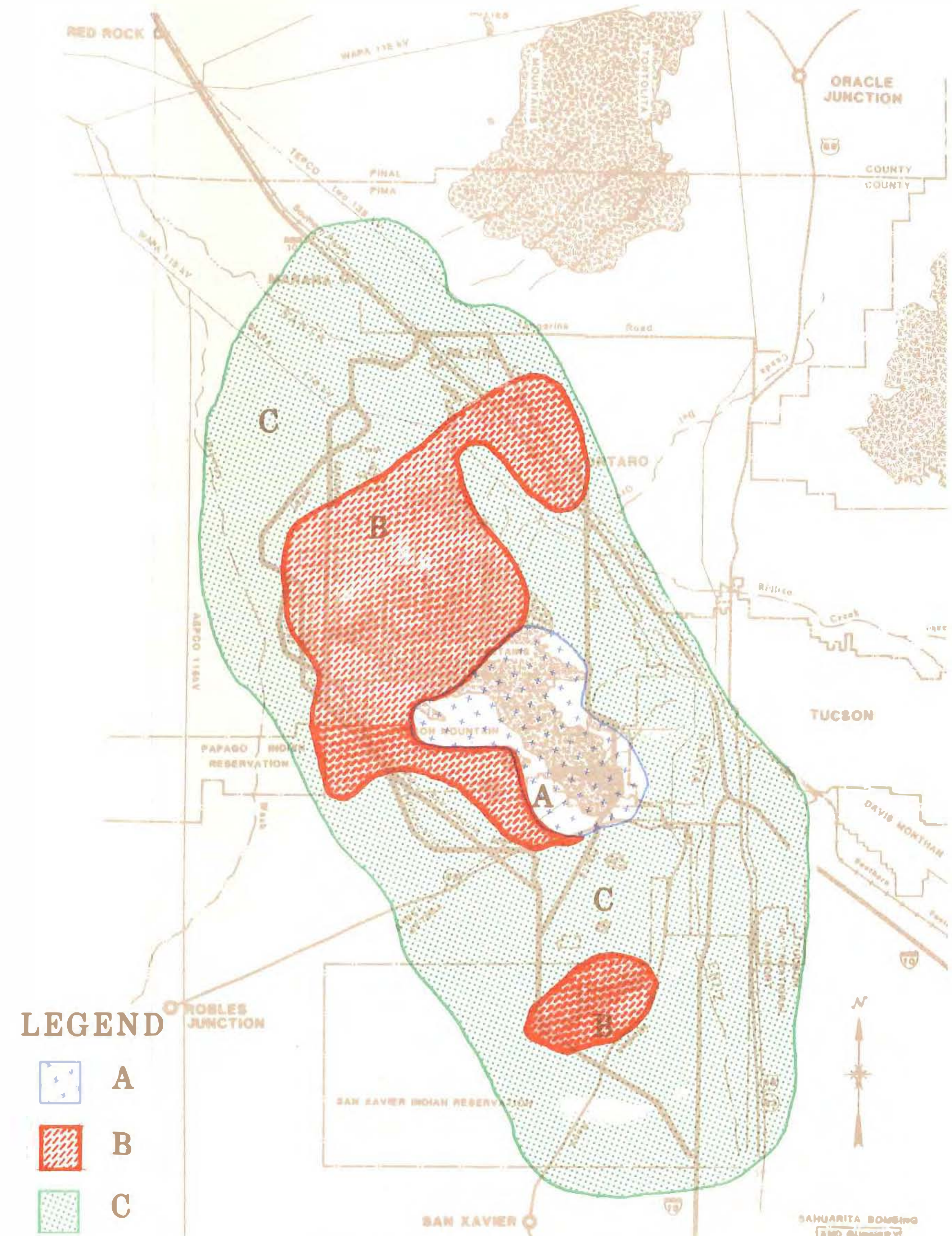
SCALE OF MILES

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

CENTRAL ARIZONA PROJECT
TUCSON DIVISION-ARIZONA
TUCSON AQUEDUCT
DISSOLVED-SOLIDS CONTENT OF GROUND WATER
344-330-4786
APRIL, 1984
REV. MARCH 1985

Dwn: RMM, PM

Figure 47

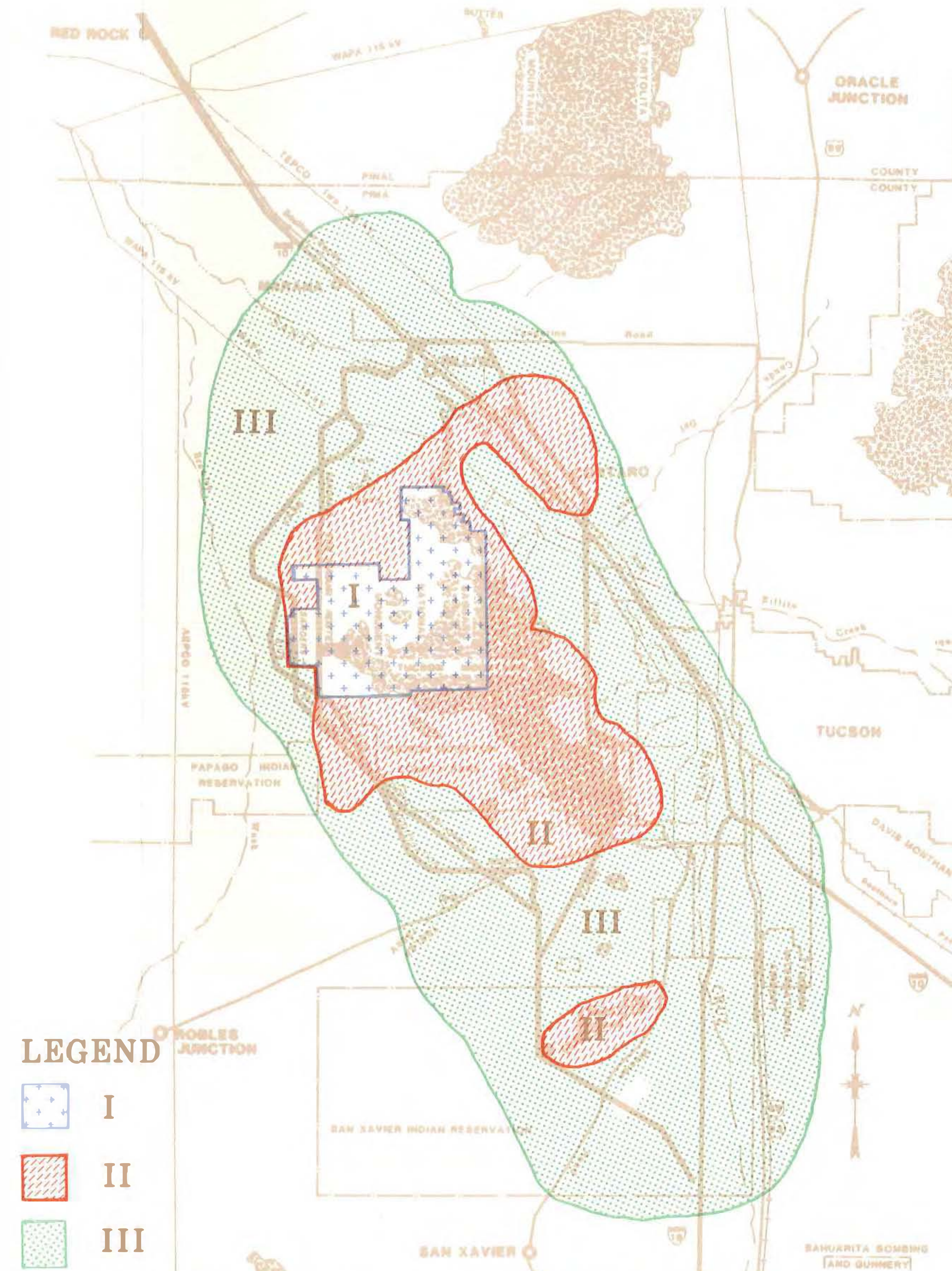


SCENIC QUALITY

TUCSON AQUEDUCT-PHASE B CENTRAL ARIZONA PROJECT

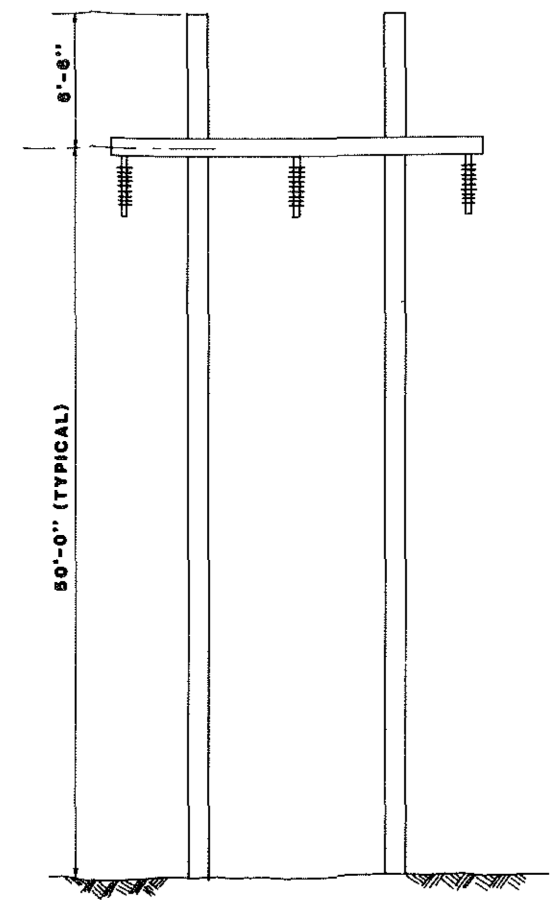
Dwn: RMM,PM Figure 48 344-330-4779

REV. MARCH 1985

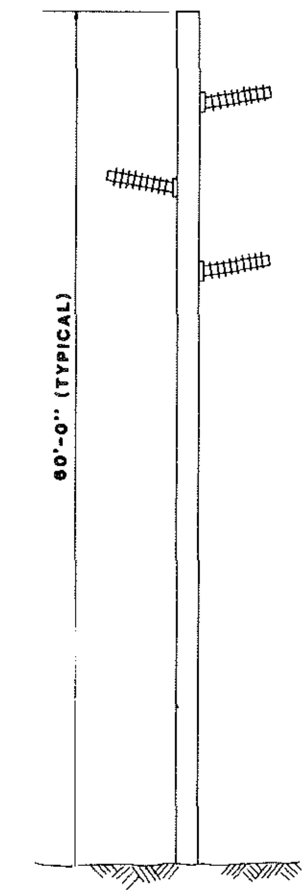


VISUAL RESOURCE MANAGEMENT(VRM) CLASSES
TUCSON AQUEDUCT-PHASE B CENTRAL ARIZONA PROJECT
Dwn: RMM,PM Figure 49 344-330-4780
REV. MARCH 1985

Figure 50. View of Granite Reef Aqueduct--Central Arizona Project From About 2 miles Upslope. The canal is visible as a linear feature across the center of the photo.



SINGLE CIRCUIT -H- FRAME
WOOD POLE STRUCTURE



SINGLE CIRCUIT
WOOD POLE STRUCTURE

NOTE

Dimensions are typical and may change in final design.
For comparison of relative structure sizes only.

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

CENTRAL ARIZONA PROJECT
TUCSON DIVISION-ARIZONA
TUCSON AQUEDUCT PHASE-B
69kV or 115kV TRANSMISSION LINE
344-330-4150
JANUARY 1984

Dwn: RMM

Figure 51

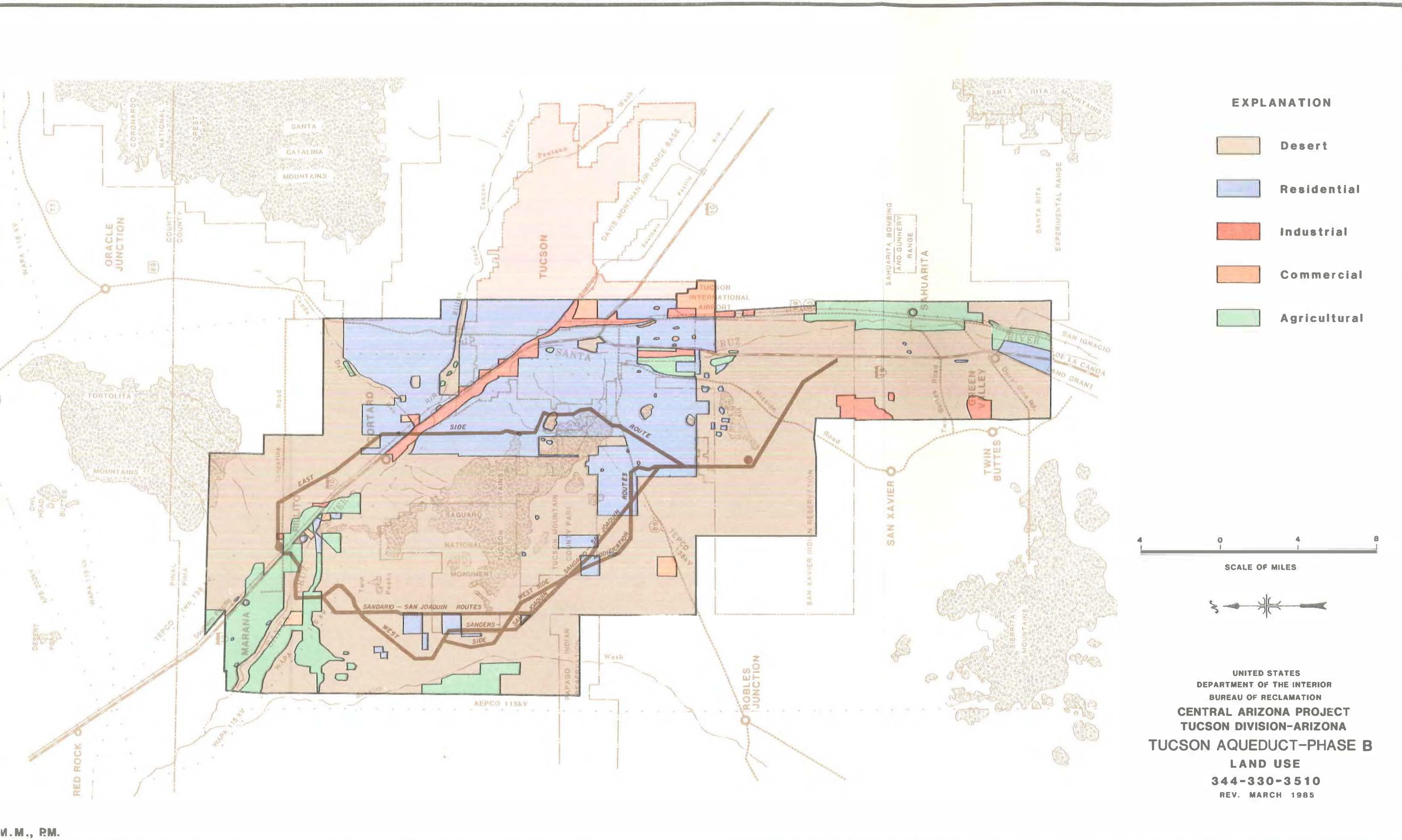

EXPLANATION
Desert
Residential
Industrial
Commercial
Agricultural
4 0 4 8
SCALE OF MILES
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CENTRAL ARIZONA PROJECT
TUCSON DIVISION-ARIZONA
TUCSON AQUEDUCT-PHASE B
LAND USE
344-330-3510
REV. MARCH 1985
SANTA CATALINA MOUNTAINS
CORONADO NATIONAL FOREST
ORACLE JUNCTION
TORTOLITA MOUNTAINS
TUCSON
DAVIS MONTHAN AIR FORCE BASE
TUCSON INTERNATIONAL AIRPORT
SAHUARITA BOMBING AND GUNNERY RANGE
SAHUARITA
SANTA RITA MOUNTAINS
SANTA RITA EXPERIMENTAL RANGE
SAN IGNACIO DE LA CANOA LAND GRANT
GREEN VALLEY
TWIN BUTTES
SAN XAVIER
SAN XAVIER INDIAN RESERVATION
SIERRITA MOUNTAINS
ROBLES JUNCTION
PAPAGO INDIAN RESERVATION
SAGUARO NATIONAL MONUMENT
TUCSON MOUNTAIN COUNTY PARK
SANDARIO - SAN JOAQUIN ROUTES
SANDERS
WEST SIDE
EAST SIDE ROUTE
MARANA
RED ROCK
AEPCO 115kV
WAPA 115 kV
TEPCO 138kV
M.M., P.M.

Figure 52

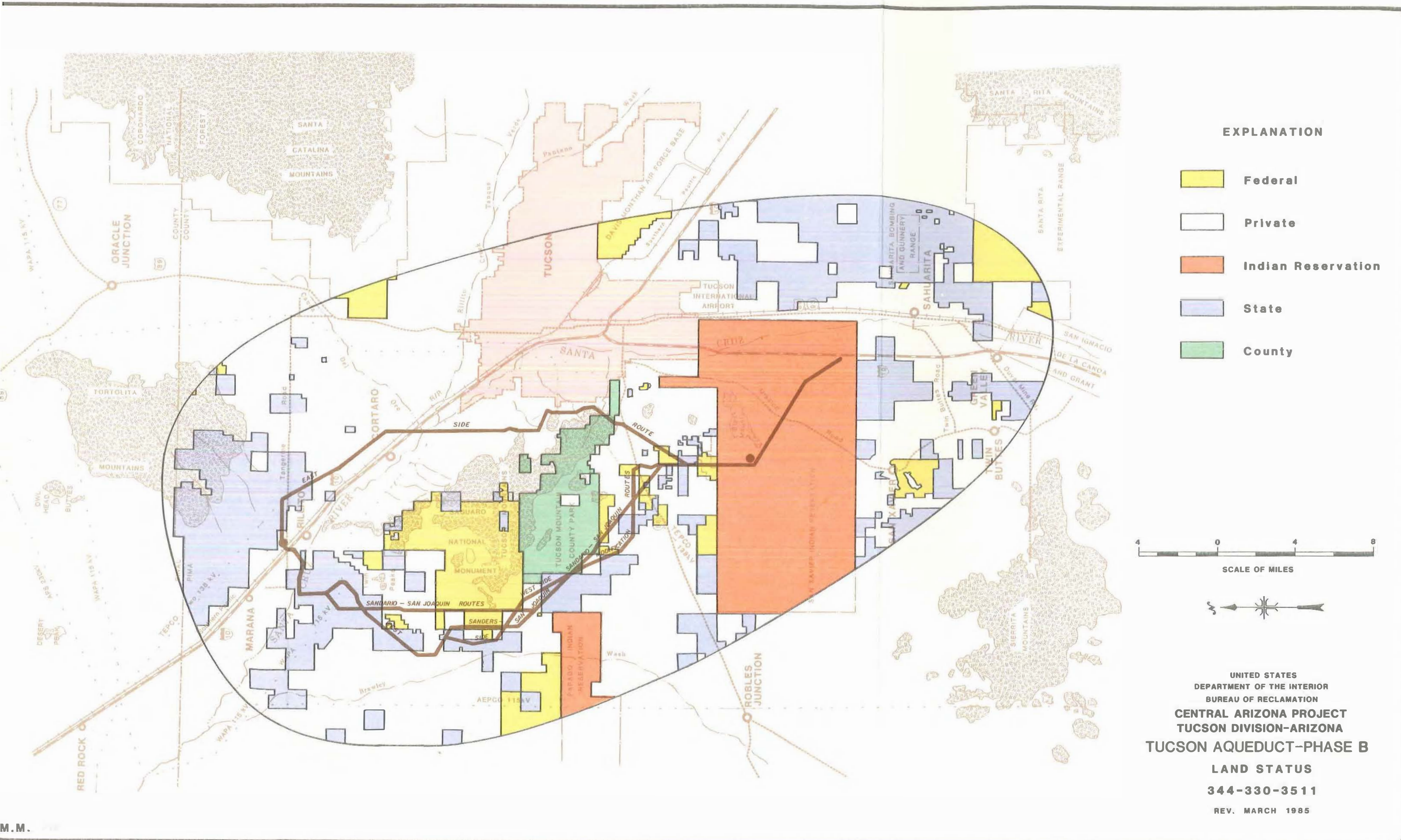
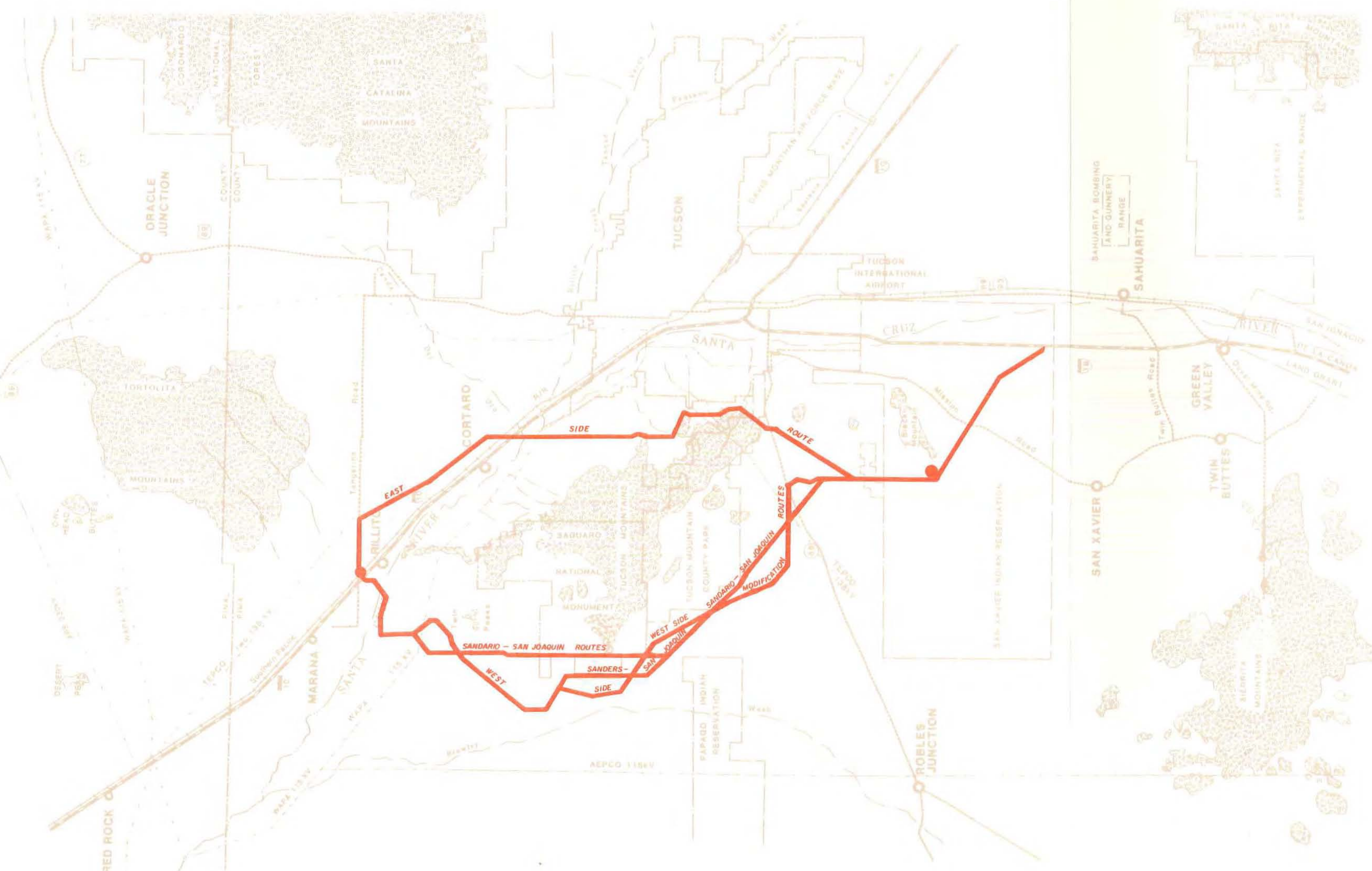

EXPLANATION
Federal
Private
Indian Reservation
State
County
SCALE OF MILES
4
0
4
8
SANTA CATALINA MOUNTAINS
CORONADO NATIONAL FOREST
ORACLE JUNCTION
TORTOLITA MOUNTAINS
TUCSON
DAVIS MONTHAN AIR FORCE BASE
TUCSON INTERNATIONAL AIRPORT
SANTA CRUZ RIVER
CORTARO
MARANA
RED ROCK
ROBLES JUNCTION
SAHUARITA
SANTA RITA MOUNTAINS
SANTA RITA EXPERIMENTAL RANGE
SAHUARITA BOMBING AND GUNNERY RANGE
SAN IGNACIO DE LA CANOA LAND GRANT
TWIN BUTTES
SIERRITA MOUNTAINS
SAGUARO NATIONAL MONUMENT
TUCSON MOUNTAIN COUNTY PARK
PAPAGO INDIAN RESERVATION
SAN XAVIER INDIAN RESERVATION
EAST SIDE ROUTE
SANDARIO – SAN JOAQUIN ROUTES
SANDERS
WEST SIDE
SAN JOAQUIN
ROUTE 85
AEPCO 115 kV
WAPA 115 kV
TEPCO
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CENTRAL ARIZONA PROJECT
TUCSON DIVISION-ARIZONA
TUCSON AQUEDUCT-PHASE B
LAND STATUS
344-330-3511
REV. MARCH 1985
M.M.

Figure 53



UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

CENTRAL ARIZONA PROJECT
TUCSON DIVISION-ARIZONA

TUCSON AQUEDUCT-PHASE B

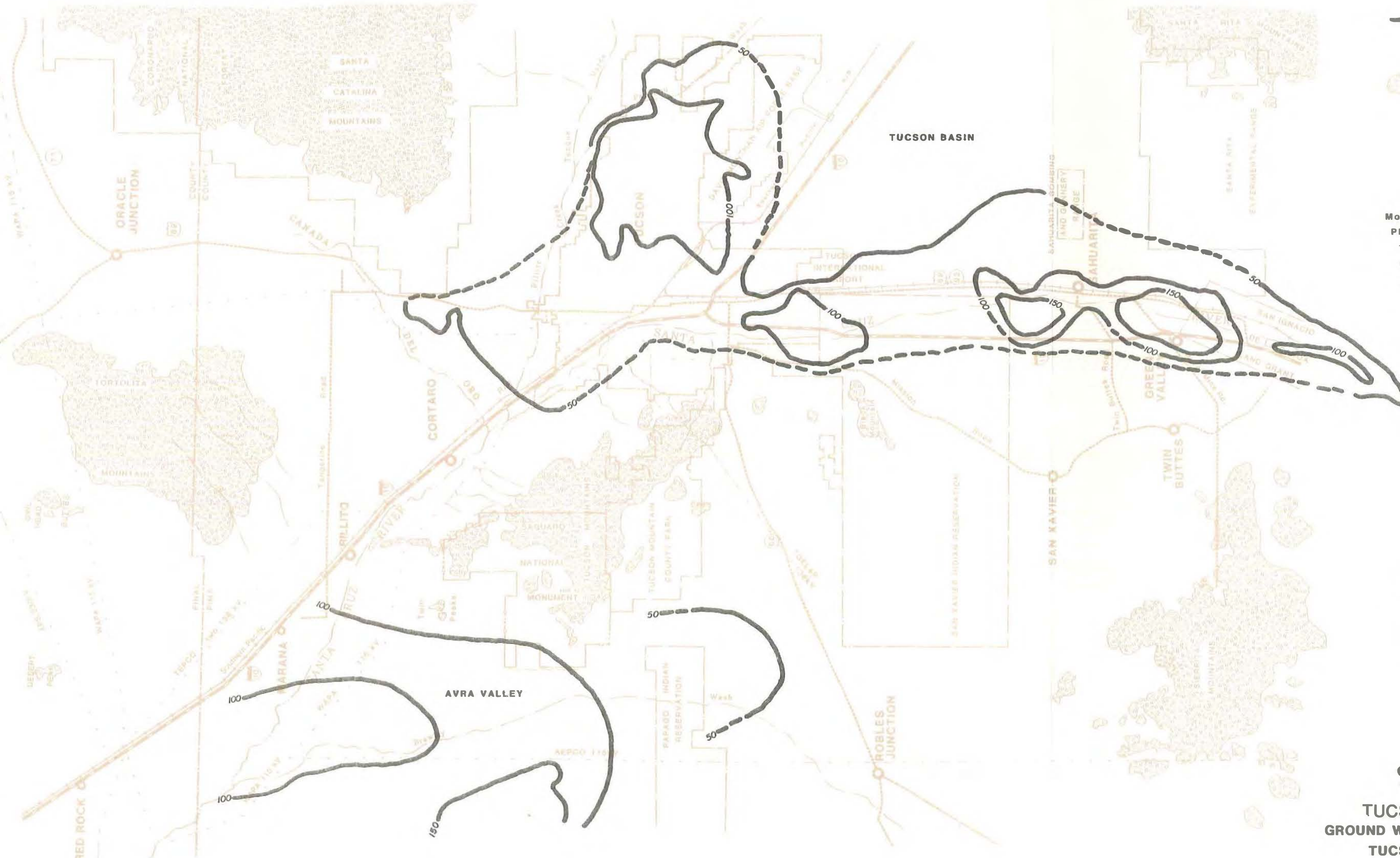
ALTERNATE ROUTES

344-330-4149

JANUARY 1984
REV. MARCH 1985

wn: RMM, PM

Figure 54



EXPLANATION

50 Lines of equal change in water level, 50 ft. intervals, dashed where inferred. Water level changes 1952-1981 in Avra Valley and 1947-1981 in Tucson Basin

Bedrock or mountainous area.

NOTE

Modified from city of Tucson, Tucson Water Planning Division,1981. Annual Static Water Level Basic Data Report-Tucson Basin and Avra Valley, Pima Co., Arizona: City of Tucson, Figures 2-3 and 3-3

2 0 2 4 6
SCALE OF MILES

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

CENTRAL ARIZONA PROJECT
TUCSON DIVISION-ARIZONA

TUCSON AQUEDUCT-PHASE B

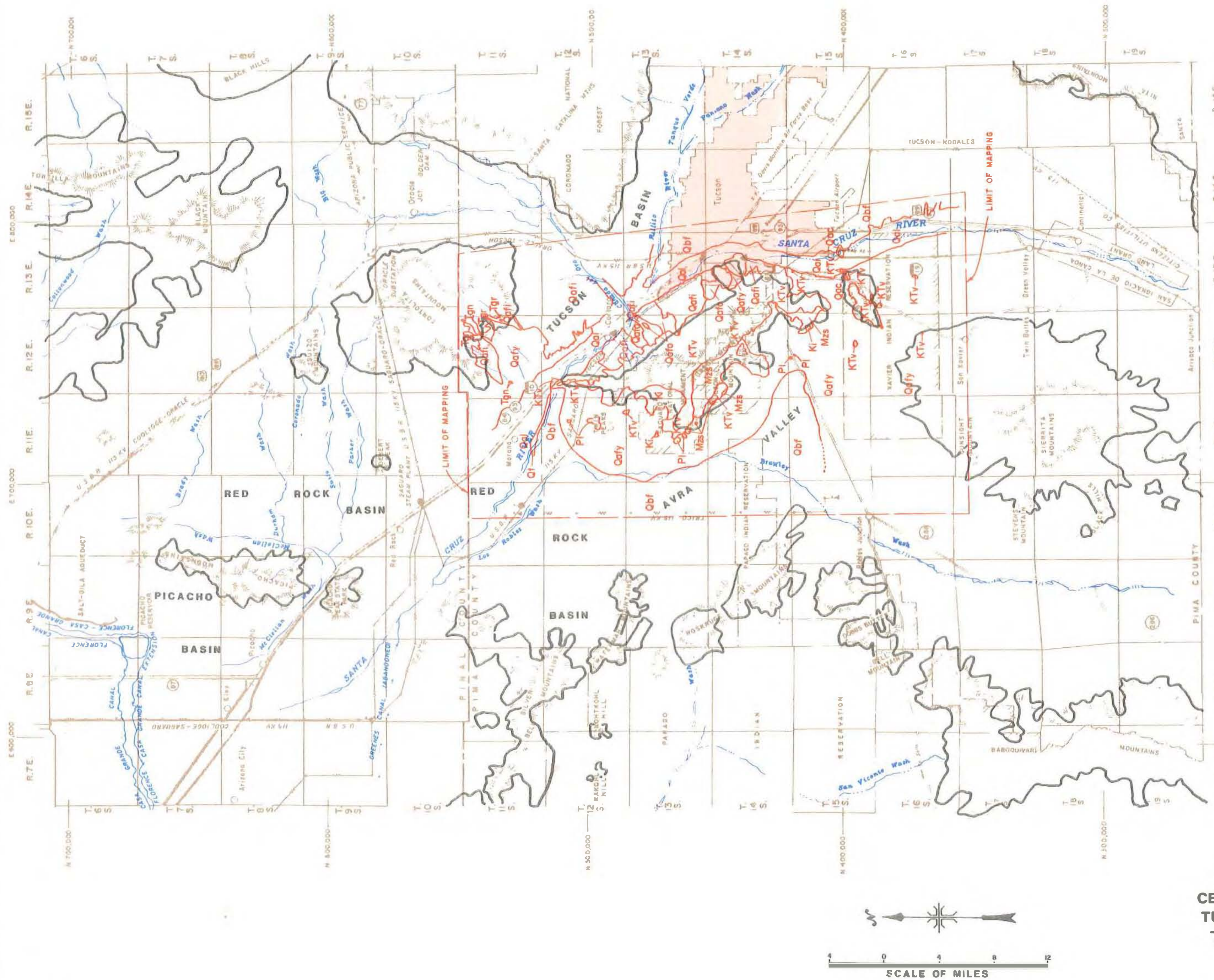
GROUND WATER LEVEL CHANGES 1947- 1981
TUCSON BASIN AND AVRA VALLEY

344-330-3544

DEC. 2, 1982

n: RMM

Figure 55



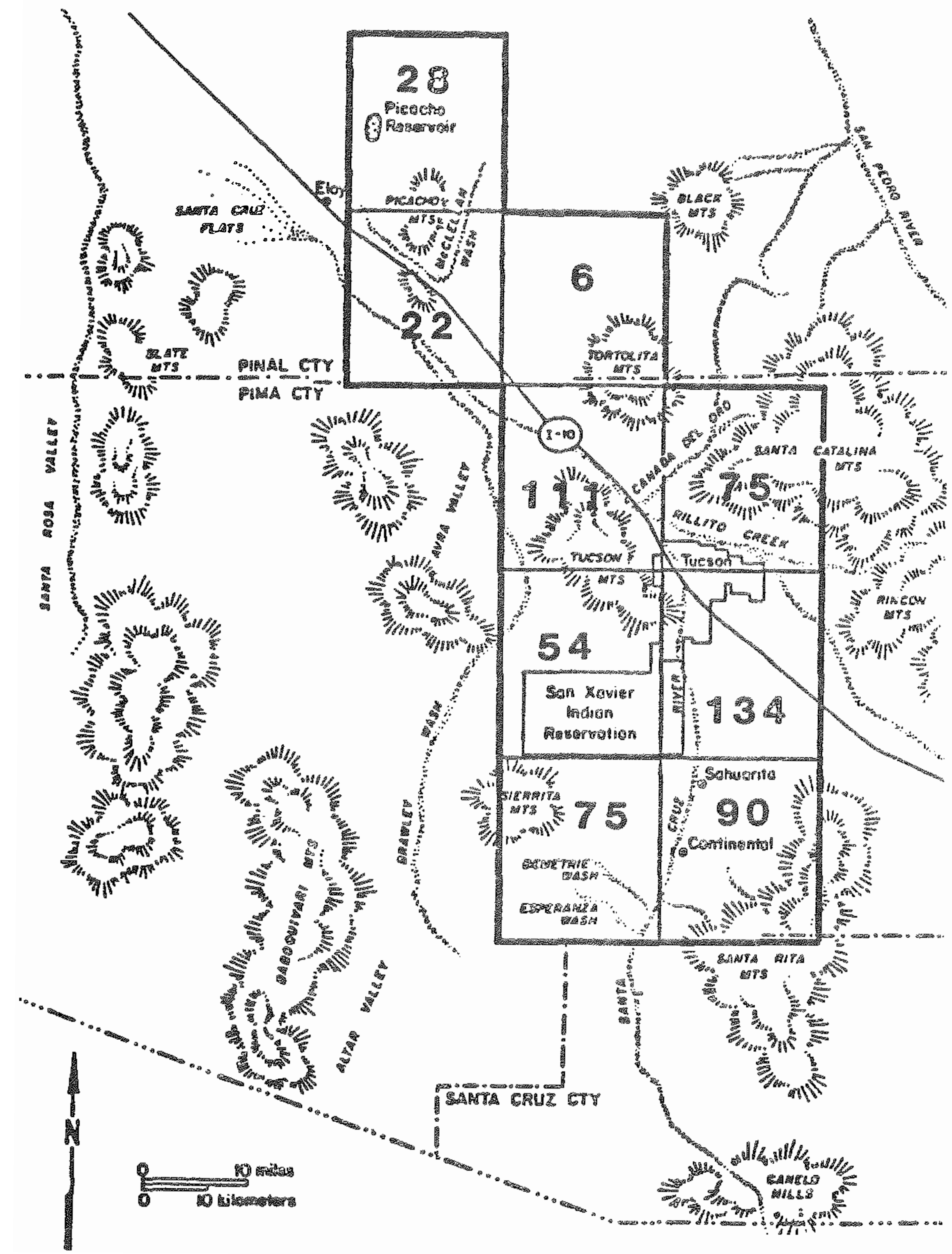
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

CENTRAL ARIZONA PROJECT
TUCSON DIVISION-ARIZONA

TUCSON AQUEDUCT
SURFACE GEOLOGY
344-330-4787
APRIL, 1984

Dwn: RMM

Figure 56



CLASS I CULTURAL RESOURCE SURVEY AREA (NUMBER OF ARCHEOLOGICAL SITES PREVIOUSLY RECORDED IN EACH 15-MINUTE QUADRANGLE IS INDICATED)

CENTRAL ARIZONA PROJECT TUCSON AQUEDUCT 344-330-4791

Figure 57

V. LIST OF PREPARERS

LIST OF PREPARERS

Name	Qualifications	Participation
Lynn Almer	B.S. Chemistry/Earth Science; MNS Natural Science; Environmental Protection Specialist, Bureau of Reclamation, 6 months; Physical Scientist, Corps of Engineers, 4.5 yr.	Response to comments and finalization of draft EIS.
Ted Bruce	BA Geology; Geologist, Bureau of Reclamation, 12 yr.	Final revisions to geology.
Dennis Burgett	Realty Specialist; Bureau of Reclamation, 7 yr.	Lands portion of EIS.
Randy Chandler	BS Civil Engineering; Hydraulic Engineer, Bureau of Reclamation, 6 yr.	Water Resources portion of EIS.
Gregory Crossman	BS Civil Engineering; Civil Engineer, Bureau of Reclamation, 3.5 yr.	Final revisions to water quality and air quality.
E. Frank DiSanza	BS Civil Engineering; Supervisory Civil Engineer, Bureau of Reclamation, 8 yr.	Description of future without the project.
Destry Edmondson	Word Processing Technician; Bureau of Reclamation, 2 yr.	Word Processing.
Bruce Ellis	BA Anthropology; Environmental Program Manager, Bureau of Reclamation, 6 yr.	Visual Quality.
Thomas Gatz	BS Anthropology; Wildlife Biologist, FWS, 3 yr; Bureau of Reclamation, 6 yr.	Biological Resource portion of EIS.
Chris Gehlker	BA Economics; Economist, COE, 8 yr; Bureau of Reclamation 6 yr.	Economic assessment.
Michael Golder	BS Chemistry/Biology, EIT; Environmental Engineer, Bureau of Reclamation, 3 yr.	EIS Coordinator.
Dean Hagstrom	BS Civil Engineering; Civil Engineers, Bureau of Reclamation, 4 yr.	Description of Alternatives.

LIST OF PREPARERS

Name	Qualifications	Participation
Jim Hartman	MS Zoology; Environmental Specialist, Western Area Power Administrative	Description of transmission line systems and impacts.
Wanda Hobart	BS Outdoor Recreation, MA Recreation Administration; Outdoor Recreation Planner, NPS, 1 yr; HCRS, 1 yr; Bureau of Reclamation, 2 yr.	Recreation portion of EIS.
Tom Lincoln	BS MA Anthropology; Archaeologist Bureau of Reclamation, 6 yr.	Cultural Resources portion of EIS.
Paul Manuelito	Engineering Draftsman, Bureau of Reclamation, 2.5 yr.	Revision of maps and figures
Steve Marcus	MS Geology; Geologist Bureau of Reclamation, 2 yr.	Geology portion of EIS.
Bob Martin	Draftsman; Bureau of Reclamation 4 yr.	Preparation of maps and figures.
Cecil Ouellette	B.A., Geography; M.A. Public Administration; Outdoor Recreation Specialist, BOR, 2 yr; Water Quality Specialist, FWPCA, 2 yr; Environmental Specialist, EPA 10 yr; Environmental Specialist, Bureau of Reclamation 3 yr.	Regional Environmental Coordination.
Tom Renckley	BS Civil Engineering; Civil Engineer Design Branch, Bureau of Reclamation, 3 yr.	Engineering layouts, systems and cost estimates.
Richard H. Raymond	MS Geology; Supervisory Geologist U.S. Geological Survey, 1 yr, Bureau of Reclamation, 23 yr.	Subsidence and Earth Fissure portion of EIS.
Mike Robbeloth	Supervisory Civil Engineering Technician; Bureau of Reclamation, 8 yr.	Cover Design and preparation of maps and figures.
Debby Saint	BA Geography; Sound Factors Analyst, Bureau of Reclamation 10 yr.	Social Impacts portion of EIS.

LIST OF PREPARERS

Name	Qualifications	Participation
Randy Stauffer	AA Mechanical Drafting & Design; Engineering Draftsman, Bureau of Reclamation, 5 months.	Revision of maps and figures.
Rexford Stone	BS Agricultural Engineering Civil Engineer, Soil Conservation Service, 25 yr, Bureau of Reclamation, 4 yr.	Tucson Study Team Leader; Plan formulation and description of alternatives.
Paul E. Strauss	M.A. English; Technical Publication Writer, Bureau of Reclamation, 13 yr.	Technical writing and editing.
Kevin Thornton	BS Electrical Engineering; Electrical Engineer, Western Area Power Administration.	Transmission system studies.
Sheryl Vaughan	B.S. Biology; MS Zoology; Biologist Bureau of Reclamation, 3 yr.	Technical evaluation.

GLOSSARY

Acre-Foot
The quantity of water required to cover one acre of land to a depth of one foot; equivalent to 43,560 cubic feet or 325,851 gallons (U.S.).

Air Quality Standards (National Ambient Air Quality Standards):

Primary - the maximum pollutant levels allowable to protect the public health with an adequate margin of safety.

Secondary - the maximum pollutant levels allowable to protect the public welfare from any known or anticipated adverse effect.

Alluvium
General term for clay, silt, sand, gravel, or unconsolidated detrital material deposited by a stream or other body of running water.

Ambient
Encompassing or surrounding.

Bajada
A nearly flat surface formed from confluent alluvial fans along the base of a mountain range.

Bosque
A densely wooded area along a stream or river.

CFS (cfs)
Cubic feet per second. A unit of measure of the rate of liquid flow past a given point equal to one cubic foot in one second.

Check Structure
A structure in a canal that regulates water surface elevation upstream of the structure and flow in canal.

Collective Dike
Earthen structure which impounds surface water on the upslope side of the aqueduct.

Conductor
The wire utilized in electrical circuits to carry current.

Decibel (dB)
A unit for expressing the relative intensity of sounds on a scale from zero for the average least perceptible sound to about 130 for the average pain level.

Earth Fissures
Cracks in the alluvium of basins which have land subsidence due to large water level declines.

Easements
An interest in land owned by another that entitles its holder to a specific limited use.

Forb
Any herb other than grass.

Genus
In taxonomy, a group of closely related species comprised of common distinguishing characteristics.

Gigawatt
A unit of electrical power equal to 1×10^9 watts.

Ground water
Water which is stored or moving between the soil particles below the earth's surface. When all voids between the soil particles are filled with water, the soil is saturated. The top surface of the saturated soil is the water table.

Ground water recharge
Replenishing of ground water.

Habitat
An area where a plant or animal lives. (Sum total of environmental conditions in the area.)

Impact
Measured change due to a project action; residual impacts are those impacts which remain after mitigation.

Infiltration
The movement of water or solution into soil or rock.

Insulating Oil
A special oil, usually refined from petroleum, used to provide electrical insulation and heat transfer in many types of electrical equipment.

Interconnection
A tie permitting a flow of energy between the facilities of two electric systems.

Intertie
Same as Interconnection.

kV (kilovolt)
The term for thousand volts.

kWh (kilowatthour)
The term for thousand-watt-hours (electrical energy).

Mitigation
An action to reduce or eliminate an adverse impact.

Overchute
Structure (usually a pipe or flume) which conveys surface water over an open canal section.

Overdraft
Withdrawal of ground water in excess of replenishment.

Perennial stream
A stream that flows at all times.

Predator
Animal that gains nutrients by capturing and feeding upon other animals.

Prey
An animal hunted or killed and used as a food source by another animal.

Prime farmland
Classification of U.S. Soil Conservation Service for lands with the soil quality, growing season, and moisture supply necessary to produce sustained high agricultural fields by modern farming methods.

Raptor
A predatory bird that catches its prey by using its talons (i.e., eagles, hawks and owls).

Right-of-way
The right of passage over another's land.

Riparian
Associated with the banks of rivers or other stable water bodies.

Salt loading
An increase in the volume of salts in a basin usually brought about by interbasin transfer of water. Salt loading is most critical in the plant root zone and in any aquifers which might be affected by the imported salts.

Species
In taxonomy, a subdivision of a genus which (1) has a high degree of similarity, (2) is capable of interbreeding only among themselves, and (3) shows persistent differences from members of allied species.

Structure

A means of supporting transmission line conductors. A structure may be made of many types of material and constructed in various shapes.

Subsidence
A lowering of ground elevation as a result of excessive ground water pumping, dewatering of sediments, ground movements due to earthquakes, etc.

Substation
A single facility at which connections between the various components of a system, such as lines and transformers, are made and the switching of these components is carried out.

Switchyard
A facility that is part of a larger features such as a pumping plant or powerplant at which connections between the various components of a system are made and the switching of these components is carried out. A typical example is Parker Dam 230-kV switchyard.

Threatened species
Any species likely to become endangered within the foreseeable future throughout all or a significant portion of its range.

Transformer
An electrical device which changes electric energy from one voltage to another at the same frequency.

Transmission Line
A facility for transmitting electrical energy at high voltage from one point to another point. Transmission line voltages are normally 115-kV or larger.

Transmission Line Capacity
The maximum continuous rating of a transmission line. The rating may be limited by thermal considerations, capacity of associated equipment, voltage regulation, system stability or other factors.

Transmission System
An interconnected group of electric transmission lines and associated equipment for the movement or transfer of electric energy in bulk between points of supply and points at which it is transformed for delivery to ultimate consumers, or is delivered to electric systems of others.

Turbidity
A measure of the extent to which light passing through water is reduced due to suspended materials. Excessive turbidity may interfer with light penetration and minimize photosynthesis, thereby causing a decrease in primary productivity. It may interfer directly with essential physiological functions of fish and other aquatic organisms, making it difficult for fish to locate a food source, and alter water temperature.

Utility Lines
Low voltage, usually 69-kV or less, electric powerlines, telephone lines, or other like facilities.

Water exchange
An institutional arrangement utilizing physical facilities where one user's water is stored while his water needs are met by deliveries from a second user and then the second user has water "credits" against this first user; during a later period the second user may request that his credited water be released from the first user's storage facilities and delivered as required.

Watt
The unit of power in the International System of Units; equivalent to 1/746 of a horsepower.

Watt-Hour
Unit of electrical energy, or work, equal to one watt acting for one hour.

Bibliography

Algermissen, S.T., D.M. Perkins, P.C. Thenheus, S.L. Hanson, and B.L. Bender, 1982, Probabilistic Estimates of maximum acceleration and velocity in rock in the contiguous United States. U.S.G.S. open File Report. 82-1033. 1982.

Anderson, B.W. and R.D. Ohmart. 1977, Climatological and physical characteristics affecting avian population estimates in southwestern riparian communities using transect counts in Symposium on the importance, preservation and management of the riparian habitat. Forest Service General Technical Report FSGTR/RM-43. 193-200pp.

Anderson, S.R., H.H. Schumann, and B.L. Wallace, 1982, Progress Report on Measurements of Aquifer Compaction in the Tucson Basin In City of Tucson Report, Annual Static Water Level Basic Data Report Tucson Basin and Avra Valley, Pima County, Arizona, 1981, Tucson, 32 pp.

Arizona Bureau of Mines, 1969, Mineral and Water Resources of Arizona: Univ. Ariz., Ariz. Bur. of Mines Bull. 180, 638 p.

Arizona Game and Fish Commission, 1982, Threatened native wildlife of Arizona. Arizona Game and Fish Department Publication. 12pp.

Arizona Game and Fish Department.1982, Endangered species assessment for Central Arizona Project, Tucson Division, Phase B. January 29.

Arizona Water Commission (AWC), 1978, Projected Water Uses, Supplies, and Ground Water Conditions in Selected Basins in Arizona: A Baseline Conditions Report to the Ground Water Management Study Commission. Phoenix, Arizona.

Arizona Water Commission (AWC), 1975, Arizona State Water Plan. Phase I, Inventory of Resource and Uses. Phoenix, Arizona.

Brown, D.E., 1978, The vegetation and occurrence of chaparral and woodland flora on isolated mountains within the Sonoran and Mojave desert in Arizona. J. of Arizona-Nevada Acad. of Sci. 12:7-12.

Brown, D.E., C.H. Lowe, and C.P. Pase, 1979, A digitized classification system for the biotic communities of North American, with community (series) and association examples for the southwest. Journal of the Arizona-Nevada Academy of Science. 14 Suppl.:1-16.

Campbell, H.W. and S.P. Christman, 1977, Techniques for herpetofauna/community analysis. Nat. Fish and Wildlife Lab. Gainesville, Fla.

City of Tucson, 1981, Annual Static Water Level Basic Data Report, Tucson Basin and Avra Valley, Pima County, Arizona, 1981, 21 pp. with appendices.

Czaplicki, J.S., Compiler, 1984, A Class III Survey of the Tucson Aqueduct Phase A Corridor, Central Arizona Project. Arizona State Museum Archaeological Series No. 165.

Czaplicki, J.S. and J.E. Mayberry, 1983, An Archaeological Assessment of the Middle Santa Cruz River Basin, Rillito to Green Valley, Arizona, for the Proposed Tucson Aqueduct Phase B, Central Arizona Project. Arizona State Museum Archaeological Series No. 164

Dames & Moore, Inc., 1979, Environmental Assessment. Municipal and Industrial Water Allocations. Central Arizona Project. March 1979. Prepared under contract for U.S. Bureau of Reclamation. Arizona Project Office, Phoenix, Arizona

Damon, P.E., Bryant, D.L., and Mayo, E.B., 1968, Stratigraphic and Volcanic Geology, Tucson Mountains: Field Trip V. in Southern Arizona Guidebook III: Arizona Geological Society, ed. by S.R. Titley, pp. 339-351. Tucson, Arizona.

Davidson, E.S., 1973, Geohydrology and Water Resources of the Tucson Basin, Arizona: U.S. Geol. Survey Water-Supply Paper 1939-E, 81 p.

Department of the Interior, 1982, Final Environmental Impact Statement, Water Allocations and Water Service Contracting. Bureau of Reclamation, INT-FES 82-7. Boulder City, Nevada

deVos, James C., Jr., C. Richard Miller, Sandra L. Walchuk, William D. Ough, and Daisan E. Taylor. 1983, Biological resource inventory, Tucson Division - Phase B--Central Arizona Project. Prepared for USDI - Bureau of Reclamation Contract #32-V0151. 470 pp.

deVos, James C., Jr., Samuel R. Lowry, and Charles R. Miller. 1985, Final report for the biological resources inventory, Tucson Division - Phase B--Central Arizona Project. Prepared for USDI - Bureau of Reclamation, Contract Extension #1-07-32-V0151. 125 pp.

Dixon, R.M. and J.R. Simanton, 1980, Land imprinting for better watershed management in Symposium on watershed management 1980. Vol. II. American Soc. Civil Engineers New York.

DuBois, S.M., and Smith, A.W., 1980, The 1887 Earthquake: State of Arizona, Bur. of Geol. and Min. Tech., Special Paper No. 3, 112 p.

Eberly, L.D., and Stanley, T.B., Jr., 1978, Cenozic Stratigraphy and Geologic History of Southwestern Arizona: Geol. Soc. Amer. Bulletin, v. 89, pp. 921-940.

Emlen, J.T., 1971, Population densities of birds derived from transect counts. Auk 88:323-341.

Ertec Western, Inc., 1982, Seismotectonic study, Buttes Damsite, Arizona: Ertec Project No. 80-239, 47 pp.

Grieve, R.E., J.A. Ludwig, S.P. Berger, 1978, Vegetative succession study related to transmission facilities in the arid Southwest. Electric Power Research Inst., Research Project RP756-1. 112 pp.

Gutenberg, G., and Richter, C.F., 1956, Seismicity of the Earth and Associated Phenomena: Hefner publishing company, 310 p., table 20.

Holzer, T.L., 1976, Ground Failure in Areas of Subsidence Due to Ground Water Decline in the United States in Proc. of the Anaheim Symposium, Dec. 1976: Internatl. Assoc. of Hydrological Sciences, pub. no. 121, p. 423-433.

Holzer, T.L., 1979, Elastic Expansion of the Lithosphere Caused by Ground Water Depletion: Journal of Geophys. Research, v. 84, no. 89, pp. 4689-4698.

Holzer, T.L., 1981, Preconsolidation Stress of Aquifer Systems in Areas of Induced Land Subsidence. Water Resources Research, 17(3), p. 693-704

Jones, K.B., 1980, Distribution, ecology and habitat management of the reptiles and amphibians of the Hualapai - Aquarius Planning Area, Mohave and Yavapai Counties, Arizona an inventory and analysis by standard habitat site. USDI, Bureau of Land Management, Phoenix District.

Laney, R.L., R.H. Raymond, and C.C. Winikka, 1978, Maps Showing Water Level Declines, Land Subsidence and Earth Fissures in South-Central Arizona. U.S. Geological Survey Water-Resources Investigations Open File Report 78-83.

Laney, R.L., R.H. Raymond, and C.C. Winikka, 1978, Maps Showing Water Level Declines, Land Subsidence and Earth Fissures in South-Central Arizona. U.S. Geological Survey Water-Resources Investigations Open File Report 78-83, 2 sheets.

Lowe, C.H., 1964, The vertebrates of Arizona. University of Arizona Press, Tucson. 259pp.

Marmaduke, W.S., 1983, The Ak-Chin Farm Project: Archaeological Survey on the Ak-Chin Indian Reservation, West Half. Northland Research, Inc., Flagstaff. 267 pp.

Marmaduke, W.S. and W. Bostwick, 1982, Class III Archaeological Survey in Vekol Valley, Arizona: Ak-Chin Water Supply Project Phase I, Northland Research, Inc., Flagstaff, 224 pp.

Marmaduke, W.S. and D.G. Robinson, 1983. The Chuichu Survey: Evaluation of Archaeological Sites on the Edge of the Papagueria. Northland Research, Inc., Flagstaff. 211 pp.

McCarthy, C. Heathington, 1982, An archaeological sample survey of the middle Santa Cruz River Basin, Pichacho Reservoir to Tucson, Arizona. Arizona State Museum Archaeological Servies No. 148.

McCarthy, C. Heathington, and E. Sires, 1982, An archaeological overview of the middle Santa Cruz basin: a supplemental class I cultural resource survey for reach 3 of the Central Arizona Project--Tucson Division. Arizona State Archaeological Series No. 134

McCory, Fred J., and O'Haire, Robert T., 1979, Map of Known Nonmetallic Mineral Occurrences of Arizona, Arizona State Bureau of Geology and Mineral Technology, Tucson, Arizona revised September 1965, scale 1:1,000,000.

Monson, Gale and Allen R. Phillips, 1981, Annotated checklist of the birds of Arizona. 2nd Edition. Univ. of Arizona Press, Tucson. 240 pp.

National Oceanic and Atmospheric Administration, 1982, Earthquake History of the United States: U.S. Dept. of Commerce and U.S. Dept. of Interior, Publ. 41-1.

Oppenheimer, J., and J.S. Sumner, 1980, Depth to Bedrock Map, Basin and Range Province, Arizona. Laboratory of Geophysics, University of Arizona, Tucson.

Parker, K.F., 1972, An illustrated guide to Arizona weeds. Univ. of Arizona Press, Tucson. 338pp.

Pima County Air Quality Control District, 1984, Annual Data Summary, Air Quality in Tucson, Arizona. Tucson, Arizona.

Poland, J.F., B.E. Lofgren, R.L. Ireland, and R.G. Pugh, 1975, Land Subsidence in the San Joaquin Valley, California, as of 1972. U.S. Geological Survey Professional Paper 437-H, 78pp.

Reeter, R.W., and Cady, C.V., 1981, Maps Showing Ground-water conditions in the Avra-Altar Valley area, Pima and Santa Cruz Counties, Arizona, 1981: State of Arizona, Dept. Water Resources, Hydrologic Map Series, Rept. No. 7.

Roughton, R.D., 1979, Developments in scent-station technology in Proceedings Midwest furbearer workshop, Kansas State Univ. 17-44pp.

Schumann, H.H., and Pland, J.F., 1970, Land Subsidence, Earth Fissures, and Ground Water Withdrawal in South-Central Arizona, U.S.A., in Land Subsidence: Tokyo Internat. Assoc. Sci. Hydrology, Pub. 88, v. 1, pp. 295-302.

Schumann, H.H., and Poland, J.F., 1970, Land Subsidence, Earth Fissures, and Groundwater Withdrawal in South-Central Arizona, U.S.A., in Land Subsidence, International Assoc. of Hydrological Sciences, Publication 88, 295-302.

Shafiqullah, M., Damon, P.E., Lynch, D.J., Reynolds, S.J. Rehrig, W.A., and Raymond, R.H., 1980, K-Ar Geochronology and Geologic History of Southwestern Arizona (and Adjacent Areas). Arizona Geologic Digest, vol. 12, pp. 201-260.

Strange, William E., 1983, Subsidence Monitoring for the State of Arizona, Publication of the U.S. Department of Commerce, National Oceanic and Atmospheric Administration, 74 pp.

Tucson Water Planning Division, 1981, Annual Static Water Level - Basic Data Report - Tucson Basin and Avra Valley, Pima Co., Arizona: City of Tucson.

U.S.D.A. Forest Service, 1975, Endangered and unique wildlife of the Southwest National Forests.

U.S.D.I. Bureau of Reclamation (USBR), 1968, Engineering Geology Appendix (appendix E)-Central Arizona Project-Aqueduct System (Colorado River source). Phoenix Development Office, Phoenix, Arizona.

U.S.D.I. Bureau of Reclamation, 1973, Environmental Statement, INT-FES 73-2, Havasu Intake Channel, Havasu Pumping Plant, and Buckskin Mountains Tunnel, A Feature of the Central Arizona Project, Lower Colorado Region, Boulder City, Nevada.

U.S.D.I. Bureau of Reclamation, 1974, Environmental Statement, INT-FES 74-5, Granite Reef Aqueduct, A Feature of the Central Arizona Project, Lower Colorado Region, Boulder City Nevada.

U.S.D.I. Bureau of Reclamation, 1975, Environmental Statement, INT-FES 75-66, Granite Reef Aqueduct Transmission System, A Feature of the Central Arizona Project, Lower Colorado Region, Boulder City, Nevada.

U.S.D.I. Bureau of Reclamation, 1979, Environmental Statement, INT-FES 79-60, Salt-Gila Aqueduct, A Feature of the Central Arizona Project, Lower Colorado Region, Boulder City, Nevada, 1981,

U.S.D.I. Bureau of Reclamation, 1982, Environmental Statement, INT-FES 82-26, Tucson Aqueduct Phase A, A Feature of the Central Arizona Project Lower Colorado Region, Boulder City, Nevada.

U.S.D.I. Bureau of Reclamation, 1984, Environmental Statement, INT-FES 84-4, Regulatory Storage Division, A Feature of the Central Arizona Project, Lower Colorado Region, Boulder City, Nevada.

U.S.D.I. Bureau of Reclamation, 1982, Environmental Statement, INT-FES 82-7, Water Allocations & Water Service Contracting, A Feature of the Central Arizona Project, Lower Colorado Region, Boulder City, Nevada.

U.S.D.I. Fish and Wildlife Service, 1981, Species list for Central Arizona Project, Tucson Division Phase B. July 1.

U.S.D.I. Fish and Wildlife Service, 1983, Draft Fish and Wildlife Coordination Act Report for Phase B of the Tucson Aqueduct, Central Arizona Project, Tucson Division, Arizona (USBR). December 13.

U.S. Geological Survey, 1970, Earthquake History of Arizona: Earthquake Information Bulletin, May-June, v. 2, no. 3, pp. 26-27.

_____ 1981, Annual Summary of Ground-water Conditions in Arizona, Spring 1979 to Spring 1980: Water-Resources Investigations, Open-File Report 81-906, 2 sheets.

U.S. Environmental Protection Agency (EPA) 1976, Quality Criteria for Water, July 1976.

University of Arizona, 1970, The Quality of Arizona's Domestic, Agriculture, and Industrial Waters, Tucson, Arizona.

Viets, V.F., C.K. Vaughan, and R.C. Harding, 1979, Environmental and Economic Effects of Subsidence; Report prepared by EDAW, Inc., and Earth Sciences Associates for the Geothermal Sub-Sidence Research Program, Lawrence Berkeley Laboratory, 236 pp. LBL-8615 GSRMP-1.

Vuich, J. S., and Peirce, H.W., 1973, Bedrock Shoulders and Land Use: Arizona Bur. of Mines, Fieldnotes, vol. 3, no. 4, pp. 1-3 and 8-10.

Vuich, J.S., 1975, Geology and Land-Use Planning: Arizona Bureau of Mines, Fieldnotes, vol. 5, no. 3, pp. 1-3.

Westfall, Deborah A. 1979, An archaeological overview of the middle and lower Santa Cruz basin: a class I cultural resource study for the Central Arizona Project--Tucson Division. Arizona State Museum Archaeological Series No. 134.

White, N.D., Matlock, W.G., and Schwalen, H.C., 1966, An Appraisal of the Ground Water Resources of Avra and Altar Valleys, Pima County, Arizona: Ariz. State Land Dept. Water Res. Rep. 25, 66 p.

Wilson, E.D., Moore, R.T., and O'Haire, R.T., 1960, Geologic Map of Pima and Santa Cruz Counties, Arizona, Arizona Bur. of Mines, 1:375,00.

Wilson, E.D., 1962, A Resume of the Geology of Arizona. Arizona Bureau of Mines Bulletin 171.

INDEX

VI. APPENDICES

APPENDIX A

DISTRIBUTION LIST

APPENDIX A

DISTRIBUTION LIST

1. Statements to be distributed by the Commissioner, Bureau of Reclamation:

    Department of the Interior

        Fish and Wildlife Service, Washington D.C.

        National Park Service, Washington D.C.

        Assistant Secretary for Indian Affairs, Washington, D.C.

        Geological Survey, Washington, D.C.

        *Bureau of Mines, Washington, D.C.

        Bureau of Land Management, Washington, D.C.

        Bureau of Indian Affairs, Office of Trust Responsibilities

        Advisory Council of Historic Preservation, Denver, Colorado

    Department of Agriculture, Washington, D.C.

    Department of Energy, Washington, D.C.

    Department of Transportation, Washington, D.C.

    Health and Human Resources, Washington, D.C.

    *Department of Commerce, Washington, D.C.

    Department of Defense, Washington, D.C.

        Office of the Chief of Engineers, Department of Army, Washington, D.C.

    Department of Housing and Urban Development, San Francisco, California

    *Environmental Protection Agency, Region IX, San Francisco, California

2. Statements to be distributed by the Commissioner, Bureau of Reclamatio for information only:

    Honorable Dennis DeConcini, United States Senate, Washington, D.C

Honorable Barry M. Goldwater, United States Senate, Washington, D.C.

Honorable John J. McCain, Member, United States House of Representatives, Washington, D.C.

Honorable Bob Stump, Member, United States House of Representatives, Washington, D.C.

Honorable Eldon Rudd, Member, United States House of Representatives, Washington, D.C.

Honorable James Kolbe, Member, United States House of Representatives, Washington, D.C.

Honorable Morris K. Udall, Member, United States House of Representatives, Washington, D.C.

3. Statements to be distributed by the Regional Director, Lower Colorado Regional Office, Boulder City, Nevada, for information only:

Department of the Interior:

Regional Director, Fish and Wildlife Service, Albuquerque, New Mexico

*Field Supervisor, Ecological Services, Fish and Wildlife Service, Phoenix, Arizona

District Chief, Water Resource Division, U.S. Geological Survey, Tucson, Arizona

District Hydraulic Engineer, Conservation Division, Geological Survey, Sacramento, California

Field Solicitor, Phoenix, Arizona

Area Director, Bureau of Indian Affairs, Phoenix, Arizona

Superintendent, Papago Agency, Sells, Arizona

*State Director, Bureau of Land Management, Phoenix, Arizona

Chief, Division of Planning and Environmental Coordination, Bureau of Land Management, Phoenix, AZ

District Manager, Bureau of Land Management, Phoenix, Arizona

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

Regional Environmental Officer, Office of the Secretary, Department of the Interior, San Francisco, California

Chief, Interagency Archeological Services, National Park Service, San Francisco, California

*Regional Director, National Park Service, San Francisco, Western Region California

Department of Agriculture:

State Director, Farmers Home Administration, Phoenix, Arizona

County Supervisor, Farmers Home Administration, Tucson, Arizona

State Conservationist, Soil Conservation Service, Phoenix, Arizona

River Basin and Watershed Planning Staff Leader, Soil Conservation Service, Phoenix, Arizona

Area Conservationist, Soil Conservation Service, Tucson, Arizona

Regional Forester, U.S. Forest Service, Albuquerque, New Mexico

Forest Supervisor, Coronado National Forest, Tucson, Arizona

State Executive Director, Agricultural Stabilization and Conservation Service, Phoenix, Arizona

Department of the Air Force:

Chief, Engineering, Construction, and Environmental Planning Branch, Davis-Monthan Air Force Base, Arizona

Department of the Army:

*District Engineer, Corps of Engineers, Los Angeles, California

Chief, Planning Section C, Corps of Engineers, Phoenix, Arizona

Department of Commerce:

Executive Director, Four Corners Regional Commission, Albuquerque, New Mexico

Department of Energy:

Administrator, Western Area Power Administration, Golden, Colorado

*Area Manager, Western Area Power Administration, Boulder City, Nevada

District Manager, Western Area Power Administration, Phoenix, Arizona

Department of Housing and Urban Development:

Director, Federal Housing Administration, Phoenix, Arizona

Service Office Supervisor, Tucson Service Office, Department of Housing and Urban Development, Tucson, Arizona

Department of Justice:

U.S. Attorney, Phoenix, Arizona

Department of Labor:

Area Director, Employment Standards Administration, 3221 N. 16th St., Phoenix, Arizona 85016

Department of Health and Human Services, Public Health Service:

Chief, Environmental Affairs Group Environmental Health Services, Division Center for Environmental Health

Department of Transportation:

Commander, 11th District, U.S. Coast Guard, Phoenix, Arizona

District Engineer, Federal Highway Administration, Phoenix, Arizona

Environmental Protection Agency:

Chief, Arizona Branch, San Francisco, California

Interstate Commerce Commission:

Regional Manager, San Francisco, California

Congressional Representatives:

Judith K. Abrahms, representative of Senator Dennis DeConcini, Tucson, Arizona

Peter Hershberger, representative of Senator Barry M. Goldwater, Phoenix, Arizona

Grant Woods, representative of Congressman John J. McCain, Mesa, Arizona

Arlene Lassile, representative of Congressman Bob Stump, Phoenix, Arizona

Michael J. Stubler, representative of Congressman Eldon Rudd, Phoenix, Arizona

J. Dan O'Neill, representative of Congressman Morris K. Udall, Phoenix, Arizona

Perry Baker, representative of Congressman Morris K. Udall, Tucson, Arizona

Newspapers:

The Arizona Daily Star, Tucson, Arizona

Arizona Farmer-Ranchman, Phoenix, Arizona

The Arizona Republic, Phoenix, Arizona

The Daily Territorial, Tucson, Arizona

Tucson Citizen, Tucson, Arizona

Green Valley News, Green Valley, Arizona

Libraries:

Arizona Collection, Hayden Library, Arizona State University, Tempe Arizona

Arizona Department of Library Archives, Public Records, Phoenix, Arizona

Casa Grande Public Library, Casa Grande, Arizona

Green Valley Community Library, Green Valley, Arizona

Governmental Reference Library, Tucson, Arizona

Law Library, County Courthouse, Tucson, Arizona

Library, City Hall Annex, Tucson, Arizona

Maricopa County Community College District, Phoenix, Arizona

Maricopa County Free Library, Phoenix Arizona

Nogales Public Library, Nogales, Arizona

Phoenix Public Library, Phoenix, Arizona

Pima College Library, Tucson, Arizona

Tucson Public Library, Tucson, Arizona

University Library, Documents Section, The University of Arizona, Tucson, Arizona

University Library, Northern Arizona University, Flagstaff, Arizona

4. Statements to be distributed by the Regional Director, Lower Colorado Regional Office, Boulder City, Nevada:

State of Arizona:

Central Arizona Water Conservation District, Phoenix, Arizona

Department of Emergency and Military Affairs, Phoenix, Arizona

Department of Health Services, Bureau of Air Quality Control, Phoenix, Arizona

Department of Health Services, Bureau of Water Quality Control, Phoenix, Arizona

*Department of Water Resources, Phoenix, Arizona

*Game and Fish Department, Phoenix, Arizona

Game and Fish Department, Regional Supervisor, Tucson, Arizona

Governor's Commission on Arizona Environment, Phoenix, Arizona

State Land Department, Phoenix, Arizona

Office of the Governor, Phoenix, Arizona

Power Plant and Transmission Line Siting Commission, Phoenix, Arizona

*State Clearinghouse, Phoenix, Arizona

*State Historic Preservation Officer, Phoenix, Arizona

*Water Resources, Tucson Active Management Area, Phoenix, Arizona

State of California:

Office of the Governor, Sacramento, California

Colorado River Board of California, Los Angeles, California

State Clearinghouse, Sacramento, California

Native American Heritage Commission

State of Colorado:

Office of the Governor, Denver, Colorado

State Clearinghouse, Denver, Colorado

State of Nevada:

Office of the Governor, Carson City, Nevada

State Clearinghouse, Carson City, Nevada

State of New Mexico:

Office of the Governor, Santa Fe, New Mexico

Interstate Stream Commission, Santa Fe, New Mexico

State Clearinghouse, Santa Fe, New Mexico

State Engineer, Santa Fe, New Mexico

State of Utah:

Office of the Governor, Salt Lake City, Utah

State Clearinghouse, Salt Lake City, Utah

State of Wyoming:

Office of the Governor, Cheyenne, Wyoming

State Clearinghouse, Cheyenne, Wyoming

State Engineer, Cheyenne, Wyoming

Pima County, Arizona:

*Board of Supervisors, Tucson

Transportation and Flood Control District, Tucson

Department of Sanitation, Tucson

Environmental Health Services, Tucson

Extension Service, Tucson

*Health Department, Air Quality Control, Tucson

Highway Department, Tucson

Chief Administrative Officer, Tucson

Pima Association of Governments, Tucson

*Planning and Zoning Department, Tucson

*Pima County Wastewater Management Department, Tucson

*Parks and Recreation Department, Tucson

*Office of the County Manager, Tucson

Santa Cruz County, Arizona:

Board of Supervisors, Nogales, Arizona

City of Tucson:

Mayor

City Manager

City Attorney

Department of Transportation

Operations Department

Planning Department

Water Department

Other Cities and Towns:

Town Manager, City of South Tucson, Arizona

Public Works Director City of Nogales

City Engineer, Marana, Arizona

Mayor, Nogales, Arizona

Mayor, Marana, Arizona

Public Works Director, City of Nogales

Planning Department, City of South Tucson, Arizona

Flood Control Districts:

Pima County Flood Control District, Tucson, Arizona

Irrigation and Electrical Districts:

Avra Valley Irrigation and Drainage District, Marana, Arizona

Contaro-Marana Irrigation District, Marana, Arizona

Farmers Investment Company, Inc., Sahuarita, Arizona

*Irrigation and Electrical Districts Association of Arizona, Phoenix, Arizona

Electrical District Number Two, Pinal County, P.O. Box 548, Coolidge, Arizona 85228

Indian Tribes and Communities:

Ak Chin Indian Community Council, Maricopa, Arizona

Fort McDowell Mohave-Apache Tribal Council, Fountain Hills, Arizona

Gila River Indian Community, Sacaton, Arizona

*Papago Tribe of Arizona, Sells, Arizona

Papago Tribal Council, Sells, Arizona

Salt River-Pima-Maricopa Tribal Council, Scottsdale, Arizona

*Pascua Yaqai Tribe, Tucson, Arizona

UTILITIES:

Water

Arizona Maintenance Company, Inc., Mr. Eliott Feldman, Owner, P.O. Box 5806 Tucson, Arizona 85703

Avra Water CO-op, Inc., Route 9, Box 386, Tucson, Arizona 85743

Rancho Del Conejo Water Company, Mr. Richard Howrey, Operations Manager, Rural Route 9, Box 106, Tucson, Arizona 85726

Sandario Water Company, Mr. Buck Lewis, Owner, P.O. Box 26484, Tucson, Arizona 85726

*Community Water Company, Green Valley, P.O. Box 1078, Green Valley, Arizona 85614

Transmission

American Telephone and Telegraph Company, Mr. Wade Barnes, Operations Supervisor, P.O. Box 5407, Tucson, Arizona 85703

American Telephone and Telegraph Company, Mr. A.M. Davenport, Operation Manager, 211 West Monroe Street, Room 359A, Phoenix, Arizona 85003

Mountain Bell, West Engineering Design, Mr. Ron Shortman, Manager - Distributions Service, 6448 North Oracle, Tucson, Arizona 85704

Mountain Bell, Central Engineering Design, Mr. J.W. Niegocki, Manager - Distributions Service, 4400 East Broadway, Room 206, Tucson, Arizona 85711

Trico Electric Co-op., Inc., Engineering, Mr. Chuck Wilcox, R/W Agent, P.O. Box 35970, 5100 West Ina Road, Tucson, Arizona 85704

Tucson Electric, Operation Headquarters, Mr. Howard Ault, 4250 East Irvington Road, Tucson, Arizona 85714

Tucson Electric, Operation Headquarters, Mr. Gill Bravo, 4250 east Irvington Road, Tucson, Arizona 85714

Gas

*El Paso Natural Gas Company, Mr. Allen Gattis, Manager, Titles-Control Division, Right-of-way Department, P.O. Box 1492, El Paso, Texas 79978

Southwest Gas Corporation, Mr. Blake Down, Vice President, Southern Arizona Division, P.O. Box 26500, Tucson, Arizona 85726

Southwest Gas Corporation, Mr. Derald Neagle, Manager, Central Arizona Division, 201 West 4th Street, Casa Grande, Arizona 85222

Others

Department of Transportation, Real Estate Division, Mr. Lou Lefstead, P.O. Box 27210, Tucson, Arizona 85726

Mr. Frank Brooks, Director, Tucson Water, P.O. Box 27210, Tucson, Arizona 85726-7210

Mr. Charles F. Bonnet, President, Community Water Company of, Green Valley, P.O. Box 1078, Green Valley, Arizona 85614

Mr. Robert L. Arnberger, Superintendent, Saguaro National Monument, Route 8, Box 695, Tucson, Arizona 85730

Mr. Gene Laos, Director, Pima County Parks & Recreation Dept., 1204 West Silverlake Road, Tucson, Arizona 85713

Mr. George Percival, ASARCO, Inc., P.O. Box 5747, Tucson, Arizona 85703,

Mr. John Kai, Jr., Star Route 109, Marana, Arizona 85238,

*Mr. Robert Condit, Cortaro-Marana Irrigation District, 13864B Sandario Road Marana, Arizona 85238

Mr. Joseph Kirby, Duval Corporation, 4715 East Fort Lowell, Tucson, Arizona 85707

Mr. Richard Walden, Farmers Investment Company, P.O. Box 7, Sahuarita, Arizona 85629

Ms. Priscilla G. Domingo, 333 West Santa Luisa, Tucson, Arizona 85706

Mr. John B. Narcho, Route 11, Box 664-B, Tucson, Arizona 85706

Mr. Lester Snow, Tucson Active Management Area, 371 South Meyer, Tucson, Arizona 85701

Mr. Gilbert Metz, Field Supervisor, U.S. Fish and Wildlife Service, 2934 West Fairmount Street, Phoenix, Arizona 85017

Dr. Raymond Thompson, Director, Arizona State Museum, University of Arizona, Tucson, Arizona 85721

Mr. James Ronstadt, Director, City of Tucson, Parks and Recreation Department, 900 South Randolph Way, Tucson, Arizona 85716

Mr. James Riley, Assistant County Manager, Pima County Manager's Office, 131 West Congress Street, Tucson, Arizona 85701

Mr. Ronald J. Olding, Arizona Game and Fish Department, 416 West Congress Street, Tucson, Arizona 85701

Mr. Lyle Ondracek, Sr., Vice President, Green Valley Water Company, P.O. Box 587, Green Valley, Arizona 85614

Mr. George Johnson, Foothills Water Company, 10,000 North Oracle Road, Tucson, Arizona 85704

Mr. Larry Cutrone, Pasqua Yaqui Tribe, 4821 West Calle Vicam, Tucson, Arizona 85706

*Mr. Tom Clark, Central Arizona Water Conservation District, 23536 N. 7th Street, Phoenix, Arizona 85068

Public Works Director, City of Nogales, 701 Grand Avenue, Nogales, Arizona 85621

George Amos, Tucson Realty & Trust, 6390 E. Broadway, Tucson, Arizona 85710

George Barr, Barr Associates, 2075 N. 6th, Tucson, Arizona 85705

Ms. Beverly Beddow, Department of Water Resources, 99 East Virginia, Phoenix, Arizona 85004

Jesse Brown, Pima Assoc. of Gov'ts, 177 N. Church, #405, Tucson, Arizona 85701

Bobby Jo Buel, Arizona Daily Star, United Bank Plaza, Box 1, Tucson, Arizona 85701

Bruce Billings, Economist, 2439 E. 7th, Tucson, Arizona 85716

*Scott Burrill, ASARCO, Inc., P.O. Box 5747, Tucson, Arizona 85703

Joseph Califf, Califf Consulting, 415 S. East Bourne Ave, Tucson, Arizona 85716

*Ms. Marybeth Carlile, SAWARA, 465 W. St. Mary's, #100, Tucson, Arizona 85705

John Carter, IBM Corp, General Products Division, Tucson, Arizona 85744

Tom Chandler, Chandler, Tuller, Et al, P.O. Box 3069, Tucson, Arizona 85702

*Dr. C. Brent Cluff, Water Resources Res. Cen., University of Arizona, Tucson, Arizona 85721

Mr. Jim Cocke, Valley National Bank, P.O. Box 311, Tucson, Arizona 85702

*Mr. Ray Coleman, Finical & Dombrowski, 732 North Stone, Tucson, Arizona 85745

Hanna Cortner, Renewable Natural Resources, 1245 Calle Tiburon, Tucson, Arizona 85704

Mr. Brent Davis, Eastside City Hall, 4575 East Speedway, Tucson, Arizona 85710

Mr. J. Luther Davis, Tucson Electric Power Co., P.O. Box 711, Tucson, Arizona 85702

Mr. Brad De Spain, De Spain Cattle Co., 16501 West Manville, Marana, Arizona 85238

Mr. William Ealy , Deputy City Manager, P.O. Box 27210, Tucson, Arizona 85726

Mr. Ron Eastburn, S. Arizona Homebuilders, 2840 North Country Club, Tucson, Arizona 85726

Mr. Roy Emerick, CAWCD Board Member, 2220 North Norton Ave., Tucson, Arizona 85719

*Gayle Hartmann, Sierra Club, Grand Canyon Chapter, Rincon Group, 2224 E. 4th St. Tucson, Arizona 85719

Mr. William Estes, Estes Homes, 8257 East Broadway, Tucson, Arizona 85710

Dr. Ken Foster, Arid Lands Studies, University of Arizona, Tucson, Arizona 85721

John Frame, Director, CWC Board, 733 W. Vista Hermosa, Green Valley, Arizona 85614

Mr. Gerald Garcia, P.O. Box 26767, Tucson, Arizona 85726

Mike Golder, 1362 W. 14th Street, Tempe, Arizona 85281

Michael Hard, Valley National Bank, P.O. Box 311, K-241, Tucson, Arizona 85702

Mr. T. J. Harrison, Asst. City Attorney, 5151 E. Broadway, #500, Tucson, Arizona 85711

Rep. Peter Hershberge, State Legislator, 926 West Samalayuca Dr., Tucson, Arizona 85704

Hugh Holub, Attorney at Law, 2438 E. Broadway, Tucson, Arizona 85719

Dr. Norma Kafer, 5440 West De Green, Tucson, Arizona 85743

John Kai, Jr., 2305 W. Ruthrauff Rd., Tucson, Arizona 85705

Dr. Richard Kassander, 3341 East Fourth St., Tucson, Arizona 85716

Ms. Lois Kulakowski, 7541 E. Knollwood Pl., Tucson, Arizona 85715

*Terry Lehrling, Pima County Parks Dept., 1204 Silverlake, Tucson, Arizona 85713

Linda Lewis, 1605 N. Wilmot Rd. #108, Tucson, Arizona 85712

Mr. Wayne F. Mac Gowen, 1949 East Eastland, Tucson, Arizona 85719

Dr. Gerald Matlock, University of Arizona, Tucson, Arizona 85721

Dr. Ed McCullough, University of Arizona, Tucson, Arizona 85721

Craig McDowell, Pima County Manager, 131 W. Congress, 11th Fl., Tucson, Arizona 85701

Michael McNulty, 33 N. Stone #1560, Tucson, Arizona 85701

Mark Myers, 177 N. Church #504, Tucson, Arizona 85701

John Narcho, San Xavier District, Route 11, Box 640-A, Tucson, Arizona 85746

Dan O'Neill, 300 N. Main, Tucson, Arizona 85705

Mr. R.B. O'Rielly, O'Rielly Chevrolet, 6100 East Broadway, Tucson, Arizona 85711

Mr. Chuck Pettis, 651 North Swan, Tucson, Arizona 85711

Ms. Lanae Raymond, 1735 E. Ft. Lowell Rd. #5, Tucson, Arizona 85719

Sol Resnick, University of Arizona, Tucson, Arizona 85721

Kathleen Roberts, 177 N. Church #800, Tucson, Arizona 85705

Ms. Priscilla Robinson, 115 West Washington, Tucson, Arizona 85702

*Mr. George Rosenberg, 1807 North Norton, Tucson, Arizona 85711

Mr. Robert Ruiz, 5447 East Fifth, Tucson, Arizona 85711

Ms. Tice Supplee, Arizona Game and Fish Department, 555 N. Geasewood Rd., Tucson, Arizona 85745

Mr. Richard Walden, P.O. Box 7, Sahuarita, Arizona 85629

Mr. Jim Webb, P.O. Box 871, Tucson, Arizona 85702

Patty Weiss, 4891 N. Lalomita, Tucson, Arizona 85718

Mr. Perc Williams, 571 Paseo Lazo, Green Valley, Arizona 85614

Others Cont.

Center for Environmental Studies, Arizona State University, Tempe, Arizona

*Arizona-Sonora Desert Museum, Special Events Office, Tucson, Arizona 85743

Dr. John Douglas, Archeologist, Arizona State Office, Bureau of Land Management, Phoenix, Arizona

*William Strickland, Attorney, 802 Transamerican Building, Tucson, Arizona 85701

Office of Arid Lands Studies, University of Arizona, Tucson, Arizona

Department of Hydrology and Water Resources, University, of Arizona, Tucson, Arizona

Arizona State Museum, University of Arizona, Tucson, Arizona

Arizona State University, Department of Anthropology, Tempe, Arizona

Southwest Environmental Service, P.O. Box 2231, Tucson, Arizona 85702

James M. Montgomery, Consulting Engineers, Inc., 250 North Madison Avenue, Pasadena, California 91101

Eisner-Smith and Associates, Planning Consultants 477 South Palm Canyon Drive, Suite 8, Palm Springs, California 92262

Terra Mar International Services, Inc., 5312 Banks Street, San Diego, California 92110

Institute for Raptor Studies, Box 4420, OM Star Route, Oracle, Arizona 85623

*Mr. John R. Moffitt, President, Friends of the Desert, Route 9, Box 620, Tucson, Arizona 85743

*Mr. Dale Pontius, President, Southern Arizona Water Resources Association, Suite 100, 465 W. St. Mary's Road, Tucson, Arizona 85705

Mr. Alan Lipman, Route 9, Box 620, Tucson, Arizona 85743

El Paso Natural Gas Company, Box 1492, El Paso, Texas 79978

Arizonans for Quality Environment, Box 41294, Tucson, Arizona 85717

*Ms. Julia Perry Gordon, 6301 Camino Almonte, Tucson, Arizona 85718

Mr. James L. Dick, Director, Division of Environmental Engineering & Research, 607 Home Federal Tower, 32 N. Stone Ave, Tucson, Arizona 85701

Mr. Paul W. Cella, Vice President, CBA, 2075 N Sixth Ave. Tucson, Arizona 85705

Mr. David R. Furrey, Flowing Wells Irrigation District, 900 West Prince, Tucson, Arizona 85705

Mr. Don Williamson, Environmental Director, Cyprus Pima Mining Company, Box 7187, Tucson, Arizona 85725

Ms. Ruth Granger, New Pueblo Constructors, Inc., Box 27566, Tucson, Arizona 85726

Mr. James Gray, Ranch Lands Water Company, 140 South Randolph Way, Tucson, Arizona 85716

Mr. Kim Richards, Vice President, Midvale Farms Water Company % Estes Company, 8257 East Broadway, Tucson, Arizona 85731

Mr. Royce Hardy, Duval Corporation, 4715 East Fort Lowell, Tucson, Arizona 85707

Mr. Lyle Ondracek, Sr. Vice President, Green Valley Water Company, P.O. Box 587, Green Valley, Arizona 85614

Mr. George Johnson, Foothills Water Company, 10,000 North Oracle Road, Tucson, Arizona 85704

Ms. Jimi Robb, Del Lago Water Company, P.O. Box 27324, Tucson, Arizona 85726

Mr. Tom Berning, Papago Legal Services, Box 246, Sells, Arizona 85634

Audubon Society, Tucson Chapter 38 N. Tucson Boulevard Tucson, Arizona 85716

Defenders of Wildlife, 13795 N. Como Drive, Tucson, Arizona 85741

Desert Tortoise Council, 5319 Cerritos Avenue, Long Beach, California, 90805

Nature Conservancy, 30 N. Tucson Boulevard, Tucson, Arizona 85716

*K. Bruce Jones, President, The Wildlife Society, Arizona Chapter, P.O. Box 11135, Phoenix, Arizona 85017

The Wildlife Society, University of Arizona Chapter, University of Arizona, Tucson Arizona 85017

The Wildlife Society, Arizona State University Chapter, Arizona State University, Tempe, Arizona 85721

Wildlife Federation, Arizona Chapter, 4330 N. 62nd St. Suite 102 Scottsdale, Arizona 85251

President, Friends of the Earth, 1045 Sansome, Rm. 404, San Francisco, California 94111 Attn: Dave Brower

Colonel Hugh Matheson, Route 9, Box 835, Tucson, Arizona 85743

*Dan Davis, Director, Arizona Sonora Desert Museum, Tucson, Arizona 85743

Patty Fowler, Arizona Sonora Desert Museum, Tucson, Arizona 85743

John McCain, Arizona Municpal Water Users, 1122 E. Washington, Phoenix, Arizona 85034

Brian Lauber, State Land Department, 233 N. Main Avenue, Tucson, Arizona 85705

Rita Gonsalez-Boepple, Government Documents Department, Main Library, University of Arizona, Tucson, Arizona 85721

*Richard Miller, 5330 W. St. Moritz, Glendale, Arizona 85306

Frank Rickenbacher, 2739 N. La Cienega, Tucson, Arizona 85715

Fred Schmidt, Documents Librarian, Colorado State University, Fort Collins, Colorado 80523

Randy Salzman, Fort Lewis College Library, College Heights, Durango, Colorado 81301

*Steve Perchal c/o ASDM, Route 9, Box 900, Tucson, Arizona 85743

Dorothy Montogomery, 560 E. Monaco Place, Tucson, Arizona 85704

Kathryn Vandemoer, 325 Bioscience East, Room 204, SRNR, University of Arizona, Tucson, Arizona 85721

Marshall A. Worden, 2333 E. Glenn, # 221, Tucson, Arizona 85719

John A. Cassidy, Librarian, Sergent, Hauskins & Beckwith Consulting Geotechnical Engineers, 3940 W. Clarendon, Phoenix, Arizona 85019

Robert K. Reynolds, Fort Irwin Area Office, U.S. Army Corps of Engineers, P.O. Box 10048, Fort Irwin, California 92310-0048

*Juliet Staveley, Route 9, Box 820, Tucson, Arizona 85743

Michael J. Brophy, Ryley, Carlock & Applewhite, Attorneys-at-Law, 2600 The Arizona Bank Building, 101 N. 1st Avenue, Phoenix, Arizona 85003-1923

*Janie C. Schembri, c/o Arizona Sonora Desert Museum, Route 9, Box 900, Tucson, Arizona 85743

Cary W. Meister, President, Yuma Audubon Society, P.O. Box 6395, Yuma, Arizona 85364

MEC, 12640 W. Cedar Dr., P.O. Box 15638, Denver, Colorado 80215

Jeanette Merritt, Broker, Merritt Realty, 2/540 Elvado Rd. Tucson, Arizona 85746

William D. Lloyd, P.O. Box 103815, Anchorage, Alaska 99510

Dr. Thomas R. McGuire, Department of Anthropology, University of Arizona, Tucson, Arizona 85721

Don Waye, Harvill 439, University of Arizona, Tucson, Arizona

Greg Gulseig, Code: 273, E&R Center, Denver, Colorado

Jane Johnson, Santa Cruz Properties, 120 W. Broadway, Suite 292, Tucson, Arizona 85701

Tony Felix, Route 11, Box 625-G, Tucson, Arizona 85746

Center for Environmental Studies Library, Attn: Marcella, Williams College, P.O. Box 632, Williamstown, Massachusetts 01267

Robert E. Morrison, Tucson Manu. Division, P.O. Box 11337, Tucson, Arizona 85734

Michael R. Rios, P.O. Box 2246, Tucson, Arizona 85734

*Russ Butcher, National Parks & Conservation Association, Southwest and California Representative, Cottonwood, Arizona 86326

Ron McAlpin, Papago Tribe of Arizona, P.O. Box 837, Sells, Arizona 85634

Rebecca Burke, Government Documents, Arizona State University Library, Tempe, Arizona 85287

John Rashak, 5104 East Van Buren, #1098, Phoenix, Arizona 85008

John Schladweiler, Pima County Waste Water Management, 131 West Congress, Tucson, Arizona 85701

Germaine Barnes, Route 9, Box 610, Tucson, Arizona 85743

*Mr. and Mrs. Mark Savory, Route 9, Box 40B, Tucson, Arizona 85743

Mr. & Mrs. William Henderson, Route 9, Box 563,
Tucson, Arizona 85743

Mr. Carmine Cardamone, 1415 North 3rd Avenue,
Tucson, Arizona 85705

Robert L. Armentrout, 5050 South Spencer Avenue,
Tucson, Arizona 85746

George S. Elias, Route 7, Box 482-E, Tucson, Arizona 85746

*Monte Seymour, 4860 West Ajo Way, Tucson, Arizona 85706

Catherine M. McCarthy, 8485 E. 22nd Street, #301,
Tucson, Arizona 85706

*Arthur Campbell, P.O. Box 854, Rillito, Arizona 85246

George T. Balfe, 5801 West Drexel, Tucson, Arizona 85746

Bob Anderson, 5825 West Iowa, Tucson, Arizona 85746

L. Burton, P.O. Box 7305, Tucson, Arizona 85725

*Valerie Feuer, Tucson Unified School District, P.O. Box 40400,
Tucson, Arizona 85717

Mr. and Mrs. F. W. Schupp, 5658 West Box R Street,
Tucson, Arizona 85713

Mr. and Mrs. Timothy McClain, 6964 West Mat Drive,
Tucson, Arizona 85706

Mr. James Sanchez, 2615 South Mission, Tucson, Arizona 85713

John M. Tettemer & Associates, Ltd, 1952 Fairburn Avenue, Los
Angeles, California 90025

Charles C. Bates, Chairman, Environmental Committee, GV Comm.
Council, 136 W. La Pintura, Green Valley, Arizona 85614

Franzoy & Corey, 5030 E. Sunrise Dr., Phoenix, Arizona 85044

Patrick Thorpe, 9052 E. Calle Diego, Tucson, Arizona 85710

*Rosemary Maddock, 4405 N. Old Ranch Road, Tucson,
Arizona 85743

*Tucson Rod and Gun Club, Dick Scott, Chairman Legislative
Committee, P.O. Box 12921, Tucson, Arizona 85732

*The League of Women Voters of Tucson, Marie Lynn Hunken,
Natural Resources Coordinator, 4560 E. Broadway, Tucson,
Arizona 85711

*Mr. & Mrs. C. Nolen Bell, 12661 W. Picture Rock Road, Tucson, Arizona 85743

*Finley Distributing Co., Dorothy H. Finley, 2104 S. Euclid, Tucson, Arizona 85713

*Mr. and Mrs. H.W. Peden, 6861 N. Sanders Road, Tucson, Arizona 85743

*Earl L. and S. Lorraine Percival, RR 9, Box 602, Tucson, Arizona 85743

*Judith Capen, Route 9, Box 500, 4800 N. Old West Road, Tucson, Arizona 85743

*William H. Wheeler, Central Arizona Project Association, 1124 Arizona Title Building, Phoenix, Arizona 85003

*Dean Terry, Rt. 9, Box 94, Tucson, Arizona 85743

*Gary Harwell, Rt. 9, Box 900, Tucson, Arizona 85743

*Frank Abbott, Rt. 9, Box 708, Tucson, Arizona 85743

*George James, 6350 N. Sanders Road, Tucson, Arizona 85743

*Art Pacheco, Vice-President, Evco Farm, Inc, P.O. Box 275, Marana, Arizona 85238

*Kurt Schlaefer, 5880 Chapparall, Tucson, Arizona 85748

*Donald Way, 9502 N. Clayton Place, Marana, Arizona 85238

*Craig Allison, Grener Engineering, 2950 N. Alvernon Way, Tucson, Arizona 85712

*Valerie Orstedt, Friends of the Desert, 931 S. Carnegie Drive, Tucson, Arizona 85743

*Tom Glover, Avra Valley Irrigation District, Box 6, Marana, Arizona 85238

*Boge W. Clark, Rt. 9, Box 134, Tucson, Arizona 85614

*Mark Voelkel, Rt. 9, Box 839, Tucson, Arizona 85743

*Bill Steadman, Rt. 9, Box 518, Tucson, Arizona 85743

*Stephen Hoop, 4548 N. Ovenida Ronca, Tucson, Arizona 85715

*David Morris, 6871 N. Sanders Rd., Tucson, Arizona 85743

*Teresa Linn, 6910 N. Sanders Rd., Tucson, Arizona 85743

*Michael A. Enis, P.O. Box 50849, Tucson, Arizona 85703

*Joe Millstone, 10 E. Broadway, Tucson, Arizona 85701

*Mel Norville, 5520 N. La Casita, Tucson, Arizona 85718

*Don Fornear, 606 S. Plumer, Tucson, Arizona 85743

*Doug Shakel, Box 41166, Tucson, Arizona 85717

*Brad Vandermark, 4637 N. Edgebrooke Place, Tucson, Arizona 85705

*Vicki Phelps, 1231 E. Spring, Tucson, Arizona 85719

*Mark Day, 5531 S. Oakleaf Dr., Tucson, Arizona 85746

*Tom Vincent, University of Arizona, Tucson, Arizona 85721

*Joseph Mattiaccio, 320½ N. Warren Avenue, Tucson, Arizona 85719

*Geneva Zerby, 5050 S. Spencer Avenue, Tucson, Arizona 85746

* Provided comments on the draft EIS.

APPENDIX B

CONSULTATION AND COORDINATION

B. Consultation and Coordination

In 1979, the Tucson Aqueduct was envisioned to begin at the terminus of the Salt-Gila Aqueduct in Pinal County and terminate in Northwest Tucson in Pima County where it would tie into the Tucson water distribution system. While this location would have met the needs of the city of Tucson, the city and other water users were concerned that it would not meet the needs of Eastern Pima County and requested terminus location other than northwest Tucson be considered. Furthermore, the water users requested that Regulatory Storage be included as a Tucson Aqueduct feature.

In 1980, planning for the Tucson Aqueduct was divided into two phases. The first phase, Phase A, was identified as that portion of the aqueduct beginning at the terminus of the Salt-Gila Aqueduct in Pinal County and extending to the town of Rillito in Pima County. The second phase, Phase B, was intended to include that portion beginning at Rillito and ending near Green Valley in Pima County.

Since the CAP authorizing legislation did not specify a terminus or specific features for the Tucson Aqueduct, a Solicitor's opinion was requested. The conclusion was reached that the Secretary of the Interior had the discretion to locate the terminus and define the features (USBR, Memorandum, July 21, 1980). In November 1981, Secretary Watt (USBR, Memorandum to Commissioner, November 12, 1981) identified the South boundary of the San Xavier Indian Reservation as the appropriate Tucson Aqueduct terminus and directed Reclamation to evaluate the feasibility of including Regulatory Storage as a Tucson Aqueduct feature.

Advance planning for Phase B of the Tucson Aqueduct was initiated in May 1981. During the early stages of plan formulation, cost estimates were prepared and preliminary environmental and institutional information was collected for a large number of alternative plans. Public acceptance, based on comments received at public meetings held in November 1981, and the costs of each plan were the criteria used to reduce the number of alternatives for detailed study. An information packet was distributed in October 1981 that summarized the data and described the method to obtain public input. A March 17, 1982, memorandum (USBR, Memorandum, March 17, 1982) to All Interested Persons, Groups, and Agencies summarized the comments from the November 1981 public meetings and described the process of choosing alternatives for further study.

After this initial screening, the plan formulation process progressed to a tiered analysis of the remaining alternatives. The result was the identification of six alternative plans and a no federal action plan. In September 1982, the six alternative plans and the no federal action plan were presented to a committee formed by the Southern Arizona Water Resources Association (SAWARA). This committee's goal was to develop community consensus regarding the Tucson Aqueduct location, terminus, size, and regulatory storage features. The Committee on Alinement, Terminus and Storage (CATS) recommended that the Bureau give no further consideration to storage at the Cat Mountain site. The committee made this recommendation, recognizing that as the community becomes increasingly dependent on CAP water to meet its needs, there will be a need for future surface storage of not less than

10,000 acre-feet. This need will occur sometime after the year 2000 when, it is projected, there will no longer be sufficient well capacity to meet all municipal uses should any critical element of the CAP system prove not to be reliable enough to deliver water to the Tucson area. Prior to the occurrence of such a situation, CATS recommended that appropriate economic analyses for different storage volumes and locations be conducted.

In May 1983, an information packet was distributed which described two plans (USBR Tucson Aqueduct Phase B Information Packet. Stage II. May 1983) and meetings were held to receive public comment. A summary of these meetings is contained in the June 24, 1983, memorandum to All Interested Persons, Groups, and Agencies (USBR. Memorandum, June 24, 1983).

At the May 1983 public meetings, opposition to the West Side Plan was voiced primarily by residents of Avra Valley who live near the proposed canal alinement. The major objections focused on safety, aesthetics, and the feeling that Avra Valley residents were not party to the deliberation and recommendations of SAWARA. Comments indicated that the West Side Plan would be acceptable to the Avra Valley residents if open canal along the northern one-third of the aqueduct alinement was replaced with buried pipe. By working with the Avra Valley residents and the officers of the Friends of the Desert (Friends of the Desert is an organization of citizens concerned with quality of life in the desert), three additional alternative plans were formulated and presented for their consideration.

Two of the three were considered to be worthy of further consideration and a decision was made to include them in the Draft Environmental Impact Statement (USBR, Second Supplement to the October 1982 Plan Formulation Working Document, Tucson Aqueduct - Phase B, January 1984). The plans are the Sandario Plan and the Sandario-San Joaquin Plan. A third, the Sanders Road Plan was considered but eliminated with the concurrence of the Friends of the Desert.

On July 7, 1983,the Central Arizona Water Conservation District (CAWCD) board of directors met and voted unanimously to support SAWARA's recommendations. CAWCD is the local entity that will repay the reimbursable portion of CAP costs. The significance of this action was in CAWCD's willingness to undertake repayment of the pipeline and pumping plant required to deliver the City of Tucson's water to the 2800 ft. elevation (USBR, Supplement to the October 1982 Plan Formulation Working Document, Tucson Aqueduct - Phase B, July 1983). In December 1983, following public meetings held by the city of Tucson, the city proposed to Reclamation a plan in which the city's water treatment plant would be located near the Snyder Hill pumping plant, thus enabling Reclamation to pump treated water to the 2800 ft elevation. After review, Reclamation and CAWCD concurred with the city's plan (USBR, Second Supplement, January 1984) and (CAWCD, letter to Frank Brooks, Tucson Water, December 7, 1983).

Meetings were held in October 1984 with SAWARA, Friends of the Desert (FOD), Arizona-Sonora Desert Museum, and the National Park Service (NPS) to discuss the possibility of a Sanders-San Joaquin alternative. General support for such an alternative was indicated. An informational meeting was held in January 1985 to discuss this same alternative with property owners along Sanders Road. Opposition to the alternative was expressed by the majority of those present.

Three formal public hearings were held in January 1985 to receive comments on the draft EIS. The public hearing summary is presented in Appendix H. Based on comments received both at the public hearings and letters of comment and discussions with SAWARA, FOD, NPS, and the Arizona-Sonora Desert Museum, the decision was made to include Sanders-San Joaquin Modification Plan in the final EIS.

Subsequent to the formal public hearings, meetings were held with the town of Marana and Pima County Flood Control District to discuss flooding problems around I-10 and Tangerine Road. The decision was made to construct a single siphon from the northeast side of I-10, crossing the Santa Cruz River and daylighting on the southwest side of the river, a distance of about 8700 feet.

Also subsequent to the public hearings, two informational meetings were held on the San Xavier Indian Reservation to identify specific allottees affected and to inform Reservation residents of the proposed aqueduct alinement. Reclamation will continue coordinating with the tribe as the project proceeds.

APPENDIX C

IMPACTS OF THE ALTERNATIVES ON FLOODPLAINS AND WETLANDS

C. Impacts of the Alternatives on Floodplains and Wetlands

1. Executive Order 11988 (Floodplain Management)

Executive Order 11988 requires avoiding or minimizing harm associated with the occupancy or modification of a flood plain. The West Side Plan route crosses one floodplain, the Santa Cruz River just below Rillito, and a portion of it runs adjacent to another flood plain, the Brawley Wash just west of the Saguaro National Monument. Both the Santa Cruz River and Brawley Wash are ephemeral streams and contain water only in direct response to precipitation. Due to their remote location, there is no urban or commercial development near where the route comes in contact with these washes. Therefore, no damage will occur to any structures in the floodplain. In addition, the canal will be placed in a concrete pipeline and buried underground beneath the Santa Cruz River, so no damage will result to the canal from possible flooding. Protective dikes will be constructed on both sides of the canal where it is adjacent to Brawley Wash to safeguard the canal from flooding.

During the preparation of final construction designs, hydrologic studies would determine the depth at which the pipeline would be buried to protect it. Other hydrologic studies would be done in order to provide adequate cross-drainage protection for the aqueduct. Cross-drainage structures would be designed to pass flows of the 100-year magnitude without damage to the structure or significant alteration of the flow regime. Because of this, the West Side Plan would not adversely affect the natural and beneficial value of the flood plains.

2. Executive Order 11990 (Wetlands Protection)

Executive Order 11990 provides for the protection of wetlands through avoidance or minimization of adverse impacts. As defined by the FWS (1979:3), wetlands must have one or more of the following attributes: "(1) at least periodically, the land supports predominantly hydrophytes; (2) the substrate is predominantly undrained hydric soil, and (3) the substrate is nonsoil and is saturated with water or covered by shallow water at some time during the growing season of each year." According to this definition, the Santa Cruz River contains a wetland. The flows in this river, which result from releases of treated effluent, will not be permanently altered by construction. The limited amount of riparian vegetation that will be impacted by construction will be re-established by suitable techniques.

APPENDIX D

CLEAN WATER ACT, SECTION 404 EVALUATION

D. Clean Water Act, Section 404 Evaluation

The following evaluation has been prepared in compliance with the U.S. Army Corps of Engineers regulations for Nationwide Permits (Federal Register, 22 July, 1982).

1. Purpose

The purpose of the proposed plan is to convey Central Arizona Project (CAP) water from the terminus of Phase A of the Tucson Aqueduct to the vicinity of Tucson for delivery to agricultural, municipal, industrial, and Indian users.

2. Description of Proposed Plan

This proposed alternative is located primarily west of the Tucson Mountains. It is 47.4 miles long, with 28.0 miles of concrete lined canal and six pumping plants. The aqueduct capacity ranges from 650 cfs to 200 cfs. The system would deliver 161,900 acre-feet per year and would require 174 gigawatt hours of electricity. A transmission line of approximately 33 miles would be required. Four turnouts would be provided for the Avra Valley Irrigation District. A turnout would be provided for the Schuk Toak District on the Garcia Strip, an eastern spur of the Papago Reservation. At the south boundary of the San Xavier Indian Reservation two turnouts would be needed, one would be provided for the San Xavier Indian Reservation, and the other for the town of Green Valley, Farmers Investment Company, and the city of Nogales.

The proposed action includes overchutes and culverts to provide aqueduct cross-drainage protection and mitigate adverse impacts on local surface drainages; highway and county bridges to minimize travel disruption; fencing and escape ladders for human safety; and wildlife crossings, watering sites, wildlife fencing, and tortoise barriers to mitigate adverse impacts on wildlife. The plan also includes an undeveloped wildlife corridor in the Avra Valley and revegetation of disturbed areas.

2. Authority

The Tucson Aqueduct, Phase B, is a part of the Central Arizona Project, which was authorized by the Colorado River Basin Project Act (Public Law 90-537) of September 30, 1968.

3. Findings

The U.S. Army Corps of Engineers published regulations governing the Section 404 permits program in the Federal Register on July 22, 1982. These included Part 330 - Nationwide Permit. The proposed West Side Plan is covered under the nationwide permit for discharges into non-tidal rivers, streams, and their lakes and impoundments, including adjacent wetlands above the headwaters (Section 330.4 a(1)).

A nationwide permit is a form of general permit which authorizes a category of activities throughout the nation. The nationwide permits are issued to satisfy the requirements of the River and Harbor Act of

1899 and Sec. 404 of the Clean Water Act. However, the nationwide permits are valid only if the conditions applicable to the nationwide permits are met. Reclamation has determined that the West Side Plan meets the conditions of the nationwide permit and, therefore, does not require the issuance of or compliance with the review process necessary to obtain an individual permit under Section 404(b)(1) of P.L. 92-500.

Conditions for compliance with the nationwide permit, and the West Side Plan status relative to these conditions, are discussed below.

5. Nationwide Permit Conditions

The following conditions must be met in order for the nationwide permit to be valid.

a. Discharge will not be located in the vicinity of a public water supply intake

No discharge occurring from construction of West Side Plan features will be located near a public water supply intake.

b. The discharge will not destroy a threatened or endangered species as identified under the Endangered Species Act, or destroy or adversely modify the critical habitat of such species

Federal agencies must review their actions to determine if an action may affect any listed species or critical habitat. If so, the agency must consult with the Fish and Wildlife Service. The West Side Plan could affect one species, Thornber's Fishhook Cactus, which is proposed for listing as a threatened species by the Fish and Wildlife Service. Another species, the Tumamoc Globeberry, is scheduled to be proposed as an endangered species. When these species are listed, the Bureau will enter into formal consultation with the Fish and Wildlife Service under the provision of Section 7 of the Endangered Species Act. If it is determined that the West Side Plan will jeopardize the continued existence of either species, the Bureau will implement whatever reasonable and prudent alternatives are proposed by the Service to protect these species.

c. Discharge will consist of suitable material free from toxic pollutants in toxic amounts

All discharge will be composed of materials currently found in the affected site areas or wastes from materials obtained from commercial sources. Since affected site areas are located in generally undeveloped areas away from urban uses and sources of environmental pollution, there is no reason to expect the occurrence of toxic substances. The materials to be used in construction and any waste materials from borrow areas are similar in physical and, most likely, chemical properties to materials at discharge sites.

d. Fill created by the discharge will be properly maintained to prevent erosion and other non-point sources of pollution

Fill created by the West Side Plan will consist of the embankment on the sides of the canal used for maintenance roads, overchutes used for wildlife crossings, and turnouts on the canal for agricultural and municipal uses. All this fill will form slopes on the sides of the canal. These slopes will be revegetated, or allowed to revegetate, to reduce erosion.

e. Discharge will not occur in a component of the National Wildlife and Scenic River System

The only river to be crossed by the West Side Plan is the Santa Cruz River, which is an ephemeral stream. No portion of the Santa Cruz River is classified as a wild or scenic river. There are no components of the National Wild and Scenic River System in the project area.

f. Best management practices should be followed to the maximum extent practicable

Management practices are aimed at avoiding and/or reducing impacts of dredged or fill materials on water quality, spawning areas, aquatic communities, wetlands, and migratory waterfowl breeding and nesting areas. Impacts to these resources resulting from the implementation of the West Side Plan and mitigation measures to alleviate impacts are discussed in Chapter III of the EIS. Where applicable, management practices will be employed to avoid adverse impacts which could be caused by discharge. Specifically, fill areas will be revegetated or allowed to revegetate to prevent discharge during times of run off. There are no spawning areas, aquatic communities, or waterfowl migration, breeding, or nesting areas along the alinement of the West Side Plan. The Santa Cruz River does contain a wetland area. The man-made flows in the river will not be permanently altered by construction. The limited amount of riparian vegetation that will be impacted by construction will be re-established by suitable techniques.

APPENDIX E

ENDANGERED SPECIES ACT COMPLIANCE

E. Endangered Species Act, Compliance

A list of Federally threatened or endangered species that could occur in the Phase B area was provided by FWS (1981). An assessment was made by AGFD (1982) that concluded that the listed species either did not occur in the project area or, as in the case of the peregrine falcon (Falco peregrinus), would not be affected although it occurs occasionally in the area. The assessment included a recommendation to more intensively search the West Side Plan alinement for the Nichols turk's head cactus (Echinocactus horizonthalonius var. nicholii), a Federally listed endangered species. Further surveys were conducted by the Arizona Game and Fish Department which found no turks head cacti on the alinement.

A proposed species for the Federal List of Threatened Species is the Thornber's Fishhook Cactus (Mammillaria thornberi). Approximately 19,000 individuals could be impacted by the project.

In addition to listed and proposed species, there are plant and animal species being considered for listing under the Endangered Species Act. These candidate species are grouped into categories to accurately reflect present evaluation of their status. Category 1 refers to those species where sufficient information exists to support their being listed under the Act. Category 2 species refers to those where the available information is not sufficient to support listing at this time. Candidate species that occur in the project area are Tumamoc globe-berries (Tumamoca macdougalii) and Sheer's strong-spined cory cactus (Coryphantha scheeri var. robustispina), (Category 1 plants), Pringle's lip ferns, (Cheilanthes pringles) and night blooming cereus (Paniocereus greggii) (Category 2 plants), wintering ferruginous hawk (Buteo regalis), desert tortoises, and Gila monster (all category 2 animals).

The preferred conservation measure is avoidance of both M. thornberi and T. macdougalii by relocation of the aqueduct. Other recommended conservation measures that may eventually be identified for the proposed and candidate plant species was provided to USBR by the FWS (memorandum Date June 6, 1984). Measures include acquisition of land to preserve approximately 27,000 M. thornberi, avoidance and protection with dikes to preserve T. macdougalii, with transplanting as a last resort. Additional surveys for T. macdougalii and Coryphtontha scheeri were recommended. No conservation measures were recommended as necessary for Cheilantes pringlei or Peniocereus greggii.

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE

Ecological Services
2934 W. Fairmount Avenue
Phoenix, Arizona 85017

June 6, 1984

1201 -

MEMORANDUM

To: Regional Director, Bureau of Reclamation, Lower Colorado Region, Boulder City, Nevada (Attention: LC-150)

From: Field Supervisor, Fish and Wildlife Service, Ecological Services, Phoenix, Arizona

Subject: Section 7 Consultation, Tucson Aqueduct Phase B, Central Arizona Project

In your April 17, 1984 request for Section 7 consultation on Phase B of the Tucson Aqueduct (CAP), you requested us to provide you with recommended conservation measures tht could be implemented to minimize the effects of the project on the rare plant species occurring in the proposed aqueduct alignment. To that end, a meeting of representatives from your Bureau, our Service, the Arizona Game and Fish Department, and knowledgeable botanists was held on May 18, 1984 to discuss possible conservation measures.

We wish to stress that these recommendations are not binding on the Bureau and should not be confused with reasonable and prudent alternatives, reasonable and prudent measures, or conservation measures such as would be provided in a Section 7 biological opinion. The measures described in this memorandum were developed to assist you in the planning of this project and should only be used for that purpose. The implementation of all or part of these recommended measures will not insure that a non-adverse biological opinion would be issued for this project if and when the affected species are listed under the Endangered Species Act.

Five species of rare plants could be affected by construction of the Tucson Aqueduct, Phase B. Only one, Mammillaria thornberi, is presently proposed (as threatened) under the Act. It is expected that Tumamoca macdougalii will be proposed as endangered during 1984. The listing package for Coryphantha scheeri var. robustispina is not presently scheduled for further development. At this time, there are also no immediate plans to work on the listing of either Cheilanthes pringlei or Peniocereus greggii. If the status of these species change, we will inform you as soon as possible.

The best method to eliminate or minimize impacts of the project on rare plants would be to relocate project features to areas away from suitable habitat. Any relocations would require that the new routes be field checked for rare plants. Measures that would minimize the number of acres disturbed would also contribute to minimizing the number of plants disturbed. Such measures could include replacing open canal with buried pipeline, limiting surface acres affected by construction activities, and consolidating rights of way and material storage areas.

Conservation measures recommended for Mammillaria thornberi center on the proposed wildlife mitigation land. Acquisition and maintenance of this land in an undeveloped state would preserve approximately 27,000 M. thornberi, 8,000 more than would be lost to aqueduct construction. Acquisition of this area would be preferable to acquisition of section 33 T.13S.R.11E because this proposed mitigation area has high wildlife values as habitat and a movement corridor and its acquisition is essential to provide mitigation for other project impacts.

Transplantation of affected plants may not be feasible for M. thornberi because of the number of plants involved. We do recommend that institutional and legal requirements under the Arizona Native Plant Law and the Endangered Species Act be explored prior to construction to determine if transplantation or salvage on a limited scale could be accomplished. Efforts to minimize the number of acres of M. thornberi habitat disturbed by construction could also be useful. All of the plants not in the immediate construction area may not be lost as a result of the project, however some plants would be affected by inundation and water flow changes.

Avoidance of individuals plants is more important for Tumamoca macdougalii because so few plants are known. Again, re-routing the alignment to non-suitable habitat would be the most effective way to minimize direct effects of this project on the plant.

We recommend that additional surveys be done in the 1984 field season to search out more plants and obtain more information on specific habitat preferences of the species. This information would be useful in determining sites for possible acquisition or transplant sites. Coordination with Saguaro National Monument personnel and consultants on the San Xavier Indian Reservation should be attempted.

Four of the 6 plants found in the aqueduct right of way could be protected on site by dikes and fences. It may not be possible to protect the remaining 2 plants on site and transplantation may be a viable measures to protect these plants. Prior to transplantation, information on suitable habitat, appropriate procedures and potential transplant vigor should be obtained.

The 1984 field surveys should also search for individuals of Coryphantha scheeri var. robustispina on the aqueduct route. The only plant found to date should be protected on site. If other plants are found, measures similar to those described above could be implemented.

At this time we do not believe it is appropriate to recommend any specific measures for Cheilanthes pringlei or Peniocereus greggii. If these plants are eventually transferred to Category 1 or listed, measures similar to those described for the other rare plants could also be used for these species.

We hope these recommendations will be helpful in your planning. If you have any questions or require further information, please contact this office.

Gilbert D. Metz

cc: Director, Arizona Game and Fish Department, Phoenix, Arizona
Project Manager, Bureau of Reclamation, Arizona Projects Office, Phoenix, Arizona
Regional Director, (SE, AHR), Fish and Wildlife Service, Region 2, Albuquerque, New Mexico

APPENDIX F

ENVIRONMENTAL COMMITMENTS

F. Environmental Commitments

Once the final EIS has been filed and the Record of Decision prepared, an Environmental Commitment Plan (ECP) will be developed for the Tucson Aqueduct - Phase B. An ECP is the master environmental implementation document for construction, operation, and maintenance activities. The ECP specifies the environmental commitments, mitigation measures, design data, and monitoring activities to be implemented during preconstruction, construction, and operation; it sets forth the responsibilities for implementation; and provides detailed procedures to be followed by the Project Construction Engineer, the Environmental Officer, and appropriate offices in complying with NEPA compliance documents and other relevant environmental documents. An Environmental Commitment Checklist will also be prepared. The checklist summarizes the commitments from the ECP that are related to construction activities and that are to be followed or monitored in the field by the construction inspection staff and a designated Environmental Specialist. This final EIS will provide the basis for the ECP and will include the following environmental commitments.

1. Construction Considerations

a. Construction Materials

The Bureau will perform environmental analyses of any borrow areas outside the right-of-way where construction material are obtained or disposed if those areas are used solely for project purposes.

b. Erosion Control

All excavated slopes will be benched, terraced, or furrowed to prevent erosion and aid revegetation after construction. Deep cut slopes would be benched or terraced and protected from cross drainage by diking. To prevent erosion of the cut slope, surface drain would be used at the toe of each bench or terrace.

c. Access During Construction

Detours will be provided at all public roadway crossings while vehicular bridges are being constructed at those sites.

Construction access roads, haul roads, spoil areas, and other activities which require land surface disturbance outside of the construction right-of-way will require approval of the Contracting Officer including environmental review.

d. Water Resources

All intercepted floodflows would be bypassed in a manner that no damage will result to either public or private property.

Specifications would require the contractor to prevent construction-related pollution of the underground aquifers, surface washes, and rivers. The contractor would comply with applicable Federal and state laws and regulations concerning control and abatement of water pollution.

If Santa Cruz River surface flows are proposed as construction water supply, a specific environmental analysis would be required to assess impacts of diversion and permission from the Contracting Officer would be required.

e. Waste Disposal

The contractor will be required to remove all unused construction materials and other rubbish from the work area after construction.

The contractor will be required to dispose of solid waste and/or hazardous waste in accordance with Federal and State of Arizona laws and regulations.

After construction, storage yards will be returned as nearly as practicable to their preconstruction appearance. This will include removal of all surplus buildings and equipment, lumber, refuse, fencing, and all other items not at the site prior to construction. The area will be seeded with native plants species to replace vegetation.

Any excess excavated soil around transmission line structures will be spread and blended with existing soil around the structure.

f. Sound

The Bureau will review and evaluate the blasting plan submitted by the contractor before blasting is authorized.

The Bureau will maintain a construction noise monitoring program to insure normal noise levels do not exceed 75 decibels at night or 80 decibels during the day, as measured from points considered to be sound sensitive.

g. Air Quality

Dust from contractor operations will be controlled by maintaining proper soil moisture conditions. The contractor will establish watering program and maintain speed limits to reduce dust. Construction equipment use of state and county roads is to be regulated by those agencies.

Vehicles will be maintained by contractor in proper conditions to reduce emission problems. Vehicles producing excessive emissions will not be operated.

Local pollution and fire authorities will be consulted before waste material is burned.

h. Landscape Preservation

Prior to canal excavation and construction, right-of-way fences will be erected and vegetation clearing limits will be delineated in the construction specifications. Construction activities would be confined to these delineated areas within the right-of-way to reduce vegetation clearing and visual impact.

Construction specifications will specify designated use areas for contractor construction yards and other needed construction areas. These use areas would be selected based in part on their visibility from sensitive areas and other environmental considerations. Other construction use areas would require specific approval of the contracting officer.

i. Safety

The Bureau will monitor safety conditions during construction to avoid accidents.

During construction, signs, flagmen, and barricades will be used to warn of hazards.

As on other features of the CAP, appropriate fencing would be provided around structures and along right-of-way boundaries to prevent access by the public. Various types of fences and their use are discussed in the EIS for the Salt-Gila Aqueduct (Water and Power 1979: 18-19).

Safety ladders for human escape would be installed opposite each other at 750-foot (229m) intervals on each side of the aqueduct and immediately upstream of pumping plant forebays, siphons, and checks.

Additional escape devices would be installed across the aqueduct at various locations, especially upstream of such structures as the pumping plants and siphons. These may include safety nets strung across the aqueduct extending below the water surface, and suspended cables with tracers or droplines extending to the water surface.

No potentially dangerous impoundment of floodwaters is expected along the aqueduct route. Protective dikes, overchutes, and flumes would be designed to convey floodwaters across the aqueduct and to route floodflows to natural drainages with adequate capacity to convey those flows below the aqueduct.

The aqueduct will be remotely monitored at all times. Should a breach of the aqueduct be detected, check gates will be closed by remote control or by hand, thus isolating sections of the aqueduct to minimize discharge of water from the damaged section.

2. Biological Resources

a. Vegetation

Mitigation for destroyed habitat would consist of revegetation of all construction disturbed areas not required for operation and maintenance of the aqueduct.

Western will supervise the clearing of transmission line corridors to insure environmental protection measures are carried out. To enhance esthetics and control erosion, as much low growth vegetation will be preserved within the right-of-way as possible. Only the minimum amount of vegetation required by permanent facilities will be cleared.

Before being abandoned, the side of borrow pits would be stabilized, scarified, and left in a condition to facilitate revegetation. The Bureau will coordinate with other interested agencies the use of any borrow areas outside the right-of-way.

Advance notice will be given to the Arizona Commission of Agriculture and Horticulture in accordance with the Arizona Native Plant Law regarding disposition of protected native plants.

Vegetation monitoring will be established and baseline data recorded to determine seeding success and whether or not additional efforts are needed.

Any riparian vegetation that is lost during construction will be re-established through suitable revegetation techniques.

If borrow areas are selected along the Santa Cruz River, they will be confined to the river bed and will not impact adjacent bankline riparian habitat.

The "green-up" area upstream of the dikes will be fenced to preclude cattle grazing and further offset the downstream habitat losses, as recommended by Federal and State wildlife agencies.

All reasonable and prudent alternatives identified by FWS to avoid jeopardizing the existence of any federally listed, proposed or candidate plant species will be implemented.

b. Wildlife

The top portion of the side slopes of the canal lining extending 5 feet vertically below the top of the lining would receive a nonskid, longitudinally-brushed finish to facilitate exit by small animals which may fall in. The design of animal deflectors, escape ramps, and one-way gates for the removal of big game from the aqueduct is under study by the Bureau and other interested agencies. If such escape devices prove feasible and practical, they would be installed in the aqueduct along selected reaches of known game concentration and migration routes.

Wildlife-proof fencing with zero ground clearance would be used along canal sections which present a significant drowning hazard. Design of this fence would be determined after consultation with interested agencies.

Mitigation for movement severence will include the acquisition and management of a wildlife movement corridor (4.25 mi^2) in T.14S. R.11E., Sections 10, 11, 14, and 15 and SW 1/4 of T.14S. R.11E. Section 2 which would be turned over to a natural resource agency for management as wildlife habitat. Management requirements of the wildlife corridor include:

- Turn land over to a resource management agency.
- No further residential or industrial development.

- Exclude grazing, mining, dumping and off-road vehicles.
- Concentrate the location of wildlife crossings over the aqueduct in this area.
- Maintain and improve present or similar water sites (wells and tanks) on this land.
- A standard BLM livestock fence will be constructed and modified in such a manner to exclude cattle but permit movement of wildlife.

Wildlife watering sites will be constructed as part of the aqueduct construction prior to aqueduct completion. The final number, location, and design of these watering structures would be determined through negotiation with interested wildlife agencies prior to final design of the aqueduct.

Construction disturbance would be minimized from January 1 to June 1 within one-half mile of Harris' hawk nests. No new haul roads, equipment yards or other related impacts off of the right-of-way of the Phase B area would be permitted off the right-of-way in these areas.

Impacts to the desert tortoise and the Gila monster will be lessened by constructing barrier fences along portions of the canal known to support desert tortoise and Gila monster populations to prevent drowning losses and a search and removal of species along the right-of-way prior to construction.

Contractor crews will be discouraged from collecting or unnecessarily disturbing desert tortoise or Gila monsters during construction. Tortoises found in the construction area should be given to the Reclamation Inspectors, along with their location, for removal from the area.

All powerline poles will be of a design that will prevent electrocution of raptors.

Transmission lines will be monitored for the electrocution of raptors. If adverse effects are discovered, appropriate spacing and/or insultation modification will be made.

The mitigation plan would include construction of single-purpose wildlife crossings, along with vehicular bridges, overchutes and other crossings which would also be modified for use by wildlife. The final number and location of these crossings would be determined through negotiation with the FWS and the AGFD prior to final aqueduct designing.

All wildlife crossings and watering sites would be monitored to determine use and to insure that they are properly located. The entire length of the aqueduct would be monitored to determine if additional wildlife crossings or other mitigation measures are needed.

A study to monitor kit fox populations and their response to the aqueduct will be implemented to delineate problems and suggest mitigation measures if needed.

All stock tanks which are not in the construction right-of-way will be left undisturbed. Stock tanks which will be removed due to construction or dewatered due to placement of flood protection structures would be rebuilt in areas where floodflows can be intercepted.

Additional mitigation recommended by the FWS, AGFD, BLM and others would be implemented as appropriate.

3. Cultural Resources

A plan is being developed in consultation with the State Historic Preservation Officer, the Keeper of the National Register of Historic Places, and the Advisory Council on Historic Preservation to mitigate the adverse affects to significant cultural resources. This will consist of data collection studies at 32 prehistoric archaeological sites located within the impact corridor.

If evidence of previously unrecorded cultural resources is discovered during construction, operations in the vicinity of the discovery will cease until an assessment of significance is made and appropriate mitigation measures, if necessary, are completed.

4. Social Resources

Persons that must relocate their residence are eligible for relocation assistance and benefits in accordance with the Uniform Assistance and Real Property Acquisition Policies Act of 1970. Relocation benefites are separate from and in addition to money paid as compensation for property acquired. Persons who are displaced will be offered assistance in relocating to suitable replacement property and in applying for monetary benefits for which they may be eligible.

5. Visual Resource

Landscaping measures will be included for each pumping plant, and if appropriate, aqueduct reaches.

Sufficient numbers of saguaros and other cacti will be removed and stockpiled from the construction zone to be transplanted at pumping plants or along the aqueduct at specific areas.

Dikes and cut slopes will be benched, terraced or furrowed to reduce erosion and aid in revegetation.

Construction-disturbed areas will be seeded with native and/or xeric adapted perennial plants and grasses. Revegetation efforts will be coordinated with interested local agencies and input will be sought in developing final revegetation plans.

The use of cobble or gravel cover or placement of landscape stone on cut slopes or dike side slopes will be considered as a means to reduce erosion, and enhance revegetative success.

Metal canal structures, such as pipe overchutes, will be painted a color chosen to reduce visibility.

Concrete canal structures such as bridges and flume overchutes shall receive a surface treatment to reduce visual contrast to the adjoining desert.

Chain link security fencing options such as the PVC-coated type to reduce reflective glare, with fence posts and fabric of a color chosen to reduce visibility; or if such material is determined unsuitable for desert climates, the galvanized fence with a dull coat solution to reduce glare will be considered.

Non-specular conductors will be used along the entire length of the transmission line in order to reduce visual impacts.

6. Water Resources

Longstanding water ponds that may occur behind dikes or spoil banks will be monitored for vectors. County health authorities will implement vector control measures if necessary. Insecticides will only be applied to areas where it cannot enter the aqueduct water.

Use of pesticides along the Tucson Aqueduct will conform with the requirements of the Federal Environmental Pesticide Control Act of 1972 (P.L. 92-516), policy and regulations of the Department of the Interior, applicable Executive Orders, or subsequent and amendatory laws, regulations, and orders.

7. Compliance With Other Environmental Laws and Regulations

In addition to meeting all of the above environmental commitments, the contractor(s) is/are responsible for compliance with applicable Federal, state, and local laws and regulations concerning the environment. Examples include the Arizona Groundwater Management Act of 1980 and Pima County air quality regulations regarding travel on Pima County roads.

8. Changes in the Plan

Should changes in the plan or refinements in design result in environmental impacts which are significantly different from those described in the EIS, an environmental evaluation will be made and documented in accordance with the National Environmental Policy Act.

APPENDIX G

CUMULATIVE IMPACTS OF THE PROPOSED ACTION AND OTHER RECLAMATION PROJECTS

G. Cumulative Impacts of the Proposed Action and Other Reclamation Projects

The Tucson Aqueduct, Phase B is part of the CAP Aqueduct and Pumps Project, which is one of nine major projects in the Lower Colorado River Basin (LCRB) under construction or in advance planning by the Bureau of Reclamation. These projects are:

Regulatory Storage
CAP Transmission Lines
CAP Regulatory Storage Division (Plan 6)
Buttes Dam (or suitable alternative)
Hooker Dam (or suitable alternative)
Colorado River Front Work and Levee System
Colorado River Basin Salinity Control Project (Title I)
Colorado River Water Quality Improvement Program (Title II)
Hoover Dam Modifications

The location of these projects within the LCRB is shown on Figure G-1.

Cumulative impacts of these Reclamation projects are assessed in this section of the EIS. The impact assessment has been scoped to focus on four major issues: socioeconomics (including impacts to crop production, power development, recreation, and employment opportunities), biological resources (including aquatic and terrestrial biotic communities), water development and availability, and water quality (salinity). Existing data from environmental impact statements and planning reports for the projects were used to perform the assessment. A major source of baseline data was the Lower Colorado Region Comprehensive Framework Study prepared by the Lower Colorado Region State-Federal Interagency Group for the Pacific Southwest Interagency Committee (1972).

Impacts were assessed using the following major assumptions:

1) existing, accessible baseline data would be used

2) Reclamation projects in the LCRB under construction or in advance planning would constitute the action being assessed

3) projects would be operational by the year 2000

4) biological impacts would be assessed as the difference between future-without and the future-with conditions in the year 2000

5) socioeconomic and water resources impacts would be assessed using a zero baseline

1. Socioeconomic Resources

Table G-1 presents a summary of anticipated socioeconomic impacts of water resource development projects, either planned or under construction, in the LCRB. Two categories of projects are assessed:

Table G-1

SUMMARY OF ESTIMATED SOCIOECONOMIC IMPACTS OF WATER RESOURCE DEVELOPMENT PROJECTS, PLANNED OR UNDER CONSTRUCTION, LOWER COLORADO RIVER BASIN, YEAR 2000

PROJECT TYPE/TITLE	EMPLOYMENT[b] (Number of Jobs) (Construction or O&M)	CROP PRODUCTION (1,000 acres)	POWER DEVELOPMENT (GWh/yr)[e]	RECREATION[f] (1,000 recreation days) (stream or reservoir)
o RESERVOIR/AQUEDUCT PROJECTS				
Central Arizona Project (FEIS 1972)[a]				
Regulatory Storage Division (DEIS 1983)	IU[c]	NA[d]	-224.6	12.6 (str) 986.9 (res)
Pumps and Transmission Lines	IU	NA	-2,073.0	NA
Buttes Dam	3 (O&M)	NA	IU	NA
Hooker Dam	3 (O&M)	NA	IU	32.0 (str) 820.7 (res)
Granite Reef Aqueduct	-	-	NA	-
Salt-Gila Aqueduct	600 (const)	NA	NA	NA
Tucson Aqueduct	IU	NA	NA	NA
Hoover Dam Modifications (DEIS 1980)	420 (const) 3 (O&M)	NA	+1,493.0	NA
RESERVOIR/AQUEDUCT SUBTOTAL	1,020 (const) 9 (O&M)	NA	-804.6	44.6 (str) 1,807.6 (res)
o WATER QUALITY IMPROVEMENT PROJECTS				
Colorado River Basin Salinity Project (Title I)			-424.0	
Mojave- Coachella (DEIS 1974)	IU	37.3 (loss)		NA[f]
Yuma Project (DEIS 1976)	3 (O&M)	0.4 (gain)		NA
Colorado River Water Quality Improvement Project (Title II)				
Colorado River Indian Reservation Unit (FEIS 1976)	IU	93.0 (gain)	IU	NA
Las Vegas Wash (FEIS 1976)	IU	0.8 (loss)	-62.8	NA
La Verkin Springs Unit Utah (Feasibility Report 1973)	24 (O&M)	NA	-30.3	NA
Palo Verde Irrigation District Unit (FEIS 1976)	IU	IU	IU	NA
WATER QUALITY IMPROVEMENT SUBTOTAL	100 (const) 47 (O&M)	56.5 (net gain)	-522.5	NA
TOTAL	1,120 (const) 56 (O&M)	471.0-427.7 (net gain)	-1,327.1	44.6 (str) 1,807.6 (res)

[a]Date in parentheses indicates year that environmental impact statement was published.

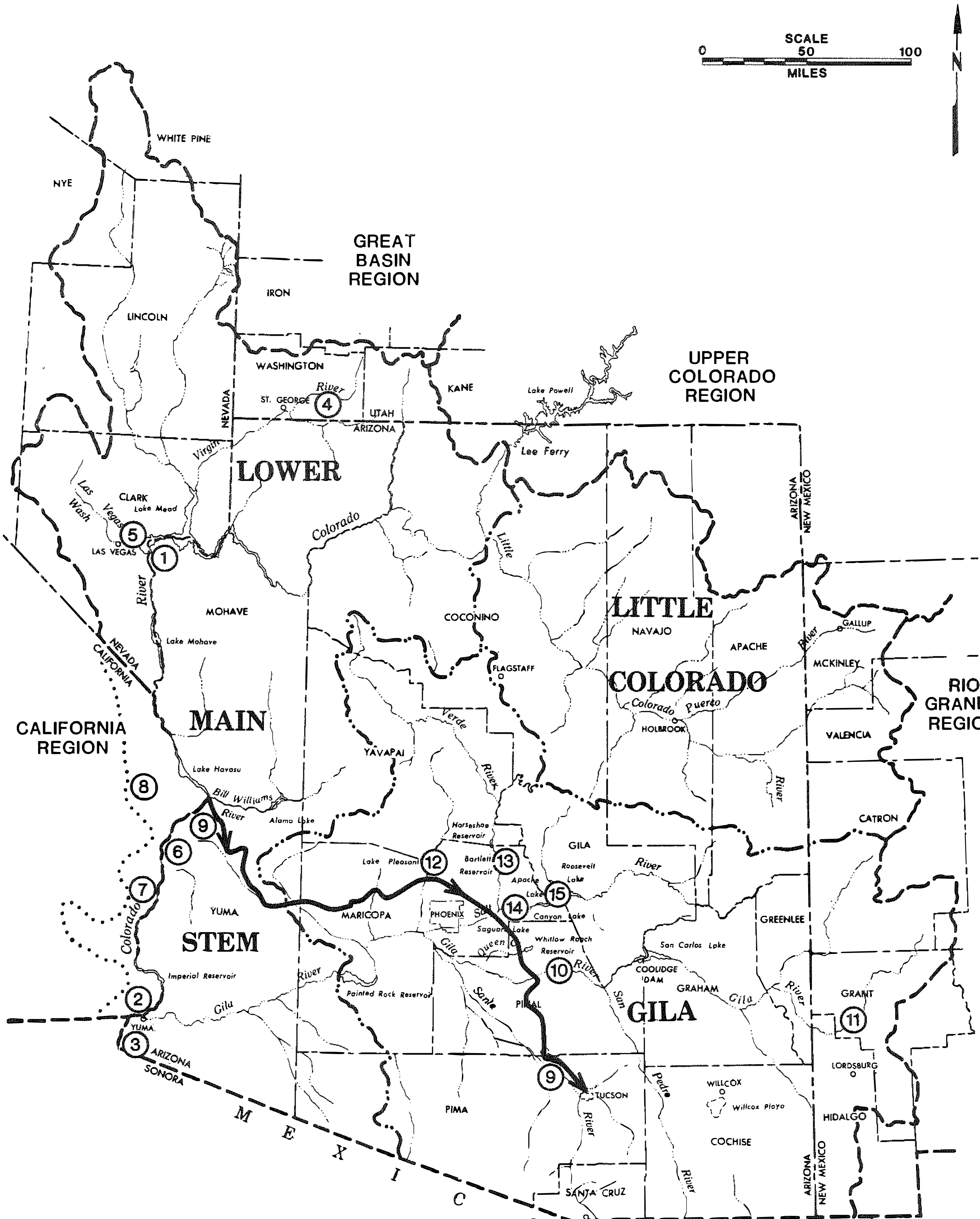
[b]Estimate of number of new jobs created through construction or operations and maintenance as a direct result of proposed project.

[c]Information unavailable.

[d]NA denotes not applicable.

[e]Estimated annual power generated (+) or consumed (-) in gigawatt hours.

[f]Recreation demand estimated for year 2000 in annual recreation days with separate projections for stream-oriented as opposed to reservoir-oriented.



HOOVER DAM MODIFICATIONS .... (1)

COLORADO RIVER BASIN
SALINITY CONTROL PROJECT (TITLE I)

- YUMA PROJECT .... (2)
- MOJAVE - COACHELLA PROJECT .... (3)

COLORADO RIVER WATER QUALITY
IMPROVEMENT PROGRAM (TITLE II)

- LAVERKIN SPRINGS UNIT .... (4)
- LAS VEGAS WASH UNIT .... (5)
- COLORADO RIVER INDIAN RESERVATION UNIT (6)
- PALO VERDE IRRIGATION DISTRICT UNIT..... (7)

COLORADO RIVER FRONT AND LEVEE SYSTEM
(EXTENDS DOWNSTREAM FROM LAKE MOHAVE) .. (8)

CENTRAL ARIZONA PROJECT

- AQUEDUCTS, PUMPS AND TRANSMISSION LINES (9)
- BUTTES DAM .... (10)
- HOOKER DAM .... (11)
- PLAN 6
  - WADDELL DAM .... (12)
  - CLIFF DAM .... (13)
  - STEWART MOUNTAIN DAM .... (14)
  - ROOSEVELT DAM .... (15)

FIGURE G-1
RECLAMATION PROJECTS UNDER CONSTRUCTION OR PROPOSED FOR THE LOWER COLORADO RIVER BASIN

reservoir/aqueduct projects and water quality improvement projects. Because the character of these projects is not comparable, impacts associated with each category or type are discussed separately. However, Table G-1 lacks completeness in that existing data are not sufficient to develop a comprehensive impact analysis.

a. Reservoir/Aqueduct Projects

As shown in Table G-1, as a result of the construction of components to the CAP and Hoover Dam Modifications, approximately 1,020 temporary construction jobs and 9 permanent jobs would be created. Additionally, recreation facility demand of the new water bodies has been estimated at approximately 44,600 annual recreation days for stream-oriented use and approximately 1.8 million annual recreation days for reservoir-oriented use.

b. Water Quality Improvement Projects

As a direct result of the water quality improvement projects in the LCRB, there will be an increase of approximately 57,000 acres of productive cropland. Approximately 100 construction jobs and 47 permanent jobs would be created by these projects. Due to the purpose and nature of the projects, there will be no impacts for power development or recreation.

c. Combined Impacts

An estimate of total reported socioeconomic impacts in the year 2000 for water development projects in the LCRB is as follows:

CROP PRODUCTION: 57,000 acres net gain

EMPLOYMENT

Construction: 1,120 construction jobs
Operation: 56 O&M jobs

POWER DEVELOPMENT: 370 to 1520 megawatt potential at Hoover Dam

RECREATION DEMAND

Stream-Oriented: 44,600 annual recreation days
Reservoir-Oriented: 1,807,600 annual recreation days

2. Biological Resources

The biological resource baseline of the LCRB includes biotic communities ranging from desertscrub to alpine tundra. The natural biotic communities as described in data (Lower Colorado Region Framework Study) include not only the natural communities shown in Figure G-2 but aquatic riparian communities and agricultural and developed urban lands. Table G-2 gives the approximate range of these communities.

As can be seen in Figure G-2 and the data presented in Table G-2, desertscrub and woodlands, scrub, and grasslands formations constitute the major portion of the cover types occurring in the Lower Colorado Region. Riparian and aquatic communities, as shown in Figure G-3, are identified with the drainage pattern, of which some 1,700 miles are represented on the main drainage as perennial stream. The drainage pattern with minor perennial streams includes some 2,500 miles of drainage. The major source of the Lower Colorado River drainage is the Mogollon Rim and White Mountain area, represented as the cross-hatched area in Figure G-3. Lakes and reservoirs represent approximately 531 square miles of water surface.

The estimated change between the 1972 baseline and the future-without Reclamation projects is shown in Table G-2. Clearly the major percentage change anticipated is in the agricultural and developed lands and riparian communities. Some 48 percent growth in urban and developed lands is anticipated over the 1972 baseline at year 2000. Agricultural lands will be converted to urban lands, and approximately 2.5 percent of the riparian communities will be lost by the year 2000.

The future-with Reclamation projects at year 2000 shows that, again, most of the important change will occur with urban land and riparian communities. In addition, perennial stream and lakes/reservoirs will undergo change between the future-without and future-with. A composite loss of about 7 percent of the riparian communities is expected by the year 2000, of which approximately 5 percent results from Reclamation projects. This represents a rather important change in this limited resource. Riparian communities are known to harbor a great deal of wildlife in the Southwestern deserts and the loss, therefore, is significant from the standpoint of resource quality, wildlife diversity, and unique resource.

The CAP will involve conveyance of water to central Arizona. This will serve as a new water source for interior Arizona. Some 14 square miles of additional water surface are expected to be developed by the year 2000 because of Reclamation projects, most of them associated with CAP. This gain in lake and reservoir surface area will not necessarily enhance the quality of fisheries, although several new bodies of water will be added to the watershed. These include the Cliff Reservoir on the Verde River and an enlarged Waddell Reservoir at Lake Pleasant, as well as reservoirs associated with Hooker and Buttes Dams on the Gila River. Some 21 miles of existing perennial streams will be lost by the enlargement of reservoirs and development of new impoundments. The loss of the perennial stream will affect riverine fisheries and riverine aquatic communities associated with these specific locales.

Several Federal endangered species occur within the Lower Colorado region and will be affected by the various projects mentioned above. The bald eagle, peregrine falcon, Yuma clapper rail, Gila topminnow, Colorado River squawfish, woundfin, humpback chub, and bonytailed chub utilize riparian

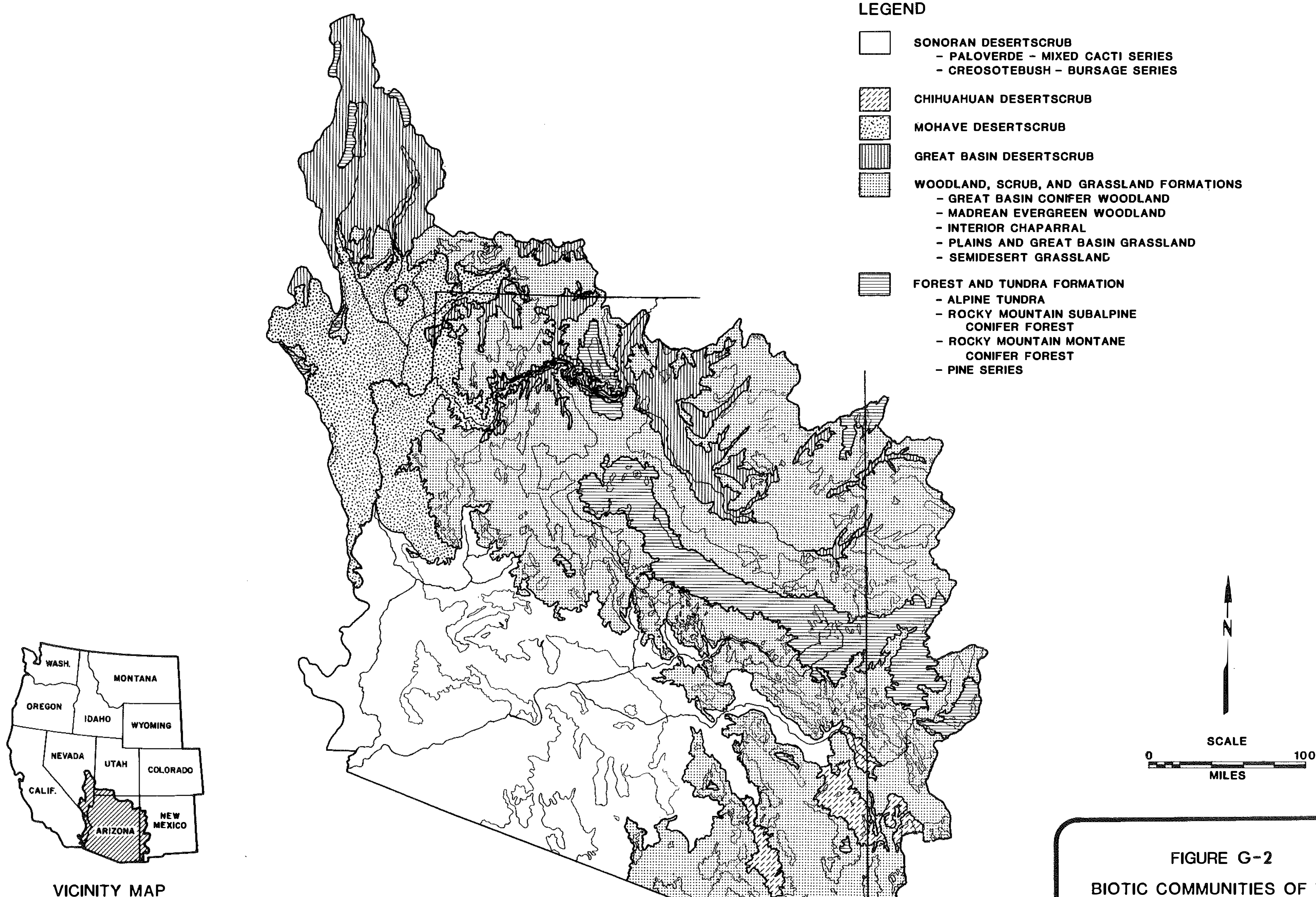


FIGURE G-2

BIOTIC COMMUNITIES OF THE LOWER COLORADO RIVER BASIN

ADOPTED FROM BROWN AND LOWE, 1977.

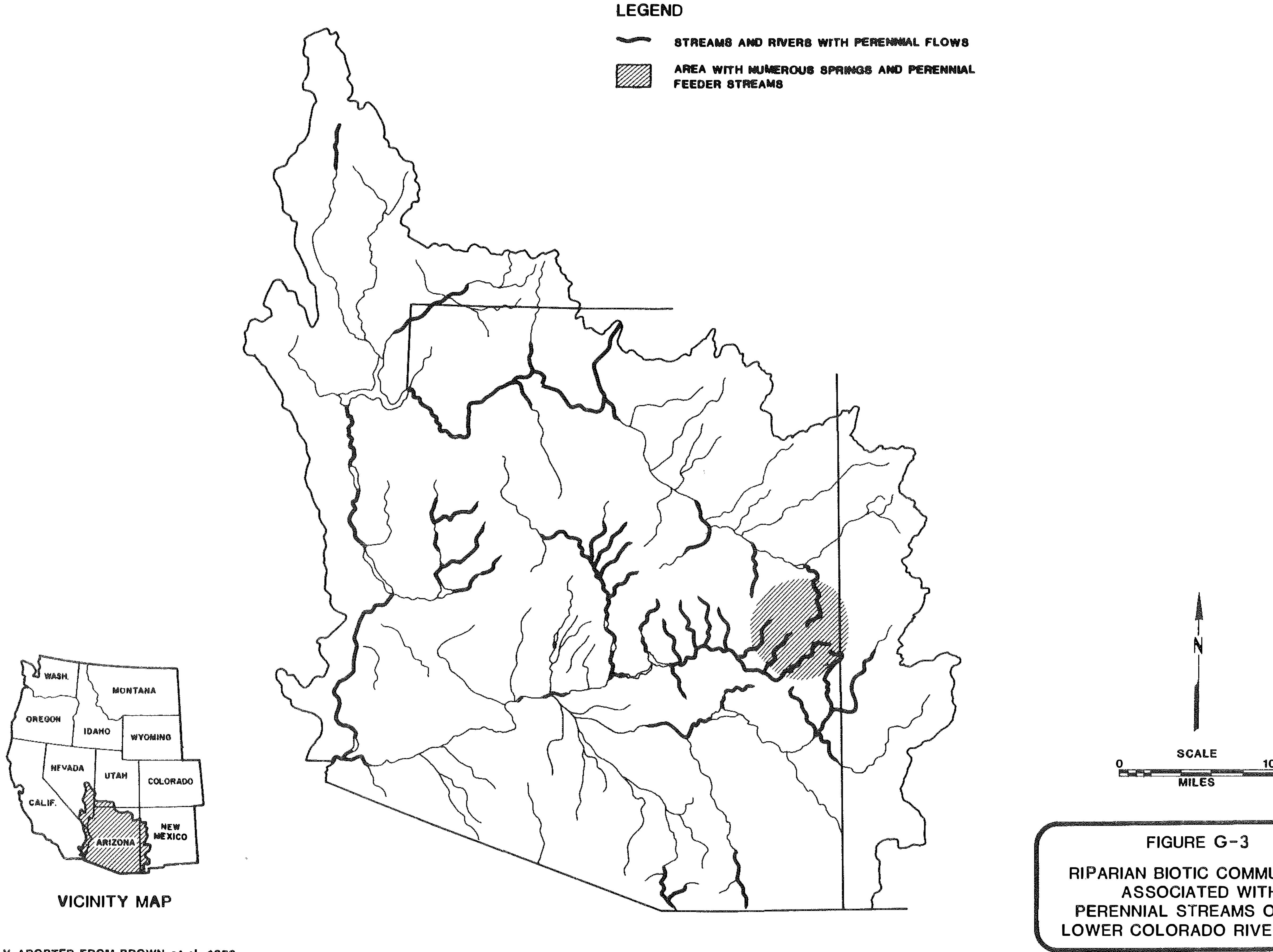


FIGURE G-3

RIPARIAN BIOTIC COMMUNITIES ASSOCIATED WITH PERENNIAL STREAMS OF THE LOWER COLORADO RIVER BASIN

Table G-2

BIOTIC COMMUNITIES OF THE LOWER COLORADO RIVER BASIN[a]

	Existing[b] Condition	Future Without	Future-without change (%)	Future-With	Impact	Impact Change (%)
Sonoran Desertscrub	35,671	35,540	-0.4	35,491	-49	-0.1
Chihuahuan Desertscrub	2,009	2,009	0	2,008	-1	T
Mohave Desertscrub	12,534	12,534	0	12,532	-2	T
Great Basin Desertscrub	13,355	13,355	0	13,255	0	0
Woodlands, Scrub, and Grassland Formations	62,923	62,923	0	62,922	-1	T
Forest and Tundra Formation	10,191	10,191	0	10,191	0	0
Agricultural Lands	2,838	2,581	-9.1	2,580	-1	T
Urban and Developed Lands	801	1,193	+48.9	1,241	+48	+4.0
Riparian Communities	166	162	-2.4	154	-8	-4.9
Perennial stream and Riverine Communities	(1,700 miles in major drainage)	(1,700)	0	(1,679)	(-21)	-1.2
Lakes and Reservoirs (Lacustrine Communities)	531	531	0	545	+14	+2.6
Miscellaneous (Non-vegetated Landscape)	119	119	0	119	0	0
TOTAL	141,138	141,138		141,138		

[a] Communities given in square miles, except perennial stream (miles).

[b] Lower Colorado Region Framework Study, State-Federal Interagency Group, 1972. Lower Colorado Region Framework Study: Fish and Wildlife, Appendix XIII.

and aquatic habitats in the drainage. These species will not, for the most part, be affected by these projects except in localized areas. The other projects will have little effect on these endangered species except for the loss of some Yuma clapper rail habitat in the extreme southern reach of the Colorado River at the International Boundary.

3. Water Development and Availability

a. Water Sources and Allocations

Water in the LCRB comes mainly from three sources: direct precipitation, the Colorado River, and the ground water system. Some of this water is used more than once through irrigation tailwater collection systems and wastewater treatment plants.

Precipitation over the LCRB varies with time of year, elevation, and location. Much of the precipitation falls on areas away from potential users. The portion of this water which does not evaporate either infiltrates into the soil or becomes overland flow towards the Colorado River. Significant efforts have been made in parts of the LCRB to control these flows and store the water for beneficial use at the locations and times when users need the water, through construction of reservoir impoundments and other measures.

The Colorado River enters the LCRB from the Upper Colorado River Basin at Lees Ferry in north central Arizona. This dividing point was established as part of the Colorado River Compact of 1921. The Compact further apportions to both the upper and lower basins 7,500,000 af of water per year from the Colorado River system. Article III(b) apportions an additional 1,000,000 af annually for beneficial use to the Lower Basin. In the summer of 1952, the State of Arizona initiated an interstate suit in the Supreme Court of the United States against California and others to confirm its title to Colorado River water. On June 3, 1963 the Supreme Court rendered an opinion on Arizona's entitlement to Colorado River water. Subsequently, on March 9, 1964, the Supreme Court decree in Arizona vs. California confirmed Arizona's entitlement to 2,800,000 af annually of the first 7,500,000 acre-feet of Colorado River main stem flow available to the Lower Basin states, plus 46 percent of flows in excess of 7,500,000 af (Central Arizona Project Final EIS, USBR, 1972).

Allocations of Colorado River water are shown below:

Allottee	Allocation (af/yr)
California	4,400,000
Arizona	2,800,000
Nevada	300,000
New Mexico	18,000
Total Individual Allocations	7,518,000
LCRB Entitlement	7,500,000

In addition there is 1,500,000 af of Colorado River supply required for Mexico. As can be seen from this information, more water is allocated than is normally available. An order of precedence has been established to guarantee minimum deliveries to senior water users. Users with lower precedence may not receive their total allocations in years when the runoff is less than the total shown above and main stem storage reservoirs are low.

Ground water is used extensively in the LCRB. This is especially true in arid regions where ground water levels have been falling significantly in recent years as pumping exceeds recharge.

b. Water Control Facilities

Existing facilities for water control in the LCRB consist of water conservation and distribution facilities. Along the main stem of the Lower Colorado River, there are three water reclamation dams and three diversion dams. The Gila River basin includes numerous facilities to store and divert water as well as several flood control features. Major water control features in the LCRB are listed below:

Location	Name	Purpose
Colorado River Main Stem		
	Hoover Dam	Water Development
	Davis Dam	Water Development
	Parker Dam	Water Development
	Imperial Dam	Diversion
	Laguna Dam	Diversion
	Morelos Dam	Diversion
Gila River Basin		
Gila River	Coolidge Dam	Water Development
	Ashurst-Hayden Dam	Diversion
	Gillespie Dam	Diversion
	Painted Rock Dam	Flood Control
Salt River	Theodore Roosevelt Dam	Water Development
	Horse Mesa Dam	Water Development
	Mormon Flat Dam	Water Development
	Stewart Mountain Dam	Water Development
	Granite Reef Dam	Diversion
Verde River	Horseshoe Dam	Water Development
	Bartlett Dam	Water Development
Aqua Fria River	Waddell Dam	Water Development

These water development features serve to capture surface water for use in the service areas of the respective water user groups. Much of the potential runoff is controlled and used beneficially for agricultural, municipal, and industrial purposes in the LCRB. Infrequent runoff events exceed the storage capacity of the existing reservoirs and flooding occurs with a loss of potentially useful water.

The facilities now exist to completely divert or store all of the surface water in the LCRB. Consequently, only on rare occasions does the Colorado River flow into the Gulf of California.

c. Cumulative Impacts to Water Availability

Reclamation has various water-related projects proposed or under construction in the LCRB. Table G-3 shows the changes in water supply which will result from operation of the projects.

The table shows a loss of 206,000 af/yr from the Colorado River main stem as a result of reservoir/aqueduct projects. All of this water would not necessarily reach the main stem under existing conditions, as much of the water would enter the ground water system before reaching the Colorado River.

The cumulative impact of the Reclamation projects is that water will be taken from the Colorado River main stem. This water will come from allocations already made to the new users (those who will divert the water). It is not anticipated that normal flows in the Colorado River would be affected by the projects. Most of the water developed by the proposed projects is flood water which will be prevented from entering the main stem of the Colorado River. Floodwaters are known to recharge ground water systems along the rivers, and the full extent of reduced flood flows has not yet been determined. The impacts caused by the projects listed above of reduced flood flows along the main stem are considered insignificant.

4. Water Quality

a. Existing Conditions

Water quality, primarily salinity varies greatly over the LCRB. Most surface water is of good quality and with standard water treatment methods meets drinking water requirements. In general, ground water is of poorer quality than the surface water but can also be treated to meet drinking water standards. There are, however, locations where the surface water and/or ground water qualities are significantly lower than the rest of the basin.

The Colorado River Basin is a large basin with substantial agricultural and increasing urban development. The quality of return flows to the Colorado River has been declining and the diversions from the main stem have depleted the flow substantially. As a result, the quality of the water in the Colorado River as well as some other tributaries has been declining. Salts from natural sources such as saline springs, as well as manmade sources, i.e., return flows of irrigated farmlands are the primary contributors to this decline.

Table G-3

LCRB WATER AVAILABILITY IMPACTS

PROJECT TYPE/TITLE	Annual Volume of Main Stem Colorado River Water Affected (af)	Comments
o RESERVOIR/AQUEDUCT PROJECT		
Central Arizona Project (FEIS 1972)[a]	(1,034,000)	Arizona allocation of Colorado River water now delivered to California (no gain or loss)
Regulatory Storage Division (DEIS 1983)	-138,000	Increased yield through operation includes local flood water and excess flow on Colorado main stem
Pumps and Transmission Lines	NA	
Buttes Dam	-50,000	Flood water captured for irrigation use
Hooker Dam	-18,000	New Mexico LCRB allocation of Colorado River water through exchange
Granite Reef Aqueduct	NA	
Salt-Gila Aqueduct	NA	
Tucson Aqueduct	NA	
Hoover Dam Modifications (DEIS 1980)	NA	
RESERVOIR/AQUEDUCT SUBTOTAL	-206,000	
o WATER QUALITY IMPROVEMENT PROJECTS		
Colorado River Basin Salinity Project (Title I)		
Mojave - Coachella (DEIS 1974)	+132,000	Canal lining and other improvements reduce irrigation losses
Yuma Project (DEIS 1976)	+16,200	Canal lining and other improvements reduce irrigation losses
Colorado River Water Quality Improvement Project (Title II)	IU[b]	
Colorado River Indian Reservation Unit (FEIS 1976)		
Las Vega Wash (FEIS 1976)	-3,600	Water lost from Las Vegas Wash during salt reduction operation
La Verkin Springs Unit Utah (Concluding Report 1981)	-2,470	Water lost from La Verkin Springs Unit during salt reduction operation
Palo Verde Irrigation District Unit (FEIS 1976)	IU	
WATER QUALITY IMPROVEMENT SUBTOTAL	+143,130	
TOTAL	- 63,870	

[a]Date in parentheses indicates publication date of environmental impact statement.

[b]Information unavailable.

Although a number of water quality-related legislative actions have been taken on the State and Federal levels, four Federal acts are of special significance to the Colorado River Basin: (1) The Water Quality Act of 1965 and related amendments, (2) the Federal Water Pollution Control Act Amendments of 1972 (Public Law 92-500), (3) the Colorado River Basin Salinity Control Act of 1974, and (4) the Clean Water Act of 1977. Also central to water quality issues are agreements with Mexico on Colorado River system waters entering that country.

The first of these, the Water Quality Act of 1965 (Public Law 89-234), amended the Federal Water Pollution Control Act and established a Federal Water Pollution Control Administration (now EPA). Among other provisions, it required states to adopt water quality criteria for interstate waters inside their boundaries. The seven basin states initially developed water quality standards which did not include numeric salinity criteria for the Colorado River primarily because of technical constraints. In 1972, the states agreed to a policy which called for the maintenance of salinity concentrations in the Lower Colorado River system at or below existing levels while the Upper Basin states continued to develop their compact apportioned waters. The states suggested that the Bureau of Reclamation should have primary responsibility for investigating, planning, and implementing the proposed Colorado River Basin Salinity Control Program with the assistance of the Federal Office of Saline Water and EPA.

Enactment of the Federal Water Pollution Control Act Amendments of 1972 affected salinity control in that the legislation was interpreted by EPA to require numerical standards for salinity in the Colorado River. In response, the basin states founded the Colorado River Basin Salinity Control Forum to develop numeric salinity criteria and a basinwide plan of implementation for salinity control. The Basin States held public meetings on the proposed standards as required by the enacting legislation. The forum recommended that the individual Basin States adopt the Proposed Water Quality Standards for Salinity Including Numeric Criteria and Plan of Implementation for Salinity Control, Colorado River System. The proposed water quality standard called for maintenance of flow-weighted average TDS concentrations of 723 mg/L below Hoover Dam, 747 mg/L below Parker Dam, and 879 mg/L below Imperial. Included in the plan of implementation were four salinity control units and possibly additional units, the application of effluent limitations, and use of saline water whenever practicable and for future studies. The standards are to be reviewed at 3-year intervals. All of the Basin States adopted the 1975 Forum-recommended standards.

The Colorado River Basin Salinity Control Act of 1974 (Public Law 93-320) provided the means to comply with United States obligations to Mexico which included as a major feature a desalting plant and brine discharge canal. These facilities will enable the United States to deliver to Mexico water having an average salinity no greater than 115 ppm±30 ppm (Mexican count) over the annual average salinity of Colorado River waters at Imperial Dam. Units authorized for construction under Title II of that Act, are Paradox Valley Unit and Grand Valley Unit, Colorado; Crystal Geyser Unit, Utah; and Las Vegas Wash Unit, Nevada.

Planning Units are:

Irrigation sources -
Colorado River Indian Reservation Unit, Arizona
Lower Gunnison Basin Unit, Colorado
Unita Basin Unit, Utah
McElmo Creek Unit, Colorado 1/
Palo Verde Irrigation District Unit, California

Point sources -
LaVerkin Springs Unit, Utah
Lower Virgin River Unit, Nevada-Arizona
Glenwood-Dotsero Springs Unit, Colorado
Meeker Dome Unit, Colorado

Diffuse sources -
Big Sandy River Unit, Wyoming
Price-San Rafael Rivers Unit, Utah
Dirty Devil River Unit, Utah

Of the 12 units listed above, 10 (excluding Colorado River Indian Reservation Unit and Palo Verde Irrigation District) were approved for feasibility study by Public Law 96-375 in October 1980. Other studies include Blue Springs Unit, Saline Water Use and Disposal Opportunities Unit, and the Aquatrain Project.

In 1978, the Forum reviewed the salinity standards which were adopted by all of the seven basin states, and recommended the construction of 3 of the 4 salinity control units and 10 of the 12 projects identified in the 1974 Act, the placing of effluent limitations on industrial and municipal discharges, and the reduction of the salt loading effects of irrigation return flows, the plan also called for the inclusion of Water Quality Management Plans to comply with Section 208 provisions after the plans' adoption by the states and approval of EPA. It also contemplated the use of saline water for industrial purposes and future salinity use/control methods.

b. Cumulative Impacts to Water Quality

Because of the manner in which the impacts of individual projects are analyzed, it is not practical to sum up the total impact of all LCRB projects. Table G-4 shows the effect of selected Water Quality Improvement Projects being constructed or proposed in the basin. Generally, however, the proposed water quality improvement projects will reduce the Colorado River main stem TDS. This will help to meet the requirements of Minute No. 242 as well as to help stabilize the salinity of the lower Colorado River below the project locations. This water quality improvement is considered to be significantly beneficial in that the many users along the lower Colorado River will have water of better and more dependable quality.

Table G-4

ANNUAL IMPACTS TO WATER QUALITY

PROJECT TYPE/Title	Annual Impacts to Water Quality
o RESERVOIR/AQUEDUCT PROJECTS	
Central Arizona Project (FEIS 1972)[a]	Same Main Stem withdrawal from different location but reduction in basin depletion.
Regulatory Storage Division (DEIS 1983)	Additional withdrawal of 138,000 af main stem and local surface water
Pumps and Transmission Lines	NA
Buttes Dam	-50,000 af withdrawn from Gila River at dam site
Hooker Dam	-18,000 af withdrawn from Gila River at dam site
Granite Reef Aqueduct	NA
Salt-Gila Aqueduct	NA
Tucson Aqueduct	NA
Hoover Dam Modifications (DEIS 1980)	NA
o WATER QUALITY IMPROVEMENT PROJECTS	
Colorado River Basin Salinity Project (Title I)	lowers TDS at Morelos Dam from 1,355 to 910 mg/l
Mojave - Coachella (DEIS 1974)	
Yuma Project (DEIS 1976)	
Colorado River Water Quality Improvement Project (Title II)	
Colorado River Indian Reservation Unit (FEIS 1976)	IU[b]
Las Vega Wash (FEIS 1976)	Reduce TDS at Imperial Dam by 8 mg/l
La Verkin Springs Unit Utah (Feasibility Report 1973)	Removal of 103,000 tons of salts from Virgin River salt load
Palo Verde Irrigation District Unit (FEIS 1976)	IU

[a]Date in parentheses indicates publication date of environmental impact statement.

[b]Information unavailable

APPENDIX H

RESPONSES TO COMMENTS

APPENDIX H

RESPONSES TO COMMENTS

The draft Environmental Impact Statement (EIS), Tucson Aqueduct-Phase B, Central Arizona Project, was filed with the Environmental Protection Agency and released to the public on December 18, 1984. Approximately 550 copies of the draft statement were distributed for review.

Public hearings on the draft statement were held in Marana, Arizona on January 28, 1985, and in Tucson, Arizona on January 29, 1985. Approximately 188 people attended the three hearings. The official transcript of the proceedings is available for inspection in the Lower Colorado Regional Office of the Bureau of Reclamation at the address given on the abstract page of the EIS, or at the Environmental Division, Bureau of Reclamation, Arizona Projects Office, 21640 North 19th Avenue, Suite C-2, Phoenix, Arizona. The comments expressed at the public hearings are summarized below.

The public comment period on the draft statement ended on February 16, 1985. Forty-two written comments were received during the comment period. Each letter has been reproduced with each substantive comment identified and numbered in the Comment Responses. Appendix H is divided into two sections:

- Public Hearing Summary
- Letters of Comment

PUBLIC HEARING SUMMARY

Three formal public hearings were held to receive comments on the draft EIS. Notice of Availability of the draft EIS and announcement of public hearings appeared in the December 24, 1984, Federal Register. A printing error in the public hearing date for Tucson was corrected in the January 14, 1985, Federal Register. In addition, local newspapers carried press releases on the time and location of the hearings.

The hearings were conducted by William Swan, Attorney with the Department of the Interior, Office of the Field Solicitor, Phoenix, Arizona. Officially representing the Bureau of Reclamation from the Arizona Projects Office to receive testimony were Edward M. Hallenbeck, Project Manager; Stephen V. Magnussen, Chief, Advance Planning Division; and Bruce Ellis, Chief, Environmental Division. William Plummer, Regional Director, was also present at the hearing held in Marana.

The first meeting was held January 28, 1985, at 7:00 p.m. in the High School auditorium, Marana, Arizona. Eighty-three (83) people signed the attendance register with 31 people presenting oral testimony. The following is a list of those testifying in the order in which they appeared:

Name	Affiliation
William Wheeler	Central Arizona Project Association

Dale Pontius	Southern Arizona Water Resources Association (SAWARA)
John S. Hayes	Community Water Company of Green Valley
Michael McNulty	Self
Robert Condit	Cortaro-Marana Irrigation District
Cliff Gatlin	Central Arizona Water Conservation District (CAWCD)
Dean Terry	Self
Steve Prchal	Self
Ray Coleman	Town Engineer, Marana
Gary Harwell	Self
Frank Abbott	Self
Julie Savory	Self
Mark Savory	Self
George James	Self
Art Pacheco	Apex Farm
George Montgomery	Self
Kurt Schlaefer	Self
Esther Bell	Self
George Rosenberg	Self; and Ground Water Users Advisory Council of the Tucson Active Management Area
Donald Way	Self
Craig Allison	Greiner Engineering representing MSP Companies
Valerie Orstedt	Friends of the Desert
Tom Glover	Avra Valley Irrigation district
Dan O'Neill	Congressman Udall's Office
Curly Clark	Self
Mark Voelkel	Self
Bill Steadman	Self
Arthur Campbell	Self
Steve Hoop	Self
David Morris	Self
Teresa Linn	Self

The second public hearing was held January 29, 1985, at 1:00 p.m. at the Tucson Community Center, Tucson, Arizona. Fifty five (55) people signed the attendance register with 11 people presenting oral testimony. The following is a list of those testifying in the order in which they appeared:

Name	Affiliation
William Wheeler	Central Arizona Project Association
Marybeth Carlile	Southern Arizona Water Resources Association
Tom McLean	Tucson Water
Scott Burrill	ASARCO, Inc.
Cliff Gatlin	Central Arizona Water Conservation District
Michael Enis	Defenders of Indian Land Rights, Inc.
David Yetman	Board of Supervisors, Pima County
Joe Millstone	Self
Mel Norvelle	Self
Brent Cluff	Self and CAP Recharge Association
Don Fornear	Self

The third public hearing was held on January 29, 1985, at 7:00 p.m. at the Tucson Community Center. Fifty (50) people signed the attendance register with 16 people presenting oral testimony. The following is a list of those testifying in the order in which they appeared:

Name	Affiliation
William Wheeler	Central Arizona Project Association
Doug Shakel	Self
Brad Vandermark	Self
Cliff Gatlin	Central Arizona Water Conservation District
Gayle Hartmann	Sierra Club
Monte Seymour	Self
George Rosenberg	Tucson Active Management Area; and Southern Arizona Water Resources Association
Julia Perry Gordon	Arizona-Sonora Desert Museum
Vicki Phelps	Self
Robert Armentrout	Self
Mark Dansk	Self
Anselmo Valencia	Pascua Yaqui Tribe
Tom Vincent	Self
Joseph Mattiaccio	Self
Dan O'Neill	Congressman Udall's Office
Geneva Zerby	Self

Many commentors had similar concerns. Major comments received at the public hearings are presented in the following discussion with responses to each immediately following the specific comment.

Comment #1:

We support the West Side Plan as the preferred route of the CAP, Tucson Aqueduct, Phase B.

Commentors:

- Southern Arizona Water Resources Association
- John S. Hayes, Community Water Company of Green Valley
- Robert Condit, Cortaro-Marana Irrigation District
- Cliff Gatlin, Central Arizona Water Conservation District
- Ray Coleman, Town Engineer of Marana
- Esther Bell
- George Rosenberg, Southern Arizona Water Resources Association and Tucson Active Management Area
- Tom Glover, Avra Valley Irrigation District
- David Morris
- Tom McLean, Tucson Water

Response:

Support for the West Side Plan, the agency proposed action, has been noted and the comment is available to decision makers.

Comment #2:

The Sanders Road-San Joaquin Plan should be included in the Final EIS. These plans use more underground pipe and would have less impact on the environment compared to the West Side Plan. The Bureau has failed to include the most cost-effective least environmentally damaging plan.

Commentors:

Frank Abbott
Julie Savory
Mark Savory
George James
George Montgomery
Kurt Schlaefer
Donald Way
Valerie Orstedt, Friends of the Desert
Bill Steadman
Teresa Linn

Response:

The Sanders-San Joaquin Modification Alternative has been added to the final EIS in response to these comments. This alternative incorporates 28.0 miles of buried pipeline to mitigate the visual and other environmental impacts associated with open canal. We do not believe that the difference in environmental impact justifies the additional cost (about $24 million in capital costs) of this alternative. Therefore, the West Side Plan remains our proposed action.

Comment #3:

Underground pipeline is preferred wherever and as much as possible.

Commentors:

Dean Terry
Frank Abbot
Art Pacheco
George Montgomery
David Morris
David Yetman
Joe Millstone
Gayle Hartmann, Sierra Club
Julia Perry Gordon, Arizona-Sonora Desert Museum
Vicki Phelps
Anselmo Valencia, Pascua Yaqui Tribe
Tom Vincent

Response:

Because the cost of buried pipeline is about four times that of open canal, we have sought to maximize the use of open canal on the Tucson Aqueduct, as elsewhere on the CAP aqueduct system. Operational costs are also reduced, since buried (pressure) pipeline requires significantly more electrical energy for pumping. Many alternative aqueduct systems have been evaluated during planning for the Tucson Aqueduct, including several which incorporated buried pipeline as an environmental mitigation measure. Our conclusion is that wildlife, visual, and other environmental impacts can be adequately mitigated for the West Side Plan, at much less cost than for additional buried pipeline. The West Side Plan includes about 19 miles of buried pipeline in its overall 47 mile length.

Comment #4:

In the past, flooding has occurred in the vicinity of I-10 and Tangerine Road. Drainage and ponding in the areas near the aqueduct are a major concern. Measures should be provided to assure the aqueduct will not cause significant flooding problems. Standing water due to sheet flow was also not addressed in the EIS.

Commentors:

Robert Condit, Cortaro-Marana Irrigation District
Dean Terry
Ray Coleman, Town Engineer of Marana
Mark Savory
Art Pacheco
Craig Allison, Greiner Engineering representing MSP Companies
Curly Clark
Arthur Campbell

Response:

The proposed alinement through the Avra Valley will follow the western slope of the Tucson Mountains and along the east side of the Brawley Wash flood plain. The alinement approaches the Brawley flood plain in three areas. These areas are just upstream of the Sandario, Brawley and San Xavier Pumping Plants. This is based on the flood maps provided by the Pima County Flood Control District. The dikes are sized to detain the flows for release into the existing channels at the rate that could be expected from a three hour thunderstorm on the drainage basin. All land that will be flooded in the dentention area will be purchased. The outlets from the overchutes will have energy dissipators constructed to bring the water to a velocity that is not conducive to erosion. The area on the downstream side between the overchutes would be protected from the flooding they now experience.

Meetings have been held with Pima County Flood Control District and the Town of Marana to address the issue of flooding in the Tangerine Road area. As a result of the meetings the decision has been made to construct a single siphon from the northeast side of I-10, daylighting upon crossing the southwest side of the Santa Cruz River, a distance of about 8,700 feet.

Comment #5:

Several concerns were raised regarding the esthetics of the open canal, pumping plants, and surge tanks compared to the natural desert environment.

Someone stated that the projected development would not cover up the scars. It was stated that revegetation should be a high priority for all areas, including the spoil areas.

Commentors:

Steve Prchal
Frank Abbott
Mark Savory
Kurt Schlaefer
Gayle Hartmann, Sierra Club
Julia Perry Gordon, Arizona-Sonora Desert Museum
Mark Dansk
Anselmo Valencia, Pascua Yaqui Tribe
Joseph Mattiaccio
Geneva Zerby

Response:

Visually sensitive areas within the Phase B project area were compared to similar areas near Phoenix where the CAP aqueduct has already been completed. It was determined that the open canal of the West Side Plan would not be a dominant feature of the view due to the topography of the area and vegetative screening. In addition, earthen dikes on the upslope side of the canal would, for the most part, screen the canal from view. The dikes would also be revegetated. The decision has been made to use the air chamber surge tank in place of the two-way surge tank at the Brawley, Snyder Hill, Black Mountain, and San Xavier pumping plants in order to reduce the impact on the environment as viewed from the Arizona Sonoran Desert Museum and Saguaro National Monument. The air chamber surge tank would be located next to the pumping plant, below the ground.

INDEX OF LETTERS COMMENTING ON ENVIRONMENTAL IMPACT STATEMENT

TUCSON AQUEDUCT, PHASE B

COMMENT AND RESPONSE NO.	ENTITY OR INDIVIDUAL SUBMITTING COMMENT
1	ASARCO, Inc., Southwestern Mining Department, Tucson, Arizona, S. L. Burrill, Director of Technology and Environment
2	Arizona State Parks, Phoenix, Arizona, Donna J. Schober, State Historic Preservation Officer
3	Southern Arizona Water Resources Association, Tucson, Arizona, Dale Pontius, President
4	El Paso Natural Gas Company, El Paso, Texas, Ralph H. Oppenheim, Manager, Titles-Control Division, Right-of-Way Department
5	Mr. and Mrs. C. Nolen Bell, Tucson, Arizona
6	Pima County, Office of the County Manager, Tucson, Arizona, Craig A. McDowell, County Manager
7	Pima County Health Department, Air Quality Control District, Tucson, Arizona, Donald L. Burtchin, Senior Air Quality Analyst
8	Finley Distributing Co., Tucson, Arizona, Dorothy H. Finley
9	Julie Savory, Tucson, Arizona
10	Mr. and Mrs. H. W. Peden, Tucson, Arizona
11	Irrigation and Electrical Districts Association of Arizona, Phoenix, Arizona, Robert S. Lynch, Secretary-Treasurer
12	University of Arizona, College of Engineering, Water Resources Research Center, Tucson, Arizona, C. Brent Cluff, Associate Hydrologist
13	Residents of Avra Valley (19 signatures)
14	Sierra Club, Grand Canyon Chapter, Arizona, Gayle Hartmann, Rincon Group, Tucson, Arizona
15	U.S. Department of the Interior, National Park Service, Western Region, San Francisco, California, W. Howell White, Acting Regional Director

16 Earl L. and S. Lorraine Percival, Tucson, Arizona

17 Janie C. Schembri, Tucson, Arizona

18 U.S. Department of the Interior, Bureau of Land Management, Arizona State Office, Phoenix, Arizona, Beaumont C. McClure, Acting State Director

19 Judith Capen, Tucson, Arizona

20 National Parks and Conservation Association, Russell D. Butcher, Southwest and California Representative, Cottonwood, Arizona

21 Strickland and Altaffer, Tucson, Arizona, William E. Strickland, General Counsel for Papago Tribe of Arizona

22 Rosemary Maddock, Tucson, Arizona

23 Tucson Rod and Gun Club, Tucson, Arizona, Dick Scott, Chairman, Legislative Committee

24 Pima County, Parks and Recreation Department, Tucson, Arizona, Terry J. Lehrling, Chairman, Pima County Parks and Recreation Commission

25 U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Office of the Administrator, Washington, D.C., Joyce M. Wood, Chief, Ecology and Conservation Division

26 The League of Women Voters of Tucson, Tucson, Arizona, Marie Lynn Hunken, Natural Resources Coordinator

27 Tucson Unified School District, Tucson, Arizona, Valerie B. Feuer, School District Planner

28 Pima County Wastewater Management Department, Tucson, Arizona, Jon C. Schladweiler, P.E., Chief Engineer

29 U.S. Department of the Interior, U.S. Fish and Wildlife Service, Ecological Services, Phoenix, Arizona, Robert Mesta, Acting Field Supervisor

30 Friends of the Desert, Tucson, Arizona, John R. Moffitt, President

31 Dr. Richard Miller, Certified Wildlife Biologist, Glendale, Arizona

32 U.S. Department of Energy, Western Area Power Administration, Boulder City Area Office, Boulder City, Nevada, Thomas A. Hine, Area Manager

33 U.S. Environmental Protection Office, Region IX, San Francisco, California, Charles W. Murray, Jr., Assistant Regional Administrator for Policy and Management

34 Juliet Staveley, Tucson, Arizona

35 The Arizona-Sonora Desert Museum, Tucson, Arizona, Dan Davis, Director, Bernard L. Fontana, President, Board of Trustees

36 Pima County Planning and Zoning Department, Tucson, Arizona, Robert C. Johnson, Director

37 Arizona Chapter, The Wildlife Society, Phoenix, Arizona, K. Bruce Jones, President

38 Department of Water Resources, State of Arizona, Phoenix, Arizona, Wesley E. Steiner, Director

39 Department of the Army, Corps of Engineers, Los Angeles District, Los Angeles, California, Carl F. Enson, Chief, Planning Division

40 Arizona Game and Fish Department, Phoenix, Arizona, Bud Bristow, Director

41 U.S. Department of the Interior, Bureau of Mines, Washington, D.C., Gordon M. Miner, Acting Director

42 Arizona State Clearinghouse, Office of Economic Planning and Development, Phoenix, Arizona

1

ASARCO

Southwestern Mining Department
T. E. Scartaccini
General Manager

OFFICIAL FILE COPY
U.S. Bureau of Reclamation
Lower Colorado Region
RECEIVED
B DEC 24 1984
Action
Action Taken — Initial

Date	Initial	To
12/27		150
File		

copy APO

December 2 , 1984

Regional Environmental Officer
Lower Colorado Region
U. S. Bureau of Reclamation
Box 427
Boulder City, NV 89005

Dear Sir:

We have received the draft Environmental Impact Statement for the Tucson Aqueduct Phase B, Central Arizona Project. Throughout the development of the Phase B Plan, we have had an opportunity to provide input to the routing, namely for the southern terminus of Phase B. Prior to this current EIS, the terminus has been shown on all sketches as being north of Pima Mine Road and west of I-19 on the San Xavier Indian Reservation. The current EIS sketch shows the southern terminus south of the Pima Mine Road and west of I-19. This sketch (example 344-330-4106) indicates that the terminus reservoir would be located on Asarco deeded land. This coincides with two fresh water wells supplying water to our operation to the west at the Mission Unit. This is being pointed out to you in that no negotiations or discussions have been held with Asarco to date concerning this indicated change of site of the reservoir. Copies of the Bureau of Reclamation sketches are attached to indicate the problem area. 1

Very truly yours,

S.L. Burrill

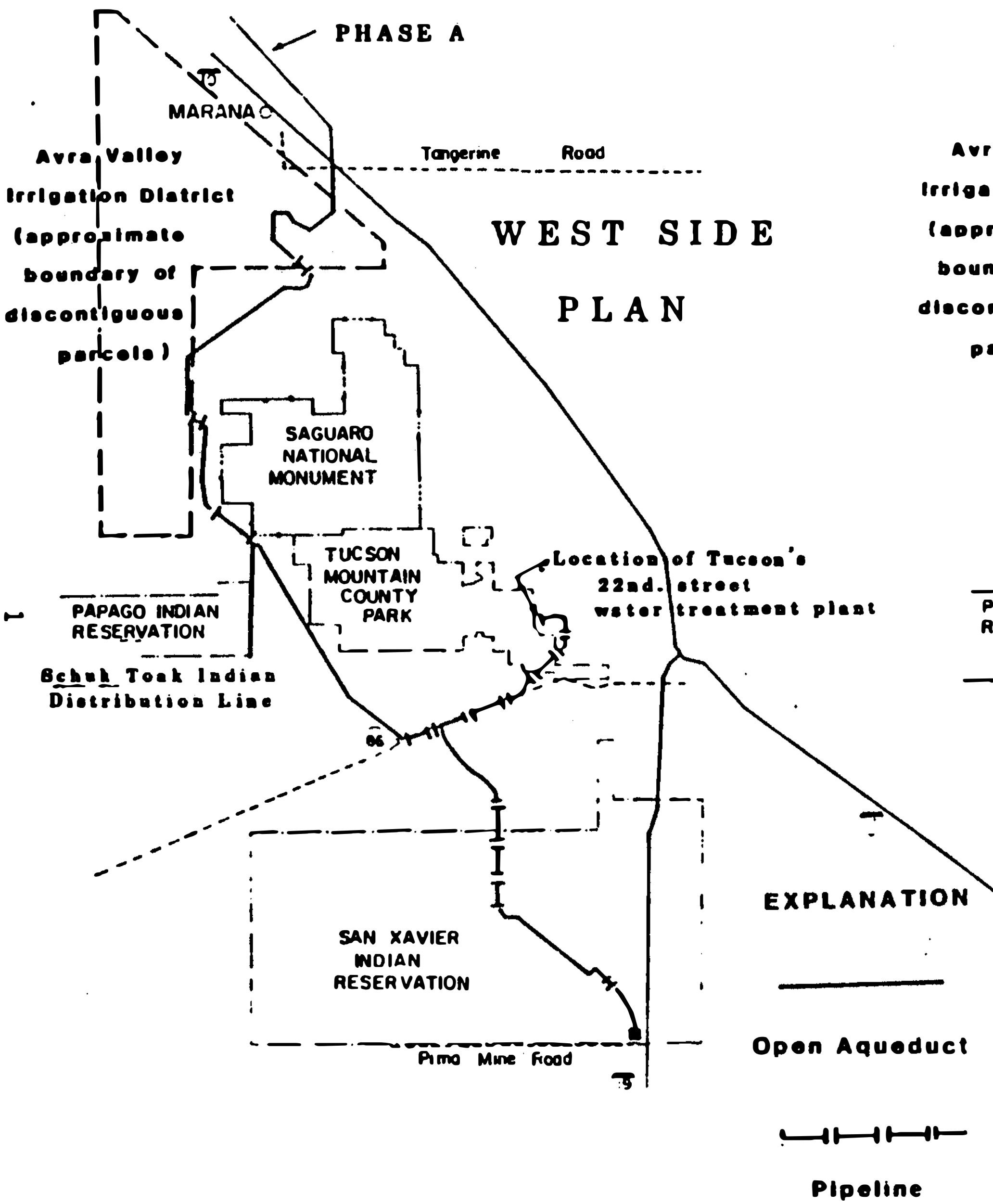
S. L. Burrill
Director of Technology and
Environment

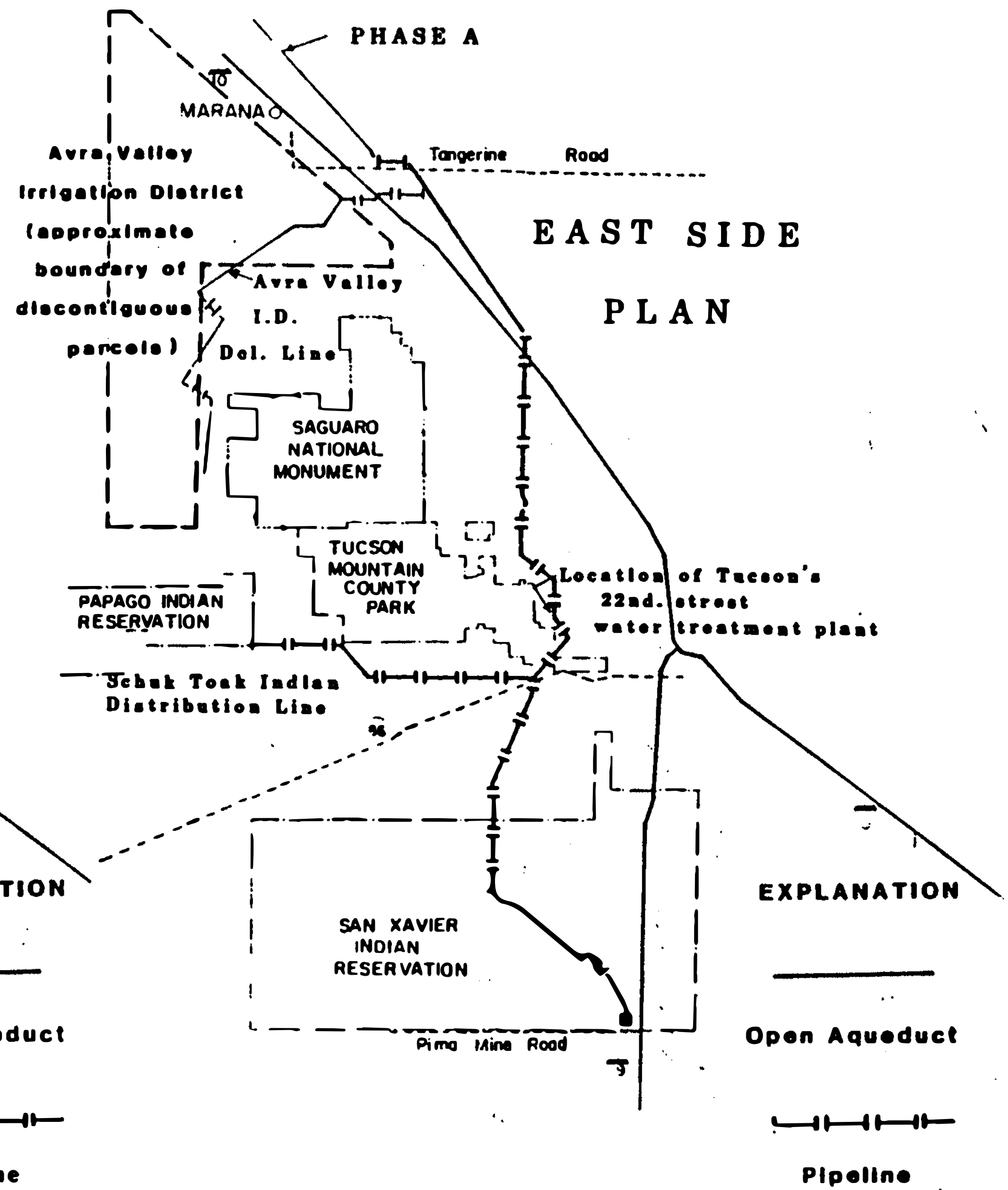
SLB/kh

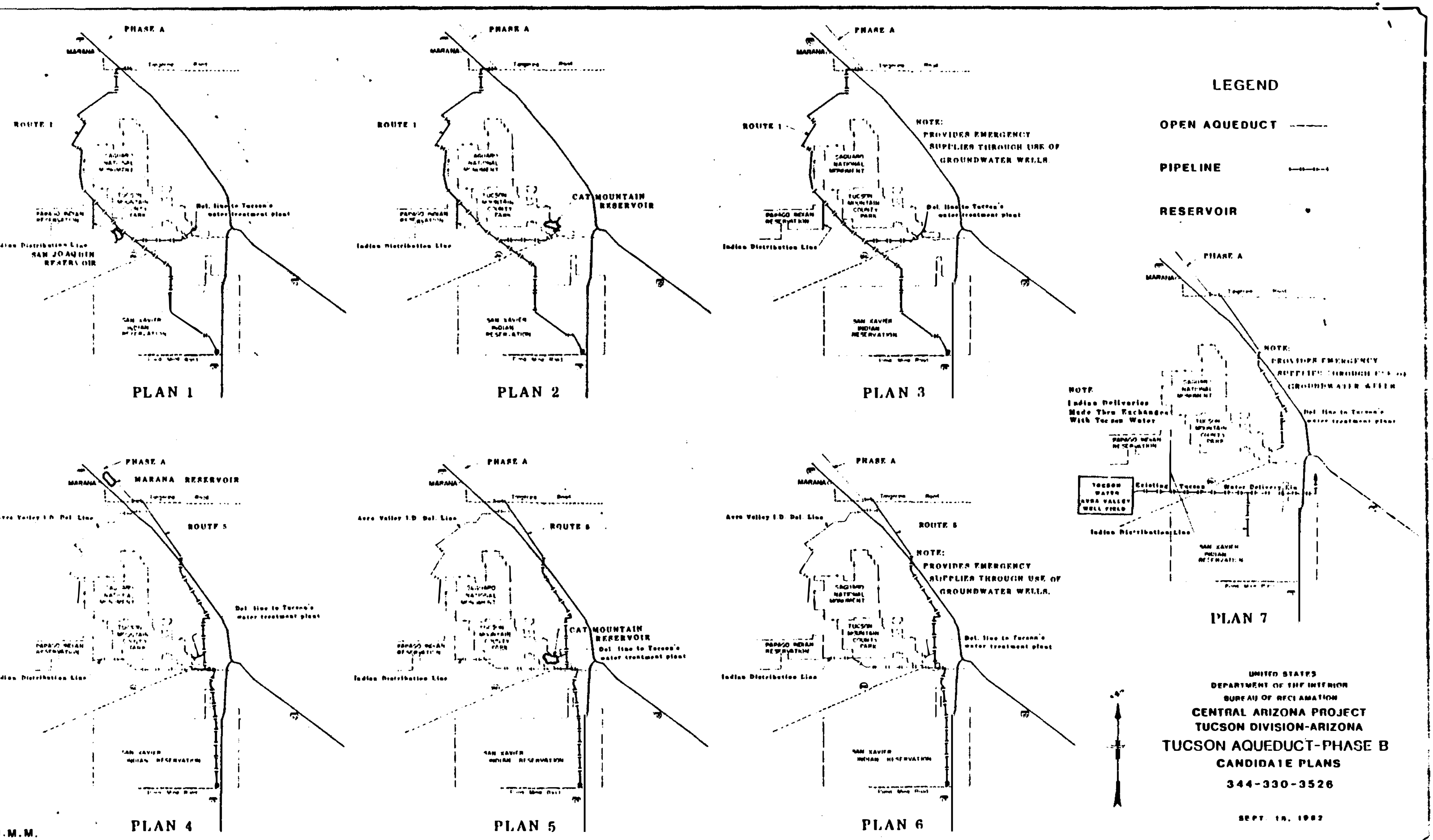
Attach.

cc: Bruce Ellis
Bureau of Reclamation
Arizona Projects Div.
Phoenix, AZ.

ASARCO Incorporated P. O. Box 5747 Tucson, Az 85703-0747
1150 North 7th Avenue (602) 792-3010


PHASE A
WEST SIDE
PLAN
MARANA
Tangerine Road
Avra Valley
Irrigation District
(approximate
boundary of
discontiguous
parcels)
SAGUARO
NATIONAL
MONUMENT
TUCSON
MOUNTAIN
COUNTY
PARK
Location of Tucson's
22nd. street
water treatment plant
PAPAGO INDIAN
RESERVATION
Schuk Toak Indian
Distribution Line
SAN XAVIER
INDIAN
RESERVATION
Pima Mine Road
EXPLANATION
Open Aqueduct
Pipeline


PHASE A
EAST SIDE
PLAN
MARANA
Tangerine Road
Avra Valley
Irrigation District
(approximate
boundary of
discontiguous
parcels)
Avra Valley
I.D.
Del. Line
SAGUARO
NATIONAL
MONUMENT
TUCSON
MOUNTAIN
COUNTY
PARK
Location of Tucson's
22nd. street
water treatment plant
PAPAGO INDIAN
RESERVATION
Schuk Toak Indian
Distribution Line
SAN XAVIER
INDIAN
RESERVATION
Pima Mine Road
EXPLANATION
Open Aqueduct
Pipeline


LEGEND
OPEN AQUEDUCT
PIPELINE
RESERVOIR
PHASE A
MARANA
ROUTE 1
SAGUARO NATIONAL MONUMENT
TUCSON MOUNTAIN COUNTY PARK
PAPAGO INDIAN RESERVATION
Indian Distribution Line
SAN JOAQUIN RESERVOIR
Del. line to Tucson's water treatment plant
SAN XAVIER INDIAN RESERVATION
CAT MOUNTAIN RESERVOIR
NOTE: PROVIDES EMERGENCY SUPPLIES THROUGH USE OF GROUNDWATER WELLS.
MARANA RESERVOIR
Avra Valley I.D. Del. Line
ROUTE 5
ROUTE 6
NOTE Indian Deliveries Made Thru Exchanges With Tucson Water
TUCSON WATER AVRA VALLEY WELL FIELD
PLAN 1
PLAN 2
PLAN 3
PLAN 4
PLAN 5
PLAN 6
PLAN 7
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CENTRAL ARIZONA PROJECT
TUCSON DIVISION-ARIZONA
TUCSON AQUEDUCT-PHASE B
CANDIDATE PLANS
344-330-3526
R.M.M.

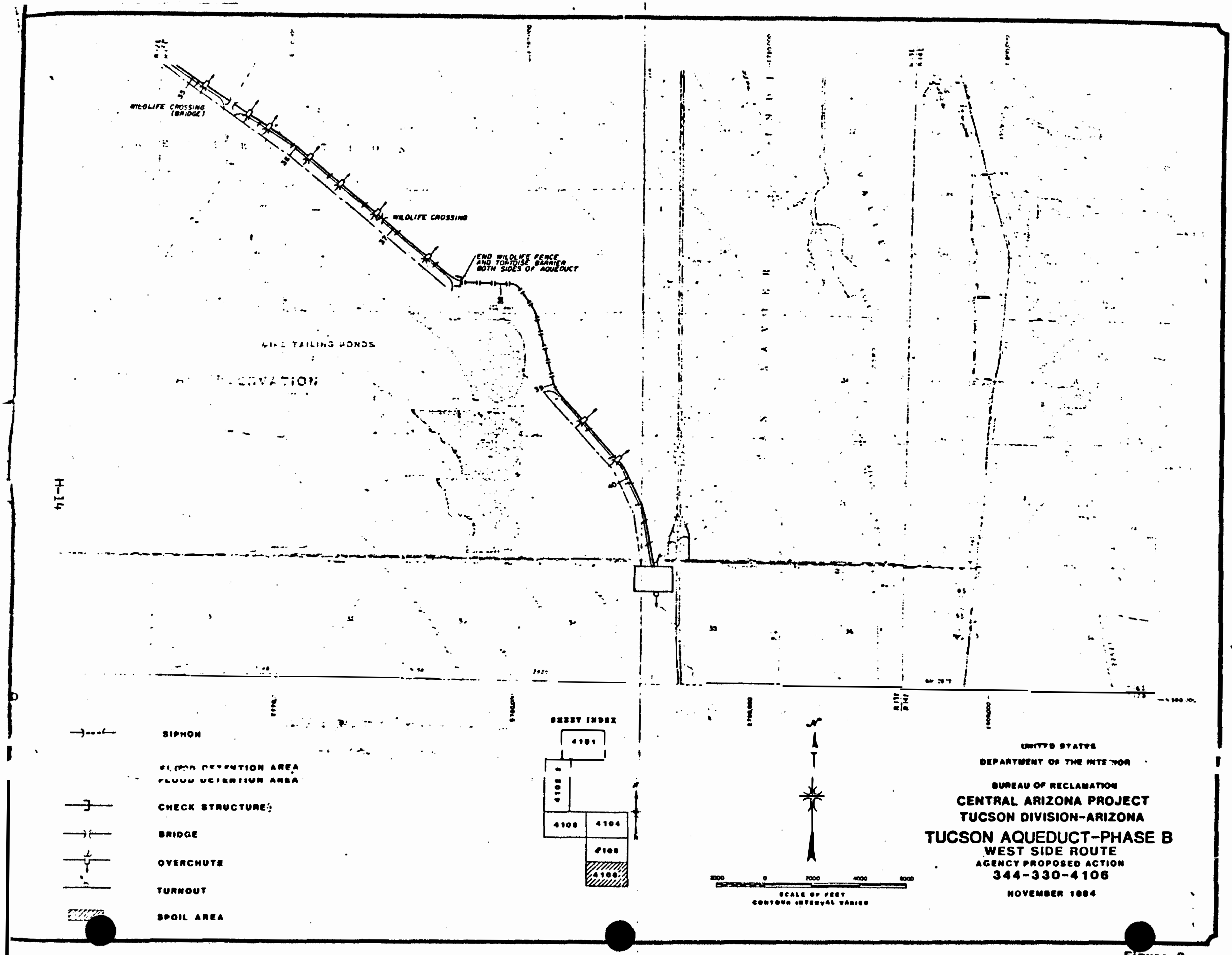

WILDLIFE CROSSING (BRIDGE)
WILDLIFE CROSSING
END WILDLIFE FENCE AND TORTOISE BARRIER BOTH SIDES OF AQUEDUCT
TAILING PONDS
SHEET INDEX
4101
4102
4103
4104
4105
4106
SIPHON
FLOOD DETENTION AREA
CHECK STRUCTURE
BRIDGE
OVERCHUTE
TURNOUT
SPOIL AREA
N
2000
0
2000
4000
6000
SCALE OF FEET
CONTOUR INTERVAL VARIES
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CENTRAL ARIZONA PROJECT
TUCSON DIVISION-ARIZONA
TUCSON AQUEDUCT-PHASE B
WEST SIDE ROUTE
AGENCY PROPOSED ACTION
344-330-4106
NOVEMBER 1984

Figure 8

Responses to Comments

ASARCO, Southwestern Mining Department

1-1 Subsequent to the latest discussions with ASARCO, we have revised the location of the terminus and regulating reservoir. Due to the potential for water pollution problems from the mine tailings or the failure of the dikes at the mines, the decision has been made to put the aqueduct in pipeline from Black Mountain to the terminus. The proposal now is to locate the regulating reservoir just southwest of Black Mountain and the aqueduct terminus at the south boundary of the San Xavier Indian Reservation, with a turnout on the south side of Pima Mine Road. The exact location and design of the pipeline terminus will be coordinated with ASARCO to ensure acceptability of location and design in order to facilitate water deliveries to the south.

ARIZONA
STATE
PARKS

1688 WEST ADAMS STREET
PHOENIX, ARIZONA 85007
TELEPHONE 602-255-4174

2

January 2, 1984

Mr. William E. Rinne
Regional Environmental Officer
Lower Colorado Region
U.S. Bureau of Reclamation
Box 427
Boulder City, NV 89005

Re: Draft EIS
Tucson Aqueduct - Phase B, CAP
Statement No. INT DES 84-68
DOI-BR

Dear Mr. Rinne:

I have reviewed the draft report submitted for the above project. The report appears to consider adequately the cultural resources of the project area at this stage of investigation. Pursuant to 36 CFR, Part 800 of the Advisory Council's regulations ("Protection of Historic and Cultural Properties"), we look forward to continuing the consultation process regarding the cultural resources of this project.

We appreciate your cooperation with this office in complying with the historic preservation requirements for federal undertakings. If you have any questions about any of this, please contact me at (602) 255-4174.

Sincerely,

Teresa L. Hoffman
Archaeologist

for Donna J. Schober
State Historic Preservation Officer

TLH:mes

3

OFFICIAL FILE COPY
U.S. Bureau of Reclamation
Lower Colorado Region
RECEIVED A JAN 14 1985
Action CO/MW
Action Taken _____ Initials

Date	Initial	To
		150
File		

Copy APO

southern
arizona
water
resources
association

SAWARA

January 8, 1985

W.E. Rinne
Regional Environmental Officer
Lower Colorado Region
U.S. Bureau of Reclamation
Box 427
Boulder City, Nevada 89005

Dear Mr. Rinne:

Subject: Draft Environmental Impact Statement
Tucson Aqueduct Phase B
Statement Number: INT DES 84-68

This letter is written to provide comment regarding one particular item of concern we have observed during our review of the Draft EIS. SAWARA may have additional comments as our review continues, however, we felt the need to express this concern immediately.

As indicated in Appendix B, "Consultants and Coordination", SAWARA formed a committee (Committee on Alignment, Terminus and Storage - CATS) to work with the Bureau of Reclamation in developing community consensus regarding the Tucson Aqueduct location, terminus, size and regulatory storage features. This appendix contains two statements which we feel do not accurately portray the recommendation of CATS and gives the reader the wrong impression. 1

> "The most significant recommendation of the SAWARA committee was that storage not be included as a Tucson Aqueduct - Phase B feature, but that it be reconsidered in the future after the Tucson area municipal user's reliance on CAP becomes substantial and after some history of CAP operation is documented."

> "With the deletion of Regulatory Storage from Tucson Aqueduct - Phase B planning objectives, the six alternative plans were reduced to two: the West Side Plan, alined on the west side of the Tucson Mountains, and the East Side Plan, alined on the East side of the Tucson Mountains."

We feel that these statements leave the reader with the impression that storage for the Tucson Aqueduct - Phase B has been deleted indefinately. Furthermore, it is our concern that they do not convey the actual direction CATS received from the community, that storage in the Tucson area must be provided as a basic feature of the Central Arizona Project. The precise recommendation of CATS, as expressed to the Bureau in our report of April 22, 1983, is as follows:

SUITE 100
465 W. ST. MARY'S RD
TUCSON, ARIZ. 85705
624-9000

southern
arizona
water
resources
association

W.E. Rinne
Page 2
January 8, 1985

SAWARA

> "CATS recommends that the Bureau give no further consideration to storage at the Cat Mountain site. The committee makes this recommendation, recognizing that as the community becomes increasingly dependent on CAP water to meet its needs, there will be a need for future surface storage of not less than 10,000 acre-feet. This need will occur sometime after the year 2000 when, it is projected, there will no longer be sufficient well capacity to meet all municipal uses should any critical element of the CAP system prove not to be reliable enough to deliver water to the Tucson area. Prior to the occurrence of such a situation, appropriate economic analyses for different storage volumes and locations should be conducted."

We appreciate your attention to this matter of significant importance to us and respectfully request that the language of the SAWARA recommendation be included in the final version of the EIS.

Sincerely,

Dale Pontius

Dale Pontius
President, SAWARA

DP:TMc:mk

SUITE 100
465 W. ST. MARY'S RD
TUCSON, ARIZ. 85705
624-9000

Response to Comment
Southern Arizona Water Resources Association

3-1 We concur with your concern. The final EIS has been changed to accurately portray the recommendation of CATS.

150

El Paso
Natural Gas Company

P O BOX 1492
EL PASO, TEXAS 79978
PHONE 915-541-2600

4

JAN 17 1985

2270

January 14, 1985

U.S. Department of the Interior
Bureau of Reclamation
Arizona Projects Office
Suite 2200, Valley Center
201 North Central Avenue
Phoenix, Arizona 85073

Attention: Mr. Edward M. Hallenbeck
Project Manager

Re: R/W 81721
Bureau of Reclamation - C.A.P.
Tucson Aqueduct (Phase B);
Various EPNG Facilities
Pima County, Arizona

Gentlemen:

Our Company has completed its review of the recently submitted Draft Environmental Impact Statement covering the Phase B proposals for the Tucson Aqueduct project.

Based on the proposed route (West Side Plan) outlined in the Statement, El Paso Natural Gas Company facilities will be involved in the following areas: 1

1. 10-3/4-inch Tucson-Phoenix Line; M.P. 124 - Section 12, Township 12 South, Range 11 East (Drawing 1007.0-23A)

   an open canal crossing is proposed

2. 26 & 30-inch California Lines; M.P. 504+ - Section 14, Township 14 South, Range 11 East (Drawing 1100.0-94A)

   an open canal crossing is proposed

3. 26 & 30-inch California Lines, M.P. 499+ - Section 4, Township 15 South, Range 12 East (Drawing 1100.0-93A)

   a buried pipeline crossing is proposed

4. 26 & 30-inch California Lines, M.P. 496+ - Section 11, Township 15 South, Range 12 East (Drawing 1100.0-92B)

   an open canal crossing is proposed

5. <u>8-5/8-inch Twin Buttes Line - Sections 11 and 14, Township 15 South, Range 12 East (Drawing 2143.0-1)</u>

an open canal is proposed to parallel approximately ¼ mile of this pipeline

2 Due to the above listed involvement of El Paso facilities with the proposed aqueduct alignment, it is imperative that as detailed plans become available, we be provided copies in order to provide specific comments for the crossings.

For your reference and information, we are enclosing copies of our drawings reflecting the anticipated crossing locations addressed in this letter

Your continued cooperation is appreciated.

Very truly yours,

Ralph H. Oppenheim
Manager
Titles-Controls Division
Right of Way Department

BN/ek

Enclosures

Responses to Comments
El Paso National Gas Company

4-1 The facilities belonging to the El Paso Natural Gas Company that are effected by the Tucson Aqueduct will be crossed as follows:

1. The 10-3/4-inch Tucson - Phoenix Line mile post 124, in Reach 4 will be relocated.

2. The 26 and 30-inch California Lines mile post 504, in Reach 5 will have the canal siphoned under.

3. The 26 and 30-inch California Lines miles post 499, will have the discharge line from the San Xavier Pumping Plant placed under these lines.

4. The 26 and 30-inch California Lines mile post 496+, in Reach 6 will have the canal siphoned under these lines.

5. The 8-5/8-inch Twin Buttes Line, will not be affected as the aqueduct facilities will be located to the east of this line.

4-2 The pipeline in Reach 6 will parallel the east side of your corridor. Detailed plans will be coordinated with you as they become available.

5

OFFICIAL FILE COPY
U.S. Bureau of Reclamation
Lower Colorado Region

RECEIVED JAN 24 1985

Action MW

Action Taken ______ Initials

Date	Initial	To
1-28		150
File		

January 19, 1985

Regional Environmental Officer
Lower Colorado Region
U. S. Bureau of Reclamation
Box 427
Boulder City, Nv. 89005

RE: Environmental Impact Hearing - Central Arizona Project - Tucson Aqueduct

Gentlemen:

We are very much against changing from the West Side Plan to any of the proposed alternative plans, especially the plan that would follow Sanders Road. 1

We feel the alternative plans are costly, will have a heavy impact on a great many more people, involving moves, disruption of transportation and services, and more miles of buried pipeline, which affects time as well as costs.

The West Side Plan follows the natural contour of the land, utilizes Brawley Wash and the flood plain, crosses some Federal land, disrupts fewer people and services, and costs less.

The so called "Friends of the Desert" and the Park Service seem more concerned about a small part of the desert which is sparsely settled, used very little and populated by very few birds and animals, compared to the need for water and the human element.

Our vote is for the West Side Plan.

Sincerely,

Mrs. Mr. C. Nolen Bell

Mr. and Mrs. C. Nolen Bell
12661 W. Picture Rock Road
Tucson, Arizona 85743

Response to Comments
Mr. & Mrs. C. Nolen Bell

5-1 Your support for the West Side Plan has been noted and your comment is available to decisionmakers.

6

PIMA COUNTY
OFFICE OF THE COUNTY MANAGER

131 W. CONGRESS, 11th FLOOR
TUCSON, ARIZONA 85701
(602) 792-8661

CRAIG A. McDOWELL
COUNTY MANAGER

OFFICIAL FILE COPY
U.S. Bureau of Reclamation
Lower Colorado Region

RECEIVED A JAN 24 1985

Action mw

Action Taken ______ Initials

Date	Initial	To
1-25		150
File		

January 22, 1985

Regional Environmental Officer
Lower Colorado Region
U.S. Bureau of Reclamation
Box 427
Boulder City, Nevada 89005

RE: Draft Environmental Impact Statement
Tucson Aqueduct - Phase B
Central Arizona Project
Statement Number: INT DES 84-68

Gentlemen:

The planned mitigation efforts in the five aqueduct alternatives address the requirements necessary to minimize the eleven impact areas which were analyzed. If a regional consensus can be reached quickly, the western alignment may be the most viable course of action taking into consideration cost, physical impact, and mitigation efforts to wildlife.

I hope that the Environmental Impact Statement is completed on schedule in August and the Phase B Aqueduct is funded and implemented as soon as possible. This region needs the CAP water allocation by 1990 to minimize the impact of overdrafting to our groundwater reserves.

Sincerely,

Craig A. McDowell

CAM:jm

7

PIMA COUNTY HEALTH DEPARTMENT
151 West Congress Street
Tucson, Arizona 85701

PATRICIA A. NOLAN, M.D.
DIRECTOR

OFFICIAL FILE COPY
U.S. Bureau of Reclamation
Lower Colorado Region
RECEIVED JAN 23 1985
Action 150 MW
Action Taken ____ Initials

Date	Initial	To
1/24	WR	150
File		

January 18, 1985

Regional Environmental Officer
Lower Colorado Region
U.S. Bureau of Reclamation
Box 427
Boulder City, Nevada 89005

Dear Sir:

Thank you for the opportunity to review and comment on the draft environmental impact statement (INT DES 84-68) for Phase B of the Tucson Aqueduct.

We are concerned about the proposed use of maintenance roads along the aqueduct right-of-way by recreation vehicles (Chapter II, C.5.b., page 66). Dust generated by off-road and recreation vehicles operated in dry washes, riverbeds, and open areas has had significant localized impacts on air quality in Pima County in the past. Rule 345 of the Pima County Air Quality Control Rules and Regulations was adopted in 1982 to restrict those activities and reduce their impacts on air quality. The unrestricted use of the access roads by recreation vehicles would be contrary to both the intent and the spirit of Rule 345. Moreover, as future development in the areas near the aqueduct occurs, it is likely that there would be numerous complaints regarding dust from recreation vehicles. For these reasons the Pima County Air Quality Control District suggests access to these roads should be restricted to maintenance vehicles only. 1

If access is not limited, Rule 315 of the Pima County Air Quality Control Rules and Regulations requires the intermittent application of oil, water, or chemical dust suppressants to the road after construction to control dust emissions. Copies of Rules 315 and 345 are attached for your information.

Sincerely,
AIR QUALITY CONTROL DISTRICT

Donald L. Burtchin

Donald L. Burtchin
Senior Air Quality Analyst

DLB:mqn
Attachments
c: C. Lee Fox, Director Air Quality Control District

capacity less than or equal to 40,000 gallons, if the fill line between the fill connection and the tank is offset.

Rule 315: Roads and Streets

A. Dust emissions from an existing unpaved public road must be minimized with use of an effective dust suppressant, paving, detouring, barring access, limiting vehicular speeds, or other equivalently effective controls applied to the entire width of the road surface available to vehicular traffic.

B. Dust emissions from the construction phase of a new road must be minimized by applying the same measures specified in Part A of this RULE.

C. No new unpaved private driveway shall be constructed unless the road will not be used by more vehicular traffic than that associated with a one- or two-family private residence, and the road will not be adjacent to any recreational, institutional, educational, or retail sales facility.

D. No new unpaved service road or unpaved haul road shall be constructed unless dust will be suppressed after construction by intermittently oiling, watering, limiting access, or applying chemical dust suppressants to the road, in such a way that visible dust emissions caused by vehicular traffic on the road do not diffuse beyond the property line within which the emissions become airborne.

E. No new public road shall be constructed unless the following conditions are met (zoning terms and paving specifications in the following are those defined by or equivalent to those of the Pima County Planning Department and Pima County Highway Department, respectively):

1. If zoned CR-1 (one full acre or larger) or less dense, at least a 4-inch base coarse and double bituminous surface treatment shall be applied, or
2. If zoned CR-2 or denser, at least a 4-inch base coarse covered with at least 1.5 inches of asphaltic concrete shall be applied, and
3. A chemically treated substitute base and appropriate surface treatment may be used if approved by the Pima County Highway Department.

F. The surfacing of roadways with asbestos tailings is prohibited.

Rule 316: Particulate Materials

A. Dust emissions from the processing of material must be minimized by hooding and use of dust-collection equipment, water sprays, or use of wet scrubbers, fabric filters (baghouses), electrostatic precipitators, or other equivalently effective controls.

B. Dust emissions from construction activity must be minimized by applying adequate amounts of water or other equivalently effective dust controls.

C. Dust emissions from the transportation of materials must be minimized by covering stock loads in open-bodied trucks, limiting vehicular speeds, or other equivalently effective

Rule 344: Odor Limiting Standards

A. No person shall cause or permit emissions from malodorous matter to cross a property line between the source and a residential, recreational, institutional, educational, retail sales, hotel, or business premise without minimizing the emissions by applying good modern practices.

1. Malodorous matter shall include but not be limited to paints, acids, alkalies, pesticides, fertilizer, and manure.
2. This RULE shall apply to the processing, storing, use, and transporting of malodorous compounds.
3. Emissions from live trees, shrubs, plants, flowers, domestic gardening, and residential fireplaces shall not be considered malodorous within the meaning of this RULE.

B. The Control Officer shall not formally prosecute violations of this RULE unless five or more persons register complaints with the Control Officer during a consecutive 12-month period (regarding the same apparent source of odors).

Rule 345: Fugitive Dust Emissions Standards for Motor Vehicle Operation *(Amended 6/7/82)*

A. No person shall drive a motor vehicle in a dry wash, riverbed or open area in such a way as to cause or contribute to visible dust emissions which then cross property lines into a residential, recreational, institutional, educational, retail sales, hotel or business premises.

B. Any operator of a motor vehicle found to be in violation of this RULE shall be guilty of a petty offense as provided under ARS 36-789.01.

C. In accordance with the provisions of ARS 36-789.01, peace officers are authorized to issue a notice to appear for any violation of this RULE. In lieu of issuing a notice to appear, peace officers may file a violation report with the Control Officer, requesting him to file a complaint alleging violation of this RULE pursuant to ARS 36-789.01.

D. The Control Officer and his deputies shall conduct surveillance of the dry washes, riverbeds, and open areas and investigate citizens' complaints alleging violations of this RULE. When the Control Officer has reasonable cause to believe that there may be a violation of this RULE, he shall request the appropriate peace officer to take such actions as are necessary to enforce this RULE.

REGULATION 35: HAZARDOUS AND TOXIC POLLUTANTS

Rule 351: National Emissions Standards for Hazardous Air Pollutants {NESHAP} *(Amended 12/6/83)*

A. 40 CFR 61, except for 61.04, as of June 8, 1983, is hereby adopted by reference and made a part hereof.

REGULATION 36: STANDARDS FOR SELECTED SOURCES

Rule 361: New Source Performance Standards {NSPS} *(Amended 12/6/83)*

A. 40 CFR 60, except for 40 CFR 60.4 and Subparts B and C, as of June 8, 1983, is hereby adopted by reference and made a

Response to Comments
Pima County Health Department

7-1 The discussion on Long Term Impacts in Chapter III, C.5.b., does not refer to unrestricted use of the maintenance roads by motorized recreation vehicles. Any recreational use of the CAP right-of-way is contingent upon a local municipality becoming a local recreation sponsor, taking responsibility for the establishment and management of the recreation areas. We are currently working to obtain a local recreation sponsor for areas along the Tucson Aqueduct. Any recreation sponsor developing or managing CAP lands along the Tucson Aqueduct will be required to address, in a recreation development and/or management plan, and comply with all county rules and regulations concerning air quality control.

Current recreation planning for the Tucson Aqueduct include the establishment of a multi-purpose trail along the upslope boundary of the CAP right-of-way and a few trail-related areas in the flood detention basins. The only motorized recreation vehicles anticipated to use the maintenance roads are those official vehicles necessary to provide recreation security and maintenance. This motorized use would be limited and restricted to those areas along the Tucson Aqueduct which are otherwise inaccessible.

8

Finley Distributing Co.

2104 S. Euclid — Tucson, Arizona 85713
602-623-8800

OFFICIAL FILE COPY
U.S. Bureau of Reclamation
Lower Colorado Region

RECEIVED A	JAN 28 1985	
Action	/ML	
Action Taken		Initials
Date	Initial	To
		150
File		

copy APO

January 23, 1985

To: Regional Environmental Officer
Lower Colorado Region
U.S. Bureau of Reclamation
P.O. Box 427
Boulder City, Nevada 89005

From: Dorothy H. Finley D. Finley

Re: Westside Alignment Plan of the Central Arizona Project.
I am writing to support the "Westside Alignment Plan" as studied and evaluated in the draft Environmental Impact Statements, and request that the construction begin as soon as possible since the adveerse environmental impact is slight. 1

DHS/kam

Responses to Comments
Finley Distributing Company

8-1 See response to comment 5-1.

9

Lower Colorado Region
RECEIVED JAN 02 1985

Julie Savory
Rt 9 BOX 40B
6105 N. Sanders Rd
Tucson Az 85743

Cpy APO

1. Why has the Bureau overlooked the most environmentally sound route for the CAP, the "Sanders,-San Joaquin Modification? 1

2. Why hasnt the Bureau done a complete Environmental Study on the Sanders-San Joaquin Modification? 2

3. Why has the Bureau overlooked the Sanders-San Joaquin Modification without even have done the study? 3

4. Why did the Bureau not even Consider the Sanders-San Joaquin Modification, for reasons not having to do with the environment? (money, residents) 4

Please answer these questions and answer them in the final E.I.S.

Responses to Comments
Julie Savory

9-1 In response to public comments, both verbal and written, to the draft EIS and based on discussions with the National Park Service, Friends of the Desert and the Southern Arizona Water Resources Association, the decision was made to include Sanders-San Joaquin Modification Plan to the final EIS. Discussions relative to this plan have been incorporated throughout the document where appropriate.

9-2 The Sanders-San Joaquin Modification Plan has been studied to the same level of detail as the other plans.

9-3 See response 9-1.

9-4 See response 9-1.

10

copy APO 2/7/85

Jan

Regional Environmental officer
Lower Colorado Region
U. S Bureau of Reclamation
Box 427
Boulder City NV 89005

RE. Environmental Impact hearing Central Arizona Project Tucson Aqueduct

Gentlemen

We wish to express our thoughts about the west side plan. We feel it is the most acceptable. and are very much against any alternative plan especially the one that would follow Sanders Road. 1

The west side plan follows the natural contour of the land, crosses some federal land disrupts fewer people and services and cost less to build and later maintenance.

The Park service and so called Friends of the Desert seem more concerned about a small part of the desert which is least

Very little. Not much populated. Very few birds and animals. Compared to the need for water and human element.

Our Vote is for the West Side Plan
Sincerely

Mr + Mrs H.W. Peden
6861 No Sanders Rd
Tucson Az 85743

H W Peden
Mildred M. Peden

Responses to Comments
Mr. & Mrs. H.W. Peden

10-1 See response to comment 5-1.

11

IRRIGATION & ELECTRICAL DISTRICTS ASSOCIATION OF ARIZONA

SUITE 720
2845 E. CAMELBACK ROAD
PHOENIX, AZ 85016
TELEPHONE: 956-8878

H. S. RAYMOND
PRESIDENT
W. A. DUNN
VICE-PRESIDENT
ROBERT S. LYNCH
SECRETARY-TREASURER

OFFICIAL FILE COPY
U.S. Bureau of Reclamation
Lower Colorado Region
RECEIVED FEB 7 1985
A

Action CD
Action Taken Initials

Date	Initial	To
2-7		700
		210
2-8		740
		150
File		

Copy to APO 2/13/85

February 4, 1985

Mr. N. W. Plummer
Regional Director
Lower Colorado Region
U.S. Bureau of Reclamation
Post Office Box 427
Boulder City, Nevada 89005

RE: Draft Environmental Impact Statement for Tucson Aqueduct - Phase B, Central Arizona Project

Dear Mr. Plummer:

We have reviewed the draft Environmental Impact Statement for Tucson Aqueduct - Phase B and have the following comments.

First, we support the agency proposed action to construct the aqueduct along the alignment known as the "Westside Plan". It is obvious from the Environmental Impact Statement that this alternative is the most economical way to deliver water to the City of Tucson and other water contractors in that area. Given the fact that funding for the Central Arizona Project is coming under increasing scrutiny in Congress and at the Office of Management and Budget, and up-front funding is being actively considered here in Arizona, it would be hard to justify something other than the most economical alternative for this part of CAP. This alternative is also the most economical in terms of power use for water pumping purposes. Adopting this route will conserve scarce power resources and aid in holding down municipal and industrial water costs. This alternative thus aids national and local power conservation objectives. 1

Second, we feel both the conservation of funds and conservation of power resources that could be achieved with the Westside Plan meet the spirit of Title II of Public Law 98-381, the 1984 Hoover Act Amendments. The obligations that many of us agreed to shoulder in that act were assumed on the basis that the United States would achieve economies in completion of the Central Arizona Project wherever it could.

Third, we believe the draft Environmental Impact Statement adequately displays the trade-offs between environmental consequences and economic decisions. Thus, we feel it can provide an adequate basis, when finalized, for a decision by the Secretary of the Interior.

We thank you for the opportunity to comment on this draft Environmental Impact Statement. We would appreciate being kept informed of further actions to develop the final statement.

Sincerely,

Robert S. Lynch
Secretary-Treasurer

RSL:kbs
D3/n

cc: IEDA Members
Congressional Delegation
CAWCD

Responses to Comments
Irrigation & Electrical Districts
Association of Arizona

11-1 See response to comment 5-1.

12

THE UNIVERSITY OF ARIZONA
TUCSON, ARIZONA 85721

COLLEGE OF ENGINEERING
WATER RESOURCES RESEARCH CENTER
A.E. DOUGLASS BUILDING 28

OFFICIAL FILE COPY
U.S. Bureau of Reclamation
Lower Colorado Region
RECEIVED B FEB 8 1985
Action CO
Action Taken ______ Initials

Date	Initial	To
		150
File		

Copy to APO 2/13/85

February 1, 1985

Mr. Edward M. Hallenbeck
CAP Project Manager
P.O. Box 9980
Phoenix, Az. 85068

Dear Mr. Hallenbeck:

Enclosed is an edited version of the statement I presented at the January 25, 1985 hearing to include in your final draft of the EIS. I would appreciate a specific response to each of the issues presented in the statement in the final version of the EIS.

It is essential that the State of Arizona follow California's lead and use our streams to recharge the state's aquifers with surplus waters now being wasted due to inadequate storage. The stream recharge of CAP water in the Tucson Basin would be an important beginning to accomplish this goal. **1**

Yours truly,

C. Brent Cluff

C. Brent Cluff
Associate Hydrologist

CBC:pn
Enc.
cc: N.W. Plummer, Regional Director

STATEMENT ON RECHARGE OF CAP*

(1) Recharge of CAP in the Tucson Area has not been adequately considered by the USBR. This is evident in the evaluation as reported in the Phase B Environmental Impact Statement. Specific problems with the USBR evaluation are as follows:

---

2 a.The USBR determined costs of the CAP/Floodwater storage as $95,000,000 but allowed only $150/acre-foot value for the floodwater conserved. This is several times less than the true cost of getting an acre-foot of Colorado River pumped 2400 feet uphill from the Colorado River to Tucson. Treated sewage effluent is being sold to the La Paloma development for $300/acre-foot. The value of the much better quality floodwater should at least be equivalent to that. The CAP/Floodwater storage reservoir located west of Rattlesnake Pass also provided 10,000 acre feet of emergency storage for CAP. No benefits were listed for this storage in the USBR Floodwater/Recharge Analysis. The least expensive 10,000 acre-feet storage other than CAT mountain was the San Joaquin site. It was estimated by the USBR to cost $36,000,000 with an annual OM&R cost of over 3 million. These costs should be added to the preferred Westside alignment in any comparison with the Floodwater/CAP Recharge proposal. Because of these complications surface storage of both floodwater and CAP water has been deleted from the attached cost comparison.

---

3 b.The USBR used greatly reduced capital and operating costs of the proposed three phases of the Tucson treatment plant and distribution systems. It used $57,000,000 as the total capital cost instead of a previously announced City of Tucson estimate of $200,000,000 cost for the first phase. The USBR used a $13.40/acre-foot cost instead of the $40 acre-foot O & M cost used by the City of Phoenix for its CAP Treatment Plant.

---

4 c.Energy rates used for the recharge alternative were 68 mills/KWH compared to 43 mills for the preferred Westside Plan. This and other factors produced energy costs nearly two times higher for the recharge proposal. Under the Westside Plan all water delivered to Tucson will be pumped to the 2800 ft elevation. Under the Eastside recharge plan not more than 1/2 of the water would need to be pumped that high the rest would be below 2600 ft. The energy cost of operating the recharge aqueducts should be less not more than pumping an equivalent amount of water to the treatment plant. The energy and and operation cost of continued pumping from wells is $45/acre/foot in 1982 dollars. This is offset by the $40/acre-foot operation cost of the treatment plant.

---

* Statement by C. Brent Cluff made on January 25, 1985 at the USBR Hearing on the Phase B Environmental Impact Statement, Tucson, Arizona.

d.The USBR did not consider the value of being able to store surplus CAP waters using recharge, in wet years that can be used during times of drought. With recharge Tucson would not be dependent on a day to day delivery from a flucuating water source 350 miles away. **5**

e.The USBR did not consider power management benefits similar to those being used to justify construction of storage dams in Plan 6 near Phoenix. To obtain these benefits all recharge would be done in the winter when power costs are lower. The excess summertime power made available could be sold. If these benefits are included the average annual costs of the Phase B aqueduct could be reduced by 20%. **6**

f.The USBR analysis did not consider the value of recreational benefits inherent in the recharge alternative. There will be little or no recreation benefits in the preferred route. **7**

g.The USBR charged for the value of water lost to Tucson Water without showing the same value for additonal water stored in the aquifer that would be used by other pumpers or be available for Tucson Water in the future. **8**

As shown in the accompanying table when a proper accounting is made the annual costs using the Eastside Route with recharge is 63 percent of the annual costs of the favored Westside plan without recharge. Although the construction costs of the aqueducts are $67,000,000 higher with the Eastside Recharge Plan additional costs can be easily repaid by the large power management benefits. The major monetary savings between the two concepts would accrue to local water users. The need for a expensive treatment plant and distribution system would be eliminated.

(2) The Westside Alignment does not provide the possibility of a combined system so that a mixture of CAP and treated effluent can be delivered to the Avra Valley Irrigation District and the Shuk Toak District. This delivery would be made in a buried pipeline without the environmental consequences of the open canal of the preferred Westside alignment. **9**

(3) The Westside Alignment with "clear water" delivery after treatment is a departure from the traditional method of USBR delivery and may be difficult to defend in congress. **10**

(4) In contrast the U.S. Congress recently passed a recharge bill directing the USBR to become involved in recharge projects. The inclusion of the possibility of recharge in the Phase B aqueduct will enhance continued Federal funding. **11**

The available storage in the Tucson Basin Aquifer has been compared in a recent newspaper article to Lake Mead. If this vast slowly draining 30,000,000 acre-foot storage were above ground and visible the citizens of this area would insist that any importation of CAP water from a flucuating water source 350 miles away be connected to that water storage. Unfortunately the storage is not visible, the general public is unaware of its potential and of the serious future consequences of failing to connect the CAP aqueduct to the Tucson aquifer using stream recharge.

Recharge of imported water is not a new concept. It has been done on a large scale in California for over 50 years. The method is economical particularly when stream recharge is used.

In conclusion for all of the above reasons the USBR should designate the Eastside Alignment as the preferred alignment in the final Phase B, Environmental Impact Statement. This would be done as a means of reducing the environmental impact and to better facilitate the recharge of both allocated and surplus CAP water in the Tucson Basin. This should not significantly delay the project. No new environmental studies would be needed for the basic aqueduct. The floodwater/CAP storage reservoir and recharge features can be added at a later date.

ALTERNATIVE
COST COMPARISON TABLE
(All costs are in Thousands of Dollars)
January 1982 Price Levels

CONSTRUCTION COST	Recharge Eastside	Recharge Westside	No Recharge Westside Plan
CAP/Tucson Aqueduct	197,506	172,766	186,338
Clear Water Delivery(1)	N/A	N/A	40,800
CAP/Indian Delivery (2)	8,250	1,750	1,750
Avra Valley Delivery(3)	N/A	N/A	N/A
Canada Del Oro Pipeline	17,349	27,253	N/A
Pantano/Tanque Verde Pipeline	68,712	96,320	N/A
Santa Cruz Canal(4)	1,530	16,003	N/A
Subtotal	294,097	314,092	227,088
Water Treatment Plant(5)			
(First Phase)	N/A	N/A	50,000
(Second Phase)	N/A	N/A	?
(Third Phase)	N/A	N/A	?
Distribution System(6)			
(First Phase)	N/A	N/A	150,000
(Second Phase)	?	?	?
(Third Phase)	?	?	?
Well Collection System(7)			
(First Phase)	N/A	N/A	N/A
(Second and/or Third Phases)	26,000	26,000	26,000
Total Field Costs	320,097	340,092	453,088
Non Contract @25%	73,524	78,523	113,272
Total Const. Costs	400,121	425,115	566,360
Interest during Const.	76,272	81,037	107,962
Environmental Mit.(8)	6,910	8,380	2,430
Total Capital Costs For First Phase	483,303	514,532	676,752

ANNUAL COSTS

Annual Equivalent of Construction Costs	36,874	39,257	51,634
OM&R			
Aqueduct System	7,969(9)	9,079(9)	8,650
Treatment Plant (89,507 a.f. @ $40)	N/A	N/A	3,580
Wells Repump System (89,507 a.f. @ $45)	4,027	4,027	N/A
Recharge System(10)	688	680	N/A
Value of Water Lost			
Due To Evaporation(11)	1,252	1,776	1,024
To Tucson Water(12)	5,306	5,306	N/A
Value of Water Added to Aquifer(13)	(5,306)	(5,306)	N/A
Value of Surplus CAP Added to Aquifer(14)	(?)	(?)	N/A
Recreational Benefits(15)	(?)	(?)	N/A
Power Management Benefits	(9,800)(16)	(9,800)(16)	N/A
Total Annual Costs (17)	41,002	45,019	64,888

FOOTNOTES

(1) Clear Water Delivery will be made by USBR in the Westside no-recharge plan.

(2) This cost for the delivery to the Shuk Toak District of the Papago Reservation was taken from the Draft Copy of the EIS Tucson Aqueduct Phase-B.

(3) Avra Valley Delivery is no longer applicable to any delivery plan since the City of Tucson's announced intention to purchase and retire the farmlands belonging to the AVRA Valley Irrigation District. If Tucson does not purchase the farmlands as announced delivery of CAP can be made using the same pipeline that would also deliver treated effluent.

(4) Santa Cruz Canal will deliver water from the upper end of Aqueduct to Santa Cruz River for the purposes of recharge.

(5) The Water Treatment Plant is to be built in three stages each of which will have a capacity of approximately 50,000 acre-feet. The cost of the second and third phases has not been announced.

(6) The distribution system to move water from the treatment plant to the existing distribution system will also be built in stages however some portions of the first stage will be designed to carry the full capacity of the final treatment plant so that the cost of subsequent stages should be less than the first stage. The costs of the second and third stages needed for the treatment plant have not been announced. Similarly the costs of the connecting new wells to the existing system have not been determined.

(7) The Tucson Water Department has on several occasions announced that wells would continue to be used if CAP water was not available because of drougth. Thus a large well field will have to be built and maintained even with the advent of CAP water. The City has sufficient well capacity for the near future particularly if the aquifer is recharged and the rate of drop in the water table is reduced. However in the future additional wells will be needed for an emergency source of water. For this reason the $26,000,000 estimated cost by the Tucson Water Department was applied to all alternatives.

(8) Environmental mitigation costs were left the same as is described in the USBR memo of Jan. 5, 1984. These costs would be less without floodwater storage.

(9) These costs were reduced substantially from the USBR Phase B draft of the EIS due to a dropping of the surface storage reservoir and use of the 43 mills/kwh rate. The total energy costs of the recharge alternatives should be less than the West Side Plan since 1/2 of the water is pumped to less than 2600 ft. elevation. The remaining water is pumped to the 2800 foot elevation. There is more pipeline particularly in the Eastside Recharge alternatives. The pipeline uses more energy than an equivalent sized open canal but costs less to maintain. Therefore the O&M costs for the recharge alternatives should not be much different than the West Side Plan.

(10) The costs of operating the recharge system is based on costs of a similar stream recharge system in Orange County, Calif.

(11) This is the value of the maximum expected evaporation @ $200 per acre-foot. These costs should be increased to reflect the actual costs of importation, however with wintertime recharge the evaporation loss as reported here would be significantly reduced.

(12) Tucson Water estimates that they can only recover about 70% of the water recharged using their wells. The other 30% would be recovered by private pumpers and water companies. Therefore this would be considered a loss by Tucson Water.

(13) This represents the value to private pumpers and water companies of the 30% of the recharged water that they will pump. They would pump this amount of water with or without the recharge alternative. However with the recharge alternative the water not recovered directly by Tucson water will reduce the overdraft in the Tucson Basin. This will also benefit the Tucson Water Department. Many of the largest private pumpers already have agreed to take delivery and pay for their CAP water through Tucson Water.It is expected that the use by the City of Tucson of the recharge alternative will not affect these basic agreements.

(14) With the West Side Plan and Treatment Plants there will be no opportunity for the Tucson Basin to take advantage of available surplus waters from the Colorado River. At the present time all such waters will go to agricultural users. They are contracting for a percentage of all CAP water remaining after the Urban and Indian allotments are met. The opportunity to bring both allocated and surplus CAP water to Pima county will be greatly reduced if the City continues to purchase and retire Avra Valley farmlands. In the case of a wet year such as we have had the past three years agricultural contractors may not be able to use the 1,000,000 acre-feet/year of surplus water that will be available to the CAP. Tucson could utilize these surplus waters if the recharge alternative was constructed. With recharge surplus water can also be utilized from the Salt and Gila Rivers. These rivers have had over 6,000,000 acre-feet of surplus water since 1978.

(15) The recreational benefit of using live streams to recharge the Tucson Basin should be substantial but as yet has not been determined. In a desert area just west of Palm Springs, California where a live stream is used to recharge the aquifer with surplus Colorado River Water there is considerable recreational activity surrounding the running water. In Tucson it would be no different.

(16) Based on data presented by the USBR to justify the Plan 6 Reservoirs in the Phoenix area a power savings of 165/acre-foot could be achieved in the Tucson area for every acre-foot that could be delivered in the winter vs. summer delivery. With recharge all of Tucsons average 89,507 acre-foot delivery could be delivered in the winter. The $165/acre-foot power management savings would only apply to the water now scheduled to be delivered in the summer months. The scheduled May-September delivery is approximately 2/3 of the average delivery or 59,771 acre-feet. Delivering this water in the winter would give a power management savings of 9.8 million dollars for the recharge alternatives.

(17) These costs exclude some second and third phase annual equivalent of capital costs for the treatment plant and distribution system. These costs would be added to the no-recharge alternative. Benefits of recreation and value of surplus water added to the aquifer would be subtracted from the annual costs of the recharge alternatives. This would substantially increase the difference between the recharge and no-recharge alternatives.

Response to Comments
C. Brent Cluff, University of Arizona

12-1 The thrust of the recharge proposal is that this process would negate the need for traditional treatment plants. Many of the benefits are predicated upon this strategy. The decision as to how CAP water is treated for Tucson's municipal purposes is the responsibility of the Mayor and Council of the city of Tucson. To the best of our knowledge, the city has not adopted this method of treatment. Unless the city of Tucson accepts and adopts recharge as a substitute for traditional treatment, none of the potential benefits related to water treatment will be realized. Although the recharge proposal has been included in some of the plans, the fact remains that its implementation is a local decision and that it is not a part of the CAP.

12-2 The analysis of the recharge alternative used a value of $200 per acre-foot for flood water and not $150, as stated in comment (1)a. It was assumed that approximately 70 percent of the water would be recoverable. Additionally, the $300 per acre-foot paid by La Paloma for treated effluent consists mostly of the annualized capital cost of constructing the system to deliver the water from the treatment plants to the development. The actual cost to treat this water makes up only a small portion of the total delivery cost. Our analysis also indicates that a 10,000 acre-feet storage site is presently not required as part of the CAP delivery system. Since there is no demonstrated need for emergency storage, these benefits were not included in the analysis. Plans for floodwater recharge were analyzed on an incremental benefit/cost basis where such opportunities for this concept were apparent. Floodwater recharge is not an essential component of the Tucson Aqueduct. Therefore, it was not included in plans where it offered no obvious advantage, such as the West Side Plan.

12-3 Initially the capital and operating costs that were used in the analysis, were obtained from the staff of Tucson Water. These costs were considered valid and have been updated to 1985 price levels.

12-4 In the analysis of the West Side Plan, it was assumed that as much water as possible was pumped during off peak times. By assuming an operational plan, the cost of power decreases, since the amount of power used during peak times of the day would be reduced. However, the same operational plan was not used for the recharge alternatives. It was assumed that, once the water left the main CAP aqueduct, it became part of the city of Tucson's distribution system and, therefore, was not authorized to use CAP power. Using this assumption, the city of Tucson would need to acquire power at the local market rates. It did not appear that this was a realistic assumption, inasmuch as there is insufficient generating capacity available in the Tucson area. Therefore, 66.8 mills per kilowatt-hour (kWh) was used for the local power cost.

12-5 Recharge of surplus CAP water was not considered, since there is no foreseeable surplus water. According to the Secretary of Interior's CAP allocations, any water not allocated to municipal and industrial (M&I) or to Indians, is allocated for non-Indian agricultural uses. Even if the allocations result in surplus water, it is difficult to assess a value on surplus water, since it is not known if or when it would be available or whether the city of Tucson would be willing to purchase this water for the benefit of others.

12-6 As discussed in response 12-4, we did not include any power management benefits, since we did not think that the city of Tucson could obtain the power required to pump all the water during off peak times. Also, in Dr. Cluff's analysis, power management benefits were counted twice. The power cost of 43 mills/kWh, which he states is determined by pumping as much water as possible during off peak times, is power management.

12-7 To determine recreational benefits, there are many questions which would need to be answered. The major question is, "would the Bureau be required to purchase the land used for recharging the water?" (Our estimates do not include this cost.) Current Bureau policy is that such land purchased by the Bureau would be fenced, not allowing any recreation to take place. Should the Bureau allow recreation, then an entity must be found to manage the facilities. Our current thinking is that an entity would not be willing to manage the entire area required for recharge. Finally, because of the shallow depth of the water and relatively short storage period, fishing could not take place, and the majority of recreational benefits are derived from fishing.

12-8 Our analysis assumed that this water would be retained in the vadose zone, or lost through evaporation and transpiration, and would not be available for recovery by wells.

12-9 It is true that the West Side Plan does not allow for a combined mixture of CAP and effluent waters to Avra Valley. However, this EIS concerns CAP water and not effluent. Our planning focused on delivering CAP water to Avra Valley. Currently, the Avra Valley Irrigation District does not have a contract for effluent. Also, it is unsure that they will ever use effluent. Since the Schuk Toak allocation can be used for M&I purposes, a combined system could not be constructed.

12-10 The Act itself does not specify the terminus and capacity of the Tucson aqueducts, nor does it incorporate by reference any reports which do so. The July 21, 1980, Solicitor's Opinion concluded, "that Congress meant to accord the Secretary substantial discretion to modify the project features to fit changing needs so long as the basic facilities Congress described were built to carry out the project purposes. 85 I.D. at 337, 339."

Before a decision was made by the Bureau to include clear water delivery for Tucson, the city of Tucson and the Bureau confirmed that the Central Arizona Water Conservation District (CAWCD) would be willing to pay the associated cost for a pumping plant and the pipeline to the clear water reservoir. This decision was also the consensus of the other water users that can be served by the Tucson Aqueduct.

12-11 The Bureau is involved in two different programs which will add to the artificial recharge "state-of-the-art" as it might be applied to Pima County.

- We have initiated a research project this year entitled "Remote Sensing Applications of Ground-water Exploration", to be managed jointly by the Bureau's Engineer and Research Center in Denver, Colorado, and the Arizona Projects Office of the Lower Colorado Region. This three-year study will explore the feasibility of identifying potential sites for ground water recharge using remote sensing techniques.

- We will be involved in the implementation of the High Plains States Ground Water Demonstration Projects Act of 1983. Areas in both Pima and Maricopa Counties in Arizona will be considered as potential demonstration project sites as authorized by that Act.

13

OFFICIAL FILE COPY
U.S. Bureau of Reclamation
Lower Colorado Region
RECEIVED FEB 8 1985
A
Action CO
Action Taken Initials

Date	Initial	To
F1	DB	150
File		

cpy 400
2/13/85

Regional Environmental Officer
Lower Colorado Region
U. S. Bureau of Reclamation
Box 427
Boulder City, Nevada 89005

January 29, ~~1986~~

Ref: Environmental Impact Statement (Draft) # INT DES 84-68

Dear Sir:

We, the undersigned, have reviewed the draft Environmental Impact Statement concerning Phase B of the Central Arizona Project, Tucson Aqueduct. Although there were several comments in the E.I.S. regarding the construction of pumping stations and their associated 115 Kilovolt power transmission lines, we have one concern which has not been addressed by the Environmental Impact Statement.

1

It is our considered opinion that the construction and, particularly, the operation of the pumping stations and associated high voltage transmission lines will create a serious environmental impact in regard to the reception of television, radio, and other forms of radio frequency signals. There are now about two-thousand (2,000) homes located in the Avra Valley area. Commercial television and radio reception, in most cases, is barely adequate at this time since Avra Valley is in the "shadow" of the Tucson Mountains where Tucson stations are concerned and a great distance separates Avra Valley residents from Phoenix stations. These problems have been alleviated to some extent by residents who have installed large and expensive antenna arrays and/or receive preamplifiers in order to increase received signals to a usable level. We believe that introduction of the 115 Kilovolt power transmission lines, as well as the pumping stations, will create enough electrical interference in this environment to impair, if not preclude, the reception of television and radio signals.

In addition, there are several Amateur Radio operators, licensed by the Federal Communications Commission, who reside in Avra Valley. During the disasterous flooding which occurred in October of 1983 these amateur radio operators provided one of the few emergency communications links out of the Avra Valley area, resulting in commendations from the Mayor of Tucson and the Chief of the Picture Rocks Fire District, among others. Virtually all of these amateur radio operators chose to reside in Avra Valley because it is almost totally free of the electrical interference associated with the city environment such as high voltage power lines, industrial equipment (motors, diatherm machines, etc.), and other man-made sources of interference to radio reception. Recent measurements of electrical "noise" in the Avra Valley area by amateur radio operators show an extremely low background noise level of less than .3 microvolts on the 20 meter (approximately 14.3 Megahertz) band. Some of the amateur radio operators mentioned now reside in areas which would be less than one (1) mile from a pumping station and the high voltage transmission lines. We feel that electrical interference from the pumping stations and transmission lines will impair, if not preclude, the reception of the very weak signals associated with the Amateur Radio Service.

Furthermore, the most significant of our concerns is in regard to the possibility of a detrimental impact on public service radio transmission and reception. The Picture Rocks Fire District uses low to medium power radio equipment to serve a very large geographical area. Their communications system, particularly when one or more of the units is a portable unit, is "just adequate" at this time. The same holds true for the Pima County Sheriff's Office, the Marana Marshall's Office, and Pima County Emergency Medical Service insofar as the Avra Valley area is concerned. Any interference to these communications systems, such as the electrical interference which may be caused by pumping stations and high voltage transmission lines, could result in the loss of property or lives since the residents of Avra Valley depend on these organizations for fire, police, and medical services.

In summary, we ask that an in-depth study be completed to establish the levels of electrical interference which would be created by introduction of the Tucson Aqueduct Phase B pumping stations and their associated power transmission lines. Further, we ask that the study describe the possible impact which interference would have on each of the radio and television services mentioned above and that the study offer methods of mitigating any possible interference to these services.

Sincerely,

The Undersigned Residents
of Avra Valley

cc: Senator Barry Goldwater
Senate Office Building
Washington, D.C. 20510

Senator Dennis Deconcini
Senate Office Building
Washington, D.C. 20510

Representative Morris Udall
U.S. House of Representatives
Washington, D.C. 20515

Friends of the Desert
Route 9 - Box 620
Tucson, Arizona 85743

Federal Communications Commission
Engineer in Charge, District #11
Suite 501
3711 Long Beach Blvd.
Long Beach, California 90807

American Radio Relay League
225 Main Street
Newington, Connecticut 06111

Avra Valley Repeater Association
P.O. Box 224
Marana, Arizona 85238

RE: POSSIBLE INTERFERENCE TO RADIO/TELEVISION SIGNAL RECEPTION

DUE TO C.A.P. TRANSMISSION LINES/PUMPING STATIONS

NAME	ADDRESS
[illegible]	Rt 9 - Box 31B, Tucson, AZ 85743
Thomas J. Workman	RT. 9 - Box 688, TUCSON, AZ. 85743
Rosemary Workman	Rt 9 Box 688, Tucson, Az. 85743
Charles E. Hay Asst. Chief	Picture Rocks F.D. 6625 N. Sandario Tuc Az 85743
" " Residence	12300 W. Lord. Ln. Tucson Az 85743
Ramsey E Clarkson	Chief - Picture Rocks Fire Dept.
[illegible]	Communications Officer 6625 N. Sandario Rd Tucson, AZ 85743 Picture Rocks Fire Dept.
" " Residence	6971 N. Guthrie Rd - Tucson, AZ 85743
Jeanette M [illegible]	12825 W. Well Pump Drive Tucson Az 85743
Carol A Steadman	12825 W Well Pump Drive, Tucson, Az 85743
[illegible] A. [illegible]	10500 W Nolan Rd Tucson Az 85743
Vernon Earle Dupee	6170 So Mastellar Rd Box 452 Sells Star Rt Tucson Az 85735
William D. [illegible]	5150 N. Old West Rd Tucson, AZ 85743
Sue Steadman	5150 N. Old West Rd Tucson, Az 85743
D. A. [illegible] Marana	Marana RT. 9 Box 578 Tuc Az 85743
Harvey J Imhoff	12405 W. Ranchettes Tucson 85743
Sandra J. Imhoff	12405 W. Ranchettes Tucson, Az 85743
[illegible]	4241 N Old Ranch Rd Tucson Az 85743
Harold C Leaf	4241 N OLD RANCH RD TUCSON AZ 85624
[illegible]	4241 N. Old Ranch Rd Tucson AZ 85743
Patricia R Calvillo	Rt. 9, Box 616, Tucson, Az 85743

4

Response to Comments
Residents of Avra Valley

13-1 The EIS has been revised to address electrical effects attributed to transmission lines and pumping plants (see Chapter III.J.3.).

14

SIERRA CLUB

Grand Canyon Chapter · Arizona

OFFICIAL FILE COPY
U.S. Bureau of Reclamation
Lower Colorado Region
RECEIVED A FEB 11 1985
Action CO
Action Taken ________ Initials

Date	Initial	To
		150
File		

copy to APO 2/13/85

4 February 1985

To: Regional Environmental Officer
Lower Colorado Region
U.S. Bureau of Reclamation
Box 427
Boulder City, Nevada 89005

From: Gayle G. Hartmann
Rincon Group, Sierra Club
2224 E. 4th Street
Tucson, Az. 85719

Re: Tucson Aqueduct Phase B

The following statement was presented at the 29 January 1985 public meeting sponsored by the Bureau of Reclamation in Tucson, Arizona. It reflects the Sierra Club's position regarding the Tucson Aqueduct.

The Sierra Club has never been and is not now an enthusiastic supporter of the Central Arizona Project. We believe that bringing water to southeastern Arizona from the Colorado River is an expensive, short-term approach to our water problem. Instead of encouraging serious conservation measures on the part of the City of Tucson, the mines, and agriculture, CAP water offers a misleading mirage -- low quality water (and probably a small amount of that) which, at best, augments Tucson's water for a few decades.

However, the matter under discussion here concerns the merits of a specific alignment, not the merits of the CAP as a whole. In that regard, the Sierra Club is pleased to be able to support all the environmental mitigation measures in the preferred West Side Plan. **1**

We especially support a wildlife mitigation corridor of no less than 2530 acres and urge that, through the corridor, the aqueduct be underground. Such a corridor is the only measure that will prevent wholesale disruption of the wildlife population in the area. More specifically we recommend the following: **2**

---

1. All facilities associated with the aqueduct such as transmission lines, earthen dikes, pumping plants, surge tanks, and access roads should be camouflaged to the extent possible to reduce visual impact. In particular, the recommendation of the Arizona-Sonora Desert Museum concerning the pumping station at Brawley Wash should be followed. **3**

4 2. Shielded, low pressure, sodium vapor lights should be used to reduce light pollution and minimize the impact on astronomical facilities.

---

5 3. All environmental mitigation activities should follow recommendations of the appropriate wildlife agencies as listed on pages 41-42 of the Draft EIS.

---

6 Although we support these mitigation efforts of the Bureau, we cannot support the West Side Plan as a whole. As noted on page 10 of the summary to the Draft EIS, "The greatest overall biological impacts would occur with the West Side Plan..." The only real way to minimize biological impacts is to use underground pipe. Therefore, we strongly urge the Bureau of Reclamation to consider long-term environmental effects rather than short-term costs and adopt the "West Side Modification - Low Pressure Pipeline Plan" (basically, a pipeline along Sanders and San Joaquin Roads.) It is the only plan that makes any long-term sense!

Response to Comments
Sierra Club

14-1 Your support of all the environmental mitigation measures/recommendations in the West Side Plan has been noted.

14-2 The purpose of the corridor acquisition is to insure the long-term usefulness of the wildlife bridges over the aqueduct in this high-use area by preventing housing development in this vicinity. The extension of the pipeline through the wildlife corridor is possible but the cost enters into the picture in construction and pumping. If Reclamation invested the additional money needed to bury this section of the aqueduct, we believe we would not have adequate justification to purchase the corridor. (see Management options attached to Letter of Comment No. 23).

14-3 During final design of the aqueduct features, measures will be included to reduce the visual impact of the aqueduct, dikes, pumping plants, and access roads. A landscape architect will specify landscaping measures to be included at each of the pumping plants, and review construction specifications for other aqueduct features to insure adequate consideration of visual impacts. Specifically, the following measures will be incorporated into the proposed action to reduce visual impacts:

- removal and stockpiling of sufficient numbers of saguaros and other cacti from the construction zone to be transplanted at pumping plants or along the aqueduct at specific areas as landscaping;

- inclusion of landscaping measures at each pumping plant and, if appropriate, aqueduct reaches to reduce visual impact;

- dikes and cut slopes will be benched, terraced or furrowed to reduce erosion and aid in revegetation;

- seeding of native and/or xeric adapted perennial plants and grasses on construction disturbed areas. The revegetation program may include the use of land surface imprinter or other techniques to encourage revegetative success. Revegetation efforts will be coordinated with interested local agencies and input will be sought in developing a final revegetation plan.

- the use of cobble or gravel cover or placement of landscape stone on cut slopes or dike side slopes will be considered as a means to reduce erosion, and enhance revegetative success, thus reducing visual impacts.

- paint metal canal structures, such as pipe overchutes, a color chosen to reduce visibility;

- concrete canal structures such as bridges, and flume overchutes shall receive a surface treatment to reduce visual contrast to the adjoining desert;

- chain link security fencing options such as of the PVC-coated type to reduce reflective glare with fence posts and fabric of a color chosen to reduce visibility; or, if such material is determined unsuitable for desert climates, the galvanized fence with a dull-coat solution to reduce glare will be considered;

- prior to the canal excavation and construction, right-of-way fences will be erected, and vegetation clearing limits will be delineated in the construction specifications. Construction activities would be confined to these delineated areas within the r-o-w to reduce vegetation clearing and visual impact;

- construction specifications will specify designated use areas for contractor construction yards and other needed construction areas. These use areas would be selected based in part on their visibility from sensitive areas, and other environmental considerations. Other construction use areas would require specific approval of the contracting officer.

The design for surge protection at the Brawley, San Xavier, Snyder Hill, and Black Mountain pumping plants has been revised to eliminate the tall surge tanks. Surge protection will be provided with an air-chamber type tank, which will be below the level of natural ground.

14-4 Outside night lighting for the canal is not planned; lights will only be used at the pumping plants for security purposes. Specifications call for high pressure sodium vapor lights. These lights are also to be aimed below the horizon and not to include private residences in the beam.

14-5 See response 14-1.

14-6 Your opposition to the West Side Plan and support of the West Side Modification - Low Pressure Pipeline Plan has been noted and is available for consideration by decisionmakers.

15

United States Department of the Interior

NATIONAL PARK SERVICE
WESTERN REGION
450 GOLDEN GATE AVENUE, BOX 36063
SAN FRANCISCO, CALIFORNIA 94102

OFFICIAL FILE COPY
U.S. Bureau of Reclamation
Lower Colorado Region
RECEIVED A FEB 14 1985
Action CO/ML
Action Taken ______ Initials

Date	Initial	To
		150
File		

IN REPLY REFER TO:
L7619 (WR-RPE)

February 6, 1985

Memorandum

To: Regional Director, Bureau of Reclamation, Boulder City, Nevada
Attention: Regional Environmental Officer

From: ACTING Regional Director, Western Region

Subject: Review of Draft Environmental Statement -- Tucson Aqueduct - Phase B, Central Arizona Project

In response to the Director, Office of Environmental Affairs, Bureau of Reclamation, memorandum of December 17, 1984, both our staff and that of Saguaro National Monument have reviewed the subject document and have the following comments.

Impacts on Saguaro National Monument

Past statements to your agency by the National Park Service, concerning the preparation of the EIS for Phase B, have emphasized the unsuitability of both the Sandario and Sandario-San Joaquin Plans (refer to our memorandums of 1/24/84 (L7619 (WR-RP) and 3/30/84 (7619 WR-RPE), and the fact that 36 CFR, Chapter I, part 14, section 14.10 prohibits such projects in National Parks and Monuments without the specific approval of Congress). Therefore, the National Park Service is very concerned about alternative plans and has emphasized the need for a viable underground pipeline alternative. It appears from the material presented in this draft EIS that no consideration is to be given to such alternatives. In Section E. Other Plans Considered but Eliminated the impression is left that neither the Sanders Road (Pipeline) nor West Side-Low Pressure Pipeline are to be considered. We strongly object to the elimination of these alternatives and recommend that they be analyzed in the statement and presented for public review and comment. We must point out however, that the Sanders Road alternative discussed in conference sessions with your office over the past year involves the potential for taking a 100 foot strip of Monument land for construction of the pipeline. This possible exchange or taking of Monument land is a decision that rests exclusively with the Secretary of the Interior. 1

The potential visual impacts that would be imposed on visitors to the Monument by the construction of the surge tanks are inadequately discussed or documented. The potential for visual intrusions on the Tucson Mountain Unit do not end at the boundary line but rather encompass the views to the west of this boundary. These views also are considered valuable to visitor enjoyment of the area and, as such, 2 must be considered as important park resources. The draft statement provides only cursory consideration of scenic quality and visual resource management in relation to the effects of the aqueduct on these qualities when viewed from the Monument. This visual intrusion was first voiced as a concern of the National Park Service some time ago (refer to our memorandum, 5/25/83, L7617 WR-RPE). The failure to adequately address this concern in the draft statement, especially with regard to the specific design elements and visual impacts of the surge tanks to the "final design phase," indicates a lack of understanding of both our purpose and management policies for the Monument and should be examined in detail. It is our understanding that there are alternatives to surge tanks for surge suppression, that these alternatives are less visually intrusive, and that such alternatives would serve to meet Service objections to surge tanks. We strongly urge that such alternatives, fully illustrated and discussed, be added to the environmental analysis.

---

3 The environmental statement fails to fully recognize the impacts to Thornber's fishhook cactus and the potential for impacts to Tumamoc globe-berry imposed by the alternative Sandario and Sandario-San Joaquin Plans. In a survey conducted by Monument personnel (related to another potential impact), it was found that there were over 500 specimens of this cactus along the .22 mile section of Sandario Road, and it is evident that these plants would be impacted by any construction activities utilizing the Sandario Road alignment. This finding is in complete disagreement with the statement in the draft statement (Summary-page 10) that "... Thornber's fishhook cactus ... would be least impacted by the Sandario-San Joaquin Plan." This in turn brings up a question as to what measures have been taken by the Bureau of Reclamation to insure that there are no specimens of Tumamoc globe-berry along this alignment that would be impacted by either of the proposed alternatives.

---

4 In the section entitled <u>Affected Environment and Environmental Consequences</u>, we are concerned about comments made on pages 36 and 37 in reference to impacts on Tumamoc globe-berry. In light of field work done this past year, we question whether the number 38 truly represents the population of known plants and whether only 6 plants of this species would be impacted. Also, we will require evidence that no specimens of this species would be impacted, inside of Saguaro National Monument, along the alternative alignments down Sandario Road.

---

5 In the above-mentioned section, on page 40 where reference is made to wildlife watering sites, the National Park Service has an interest in such structures because of possible site locations inside of the boundaries of Saguaro National Monument. We request that the Service be included as a negotiating party when consideration for the selection of such sites is examined and recommend that the proper mitigation for Monument wildlife <u>must</u> include sites within the Monument. Also, we recommend that financial support to maintain these sites be provided by the Bureau of Reclamation to the National Park Service over the life of the project.

---

6 On page 106 of the statement, subsections L. 1. a., paragraph 2, line 3, all of the paragraph following "... National Park Service feels that ..." should be rewritten to read as: "... the construction of either the Sandario or Sandario-San Joaquin Plans conflicts with legislated management policies for areas of the

National Park Service in relation to the protection and perpetuation of their character and composition. Further, 36 CFR, Chapter I, part 14, section 14.10 prohibits such projects without the specific approval of Congress."

Impacts on Cultural Resources

While the Bureau's procedural approach to cultural resources compliance is excellent, we cannot make substantive comments on the archeological data because the data are not yet available. The archeological documentation should be included in the final EIS for the project. **7**

We believe it is premature to establish a maximum dollar amount of one million dollars (page 3) for cultural resources investigations and mitigation before the specific archeological problems have been identified. Reclamation may use up to one percent (1%), or an estimated three and one-half million dollars of the total project costs for mitigating adverse effects to significant National Register eligible resources. **8**

We request the opportunity to comment on the final EIS, as well as the supplementary archeological documentation, as soon as these reports become available. **9**

We appreciate the opportunity to review and comment on this statement. For additional information on the comments regarding impacts on Saguaro National Monument, please contact either Dr. Robert Hall of Saguaro National Monument (telephone: 602-296-8576) or Jim Huddlestun of this office (telephone: FTS 556-8313). For cultural resources impacts, please contact Garland Gordon of this office (telephone: FTS 556-7972).

W. Lowell White

cc:
Superintendent, SAGU
General Superintendent, SOAR
IAS
WASO (762)

Responses to Comments
National Park Service

15-1 The Sanders Road (Pipeline) alternative is essentially the Sanders-San Modification Plan which has been added to the final EIS (see response to comment 9-1). We recognize that taking a 100 foot strip of the monument for construction of the pipeline would require a decision by the Secretary of the Interior. The West Side Modification Low Pressure Pipeline was eliminated from consideration as a viable alternative for the reasons given in the EIS, but primarily cost (see Chapter II. E.). See response to Comment 9-1.

15-2 The text has been revised to more adequately address your concerns. As you may be aware we have met with Saguaro National Monument personnel on several occasions to further discuss, and more accurately describe and display the visual impact of project features from areas within the monument boundaries. Although the canal would not be visible, for the most part, from the more highly traveled roads within the monument, it would be visible to hikers and visitors to higher elevations within the monument. The view to the west across the valley would be degraded, to some extent, by the visibility of the canal and associated structures from these vantage points. This is an impact of the West Side Plan, and it has been more fully described in the final EIS. Based in part on our discussions with SNM staff, and in response to their concerns, we have evaluated other methods for providing surge protection at the Brawley Pumping Plant. We have concluded that an air-chamber type surge tank can be constructed at this site and will be located with the pumping plant below the natural ground surface. We believe that the additional cost of this air-chamber design (an estimated $200,000) is warranted to reduce visual impacts to SNM and other visually sensitive locations in the Tucson Mountains.

15-3 Rare plant surveys were conducted on the entire West Side route and additional surveys were conducted near or on portions of the other routes. It was the investigator's conclusion that all plans except the West Side would avoid the main population of <u>Tumamoc Globe-berry</u> in the area. Since the Sandario, Sandario-San Joaquin and Sanders-San Joaquin Plans will have major portions of pipeline under existing roads and will disturb less area than the West Side Plan, it is concluded that they will have less impacts to <u>Mammillaria thornberi</u> than would the west side plan. In addition, the highest density of <u>M. thornberi</u> was found in T13S, R11E, Sec. 33. The West Side Plan would cut through this population while the other plans would follow Sandario Road in this area.

15-4 The number of <u>Tumamoc Globe-berry</u> to be impacted have been updated based on the recently completed surveys and is now 81 adult plants out of a known population of 356 adult plants. Fifteen plants (4 adult and 11 juveniles) were located on the Saguaro National Monument. It is likely that some plants would be impacted by all of the plans (except No Federal Action).

However, only the West Side Plan impacts the main population of this species in this area.

15-5 The Park Service will be included in the final location selection of all catchments within the National Monument. Included within the funding agreement to build the catchments are maintenance costs to be provided to the agency that will be responsible for them.

15-6 The paragraph has been changed as noted.

15-7 The final EIS includes the results of a Class III (total intensive) cultural resource survey for the proposed West Side Plan.

15-8 We recognize the availability of about $3.5 million for mitigative data collection studies (1 percent of total construction costs) for the proposed West Side Plan; however, we included the rough estimates ($1 million for each alternative) as an indicator of potential costs.

15-9 The final Class III cultural resource survey report for the proposed Phase B alternative will be provided to your office by our normal distribution.

16

2/9/85

OFFICIAL FILE COPY
U.S. Bureau of Reclamation
Lower Colorado Region
RECEIVED FEB 14 1985
A
Action CO/ML
Action Taken ______ Initials

Date	Initial	To
		150
File		

Regional Environmental Officer
Lower Colorado Region
U.S. Bureau of Reclamation
Box 427
Boulder City, Nevada 89005

Re: CAP Alternative Plans, Phase B
Sanders - San Joaquin Rd. Plan and Plan Modification

Dear Sir:

We are opposed to the pipeline route of the Sanders - San Joaquin Plan due to its detrimental effects on ourselves, our property and our environment. Please keep in mind that Avra Valley has not yet been despoiled, which is the major reason its residents have chosen to live here. 1
It includes the Saguaro National Monument West (across the road from our home), the Tucson Mountain Park, the reknowned Arizona Sonora Desert Museum, Old Tucson, the tourist attraction, and the beauty of a so-far unpopulated scenic valley.

Of great personal concern are the following:

Aesthetic destruction of surroundings/scenery:
- Addition of high-voltage power line - above ground.
- Slow regrowth of destroyed flora.

Health considerations:
- It is not probable that spores causing coccidioidomycosis can be completely controlled, with the possibility of prolonged, serious illness.
- Too-close residential proximity to high-voltage power lines. At the January 17 CAP meeting, we were lead to believe that the power line would be adjacent to the pipeline, even though the maps do not show that. (See attached article regarding dangers of living near high-voltage power lines.)

Other physical-danger considerations:
- The excavated ditch will remain open a long period of time (for each section), prolonging and increasing the danger to children, pets and wildlife.

Permanent loss of property value due to environmental destruction:
- Addition of the power line.
- Lack of original natural flora for period of regrowth.

There will be no improvements in exchange for the intrusion:
- Sanders will remain a dirt road.

The temporary inconvenience of being re-routed (to reach our homes) is minor compared to the above concerns of damage and destruction which we believe will be permanent losses.

We can't believe there can or will be adequate compensation (aesthetic or monetary) for any of the above.

Continued -

Our final point is the already well-documented fact that the Sanders Rd. Plan costs more to implement and maintain than all the other considered routes.

Sincerely,

Earl L. Percival
S. Lorraine Percival

Earl L. Percival
S. Lorraine Percival
RR 9 Box 602
(4615 N. Sanders)
Tucson, AZ 85743

602-682-7355

U.S. plans research on the link between power lines and cancer

By The Associated Press

WASHINGTON — The government plans to step up research on magnetic fields produced by power lines in the wake of studies suggesting that people exposed to such fields may be more likely to get leukemia or other types of cancer and to commit suicide.

Responding to increased scientific and public concern over this issue, the Department of Energy is seeking a 23 percent boost in funding for a research program investigating the biological and health effects of high-voltage transmission lines.

At the same time, a report issued by the Library of Congress has concluded that the federal government currently lacks any official safety standards or enforcement agency to deal with power-line environmental problems.

"There is no single federal agency responsible for assuring public safety and comfort in the proximity of overhead transmission lines, and no federal standards exist setting quantitative limits from HVTL (high-voltage transmission line) field exposure," it said.

The Congressional Research Service report added that although the Environmental Protection Agency "has oversight responsibility for power-line health and environmental regulation in the public sector, it has not been funded to carry out that mandate."

Scientific studies reporting an apparent link between health problems and exposure to electomagnetic fields have included epidemiological surveys of cancer incidence among residents of Denver and three other Colorado localities; leukemia among electrical workers in Washington State and Los Angeles County, Calif., and birth defects in children of power substation workers in Sweden.

In addition, a controversial study analyzing more than 600 suicides among a sample population in England concluded that "significantly more suicides occurred at locations of high magnetic-field strength" near high-voltage transmission lines.

This country's electric power grid involves more than a quarter-million miles of transmission lines, operating at voltages ranging from 115 kilovolts to 765 kilovolts. One kilovolt is 1,000 volts.

Transmission lines rated at 500 kilovolts or higher now stretch for more than 20,000 miles and are expected to cover more than 40,000 miles by 1990, the congressional report said, while lines operating at up to 1,200 kilovolts also are likely to be in service by the end of the decade.

After being transmitted longer distances from generating plants over the high-voltage lines, electricity passes through a system of secondary distribution links and step-down transformers that convert it to the standard 115-volt alternating current used by in homes.

Kenneth W. Klein, a Department of Energy official who oversees DOE's research on power-line biological effects, said the department was asking Congress to increase support for the program from $3 million this year up to $3.7 million in the 1985 fiscal year starting Oct. 1.

In seeking to expand the program, Klein said, "one of the priorities that we have is to look at not only the electric fields, but magnetic fields — something we have not done in the past."

The electricity surging through power lines creates both electric and magnetic fields radiating out from the transmission lines.

Laboratory studies funded by the DOE program are being carried out largely at Battelle Pacific Northwest Laboratory, Richland, Wash.; the University of Rochester, N.Y.; and the Veterans Administration medical center in Loma Linda, Calif.

Klein said the Energy Department program was intended to complement other power-line research efforts being undertaken by New York State as well as the private, utility-funded Electric Power Research Institute, Palo Alto, Calif.

The Library of Congress report said that "under certain exposure conditions, researchers have observed a number of health hazards possibly associated with power transmission lines. These include obvious acute effects such as electric shock, spark discharge and electric-field effects on certain cardiac pacemakers."

"However, some researchers have reported an increased incidence of certain types of blood cancers in some human populations exposed chronically to secondary feeder lines or exposed occupationally to various intensities of electromagnetic fields," it said.

The report added that as a result of recent laboratory studies, "there is accumulating a body of data that suggest subtle interactions between very weak electromagnetic fields and biological systems" at the cellular level.

Responses to Comments
Earl L. and S. Lorraine Percival

16-1 We have noted your concerns and opposition to the Sanders-San Joaquin Plan. The decision, however, has been made to include Sanders-San Joaquin Modification Plan as an alternative in the final EIS (see response to Comment 9-1).

Rt. 9 Box 815
Tucson, Az. 85743
February 11, 1985

Regional Environmental Officer
Lower Colorado Region
U.S. Bureau of Reclamation
Box 427
Boulder City, Nevada 89005

Dear Sirs:

I would like to make an official comment regarding your draft of the Environmental Impact Statement - Tucson Aqueduct - phase B. My congratulations to your professionals who worked so hard to contribute to this draft.

I personally do not enjoy the idea of any construction being started in "my front yard" but realize that there is little to be done to stop progress. But I would like to stress the importance of leaving the environment with as little impact from human encroachment as possible--that is why Environmental Impact Statements are implemented, is it not? But, unfortunately, the Almighty Dollar has a huge role to play in this continuing saga.

I suggest that your people re-evaluate the proposed plans and REALLY consider the environment to be disrupted and find a more feasible way to make more of the open canal into a pipeline for the alternative Sandario- San Joaquin plan. 1

Also, please re-evaluate the animal populations and behaviors in regards to mitigation. The puma population was never mentioned in the EIS and I do know that they inhabit this area. 2

Thank you for allowing a public input and please consider the proposed alternatives.

Sincerely,

Janie C. Schembri

Janie C. Schembri

Responses to Comments
Janie C. Schembri

17-1 The pipeline versus open canal has been evaluated on the entire aqueduct along with the environmental damages as dollar equivalent. The outcome is for the open canal with the environmental mitigations as proposed.

17-2 A small, but undetermined number of mountain lions occur in the Tucson Mountains. The proposed mitigation features (bridges, fencing, water catchments, and land acquisition) are adequate to minimize any impacts to this wide-ranging species according to the Arizona Game and Fish Department.

18

IN REPLY REFER TO:

United States Department of the Interior

BUREAU OF LAND MANAGEMENT
ARIZONA STATE OFFICE
3707 N. 7th Street
Phoenix, Arizona 85014

(933)

OFFICIAL FILE COPY
U.S. Bureau of Reclamation
Lower Colorado Region
RECEIVED A FEB 14 1985
Action CO/ML
Action Taken ______ Initials

Date	Initial	To
		150
File		

February 11, 1985

Memorandum

To: Regional Environmental Officer, Lower Colorado Region, Bureau of Reclamation, Boulder City, NV

From: State Director, Arizona

Subject: Review of Draft Environmental Impact Statement for Tucson Aqueduct Phase B

As you requested, we have reviewed the subject document.

General Comments

We would appreciate early notification of any actions involving public lands. 1

A land ownership map would have been helpful in reviewing the draft document. 2

Will the final EIS incorporate the results of the recent inventory for Tumamoca? 3

Specific Comments

Page 28. Paragraph 2. The generic epithet for night-blooming cereus is spelled Peniocereus. 4

Page 37. Paragraph 3. Is the mitigation plan available? If the mitigation plan involves public land, BLM should be contacted early in the development stages of the plan. 5

Page 37. Paragraph 4. Is land acquisition being considered to mitigate the impacts to Tuamamoca? 6

Page 38. last paragraph. Wildlife crossings should be at least 16 feet wide. 7

Page 40. Paragraph 1. If any of the proposed wildlife watering sites occur on BLM land, BLM should be consulted early in the development process. 8

Page 41. We recommend that during construction less than one-half mile of trench should be open at any one time. This measure would help reduce wildlife losses. 9

10 Page 42. No. 11. Correct the spelling of Coryphantha.

Thank you for the opportunity to review and comment on the draft environmental impact statement.

Beaumont C. McClure

Acting

Responses to Comments
Bureau of Land Management

18-1 Our Lands Division will notify you of actions that involve public lands. Once the lands have been surveyed and final locations available, we will coordinate more closely with you.

18-2 The lands status map (Figure 53) provides land ownership information.

18-3 The results of the recent inventory for Tumamoca globe-berry have been incorporated into the final EIS.

18-4 The correction has been made in the final EIS.

18-5 A general mitigation plan (in two phases) is described in Chapter III.A.3. The number, location and design of features are subject to future refinement and the BLM and other agencies will be consulted throughout the process. No wildlife water catchments are currently proposed on BLM land, but any decision to do so will be closely coordinated with BLM.

18-6 Approximately 100 acres of Tumamoca habitat now under private ownership are being considered for acquisition to offset any impacts from aqueduct construction. The need for such acquisition will be determined under consultation with the U.S. Fish and Wildlife Service after this species is proposed and listed.

18-7 The numbers, extent, and location of crossings, catchments, fencing and barriers shown in the tables are based on recommendations made by the Arizona Game and Fish Department contractor. These may be modified when the mitigation is finalized in future discussions with the AGFD, FWS, and Park Service.

18-8 See response 18-5.

18-9 The open trench has side slopes that should allow most wildlife to escape. This applies to both pipe and canal during construction. The smooth finish on the completed canal however, will trap wildlife. In the pipe operation wildlife should be able to escape at any phase of the work.

18-10 The correction has been made in the final EIS.

19

OFFICIAL FILE COPY
U.S. Bureau of Reclamation
Lower Colorado Region
RECEIVED A FEB 14 1985
Action CC/ML
Action Taken ______ Initials

Date	Initial	To
		150
File		

February 11, 1985

Regional Environmental Officer
Lower Colorado Region
U.S. Bureau of Reclamation
Box 427
Boulder City, Nevada 89005

Dear Sir:

This letter is written to express my concern with those items not completely dealt with in the EIS for the Avra Valley seciton of the CAP aqueduct through southern Arizona.

I am a property owner in Avra Valley who is most concerned with the destruction of vegetation and animals. The mountain lion was not even mentioned in the EIS. The aqueduct will disturb their natural migratory paths tothe other mountain ranges. They are too large to cross the aqueduct through the crossings for the smaller animals. How will you deal with this? **1**

Another area not covered - the flooding that occurs when the washes are full of water during storms. There is tremendous force behind the water and it carries with it lots of debri. When this natural flow is stopped by this aqueduct, it will cause damage to nearby properties. What compensation will there be for property owners who lose property to this? Also, that will be done about the standing pools of water and the mosquito problem that will result, not to mention the drownings of animals and children? **2**

Property owners have been required to put their utilities underground, yet you plan to put high power lines in. That does not seem right. Also, what about all the problems these high power lines will cause for residents? **3**

What about the lowering of property values that will be caused by the aqueduct? I currently have acreage for sale. What compensation will I get when I have to sell that property for considerably less because of the aqueduct that will destroy the beauty of the valley? Those of us who moved out to the valley chose to live there because of the beauty and peacefullness. The aqueduct will destroy them both. How sad that our beautiful valley will be destroyed and yet we will get NO BENEFITS from the aqueduct. **4**

---

5 As a parent and Parent Teacher Organization President of Desert Winds Elementary School, I am concerned with the possible injury and/or death of area children from the aqueduct. Our elementary school is within a mile of the aqueduct. It frightens me think of what may happen to our children.

6 If this project must come through Avra Valley, please look again at putting it underground. It may cost more initially, but the destruction the aqueduct will cause can never be replaced.

Thank you for your time.

Sincerely,

Judith Capen

Judith Capen
Route 9, Box 500
4800 North Old West Road
Tucson, Arizona 85743

Responses to Comments
Judith Capen

19-1 See response to Comment 17-2.

19-2 All alternatives of the Tucson Aqueduct, Phase B, have been designed to protect any portions of canal against cross drainage flows. These designs call for protecting the canal with embankment dikes and for passing any water collected behind the dikes across the canal through various cross drainage structures such as pipes, box overchutes, and culverts. No structure along the canal has been designed to retain water for any significant period of time. Large pools of water caused by extreme flood events will drain from behind the dikes usually in less than 24 hours with a maximum emptying time for any dikes being less than 36 hours. All pools will stay within the fenced right-of-way, and considering the infrequency of such events, these temporary pools should pose little risk to wildlife, domestic animals, and children. Any residual pools of water which may remain in low spots behind the dikes or in the cross drainage structures will be well within the fenced right-of-way and will pose little threat in terms of drowning. Mosquito (vector) control has been addressed in the "Central Arizona Project Operation and Maintenance Plan" which is available to the public upon request.

19-3 The problems associated with an underground transmission line are described in Chapter II.E.3. of the final EIS. The electrical effects attributed to transmission lines are described in Chapter III.J.3. of the final EIS.

19-4 Based on our experience with completed portions of the CAP aqueduct, we do not anticipate any negative affect on property values in general.

19-5 Fencing will be provided along the aqueduct to prevent the exposure to safety hazards in areas that are adjacent to schools, recreational areas, or subject to frequent visits by children. The fence will consist of a 6-feet high chainlink fabric topped by three strands of barbed wire. In addition, the safety features discussed in Chapter III, Section K Potential Safety Hazards will be provided.

19-6 See response to Comment 17-1.

National Parks & Conservation Association

1701 Eighteenth Street, N.W. • Washington, D.C. 20009

RUSSELL D. BUTCHER
Regional Representative
SOUTHWEST & CALIFORNIA
Box 67
Cottonwood, AZ 86326
(602) 634-5758

(202) 265-2717

February 12, 1985

Regional Environmental Officer
Lower Colorado Region
Bureau of Reclamation
Box 427
Boulder City, NV 89005

RE: CAP Tucson Aqueduct
Phase B

Dear Sir:

National Parks & Conservation Association, a private, nonprofit membership organization headquartered in Washington, D.C., with a regional office in Cottonwood, Arizona, appreciates this opportunity to respond to the December 18, 1984, Draft Environmental Impact Statement on the Tucson Aqueduct Phase B of the Central Arizona Project.

Regarding the "Agency Proposed Action"--the West Side Plan for the Tucson Aqueduct, it is naturally unfortunate, from our perspective, that such a large-scale engineering project is proposed for construction within the vicinity and viewshed of the Tucson Mountain Unit of Saguaro National Monument and the adjacent Tucson Mountain Park and world-famous Arizona-Sonora Desert Museum. Some degree of impairment of the visitor's use and enjoyment of these outstanding parklands will inevitably result, even with the array of proposed mitigation measures.

We urge that one totally omitted major alternative be added to the EIS document: a completely buried aqueduct following the West Side Plan route. If the EIS includes a buried alternative through Saguaro National Monument that would require an act of Congress, then logic suggests a completely buried pipeline alternative along the West Side Plan route should also be described and its environmental impacts fully indicated--irrespective of whether or not such an alternative appears economically feasible. 1

Focusing our comments upon the West Side Plan, we are aware that some of the environmental impacts of this aqueduct (wildlife migrations, for example) will be, and to an extent already are, also impacts of rapidly increasing urbanization in the Avra Valley--on lands west of Saguaro National Monument and Tucson Mountain Park. Thus, there will be a cumulative impact of aqueduct and urbanization that will impair or destroy what was, only a few short years ago, a virtually unblemished expanse of wild Sonoran Desert.

We are particularly pleased, therefore, with the proposal to acquire, as part of the cost of the aqueduct project, four sections (about four square miles) of Arizona State Trust Land adjacent to Tucson Mountain Park "as replacement acreage for habitat losses due to canal and pipeline construction, a wildlife movement corridor, and to mitigate for effects on M. thornberi [Thornber's fishhook cactus, Mammillaria thornberi] populations." (p. 42) We support with enthusiasm the plan to protect this important acreage--extending from Tucson Mountain Park to the Papago Indian Reservation--free of road construction and other developments, excepting the Tucson Aqueduct. And we favor the document's statement that "This land must be turned over for management as a wildlife area to a state or county resource agency such as the Tucson Mountain Park." (p. 39) This would be an outstanding addition to the Tucson Mountain Park/Saguaro National Monument parklands complex, and would appear to ensure, as the Draft EIS says (p.39), "a permanently open corridor in and out of the mountains regardless of future development patterns in the Avra Valley."

---

2 We do question, however, by what means this state land would be acquired: (1) by cash payment to the State from the CAP budget, (2) by an exchange for Bureau of Reclamation lands elsewhere, or (3) by a deed of relinquishment under which the Bureau of Land Management would be required to turn over lands under its jurisdiction of equivalent value? The BLM ~~has~~ is al-

ready ~~been~~ required to give up some $80 million worth of public lands in Arizona for CAP-related needs. In the case of these Arizona State Trust Lands adjacent to Tucson Mountain Park, we urge either (1) or (2) above would be preferable.

Regarding the aqueduct/pipeline itself, we commend plans to incorporate wildlife crossings "at appropriate locations along the canal"; that "Locations and number of crossings should be determined by AGFD (Arizona Game and Fish Department) based on results of their contract study (p.41, Recommendation 4). We hope that study will recommend additional wildlife crossings beyond those indicated on the accompanying EIS maps; and we urge that the operable word "should" be changed to "will" to make more certain the authority of AGFD in this critical wildlife welfare matter. **3**

Similarly, we urge that the word "should" be ~~used~~ changed to "will" in the listing of all the other recommendations listed on pages 41 and 42. These recommended actions to reduce environmental harm or restore disturbed habitat are outstanding and should be required project stipulations. **4**

We are pleased that (because of topographical constraints) two sections of the aqueduct near Saguaro National Monument are to be placed underground. The result should be to substantially reduce the disturbed corridor width, reduce visibility impairment from within the monument, and reduce wildlife migration impacts.

Our Association notes that pumping facilities will be required to push the water up these two pipelines. We are concerned that, as stated in the Draft EIS, page 67: "The operation of pumping plants will contribute to the sound levels in the adjacent areas." The document goes on to say sound levels are "well within acceptable limits." The crucial question the document fails to answer is: where and in what context will these sound levels in adjacent areas be acceptable? Against a background of **5** virtually no sounds in the desert--would the alien sound of machinery, such as a pumping station, although not of great magnitude, be nevertheless a disturbance that could impair visitors' enjoyment of the natural silences, bird songs, etc., in Saguaro National Monument? The document indicates that operation of the pumping plants "is not expected to cause a noise nuisance" (p. 67). Yet, the earlier statement says the noise "will contribute to the sound levels in the adjacent areas." Several terms here are ambiguous and should be greatly clarified in the Final EIS: what is meant by "adjacent" areas. Adjacency is a purely relative term, and could, for instance, mean just a few feet away, or within a mile or more. Anything mechanical that could "contribute to the sound levels" would predictably have a negative impact upon visitor enjoyment of a natural park area. The document should be far more specific in giving the public a clear idea of just how far such sounds will be detectible. Furthermore, if there is a question about noise nuisance--as raised by the document's own words: "is not expected to cause noise nuisance," there should be steps taken to assure there will be no noise nuisance on adjacent lands, either parkland or residential. Machinary and pump housing structures should be extraordinarily well insulated, and perhaps placed below ground level.

Our other question regarding pumping operations concerns the surge tank proposed for each of the four pumping plants. The document says (p. 72) that, for three of the tanks including Brawley close to the southwest corner of Saguaro National Monu-

6 ment, "there are no nearby topographic features to contain, or screen, the surge tanks, and they would be plainly visible for some distance. The Brawley Pumping Plant surge tank, if constructed at its full height, would be visible to sensitive areas to the east, such as the Saguaro National Monument."

We agree with the Draft EIS that the visual impact of these prominent structures could be made somewhat less conspicuous if painted a color to blend with the surrounding landscape. We question, however, the statement (p. 73) that "there would really be no way to fully mitigate the visual impact of their presence." Since a surge tank relies primarily upon a given volume for the tank to be effective, we urge that such a tank could be designed with short vertical and broad horizontal dimensions, rather than the other way around, so that it would squat low on the land. Might there not even be some way to place the tank below ground level? These design and placement modifications, it seems to us, would result in greatly reduced visual and sound impacts.

Regarding the canal itself, one way (not mentioned in the Draft EIS) to reduce its visual impact is to add coloring to the concrete that will help blend the structure into the surrounding desert landscape--doing so at least on those canal sections west of Saguaro National Monument, Tucson Mountain Park, and the Arizona-Sonora Desert Museum. In flying over the completed CAP canal west of Phoenix, we have noted how the stark whiteness of the concrete lining stands out in sharp contrast to the surrounding muted desert earth tones. This coloring process would seem a relatively easy mitigation measure that may even be environmentally and economically preferable to constructing extra high dikes to hide the canal from vantage points upslope in Saguaro National Monument and Tucson Mountain Park. Such dikes would themselves be significant visible man-made features, and they could conceivably produce undesirable environmental side effects. **7**

Regarding the proposed 69kV and 115kV transmission lines, we are naturally pleased to see the proposed alternatives avoid cutting through Saguaro National Monument. We hope these lines will follow the aqueduct corridor, since that would place them farther from the monument. To help reduce the visibility of the transmission facilities, we urge that non-specular conductors be used along the stretch visible from Saguaro National Monument and Tucson Mountain Park. We are pleased to read (p. 49) that **8**

"All powerline poles will be of a design that will prevent accidental electrocution of raptors." This measure is particularly important since Saguaro National Monument and Tucson Mountain Park provide important habitat for a wide variety of raptor species, including the golden eagle.

---

9 Concerning re-vegetating of disturbed ground along the canal corridor (beyond the canal and essential maintenance roads) or on ground above pipelines, we recognize, as the document states (p. 48), that the fragile Sonoran Desert habitats "are very susceptible to damage and re-establishment of some species is extremely slow." This is one excellent reason to reduce to a minimum all such land disturbances. We are pleased to read the document's provision that (p. 48): "Mitigation for destroyed habitat would consist of revegetation <u>attempts</u> on all construction disturbed areas not required for operation and maintenance of the aqueduct. Revegetation <u>would be attempted</u> on all spoil areas, borrow areas, and protective dikes immediately after they are used or constructed.... All areas of construction disturbance would be revegetated and areas previously disturbed would be overseeded, if necessary." [emphasis added] We urge, however, that a more precise explanation be given regarding what is intended by the terms "attempts" and "would be attempted." Will the advice of professional botanists with a proven thorough knowledge and understanding of the Sonoran Desert's native plantlife be sought and applied? What should happen if initial attempts along the route prove unsuccessful? From this document, the public cannot tell whether (1) no further attempts would be required, (2) another followup attempt would occur, or (3) attempts would continue until success is achieved. What level of success or lack thereof would constitute an "attempt," as intended by the EIS? Since we know re-vegetation does prove successful with great care, we urge attempts be carried out until success is achieved.

Regarding the unfortunate fact that "The West Side Plan would cut through Thornber's fishhook cactus habitat for several miles and destroy an estimated 19,000 cacti" (a possibly conservative estimate), and that "the area impacted by the West Side Plan contains some of the densest and healthiest stands of this species," (p. 36), we urge that every conceivable way be found to avoid or reduce such a major impact upon a species proposed as a federally designated "threatened species." We do note that the stretch of buried pipeline from Brawley Pumping Station would cause less harm than would an open canal through this cactus habitat; yet, we urge that extraordinary care be taken in pipeline construction to minimize the extent of disturbance. We question whether a shifting of the aqueduct through this area could also prevent unneccessary destruction. As "preventive archaeology" in pipeline construction projects often saves irreplaceable cultural sites, we would hope the least destructive route will be selected in this instance. **10**

Is it, for instance, not possible to shift the line essentially out of Section 33? It is within Section 33 that we understand the best and densest of Thornber's cactus plants grow. By shifting out of, or even mostly out of Sec. 33, the aqueduct would also have less sharp turns just northwest of the Brawley Pumping Plant and at the end of the pipeline in Section 3. **11**

We hope the above comments will be helpful, and our Association appreciates the chance to express our views on the Tucson Aqueduct.

Sincerely,

Russ Butcher

~~Russell D.~~ Butcher
Southwest-&-California Representative
Nat'l Parks & Conservation Ass'n.
Box 67, Cottonwood, AZ 86326
(602) 634-5758

cc: Bruce Ellis
Environ. Program Man.
AZ Projects Office
Bur. Reclamation
P.O. Box 9980
Phoenix, AZ 85068

Rob Arnberger, Superintendent
Saguaro Nat'l Mon.

Responses to Comments
National Parks & Conservation Association

20-1 A completely buried aqueduct following the West Side Plan route was considered but eliminated as an alternative (see West Side Modification - Low Pressure Pipeline, Chapter II. E. (1)). However, in response to public comment and based on discussions with the National Park Service, Friends of the Desert, and the Southern Arizona Water Resources Association, the decision was made to include Sanders-San Joaquin Modification Plan in the final EIS. This plan is very similar to the route followed by the West Side Plan but consists of more pipeline. In addition, the pipeline would be adjacent to the west boundary of the Saguaro National Monument rather than going through the Monument as with the Sandario and Sandario-San Joaquin Plans. Discussions relative to the Sanders-San Joaquin Modification plan have been incorporated throughout the document where appropriate.

20-2 If the state lands within the mitigation corridor qualify for the Deed of Relinquishment (DOR) process, then Reclamation is required to acquire these lands by the DOR process. State lands that do not qualify for the DOR process will either be purchased from the state or an exchange will be worked out between the state and Reclamation.

20-3 See response to Comment 18-7.

20-4 These recommendations are from the FWS Coordination Act and we do not have the liberty to edit their recommendations. However, we have committed to implement all of these recommendations except number 9. "Minimizing disturbance" would include restricting construction disturbance to the aqueduct right-of-way within one half mile of active Harris' hawk nests. No haul roads, equipment yards or other related impacts off of the right-of-way would be permitted off of the right-of-way in these areas. In addition, construction crews would be informed of laws protecting wildlife from disturbance and given directives in their contracts to comply with these laws. The suggestion to "curtail construction" from January 1 to June 1 near Harris Hawk nests and to "halt construction from May 1 to October 1 in the wildlife corridor" could result in only 2 months of construction being allowed per year in some areas. This would not be compatible with construction schedules and would only be considered to avoid disturbance to a federally listed species.

20-5 The design and construction of the pumping plants will minimize any sound in the area outside of the project right-of-way. The features of the plants will be constructed in an excavated basin; the pumps will be encased in concrete and below the ground; the drive motor is on top of the concrete but is enclosed for cooling purposes. This complete unit then is enclosed in a precast concrete building. With the pump in the basin the sounds that are made will be reflected upward by the excavation slopes. Therefore, there should be very little if any sound pollution in the area. The discussion in the final EIS has been modified to clarify the ambiguous terms.

20-6 Through the process of designing the system three different methods of surge control were studied. The first is the standard two-way surge tank. This tank is situated over the discharge line of the point of greatest negative pressure with the top set at the maximum hydraulic grade line. There are no valves or moving parts in this structure and it operates by taking water from the surge tank into the discharge line and back into the tank as the surge reverses itself. This type is the most economical. The second type is the low and wide one way tank. This tank is again located of the point of greatest negative pressure. This tank is sized to contain the volume of water required to maintain the discharge line full and requires a valve system that allows the water out of the tank but stops it from returning when the surge reverses. These valves are rapid closing and cause loud noises on closing. Also, depending on the size and length of the discharge line, it may require several valves, thus effecting the reliability of the system. This is also the most costly of the systems. The third method, and the design selected for the Brawley, Snyder Hill, Black Mountain, and San Xavier Pumping Plant, is the air chamber system. This system is a sphere located adjacent to the pumping plant and connected to the discharge line. This chamber is filled with water and pressurized with air to force the water into the discharge line in the event of a down surge caused by a pump failure. This tank requires an air compressor to maintain the correct volume of water and air in the system. This is rated second in reliability and cost but is the most environmentally acceptable as it is located in the basin with the pumping plant.

20-7 The dikes on the upslope side of the canal would not be constructed as visual mitigation features, but rather would be necessary to provide cross drainage protection to the canal from natural storm runoff. They would however, function to conceal the canal from most of the more visually sensitive vantage points to the east. We have evaluated the concept of coloring the canal concrete to help blend the structure into the surrounding landscape. We have concluded that coloring the entire concrete surface of the canal is not justified. Once operational, the canal will remain filled with water, except on rare occasions when maintenance may require temporary dry-ups. Because of this, and because the dike will be of adequate height to provide some visual relief, we have concluded that the additional cost is not justified. However, we agree that painting or staining highly visible canal structures, such as bridges, pipe and flume overchutes is a valid technique for reducing visual impact, and have included this commitment in the final EIS.

20-8 As a mitigation measure for visual impacts, non-specular conductors will be used along the entire length of the transmission line.

20-9 The micro-habitat of a canal dike or steep slope of a pumping plant excavation may not provide the specific requirements to support all the plants native to this specific location. Plants native to Arizona but not specifically native to the Tucson area (species that can tolerate exposure on a bare, steep, low moisture-retaining substrate such as a dike) may be the only species that can be established, at least initially. If no such native species are successful, consideration may be given to the use of non-native species but only if agreed to by other interested parties including the Arizona-Sonora Desert Museum which is working closely with us to develop a suitable seed mixture. All reasonable efforts (as determined collectively by the resource agencies and organizations involved) will be made to revegetate all disturbed areas. Necessary and effective mitigation monitoring will be designed in conjunction with the FWS and AGFD and other concerned parties once the mitigation is finalized and monitoring priorities are determined. No specific monitoring plans have been formalized at this time.

Monitoring to determine the effectiveness of the mitigation will begin immediately after construction is completed and will continue until it is determined that the mitigation is working. If additional mitigation needs are identified they will be added and monitored to determine their effectiveness.

20-10 A likely conservation measure to off-set the loss of 19,000 Mammillaria thornberi from construction would be to acquire and preserve from future development a parel of 4.25 square miles supporting an estimated 27,000 individuals of this species.

20-11 The location of the line is at its optimum position with the National Monument and the homes in section 4. To move the alinement South would require considerable more excavation or longer discharge line, both which greatly increase the overall cost of the project.

LAW OFFICES OF

STRICKLAND & ALTAFFER
2200 602 TRANSAMERICA BUILDING
TUCSON, ARIZONA 85701

WILLIAM E. STRICKLAND
DABNEY R. ALTAFFER

TELEPHONE 622-3661
AREA CODE 602

February 12, 1985

OFFICIAL FILE COPY
U.S. Bureau of Reclamation
Lower Colorado Region
RECEIVED FEB 14 1985
A
Action CO/ML
Action Taken ____ Initials

Date	Initial	To
		150
File		

Regional Environmental Officer
Lower Colorado Region
U. S. Bureau of Reclamation
P. O. Box 427
Boulder City, Nevada 89005

Re: EIS Tucson Aqueduct -- Phase B
Central Arizona Project

Dear Sir:

Representatives of the Papago Tribe of Arizona were unable to attend and present oral and written comments at the public hearings on the merits of the West Side Plan.

Therefore, the enclosed comments are hereby submitted for your consideration.

Very truly yours,

STRICKLAND & ALTAFFER

Wm E. Strickland

William E. Strickland
General Counsel for
Papago Tribe of Arizona

WES/jc
encls.

cc: Josiah Moore, Chairman
Papago Tribe of Arizona
P. O. Box 837
Sells, Arizona 85634

Bureau of Reclamation
Arizona Projects Office
Suite 2200 Valley Center
201 North Central Avenue
Phoenix, Arizona 85073-
File 330-700

THE PAPAGO TRIBE OF ARIZONA

P.O. Box 837 • Telephone (602) 383-2221

Sells, Arizona 85634

PAPAGO TRIBE'S WATER COMMISSION

February 11, 1985

To: United States Department of the Interior

From: The Papago Tribe's Water Commission

Subject: Comments on Bureau of Reclamation's decision to identify the West Side Plan as the Agency's proposed action.

The Papago Tribe of Arizona through its Tribal Council established a Water Commission whose membership was made up of designated leaders from the various Tribal Districts with serious infringement of its water rights by Non-Indian entities including the Federal Government. This Water Commission hereby submits its comments on the Bureau of Reclamation's decision to identify the west side aqueduct alinement as the proposed action.

The Southern Arizona Water Rights Settlement Act of 1982 (Title III of Public Law 97-293 enacted October 12, 1982) mandates the Secretary of the Interior to deliver Central Arizona Project water and other imported water to the San Xavier Reservation and the Garcia Strip and/or Vaya Strip of the Schuk Toak District of the Sells Reservation through the Central Arizona Project aqueduct system as soon as possible but no later than October 12, 1992. Any delay in the construction of this aqueduct would materially affect the Papago Tribe and its people. Therefore, the Papago Tribe must set a high priority on all factors that will expedite the completion of the Phase B portion of the Tucson Aqueduct which extends to the southern boundary of the San Xavier Reservation.

This action should not be construed by the Bureau or other interested parties that the Papago Tribe or its Water Commissioners are not seriously concerned with all adverse environmental impacts associated with the west side plan. The Papago people have a history of fighting for the preservation of their land in its natural state and being extremely slow and cautious in allowing any change that would or might create an adverse impact on their land, water, air, natural habitat and other natural resources of their reservation. Mr. John Narcho, Chairman of the San Xavier District, member of the Papago Tribal Council and a member of the Water Commission, actively participated as a member of the Committee on Alinement, Terminus and Storage (SAWRA) and listened and studied all alternative routes for the Central Arizona Project aqueduct. All adverse environmental impacts associated with the west side alinement were presented, discussed and considered by this committee. All other possible alinements were analyzed and compared with the west side alinement. Even though the west side alinement has adverse environmental impact, as do all alternative routes, we believe there is the ability to mitigate most adverse environmental impacts associated with the West Side Plan.

The west side aqueduct alinement is definitely an advantage to the Congressionally mandated delivery of water to the Garcia Strip and/or Vaya Strip of the Schuk Toak District of the Sells Reservation and to the San Xavier Reservation. The West Side Plan is also the least expensive alternative. Due to the large Federal budget deficit and the Administration's intent to cut funding for existing water projects, including the Central Arizona Project, it is essential that the least cost alternative plan be adopted if this project is to be completed prior to October 12, 1992. If the Central Arizona Project delivery system is not completed by this date and the quantity of water mandated by the Act is not delivered to the San Xavier Reservation and the Garcia and/or Vaya Strip of the Schuk Toak District, the United States Government will be liable for substantial damages as set forth in Title III of Public Law 97-293.

Therefore, the Papago Tribe's Water Commissioners hereby accept the West Side Plan with the exception of the aqueduct alinement through the San Xavier Reservation including the terminus point or termini points at the south boundary of the Reservation.

Although the Bureau of Reclamation has consistently pub-
1 lished materials and maps which identify a definite aqueduct alinement through the San Xavier Reservation, neither the San Xavier District, the Papago Tribal Council nor the many individual allottees agree to this alinement or any other alinement. Part of the problem involved in this matter is the lack of information and data for the Papago people to make an intelligent decision. Without this information and data it is useless to take the necessary steps to acquire a consensus of opinion as to any aqueduct alinement through the San Xavier Reservation. There are some studies being performed at this time but lack of available funds has impeded the progress of this critical decision making process. It is imperative that the Bureau of Reclamation understand that without tribal consent a right-of-way across the San Xavier Reservation cannot be obtained. It is also necessary to acquire the consent of each individual

allottee whose land is involved in any aqueduct alinement. This critical problem has been ignored too long and should be addressed as soon as possible.

The Papago Tribe's Water Commission wishes to emphasize that it is willing to work closely with the Bureau of Reclamation to expedite a solution to the problems set forth hereinabove.

John Narcho
Water Commissioner
San Xavier Reservation

Rosemary Lopez
Water Commissioner
Chukut Kuk District

Max Jose
Water Commissioner
Gila Bend Reservation

John Lewis
Water Commissioner
San Xavier Reservation

Willard Juan
Water Commissioner
Sif Oidak District

Responses to Comments
Strickland & Altaffer

21-1 We will work closely with the tribe on right-of-way acquisition procedures and requirements. We understand that tribal consent is necessary, and also individual allottee consent on allottee lands. Toward this end we have already held two public informational meetings on the San Xavier Indian Reservation to identify specific allottees affected and to inform Reservation residents of the proposed aqueduct alinement.

Reclamation realizes that the Tribe will not make a decision concerning the alinement until their development plan is completed. This plan is being developed by the Tribe under a Public Law 93-638 contract with Reclamation and is scheduled to be completed in October 1985. Reclamation intends to continue coordinating with the Tribe as the studies proceed.

22

February 10, 1985

Regional Environmental Officer
Lower Colorado Region
U.S. Bureau of REclamation
Box 427
Boulder City, Nevada 89005

Comments to: Statement Number INT DES 84-68

I am sorry the Bureau of Reclamation has proposed action on the West Side Plan inasmuch as that plan has the highest negative impact in most of the areas considered.

The impacts that I believe must be the very lowest possible are for: biological, cultural, visual, sound and recreational resources.

From this study it is expected that the West Side Plan will have the highest negative impact on biological resources. And, on page 10, last paragraph, it is stated that the adverse overall biological impacts of that plan would be satisfactorily mitigated. However, costs and time predictions to accomplish this are not given. **1**

To prevent direct and secondary destruction of all cultural resources steps need to be taken to route the pipeline through the areas known to have the lowest number of sites. **2**

Total negative impact to the visual resource will not be determined until it (heaven forbid) is in place--the design of the pipeline is subject to change and more surge tanks could be added (100 feet high)! **3**

Sound is not a matter of decibels only--a constant noise at any decibel level is often more disturbing and harmful. The plan would subject not only the residents of the area but also visitors to the Saguaro National Monument and the Arizona-Sonora Desert Museum to very distracting noise. Hikers seeking peace and quiet on the trails of the Tucson mountains will be disappointed. In addition the noise (and dust) caused by maintenance vehicles and off-road bikers (more dust) using the access roads must be added to the discomfort of those within hearing distance--and that distance is, for some reason, multiplied manyfold on the desert. **4**

The aqueduct will diminish the recreational usefulness for everyone. It is indeed unfortunate that the Saguaro National Monument, the Tucson Mountain Park and the Arizona-Sonora Desert Museum are not taking a more active role in trying to preserve their world-wide reputations. The Museum's future expansion may well be limited. **5**

I refer now to page 104. Yes, I am distressed at the prospect of having beautiful sunrises and sunsets forever ruined by the sight of pumping stations, transmission lines and surge tanks; distressed to know many cultural resources are gone forever and that unscrupulous treasure seekers will destroy more; distressed to know many of the animals and plants are also distressed and in danger of extinction; and distressed to think I will no longer be able to hike through the desert and enjoy all of nature's desert. **6**

I am not convinced that it is not only possible and, over the long haul, money saving to locate the aqueduct through existing farmland. The number of miles and the amount of material would be increased but the ease of construction (little rock to blast, etc.) would cut the time to build. The aqueduct would be nearer to one **7**

Comments to: Statement Number INT DES 84-68
Page two

of the three prime potential users and the secondary negative impact would be lessened--in fact, the environmental impact would be lessened in all areas of concern almost 100 percent. The City of Tucson owns farm land in the valley--perhaps, when Federal funds are severely cut, Tucson will be ready to offer its land and be willing to put money toward the project--Tucson will be the prime user--in 10 years the use by mines will be greatly diminished. Farmers are beginning to conserve and some farm land is being phased out. It makes no sense whatever to destroy the foothills of the west side of the Tucson Mountains when it is not even the most efficient way to go--the future must be anticipated--more money spent now will save money in the future.

---

8 The value of the homes near the aqueduct may very well decline to a level that will make it impossible to sell and relocate.

---

9 My happiness today is even now diminished by the prospect of the future I dread. Perhaps the endangered Thornber's fishook cactus and the Tumomoc globe-berry and the other severely threatened species will cause sufficient consternation to bring about a new plan design that will benefit all the native plants and animals and that we who live harmoniously among them can enjoy the peace and quiet and beauty of the desert.

Sincerely,

Rosemary Maddock

Rosemary Maddock
4405 N. Old Ranch Road
Tucson, AZ 85743

Responses to Comments
Rosemary Maddock

22-1 Mitigation costs for all alternatives are given on Table 2 of the EIS.

The mitigation schedule is discussed in Chapter III.A.3. Most structural mitigation will take place prior to or during the construction of the aqueduct while any additional needed mitigation will be implemented after construction if determined to be necessary by monitoring.

Necessary and effective mitigation monitoring will be designed in conjunction with the U.S. Fish and Wildlife Service and the Arizona Game and Fish Department and other concerned parties once the mitigation is finalized and monitoring priorities are determined. No specific monitoring plans have been formalized at this time.

Monitoring to determine the effectiveness of the mitigation will begin immediately after construction is completed and will continue until it is determined that the mitigation is working. If additional mitigation needs are identified they will be added and monitored to determine their effectivenss.

All reasonable effort (as determined collectively by the resource agencies and organizations involved) will be made to revegetate all disturbed areas.

22-2 Federal law requires Reclamation to identify significant cultural resources and mitigate adverse affects which may be caused by construction of the Tucson Aqueduct Phase B. While it is our desire to preserve our cultural heritage, this is not always feasible within the guidelines of a large construction project like the Central Arizona Project. We will develop a mitigation plan of data collection studies (subsurface excavations and data analyses) in concert with the Arizona State Historic Preservation Officer to reduce impacts to significant cultural resources.

22-3 Because of concerns raised about the visual impacts, the tall surge tanks are no longer proposed at Brawley, Snyder Hill, Black Mountain, and San Xavier Pumping Plants (see responses to Comments 14-3 and 15-2).

22-4 The sound from the pumping plants will not be a distraction to hikers on the Monument as these plants will be below the ground and enclosed in a concrete building (see response to comment 20-5). The access to the pumping plants will be by paved roads. The canal operation road will be an all weather road and will be closed to public traffic. Travel on this road will average about one round trip per day after the initial start up period.

22-5 Potential recreation opportunities along the alternative alignments are ranked low for the No Federal Action, moderate to low along pipeline sections, and moderate along open canal sections. Based on the current development and land ownership trends, very little of the land identified as CAP alignment right-of-ways R-O-W would be available for public recreation development and use. The pipeline portions of the alignments would require less CAP R-O-W, however, the availability of the pipeline for recreational uses is highly unlikely since the majority of these sections would be in or adjacent to existing roadway and utility R-O-W. In those cases where the pipeline is not in an exisitng R-O-W, recreational use could be contingent upon the form of R-O-W acquisition and management.

The open canal sections with their associated flood detention basins will require that Reclamation acquire these areas on a permanent basis. This allows the opportunity of recreational development and use along the canal R-O-W as well as in the flood detention basins. This type of recreational development and use is already taking place along the CAP canal in the Phoenix metro area and similiar types of recreation are expected to occur in the Tucson Phase B area. In many cases, the canal itself is not visible from the detention basins and along the upslope area proposed for a County trail. We have been coordinating the continuity of the trail with Pima County Planning and Zoning Department and the Pima County Parks and Recreation Department.

We agree that the quality of the recreation experience along the open CAP canal is not the same as could exist in an undisturbed natural setting, reserved for recreational and preservation purposes. However, a comparison of all the alternatives reveals that even with the No Federal Action Plan, that type of setting (undisturbed, natural) is not realistic. Therefore, we have concluded that there would not be any alternative that would qualify as having the potential to provide a high level of recreation.

22-6 See response to comments 14-3, 15-2, 20-7, and 20-9.

22-7 Your suggestion that the alignment be located on existing farm land results in several other problems in addition to the fact that over one half of the water goes for municipal and industrial use. An alignment through the farm land would require more pumping plants and/or longer discharge lines, both of which add considerable cost to the project, over the proposed West Side Plan. As far as a saving in the construction costs due to rock excavation the current alignment has virtually no rock.

22-8 See response to comment 19-4.

22-9 Formal consultation with the FWS Endangered Species Office will determine if the selected plan will jeopardize the continued existence of any listed species and will develop reasonable and prudent alternatives to prevent a jeopardy if such alternatives exist. If no reasonable and prudent alternatives are available, Federal Law could prevent the action from occurring.

23

Tucson Rod and Gun Club

P.O. BOX 12921 TUCSON, ARIZONA 85732

Tucson, Arizona.
February 11, 1985.

Regional Environmental Officer
Lower Colorado Region
U.S. Bureau of Reclamation
Box 427
Boulder City, Nevada, 89005

Dear Sir,

I am writing on behalf of the 3,500 members of the Tucson Rod and Gun Club and the Board of Directors.

We have reviewed the environmental impact statement for Phase B of the Tucson Aqueduct (INT DES 84-68). Our primary concerns are the potential impacts on wildlife, wildlife habitat, and the desert landscape in the area of the selected route. Plants and animals in the desert environment have precarious existances. In many instances, seemingly minor impacts in a desert biome have significant, long-term consequences.

We are pleased to note the mitigation measures that are contained in the draft EIS for each of the possible action alternatives. In particular, the proposal to acquire 2,530 acres of mitigation lands for a wildlife movement corridor and lost habitat compensation is commendable.

Of the four possible action proposals, we would prefer to see the Sandario-San Joaquin route adopted, since it would be least disruptive to the environment, and would have the smallest impact on wildlife and vegetation. However, we realize that economic concerns will undoubtedly be the deciding factors in the selection of an alternative for the aquaduct, and that the least expensive alternative - the West Side Plan - will likely be selected. **1**

If that is the case, we strongly urge the inclusion in the project, of all the proposed mitigation measures outlined in the draft EIS. Additionally, we would like to suggest the use of burried pipeline in the areas where wildlife crossings have been noted, rather than open aquaducts. That would help reduce destruction of habitat, and would make less of an impact on wildlife in the area. **2**

Thank you for the opportunity to review and comment on this draft environmental impact statement.

Respectfully yours,

Dick Scott

Dick Scott
Chairman Legislative Committee

Responses to Comments
Tucson Rod and Gun Club

23-1 We have noted your support for the Sanders-San Joaquin Plan and your comment is available for consideration by the decisionmakers.

23-2 The cost of putting the canal in pipe not only affects the cost of construction but would have a continuing increase on the cost of pumping due to the losses resulting from the pipe. There will be several areas where the cross drainage will be carried across the canal in a flume, and these will be incorporated in the wildlife crossings. The purpose of the corridor acquisition is to insure the long-term usefulness of the wildlife bridges over the aqueduct in this high-use area by preventing housing development in this vicinity. If the Bureau invested the additional money needed to bury this section of the aqueduct it will have met its mitigation responsibilities for this movement area and would not purchase the corridor (see attached management options 2 and 3 as defined by the Arizona Game and Fish Department contractor, deVos, et al. 1984, Draft Report). The choice of option 3 is the least costly option that adequately mitigates for wildlife impacts in this area according to the AGFD and the FWS.

We have estimated the additional cost of placing the canal into buried pipeline for the portion of the aqueduct which traverses the wildlife mitigation corridor. The additional capital cost is about $3.8 million, which increases the total annual project cost by about $327,000.

According to the AGFD Report:

"With the placement of a barrier such as a canal across the area of segments 20-25, the movement corridor will be severed. There are management options that could be employed that would significantly minimize the adverse impact of an open aqueduct. Two of these options are based on the acquisition of a 4.25-section block of land to ensure that housing developments or other disturbances are prohibited on this parcel. The description of this land is as follows:

Sections 10, 11, 14, 15 R11E T14S.

The four management options that have been reviewed are listed in the order of preference as follows:

1. Bury pipeline through segments 21, 22 and 23. Acquire the above-referenced movement corridor.

2. Bury pipeline through segments 21, 22 and 23. No corridor acquisition.

3. Acquire the movement corridor. Open canal with crossings and fencing.

4. No corridor acquisition. Open canal with crossings and fencing.

Of these options, the first three would provide adequate mitigation for severing movement routes. The fourth option would not provide adequate mitigation for the cessation of movement. It is probable that, without corridor acquisition, the development pattern in the proposed mitigation area would, before the end of the life of the project, render crossings unacceptable to mobile wildlife, especially mule deer."

24

PIMA COUNTY
PARKS & RECREATION DEPARTMENT
1204 WEST SILVERLAKE ROAD
TUCSON, ARIZONA 85713-2799

GENE LAOS
DIRECTOR

RECREATION 882-2680
ADMINISTRATION 882-2690

February 13, 1985

Regional Environmental Officer
Lower Colorado Region
U. S. Bureau of Reclamation
Box 427
Boulder City, NV 89005

Dear Sir:

We appreciate the opportunity to comment on the environmental impact statement for Phase B of the Central Arizona Project (CAP).

Although we have serious concerns along the entire CAP route, we have only addressed those issues that have a direct or indirect impact on Tucson Mountain Park.

1. We are very much in favor of acquiring the 4 1/4 sections for wildlife corridor. It is apparent that the corridor will eventually provide the only viable means of extensive wildlife movement.

2. We are strongly opposed to having an open canal through the corridor. In all probability the west side alignment will be selected; thus, the Tucson Mountains will be landlocked on all four sides. Why should we further hinder wildlife movement by placing an open canal through the corridor? I think we are all in agreement that the canal will severely downgrade the effectiveness of the wildlife corridor. Please consider having this portion of the project placed underground. **1**

3. We are strongly opposed to the above ground surge tank at the proposed Brawley Wash pumping station. We are in favor of a low profile surge suppression system that would not be visible from Tucson Mountain Park. **2**

4. We are requesting that all bridges, overchutes and mechanical equipment be painted in order to minimize their visual impact. **3**

5. We are opposed to any canal alignment which might increase
4 commuter traffic through Tucson Mountain Park. All roads
within Tucson Mountain Park are designed for scenic travel
and increased traffic is strongly opposed.

---

6. We are requesting that the limits of construction be narrowed
5 between the Brawley Wash pumping plant and Section 14 of the
wildlife corridor. We feel that tighter controls should be
placed on the contractor in order to control excessive
environmental damage.

---

7. We support the proposal to continue monitoring wildlife movement in relationship to wildlife crossings.

8. We support the inclusion of a trail system along the project right-of-way.

9. We support the proposal of Pima County Parks & Recreation Department managing the wildlife corridor as a part of Tucson Mountain Park.

We sincerely appreciate your professional consideration of all these concerns and only hope that your final decision will be based on the best interest of all concerned and not merely the cost of the project.

Sincerely yours,

Terry J. Lehrling

TERRY J. LEHRLING, Chairman
Pima County Parks & Recreation Commission

gt

xc: Edward M. Hallenbeck, Project Manager, BOR, Arizona Projects Office
David Yetman, Pima County Supervisor, District 5
Pima County Parks & Recreation Commissioners

PIMA COUNTY
PARKS & RECREATION DEPARTMENT
1204 WEST SILVERLAKE ROAD
TUCSON, ARIZONA 85713-2799

GENE LAOS
DIRECTOR

RECREATION 882-2680
ADMINISTRATION 882-2690

RESOLUTION NO. 1985-1

WHEREAS, Pima County Parks & Recreation actively supports the preservation and retention of open spaces, parklands and wildlife, and

WHEREAS, the Tucson Aqueduct, Phase B, of the Central Arizona Project will permanently affect the vistas, wildlife corridors and native vegetation, and

WHEREAS, Pima County Parks & Recreation opposes any canal alignment which might increase commuter traffic through Tucson Mountain Park,

NOW, THEREFORE, BE IT RESOLVED that the Pima County Parks & Recreation Commission request the United States Bureau of Reclamation carefully weigh the consequences of its proposed actions to the environment of Tucson Mountain Park and favorably consider placing in underground pipeline that portion of the project which traverses the corridor proposed for wildlife and plantlife impact mitigation so as to permit the free movement of wildlife across the corridor between Tucson Mountain Park and the Papago Indian Reservation.

AND BE IT FURTHER RESOLVED that in planning the Brawley Wash pumping station serious efforts be made to harmonize the installation with its environment and to reduce its visual impact in Tucson Mountain Park.

PASSED AND ADOPTED by the Pima County Parks & Recreation Commission this 13th day of February, 1985.

Terry J. Lehrling

TERRY J. LEHRLING, Chairman
Pima County Parks & Recreation Commission

ATTEST:

Responses to Comments
Pima County Parks & Recreation Department

24-1 See response to comment 23-2.

24-2 See response to comment 20-6.

24-3 See response to comment 20-7.

24-4 The canal, crossings have been coordinated with the county highway department's current and future development plans. There should be no increase in traffic through Tucson Mountain Park due to the canal construction.

24-5 The area available for use by the construction contractor is kept to the minimum that is practical for construction. If the contractor requires additional area for his yard and office space, approval is required by the Bureau before he can use any area not previously identified and approved.

25

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
Washington, D.C. 20230

OFFICE OF THE ADMINISTRATOR

OFFICIAL FILE COPY
U.S. Bureau of Reclamation
Lower Colorado Region
RECEIVED A FEB 19 1985

Date	Initial	To
		150
File		

February 12, 1985

Regional Director
Lower Colorado Region
U.S. Bureau of Reclamation
Box 427
Boulder City, Nevada 89005
Attn: Cecil Ouellette

Dear Mr. Ouellette:

This is in reference to your draft environmental impact statement for Tucson Aqueduct - Phase B Central Arizona Project. Enclosed are comments from the National Oceanic and Atmospheric Administration.

We hope our comments will assist you. Thank you for giving us an opportunity to review the document. We would appreciate receiving four copies of the final environmental impact statement.

Sincerely,

Joyce Wood

Joyce M. Wood
Chief, Ecology and
Conservation Division

Enclosure

DC:lg

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
Environmental Research Laboratories
325 Broadway
Boulder, Colorado 80303

Recd
2-12-85

R/E1:RO

DC
2-12

February 1, 1985

TO: PP2 - Joyce Wood

FROM: R/E1 - Roy Overstreet

SUBJECT: Comments on DEIS 8412.06 - Tucson Aqueduct

The two plans most likely to be carried out, assuming Federal subsidy, are the West Side Plan (the agency-recommended plan) and the Sandario-San Joaquin Plan (the most environmentally sensitive plan). The former plan could cost about 18% less to build and about 15% less to operate on an annual basis than the latter. The total environmental disturbance is considerably less with the Sandario-San Joaquin Plan (SSJP) because it would have twice as much pipeline and half as much overland canal structuring as the West Side Plan (WSP). The SSJP will affect far fewer acres than WSP and hence would have fewer impacts on habitat and Indian cultural sites. There is a third alternative. In the absence of federal funding, the water project would be about one-third the size and would be confined to the Tucson Metropolitan Area, whose population this water project would benefit. The capital costs for these three alternatives (including no federal action (NFA) are $347M for WSP, $422M for SSJP and $191M for NFA).

Regardless of what alternative is finally approved, some destruction of wildlife and floristic habitat and loss of cultural sites (Hohokam Indian ruins) will occur. However, the Tucson metropolitan area cannot continue to extract ground water indefinitely. In fact, continued groundwater pumping is likely to result in serious environmental problems within 10 years, with large-scale land subsidence and greatly increased pumping costs an almost certain outcome.

If you have questions regarding these comments, please contact Dr. Henry Diaz (FTS: 320-6649).

cc:
R/E21 - H. Diaz

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL OCEAN SERVICE
Washington, D.C. 20230

N/MB2:KEZ

February 4, 1985

Recvd
2-7-85

DC
2-12

TO: PP2 - Joyce M. Wood

FROM: N - Paul M. Wolff

SUBJECT: DEIS 8412.06 - Tucson Aqueduct - Phase B Central Arizona Project

The subject DEIS has been reviewed within the areas of the National Ocean Service's (NOS) responsibility and expertise, and in terms of the impact of the proposed action on NOS activities and projects.

Geodetic control survey monuments may be located in the proposed project area. If there is any planned activity which will disturb or destroy these monuments, NOS requires not less than 90 days notification in advance of such activity in order to plan for their relocation. NOS recommends that funding for this project includes the cost of any relocation required for NOS monuments. For further information about these monuments, please contact Mr. John Spencer, Chief, National Geodetic Information Branch (N/CG17), or Mr. Charles Novak, Chief, Network Maintenance Section (N/CG162), at 6001 Executive Boulevard, Rockville, Maryland 20852. 1

Responses to Comments
U.S. Department of Commerce
National Oceanic and Atmospheric Administration

25-1 There are no known geodetic control points within the area of construction. However, if any are discovered, relocation of those points will be coordinated with the Department of Commerce.

26

THE LEAGUE OF WOMEN VOTERS OF TUCSON
4560 E. BROADWAY, TUCSON, ARIZONA 857

OFFICIAL FILE COPY
U.S. Bureau of Reclamation
Lower Colorado Region
RECEIVED FEB 19 1985
Action
Action Taken ____ Initials

Date	Initial	To
		150

STATEMENT ON THE DRAFT ENVIRONMENTAL IMPACT STATEMENT

TUCSON AQUEDUCT - PHASE B FEBRUARY 13, 1985

The League of Women Voters of Tucson would like to commend the Bureau of Reclamation on its efforts to educate and involve the public in the planning of the Tucson Aqueduct, Phase B. The many ramifications of such a large-scale development project has evoked much comment from the public. The League believes that citizen participation must be built into the planning process to guarantee responsible governmental decisions and we hope that the Bureau will give consideration to these concerns.

The effects of the aqueduct on the environment during and following construction are of special concern. It is our position that any development project that might cause irreversible damage to fragile and historic lands be carefully **1** regulated. Measures should be taken to protect significant wildlife habitats and unique scenic areas. Therefore we support the biological mitigation measures proposed in the draft Environmental Impact Statement that would provide for wildlife barriers, bridges, water catchments, revegetation, etc. We also concur with the recommendations submitted by the U.S. Fish & Wildlife Service, (page 41, EIS) and hope that those ideas as well as any future counsel will be utilized from both the FWS and the Arizona Game & Fish Department during construction of the aqueduct.

The scenic quality of the construction area surrounding the aqueduct will be unavoidably altered. Special consideration and mitigation efforts should be made in **2** the areas of high visual sensitivity that are identified in the EIS: Arizona-Sonoran Desert Museum, Saguaro National Monument, and Tucson Mountain Park. In addition to screening the canal with vegetation and earthen dikes, use of earth-colored fencing and concrete should be considered in these sensitive areas. Some provisions for screening the Brawley Pumping Plant surge tank and the one at Sandario from Saguaro National Monument should also be incorporated into the revegetation plan.

Thank you for your consideration of our concerns.

submitted by

Marie Lynn Hunken

Marie Lynn Hunken

Natural Resources Coordinator

Responses to Comments
The League of Women Voters of Tucson

26-1 We have noted your support of the biological mitigation measures and the recommendations submitted by the U.S. Fish and Wildlife Service.

26-2 With the exception of coloring the concrete of the canal prism, we are committed to implement your recommended measures. For further description of these and other visual mitigation measures, see the response to Comments 14-3, 15-2, and 20-7.

27

TUCSON UNIFIED SCHOOL DISTRICT

P.O. BOX 40400
1010 EAST TENTH STREET
TUCSON, ARIZONA 85717-0400

February 13, 1985

OFFICIAL FILE COPY U.S. Bureau of Reclamation Lower Colorado Region		
RECEIVED A	FEB 19 1985	
Action		
Action Taken		Initials
Date	Initial	To
		150
File		

Regional Environmental Officer
Lower Colorado Region
U. S. Bureau of Reclamation
P. O. Box 427
Boulder City, NV 89005

Subject: Draft EIS
Tucson Aqueduct Phase B

Dear Sir:

The Tucson Unified School District has at least three school sites which may be impacted by proposed routes of the Tucson Aqueduct Phase B (see enclosure). Although future use of these sites is not yet programmed, rapid population growth in the neighboring areas necessitates that sites be available for construction of new schools. 1

Should any sites be located either in the aqueduct right-of-way or rendered unusable for school sites by construction of the aqueduct, the district would expect that nearby sites would be made available in exchange for the current sites, which are located on federal land.

Sincerely,

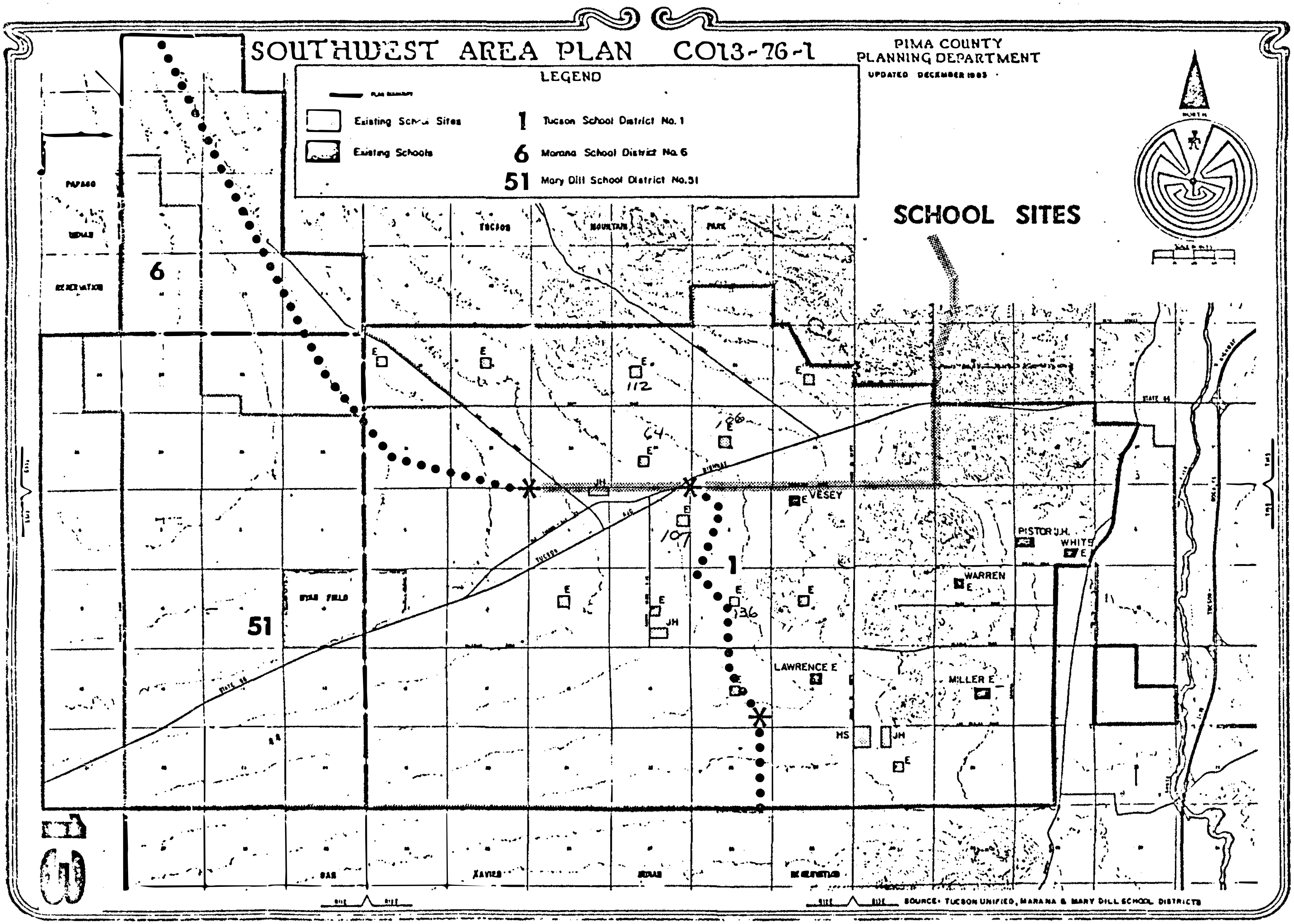
Valerie B. Feuer

Valerie B. Feuer
School District Planner

VBF:is

Enclosure

cc: David Johnson
Tucson Water


SOUTHWEST AREA PLAN CO13-76-1
PIMA COUNTY
PLANNING DEPARTMENT
LEGEND
Existing School Sites
Existing Schools
1 Tucson School District No. 1
6 Marana School District No. 6
51 Mary Dill School District No. 51
SCHOOL SITES
6
51
1
112
64
186
107
136
JH
E
VESEY
PISTOR J.H.
WHITE
WARREN
LAWRENCE E
MILLER E
HS
SOURCE: TUCSON UNIFIED, MARANA & MARY DILL SCHOOL DISTRICTS

Responses to Comments
Tucson Unified School District

27-1 Since the sites are only proposed preliminary locations, substantially in advance of actual demonstrated need, there should not be any complication in identifying new site locations. In the event the final location of the aqueduct alinement or right-of-way necessary for it, includes lands owned or leased by the school district, investigation of the District's interests would be examined and a determination made regarding actual acquisition procedures that are applicable.

28

PIMA COUNTY
WASTEWATER MANAGEMENT DEPARTMENT
131 WEST CONGRESS
TUCSON, ARIZONA 85701

GEORGE A. BRINSKO
Director

14 February 1985

U.S. Bureau of Reclamation
Lower Colorado Region
P.O. Box 427
Boulder City, Nevada 89005

ATTN: Regional Environmental Officer

RE: Draft Environmental Impact Statement
Tucson Aqueduct - Phase B
Central Arizona Project

Gentlemen:

Thank you for the opportunity to review the above referenced draft Statement. It is well prepared and presented. However, I must say that I was quite concerned when I discovered that the "impact" of the Aqueduct on the area's public sanitary sewerage system was not mentioned at all! 1

All the public sanitary sewerage facilities, in the area through which Phase B of the Tucson Aqueduct will pass, are owned and operated by Pima County Wastewater Management. It is the goal of this Agency to operate the public system in a safe, cost-effective and environmentally sound manner. The installation of a facility such as the Aqueduct (either as a open conduit or as a closed conduit) through the public sewerage system's service area can/will have a major impact on the system (operationally and physically). Also, being a mainly "gravity" type system, the public sewage conveyance facilities are more limited in how they can be "re-located" in order to accomodate a facility as large and (deep) as the Aqueduct.

Hence, I feel it is appropriate and necessary, that this Environmental Impact Statement address both the impact that the Aqueduct will have on existing public sewage facilities, and also the impact that the CAP will have on the "provision" of sanitary sewerage service to as-yet unsewered areas - through which the canal/pipe will pass. Once those "impacts" are included, then the Statement will have more closely addressed all the impacts of the proposed Tucson Aqueduct on the "environment".

I will be coordinating with Don Anderson, the Construction Engineer for Phase B, regarding the physical relocation of any public sanitary sewerage facilities found to be in conflict with the Aqueduct and, the installation of sewer stubs through or under the Aqueduct at certain designated locations.

Your attention to this Agency's concerns is appreciated. If further questions arise, please feel free to contact me at (602) 792-8676.

Jon C. Schladweiler, P.E.
Chief Engineer

JCS:lr

xc: George A. Brinsko
Tom McLean, Tucson Water

Responses to Comments
Pima County Wastewater Management Department

28-1 For those facilities already in place relocations will be included in the construction costs with the owner either doing the work or contracting it out. In either case the Government will cover the cost pursuant to a crossing agreement between the Government and the County. Where future crossings are planned we will coordinate the location and placement of stubs either before or during the construction of the canal. The cost of this work would be to the county. Also, if other crossings are required in the future they can be handled with a crossing agreement between the county and the Government.

29

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE

Ecological Services
2934 W. Fairmount Avenue
Phoenix, Arizona 85017

February 14, 1985

Memorandum

To: Director, Lower Colorado River Region, Bureau of Reclamation, Boulder City, Nevada

From: ACTING Field Supervisor, FWS, Ecological Services, Phoenix, Arizona

Subject: Comments on Draft Environmental Statement for Central Arizona Project - Tucson Aqueduct Phase B

We have reviewed the subject document and offer the following comments for your consideration.

General Comments

Overall, the document adequately addresses the major biological concerns and discusses the appropriate mitigation measures. However, we would like to suggest a change in the organization of some information. Especially section 3, "Affected Environment and Environmental Consequences," specifically starting on page 34 at "Construction Impact Analysis."

The discussion on pages 34 through 37 combines discussion of wildlife mitigation features developed under the Fish and Wildlife Coordination Act (FWCA) and the National Environmental Policy Act (NEPA) with possible and 1 speculative conservation measures and reasonable and prudent alternatives that may be developed as part of a Section 7 consultation for plant species that are not yet listed. We believe these issues should be addressed in separate sections of this document.

Both the FWCA and NEPA require federal agencies to determine the environmental effects of a proposed project and to develop mitigation measures to deal with these impacts. However, the ESA does not call for mitigation. It specifically mandates that federal agencies shall conserve endangered and threatened species. In this respect, conservation is not mitigation and agencies should not use the concept of mitigation when dealing with endangered species issues.

We suggest that the document be revised as follows. The impact analysis should be divided into 2 separate sections. One would deal exclusively with impacts and proposed mitigation measures for wildlife species developed under NEPA and the FWCA. This section could deal with the impacts to "special status" species like the desert tortoise, kit fox, and Harris' hawk and address any specific mitigation measures designed for them.

The second section should deal exclusively with discussions of the effects on proposed, threatened, or endangered species and, if the Bureau wishes, any candidate species to the list that may soon be proposed for listing as threatened and endangered. Discussions of project related impacts and some possible conservation measures would be appropriate here.

The mitigation discussion on pages 38-42 also should be addressed in a similar manner to more clearly separate mitigation measures from conservation measures.

2 We are extremely concerned about statements made in the first paragraph on page 38. You state that "--if formal consultation with-- will be reanalyzed and potentially revised in light of project cost ceilings." You further state that "this may require a trade-off--less funds may be available for acquisition of a wildlife movement corridor and Thornber's fishhook cactus habitat."

We believe these two statements are arbitrary, premature, speculative, probably unwarranted, and actually threaten to undermine the spirit and intent of our interagency attempt to provide equal consideration for fish and wildlife resources with the proposed land acquisition. We suggest that these statements be deleted.

3 Our concerns are amplified by the use of the term "maximum mitigation expenditure" in the DEIS. How does the Bureau justify setting a limit on mitigation expenditures at this time? There are some mitigation measures and conservation measures, for example the kit fox monitoring study, that will not provide data on impacts or necessary measures for several years. We are concerned that if T. macdougalii and Mammillaria thornberi become listed and conservation measures or reasonable and prudent alternatives are developed during Section 7 consultation, there would be no money to implement these measures. The DEIS calls for post-construction monitoring (Phase 2) and additional mitigation. With pre-set funding limits, these measures could not be implemented. We also suggest that expenditures for wildlife mitigation be separated from possible expenditures that may be required for endangered or special status species. The wildlife movement corridor, for example, is primarily a wildlife mitigation feature and should be addressed as such.

The Bureau has already spent $280,000 on wildlife studies and $50,000 on special plant surveys in the project area, making an honest and excellent effort to identify the effects of this project upon the wildlife and plants of the project area. This represents a remarkable commitment by the Bureau to provide the information to develop an integrated mitigation plan and identify some possible conservation measures. The mitigation plan that was developed has the support of both AGFD and the Service, as well as local support from such groups as SAWARA (Southern Arizona Water Association). The keystone of this mitigation plan is the acquisition of the 4.25 square mile movement corridor between the Tucson Mountains and the Papago Indian Reservation. Without the acquisition of this corridor, we believe the mitigation plan is grossly inadequate and would not come close to adequately addressing wildlife impacts. Residual wildlife impacts would be very high due to loss of habitat, severance of movement corridors and gene pool isolation without the acquisition of the migration corridor.

It is the responsibility of the Service, under NEPA, to comment upon the adequacy of an EIS and the agency commitments therein. After all the positive efforts made to see that an adequate mitigation plan was developed for this project, it is disappointing to see discussions aimed at limiting or eliminating necessary features of that plan in the DEIS. Without acquisition of the wildlife movement corridor, our support for construction of the West Side Plan cannot be counted on. **4**

We are also concerned about the choice of the two pipeline alternatives presented in the DEIS. We are on record as being in support of pipelines instead of canals because wildlife disturbances and long term impacts associated with pipelines are usually less severe. In fact, our FWCA report on this project stated tht the Sandario-San Joaquin Plan was our preferred alternative. **5**

At that time (March 1984), the Sandario and Sandario-San Joaquin Plans were envisioned by the Bureau as going down the centerline of Sandario Road through the Saguaro National Monument. Documents from the Bureau estimating right of way disturbed acres for all reaches of the plans indicated a disturbance of 0 acres for the reach along Sandario Road through the Monument. It was stated in a footnote to those documents that the "Estimated width of '0' is within road width." Bureau personnel were specifically queried on this point and we were told that the figures were correct, that no additional acres of the Monument would be disturbed. Since under those conditions, impacts to the Monument would be minimal, we felt that Congressional approval for the right of way could be obtained and that these two plans could be considered viable alternatives and should be considered.

However, on page 12 of the DEIS, it states that the Sandario Road pipeline is adjacent to Sandario Road. This implies that new acres will be disturbed in a new right of way. Portions of the right of way would cross the Monument and result in the destruction of a significant acreage of saguaros.

This amount of long term disturbance to a National Monument and a wilderness area is clearly unacceptable to the National Park Service and could be unacceptable to the public. Given this new information, it may be much less likely that Congress would give the necessary approval for the right of way, thus these two pipeline alternatives may not be viable or reasonably practical.

From a strict wildlife standpoint, the Sandario-San Joaquin Plan is probably still the best plan. But we are concerned that this plan and the Sandario are not reasonable alternatives because of the institutional constraints placed upon them. For that reason, we question the Bureau's choice of these two
6 pipelines, with the same institutional problem, as viable alternatives to the proposed action.

In our October 1982 Planning Aid Letter on this project, we addressed a Bureau alternative designated B-2. This was a pipeline extending from Avra Valley Road south along Sanders Road to Manville Road. This pipeline did not cross the Saquaro National Monument, thus required no special Congressional authorization to permit construction. This pipeline would address the concerns of Avra Valley residents as well as have lower wildlife impacts than the preferred West Side Plan.

The DEIS addresses an alternative down Sanders Pipeline, however it is an open canal. Why was the Sanders pipeline not addressed in place of one or both of the pipelines crossing the monument? Why was a canal addressed instead of a pipeline?

Specific Comments

SUMMARY

7 page 3, Table 2. In footnote 4, it states that a 100 year project life was used. In other sections of the document, it states there is a 50 year project life. Which is correct? The term maximum mitigation expenditure is inappropriate and should be changed.

8 page 4-5, No Action Alternative. It should state here who would receive the non-delivered allotments since the same amount of water as with federal involvement would be delivered.

9 page 7, Table 3. There is no information under the No Action Alternative from the topic of Water Resources onward. Is this intentional?

10 page 9, Special Status Species. The sentence discussing proposed and candidate plants is unclear.

11 page 12. Visual Resources. This section describes impacts of pipelines but not canals to visual resources. Please add to the discussion.

page 13. Lands. It states that all lands necessary for Operation and Maintenance, construction and mitigation would be acquired in fee title unless lesser interest would benefit the Government. What would be considered a benefit in the case? **12**

---

page 14. Geology. Would the canal be moved if tests show a high probability of earth fissures forming along the route? Or will structural modifications be made? What degree of possible fissuring would require movement of the alignment? **13**

PURPOSE AND NEED

page 1. Introduction. In the last paragraph, other CAP related features are mentioned, Buttes Dam, Hooker Dam, Upper Gila and Indian Distribution. Since Non-Indian Distribution users are mentioned in this document, it might be appropriate to add them here. **14**

---

page 3. Figure 2. Why are there 2 numbers (1 and 16) for the Cortaro-Marana Irrigation District? Could the same number be used? The numbers representing the Indian communities are misplaced (19, 20, 21) and there is no 22 on the key. Number 17 (Avna Valley Irrigation District) may also misplaced. Please check this map for other possible errors. **15**

ALTERNATIVES

All figures showing alignments. Wildlife crossings that are actually road bridges should be marked as Road Bridge (Wildlife Crossing) instead of Wildlife Crossing (Bridge) to fully indicate that these are multiple use structures, not structures for the exclusive benefit of wildlife. **16**

Figure 11. The 3 photographs between Figure 11 and page 8 should be cited as figures and mentioned in the text. **17**

---

page 12. Sandario Plan. Original project plans called for this plan to go down the centerline of Sandario Road. Present plans call for the pipeline to be adjacent to the road. Information on acres of vegetation disturbed provided in the Coordination Act Report was based on this original information. Have your acreage figures been updated to reflect this change in project plan? **18**

---

19 page 10. Sandario-San Joaquin Plan. Does the pipeline run adjacent to the road on this alternative also? There is no mention of the Avra Valley Irrigation District delivery lines shown on Figure 13. Are these lines part of the proposed action?

page 15. East Side Plan. The delivery point for Schuk Toak on Tucson water are mentioned in the text and shown on Figure 24a. However, neither feature is shown on Figure 27. Why are these features omitted?

20 Figure 29b. Move this figure to behind page 16 and renumber it since it has no relation to figure 29.

21 page 25, Table 17. There should be footnotes on this table or a reference to where the footnotes may be found.

22 page 23. Footnotes for Table 15. There should be a heading designating which table these refer to.

23 page 20. Eliminated plans. Why was Sanders Road not evaluated as a pipeline (see expanded comments under general comments)? Why were animal drownings reduced over the West Side Plan?

24 Figures 13, 14. Since the Sandario-San Joaquin alignment does not include a wildlife movement corridor in the proposed mitigation, the corridor should not be shown on the project maps.

AFFECTED ENVIRONMENT

page 27, paragraph 3. The sentence on rainfall occurring twice a year is slightly misleading and should be changed to two rainfall periods per year.

page 28, paragraph 2. We would like to suggest a rewording of the sentence "...the FWS intends to propose *Tumamoca macdougalii* as a Federally endangered species this year..." to "...the FWS has prepared a listing package for *Tumamoca macdougalii* and this plant may be proposed as a Federally endangered species in the near future..."

25 page 29, paragraph 3. It might be appropriate to remove mention of the saguaro (*Carnegia gigantea*) from the list of cacti in parenthesis since it is discussed independently in the following sentence.

page 32. sections 3 and 4. It might be appropriate to better describe the vegetation associations mentioned in these sections either here or on page 29 under Creosote-Bursage on Palo Verde-Mixed Cacti. **26**

page 33. Special Status Species, paragraph 2. Please specify which listed endangered species were addressed. **27**

page 36, paragraph 4. Please change the last sentence that deals with Tumamoca macdougalii to reflect informaion given in comment for page 28, paragraph 2.

page 37, paragraph 2. This paragraph is redundant of paragraph A.(a) on page 27 and could be eliminated.

page 37, paragraph 4. As discussed earlier, it is inappropriate to discuss mitigation for Endangered Species. It may be appropriate to state that here, or separate out the discussion of Mammillaria thornberi.

page 38, paragraph 1. Please change or eliminate this paragraph in light of information discussed under general comments.

page 39, paragraph 3. Last sentence. Perhaps the sentence could read "...This land should (or will be) turned over for management..." instead of "must be"?

page 42, item 7. This phrase is the result of a misuse of the word mitigate in our FWCA report. Since you cannot mitigate for endangered species, the sentence referring to the migration corridor being mitigation for M. thornberi should be removed. It may be stated that acquisition would preserve 27,000 M. thornberi.

page 50, paragraph 5. When will the dikes that will protect the canal be built? **28**

page 56. Table 19. The heading "Probability of Annual Diversion in % of years" is unclear and requires an explanation relative to the figures in the table. **29**

Figures 36-37. A key to the colors and symbols underneath might be useful. The pale tan features are difficult to read through the colored overlay. **30**

page 74. Table 28. Where is the 1.5 miles of Class A scenic area found along the East Side Alignment? This should be addressed in the impact statements on page 74. **31**

32 page 76-77. Table 29. Should indicate in the table that the west side pipelines do cross the Saquaro National Monument (a class 1, B) habitat area as per your figure 37.

33 page 85. paragraph 6. There is an inconsistency in the date of irrigation well development in the Avra Valley. It cannot be both 1973 and the end of World War II.

34 Figure 43. Some sort of a legend is needed for this figure.

35 page 88-89. What percent of aggregate will be available from commercial sources and how much will require new site sources? Are the borrow areas proposed for the East Side Plan new or existing areas along the Santa Cruz River?

36 page 95. paragraph 2. Was the Class II cultural resources survey of 392 square miles concentrated on the West Side Allignment?

37 page 99. Table 37. Since the acreage of these detention basins is obviously known, they should be delineated on project maps and impacts to other than cultural resources more carefully addressed.

38 page 101. Recreation. It should be noted that the development of recreation sites near crossing bridges would only be done in such a way that these wildlife mitigation structures are not compromised.

39 page 102. What is Route 5? Change to East Side Plan.

40 page 106. National Park Service. As per previous discussion, why were the only 2 pipeline alternatives on the West Side discussed in this document clearly institutionally unacceptable? Justify the elimination of other, acceptable pipeline corridors.

APPENDICES

41 B-2. paragraph 3. Why was Sanders Road dropped? Why was a pipeline not considered here?

E-1. paragraph 4. Please note that the preferred conservation measure for both M. thornberi and T. macdougalii is avoidance of individuals and populations by relocation of the aqueduct. These suggestions were provided to the Bureau at their request and represent measures that may be considered, along with others, during Section 7 consultation and should not be considered to be the official word from the Service on this issue. **42**

We appreciate the opportunity to provide comments on this document at this time. If we may be of further assistance, please contact our office at FTS 261-2493.

Robt H Martin

cc: Director, Arizona Game and Fish Department, Phoenix, Arizona
Director, Fish and Wildlife Service, Washington, D.C. (FWS/EC)
Regional Director, Fish and Wildlife Service, Albuquerque, NM (AHR)

Responses to Comments
U.S. Fish and Wildlife Service

29-1 We have clarified the distinction between mitigation for state listed species and potential conservation measures for candidate or proposed federally listed species throughout the final EIS. The format of the final EIS follows that of the FWS Coordination Report in discussing all special status species (both state and federal) under one heading.

29-2 We concur. Those statements have been deleted from the final EIS (FEIS).

29-3 The terms "maximum mitigation expenditure" have been deleted and replaced with "estimated mitigation expenditure".

29-4 See response to comment 29-2.

29-5 The statement has been corrected to read "This pipeline would be down Sandario Road through the Saguaro National Monument and adjacent to the road in all other areas."

29-6 See response to comment 9-1.

29-7 The 100 year project life referred to in Table 2 relates to the life of structural measures and benefits. The 50 year project life referred to in other sections relates to the repayment period of the project. The term "maximum" has been deleted and replaced with "estimated".

29-8 Clarification of the "No Federal Action Plan" states, "CAP water that had been identified for allocation to Green Valley and the Santa Cruz County users is assumed to be reallocated to users in the Tucson area". It is not known or assumed who these specific users would be.

29-9 This table has been corrected to include information for all topics.

29-10 The sentence has been reworded for clarity.

29-11 Additional information has been added to the final EIS to address this comment.

29-12 Transmission lines, access roads, and buried pipelines usually only require a permanent easement which is less costly to acquire. In agricultural areas this would allow continued farming within the pipeline and transmission line easements.

29-13 Upon completion of the report "Subsidence and Earth Fissure Predictions for Phase B of Tucson Aqueduct", it was determined that currently no existing fissures have crossed the proposed alinements and the closest record of one is about 3,000 feet northeast of station 400+00 on Reach 5. Only three areas have been identified, along approximately 35 miles of alinement, that are susceptible to possible future earth fissuring. These three areas combined, account for less than a conservative 7 percent of the entire alinement. These areas were defined by local abrupt changes in the subsurface bedrock. Studies show that no areas will be subjected to a high probability of earth fissures. Future groundwater pumping will decrease when surface water deliveries begin; thereby reducing the formation of future earth fissures. In areas where future earth fissures are predicted, reinforced canal lining is recommended. If the alinement was exposed to a low to intermediate (greater than 15 percent) degree of possible fissuring, the alinement would require moving.

29-14 The Non-Indian Distribution system is not an authorized feature of the CAP.

29-15 A new Figure 2 shows just the Phase B water users.

29-16 We concur and the figures have been changed accordingly.

29-17 The change has been made.

29-18 See response to comment 29-5.

29-19 As with the Sandario Plan, the pipeline would be down the road through Saguaro National Monument and adjacent to the road in all other areas for the Sandario-San Joaquin Plan. The irrigation delivery system to Avra Valley and Schuk Toak area are not part of this system but were shown to show the possible location of their delivery points.

29-20 Figure 29b is now Figure 41.

29-21 The footnotes have been added to Table 17.

29-22 This change has been made in the final EIS.

29-23 Sanders-San Joaquin Modification Plan has been added to the FEIS (see response to comment 9-1). The number of animal drownings for the Sanders-San Joaquin Modification Plan would have been reduced over the West Side Plan as the former plan would have more pipeline than the later plan.

29-24 We concur and these changes have been made in the FEIS.

29-25 The discussion has not been changed as you suggest.

29-26 The details of methodology and plant community and association definitions are extensively discussed in the supporting document (deVos, et al. 1983) for those interested in the technical aspects of the research that was used in this EIS.

29-27 These changes have been made in the FEIS.

29-28 The dikes for protection of the canal would be constructed concurrent with the canal construction.

29-29 The discussion in Chapter III. B.3.a. explains the water supply analyses which Reclamation performs for CAP investigations and which was used to develop Table 22 of the EIS. Each value in the six columns under the major heading "Probability of Annual Diversion in % of years" in Table 22 represents the percentage of the total number of years specified which fall into the line item category. For example, the third column which contains the numbers 0, 26, and 74 reveals that for the best sequence of the 15 studied sequences, the period between 1988 and 2010 (23 years) has no years which were classified as shortage years, 6 years (or 26% x 23 years) which were normal supply years having an estimated annual CAP Colorado River diversion of 1.0-1.7 million acre-feet, and 17 years (or 74% x 23 years) which were surplus supply years having an estimated annual CAP Colorado River diversion of more than 1.7 million acre-feet. Each subsequent column may be read similarly.

29-30 We concur and this addition has been made in the FEIS.

29-31 The 1.5 miles of transmission line crosses Class A scenery from the vicinity of Twin Hills (near Anklam Road and Camino de Oeste) to the south. The narrative has been revised to include this information.

29-32 You are correct. The table has been corrected to reflect this change.

29-33 "1973" should be changed to "1943" as the initial year for development of irrigation wells.

29-34 A legend has been added.

29-35 The aggregate for construction would come from the commercial pits in the area for any of the options selected for construction.

29-36 The study area consisted of a contiguous broad area of the Santa Cruz River drainage within the Tucson Basin and the Avra Valley. The area is bordered on the north by the Tortolita Mountains and on the south by the town of Green Valley. The eastern boundary is roughly the eastern extent of the Santa Cruz River floodplain and the western boundary is the eastern extent of the Brawley Wash floodplain in Avra Valley. The Tucson Mountains were entirely within the study area.

29-37 The exact area behind the dikes required for flood control is not available until the final mapping is complete and the location and designs are well under way. The right-of-way will be purchased to the 100 year storage elevation when hydrologic studies are completed.

29-38 Since your comment addressing recreation sites does not specify which wildlife mitigation structures you are referring to, it is difficult to provide an appropriate response. However, those recreation areas to be developed are to be located in conjunction with the local land managing agencies. The areas developed for recreational use or access will require fencing separating them from the rest of the detention basin, will not be located at those crossings identified exclusively for wildlife use, and will not be located on those lands acquired specifically for wildlife mitigation. The recreation development and use areas are to consist of trail-related facilities and activities.

29-39 The change has been made.

29-40 Sanders Road has been included as an alternative route. See response to comment 9-1.

29-41 See response to comment 9-1.

29-42 The preferred conservation measure has been noted and the FEIS changed accordingly.

30

FRIENDS OF THE DESERT
Route 9 • Box 620
Tucson, Arizona 85743
Tucson (602)628-7300 • Marana (602)682-7300

February 14, 1985

Bureau of Reclamation
Regional Environmental Officer
Lower Colorado Region
U.S. Bureau of Reclamation
Box 427
Boulder City, Nevada 89005

Re: CENTRAL ARIZONA PROJECT
Tucson Aqueduct - Phase B

Gentlemen:

As you well know, Friends of the Desert consists of approximately 500 members, which membership is comprised of individuals and businesses in Marana, Avra Valley and Tucson.

As we have indicated to you in the past, Friends of the Desert is unalterably opposed to the current proposal of an above ground canal through Avra Valley. 1

As was fully set forth in the report of the United States Fish and Wildlife Service dated March 1984, it is our position that placement of an above ground canal would have a deleterious effect on the environment; would destroy a great deal of the natural vegetation in the Avra Valley, some of which consists of protected species and is in danger of becoming extinct (specifically Mammillaria thornberie and Tumamoca macdougalii); would result in a greater water loss due to evaporation; would be susceptible to "tampering" by radical elements; would pose a threat to human life in the form of potential human drownings; would disrupt wildlife and migrations; presents a hazard and the potential loss of life to wildlife in the area of the Saguaro National Monument and Tucson Mountain Park (as confirmed by the U.S. Fish and Wildlife report and admitted by the Bureau of Reclamation's own figures); would introduce the threat of mosquitoes and attendant diseases in Avra Valley (as is evidenced by the recent encephalitis threat along the Colorado River); would aesthetically and visually desecrate Avra Valley; the overhead powerlines proposed by the Bureau of Reclamation would interfere with Pima County Communications and result in a "dead zone" and inability for Pima County Communications to communicate with Pima County Sheriff's deputies, personnel of the Picture Rocks Fire Department and the Avra Valley Fire Department in many areas of Avra Valley.

FRIENDS OF THE DESERT
Route 9 • Box 620
Tucson, Arizona 85743
Tucson (602)628-7300 • Marana (602)682-7300

After numerous and lengthy meetings with SAWARA, the Bureau of
Reclamation and the National Park Service, Friends of the Desert
2 wishes to formally endorce an underground pipeline extending from
the vicinity of Desert Winds Elementary School to the southern
end of Tucson Mountain Park. This proposal, which would call for
an underground pipeline to be laid along Sanders Road for the
most part, has been referred to as the Sanders - San Joaquin
Modification. It is the opinion of Friends of the Desert that
this alternative, the Sanders - San Joaquin Modification, is the
most viable alternative, should be included in the final
Environmental Impact Statement, and should be the proposed route
by the Bureau of Reclamation and ultimately the route to be
approved by the Secretary of the Interior.

Although the Bureau has proposed a number of mitigation measures in the above ground canal, clearly the best mitigation measure for the protection of wildlife, vegetation and the desert itself is an underground canal. This has been specifically referred to in the U.S. Fish and Wildlife report. Furthermore, personnel of the National Park Service, who have intimate day to day dealings with the desert in Avra Valley as well as its animal and plant life, have indicated that from an environmental standpoint an underground pipeline is far more preferable than an above ground canal or aqueduct.

Even as a result of the Bureau's mitigation measures, the Bureau, in its own draft Environmental Impact Statement, has indicated that permanent loss of vegetation and potential loss of animal life still exists, although the reduced loss would be, by the Bureau's standards, "acceptable". However, if a pipeline is underground, nothing -- human or animal -- can drown in it. If a pipeline is underground, other than an easement for ingress and egress, the area surrounding the pipeline can be revegetated and the desert restored to its natural pristine state. With an underground pipeline, no evaporation will occur. With an underground pipeline, wildlife will not be kept from crossing from one side of the pipeline to the other by fences and concrete.

As Pima County will attest to, the vast majority of Avra Valley
is in a flood plain. To be sure, the majority of the area
through which the aqueduct is scheduled to cross was underwater
3 during the floods of October 1983. And, according to Pima
County, the October 1983 floods were not an actual 50 or 100 year
flood. Pima County has precluded many developers, builders and
home owners from building structures or even putting improvements

FRIENDS OF THE DESERT

Route 9 • Box 620
Tucson, Arizona 85743
Tucson (602)628-7300 • Marana (602)682-7300

upon property which are located in Avra Valley because of its flood plain status and the resultant adverse affects that said structures and buildings would have during a flood. Notwithstanding this prohibition against the rest of the world building in Avra Valley, the Bureau of Reclamation now intends on spending millions upon millions of dollars in putting a concrete structure, together with an earthen dike, across the entire Avra Valley. As anyone from Pima County Flood Plain Management can attest to, this would have a significant detrimental impact upon Avra Valley during times of heavy rains and floods. And, by trying to reroute water around the dikes and aqueduct by having pipes across the aqueduct at various points will only result in creating, in effect, man made rivers and washes which could make the Brawley Wash look miniscule by comparison.

In light of all the foregoing, I respectfully request that the Bureau of Reclamation propose the Sanders - San Joaquin Modification consisting of an underground pipeline as the recommended alternative for the Central Arizona Project through the Avra Valley, that this letter be included along with the public comments to the draft Environmental Impact Statement, and that the Secretary of the Interior ultimately approve the route endorced by Friends of the Desert.

Very truly yours,

John R. Moffitt

JOHN R. MOFFITT
President

JRM:va

Responses to Comments
Friends of the Desert

30-1 We have noted your opposition to the proposed above ground canal through Avra Valley. Your letter of comment is available to decisionmakers.

30-2 The Sanders-San Joaquin Modification Plan has been added to the final EIS. However, the West Side Plan remains the agency proposed action.

30-3 The proposed alinement through the Avra Valley will follow the western slope of the Tucson Mountains and along the east side of the Brawley Wash flood plain. The alinement approaches the Brawley flood plain in three areas. These areas are just upstream of the Sandario, Brawley and San Xavier Pumping Plants. This is based on the flood maps provided by the Pima County Flood Control District. The dikes are sized to detain the flows for release into the existing channels at the rate that could be expected from a three hour thunderstorm on the drainage basin. All land that will be flooded in the detention area will be purchased. The outlets from the overchutes will have energy dissipators constructed to bring the water to a velocity that is not conducive to erosion. The area on the downstream side between the overchutes would be protected from the flooding they now experience. Meetings have been held with Pima County Flood Control District and the Town of Marana to address the issue of flooding in the Tangerine Road area. As a result of the meetings the decision has been made to construct a single siphon from the northeast side of I-10, daylighting upon crossing the southwest side of the Santa Cruz River, a distance of about 8,700 feet.

31

February 15, 1985

Mr. Richard Miller
5330 W. St. Monita
Glendale,

Regional Environmental Officer
Lower Colorado Region
U.S. Bureau of Reclamation
Box 427
Boulder City, Nevada 89005

Dear Sir:

The following are comments on the draft environmental impact statement, Tucson Aqueduct Phase B.

Page 5, paragraph 1d add mountain lion and skunk to species present. **1**

Page 6 & 7 table 3 wildlife disruption after mitigation is under estimated, giving the impression that the alternatives are equal which is not the case. The canal will block migration and movements and the effect of mitigation is to lower, not remove, that impact. I suggest: West Side Plan - moderate; Sandario San Joaquin - moderate to low; Sandario - moderate; East Side Plan - low.

I believe impacts on Harris hawks are underestimated for the three west side routes. Harris hawks nest and roost in Avra Valley from approximately mile 10 to mile 22 of the west side route. Concentrations occur in Section 6 adjacent to mile 10 and along the Saguaro National monument boundary. All westside routes will probably impact Harris hawks if construction is continued through the nesting season. I suggest all west side routes should be listed as having moderate impact on Harris hawks. **2**

The visual impact of all routes on the west side has got to be higher than presented in this table. The canal and/or pipeline will be a prominent feature in the view from all the most popular scenic areas, Gates Pass, the Desert Museum, Saguaro National Monument visitors center, and Ironwood picnic area. The idea of the Sandario-San Joaquin and Sandario alternatives are equivalent to the east side is naive. I suggest: west side - high; Sandario-San Joaquin - moderate; Sandario - moderate; east side - low. **3**

---

4 It bothers me to have road bridges such as the Avra Valley Road crossing labeled wildlife crossings. While it is true that wildlife (principally coyotes) will probably use the roads that use is not the primary purpose of the crossing, and will be made at some hazard to the animal. By the same logic, you could label all the overshoots as wildlife crossings which would be equally misleading.

On page 27 paragraph 5 recreation should be listed as a major land use in the Phase B area due to the presence of the Tucson Mountain Parks and Saguaro National Monument. This omission is important since it is reflected in the importance of recreation related impacts.

---

5 The discussion of construction impacts on pages 34 through 37 is well written. What is needed to complete it is a discussion of the impacts of construction related disturbance to wildlife adjacent to the route. A number of animals will be disturbed and/or displaced. While this impact should be minimal it may be important if the disturbance takes place during critical seasons, i.e. fawning, nesting or if it precludes use of critical resources or habitat, i.e. water resources in summer.

---

6 On page 37 paragraph 4 I believe the migration corridor should be included in mitigation for the Sandario San Joaquin plan (also in table 18 page 38).

---

7 On page 38 paragraph 1 mitigation is an attempt to reduce the effect of a project or to replace value lost with like value. The possible higher cost to mitigate losses to Tumamoc globe berry does not relieve the Bureau or Reclamation of any obligation to mitigate for other species. Mitigation for T&E species is in response to a separate low from normal wildlife mitigation. The cost of mitigation is dependent on the location of the canal and associated structures not on how much you budget for it. Mitigation should be carried out as designed for all species regardless of increased cost for one.

---

8 Page 40 paragraph 1. Water sites should be constructed and operating prior to construction of the canal in order to mitigate construction impacts.

---

9 Page 40 paragraph 5. The idea of restricting disturbance near Harris hawk nests is excellent, however, I am not sure that "minimized" means anything. I suggest changing the wording to "Construction will be curtailed from January 1 to June 1 within 1/2 mile of Harris hawk nests. I would also like to add that paragraph the following: "If water sources are not completed at least 6 months ahead of canal construction . Construction within the wildlife movement corridor will be halted from May 1 to October 1 to allow wildlife use of existing water sources which will be removed during canal construction.

Page 47 section 5 paragraph 1. Pipeline construction through the wildlife movement corridor will also temporarily block access to water sources. **10**

Page 49 paragraph 1. In order to mitigate for disturbance during construction and to reduce loss of wildlife to accidents during construction, water sources should be completed at least six months prior to beginning construction. **11**

Page 47 paragraph 4. At least two important water sources which are metal tanks and pumps or pipe feeds lie directly in the canal route. There should be a provision to rebuild these as well. **12**

Page 68 and beyond. A major assumption of the visual resources sections seems to be that a dike or disturbed strip left after laying pipe is not a major visual impact because the canal cannot be seen. This is not true! The canal embankment in and near the movement corridor will be a prominent feature in the view from the Desert Museum for instance. The implied suggestion that the canal will not (page 72, paragraph 4) be visible from the Desert Museum is insulting to the reader's intelligence. The embankment will be a prominent linear feature in the view from most points on the west side of the Tucson Mountains. **13**

I have confined myself to primarily comments on wildlife since that is my area of expertise. I appreciate the chance to comment and believe, despite the length of my comments, that the Bureau has done a good job with this EIS.

Sincerely yours,

Richard Miller, Ph.D.
Certified Wildlife Biologist

Responses to Comments
Mr. Richard Miller

31-1 We concur and the final EIS has been changed accordingly.

31-2 All of the Plans will cause short-term disturbance during construction. The action plans will cause a permanent loss of from 250 to 367 acres of potential Harris' hawk habitat. However, the mitigation plans for these plans include the acquisition and preservation of from 640 to 2,530 acres of potential Harris' hawk habitat that would otherwise eventually be developed for housing in future years. We conclude that this mitigation effectively reduces the impacts to "low" for these alternatives.

31-3 Although visible from many of the popular scenic areas, the canal and/or pipeline would not be a dominant feature of the view. During the construction period, the activity and environmental disturbance would be most conspicuous, and impacts to scenic views would be significant. Long term impacts would be much less severe. Because of the distance involved, the canal or dike would present a line representation on the view, visible, surely, but not a prominent feature of the view. A photo has been added to the final EIS to clarify this issue (see Figure 50). The photo shows the CAP canal (Granite Reef Aqueduct) from a scenic overlook on Shea Blvd. in Phoenix. The distance (about 2 miles), topography, and vegetation are very similar to the view of Tucson Aqueduct from the Arizona - Sonora Desert Museum.

With regard to the relative impacts of the East Side Plan with the Sandario Road Plans, the net impacts are about equal, although different in nature. On the east side, the impacts result from the greater number of viewers and greater impacts on residential areas from the power transmission lines. On the west side, the number of viewers is less, but so too is the existing degree of cultural modification.

31-4 We concur and these changes have been made in the final EIS.

31-5 The AGFD studies estimated that as many as 175 mule deer (44 percent of total in area) and 146 javelina (24 percent of total in area) could be initially impacted by a west side open aqueduct route. Impacts would range from drowning losses (from the completed canal) to avoidance of the area (during construction) depending upon the proximity of the animals home ranges to the aqueduct alinement (deVos et al. 1983). Over the life of the project, it is possible that the mule deer population in the Tucson Mountains could be eliminated if no mitigation is provided. The less wide ranging species such as javelina, tortoise and Gila monster could experience population losses within close proximity to the aqueduct without mitigation. With the mitigation features committed to in this EIS, the losses and impacts should be reduced to a level that will not jeopardize the wildlife populations in this area.

31-6 The majority of the Sandario-San Joaquin Plan is in buried pipe and would cause very little long-term disruptions of wildlife movements. Therefore, no migration corridor is included for this plan and this decision is supported by the AGFD contractor.

31-7 We concur. The paragraph has been changed and the possible trade-off clause deleted.

31-8 The paragraph has been modified in response to your comment.

31-9 "Minimizing disturbance" would include restricting construction disturbance to the aqueduct right-of-way within one half mile of the active Harris' hawk nests. No haul roads, equipment yards or other related impacts off of the right-of-way would be permitted off of the right-of-way in these areas. In addition, construction crews would be informed of laws protecting wildlife from disturbance and given directives in their contracts to comply with these laws. The suggestion to "curtail construction from January 1 to June 1 near Harris' hawk nests" and to "halt construction from May 1 to October 1 in the wildlife corridor" could result in only 2 months of construction being allowed per year in some areas. This would not be compatible with construction schedules and would only be considered to avoid disturbance to a federally listed species.

We are scheduled to have the water catchments in place and operating before aqueduct construction is completed to allow animals to become accustomed to these water sites before there is water in the canal. Because construction is scheduled to begin on Reach 4 in early 1986, it is not possible to have catchments built 6 months before that time.

31-10 We concur; the paragraph has been modified accordingly in the final EIS.

31-11 See the last part of comment 31-9.

31-12 The paragraph has been modified accordingly.

31-13 See response to comment 31-3.

32

Department of Energy
Western Area Power Administration
Boulder City Area Office
P.O. Box 200
Boulder City, NV 89005

FEB 15 1985

OFFICIAL FILE COPY
U.S. Bureau of Reclamation
Lower Colorado Region
RECEIVED FEB 15 1985
Action
Action Taken Initials

Date	Initial	To
		600
		150
File		

Refer To: G1010 (Saylor)

5440 TUC Phase B

Mr. N. W. Plummer
Regional Director
Bureau of Reclamation
Lower Colorado Region
P.O. Box 427
Boulder City, Nevada 89005

Dear Mr. Plummer:

We appreciate the opportunity to review the draft Environmental Impact Statement for the Tucson Aqueduct-Phase B. Our comments are as follows:

Executive Summary

Page 1: Change transmission line mileage for the West Side Plan to approximately 33 miles. 1

Table 1: Replace the values for transmission line mileage with the following: West Side 32.7, Sandario 33, Sandario-San Joaquin 33, East Side 32.

Page 4: Change the values for the transmission line mileages to the above. Also, remove the word miles before "approximately" in the first paragraph of No. 2 Sandario-San Joaquin plan.

Page 5; paragraph 2: The power requirement of 117 gigwatthours does not agree with Table 1 which shows 111 gWh's for the no action alternative.

Page 12; paragraph 2: In the first sentence under Visual Resources remove either transmission lines or power transmission lines. Both are not necessary.

Index

Page vi: N 5 through 8 should be page 110 not 108.

Section II

Table 1: Replace the values for transmission line mileage with the following: West Side 32.7, Sandario 33, Sandario-San Joaquin 33, East Side 32. Throughout the appropriate sections of narrative the numbers should also be changed.

601 File ________ By ________
Copy to ________________

Figure 7: The proposed transmission line in the vicinity of Los Reales Road should extend an additional 1/2 mile to the east to show that it is proposed to be interconnected with Western's Tucson-Apache 115-kV transmission line.

Figure 16: The proposed transmission line in the vicinity of Los Reales Road is not shown on the map.

Figure 22: The proposed transmission line in the vicinity of Los Reales Road is not shown on the map.

Page 14: Delete the last paragraph on the page; it repeats information in paragraph 1 on page 15.

Table 31: The title of this table should indicate that these values are for miles of transmission lines.

Table 33: The title of this table should indicate that these figures are for miles of transmission lines.

---

2 Western's discussion of undergrounding of the transmission line which was provided in response to a request at a public meeting in Tucson, must be included in the document. At the least, the fact that undergrounding was considered but rejected should be mentioned under the section on alternatives considered but rejected. A brief summary of the reasons that undergrounding was rejected should be given.

---

3 Page 9; paragraph 2: Rewrite the third sentence to read: At the location of the tap a small (about 1 acre) substation would be constructed.

Page 9; paragraph 3: Although the loop line to the Tucson-Apache transmission line is proposed to be constructed along Los Reales Road, electrical and transmission systems studies which will determine the exact location of the line are being conducted but will not be completed in time for data to be included in these DEIS comments. The data and location of the line will be provided for inclusion in the FEIS.

Add following the last sentence: "A substation of approximately 2 acres would be constructed at this tap site."

Page 9: Under b, Power Transmission Facilities, add a discussion regarding electrical effects of transmission lines. We suggest using the enclosed discussion. Effects would be the same for all alternatives except no action.

---

4 Again, we emphasize the need to discuss the effects of undergrounding a HV transmission line. In addition to the data already sent to your office some additional appropriate comments are:

1. Technology is available for an underground 115-kV transmission line however many problems exist. Among the adverse impacts associated are:

   a. An above ground switchyard (50' x 50') would be required every few miles on the right-of-way and would have some adverse visual effects.

   b. Any maintenance would require that the earth be redug to get to the oil-pressurized conduit which would insulates the line. Some leakage of oil can occur. We expect that new EPA regulations will regulate very small amounts of oil-spillage. Oil spills near drainages may contaminate water runoff and would damage wildlife resources.

2. Since revegetation of cleared areas may not occur in the life of the project, the clearing associated with an underground transmission line would produce an additional adverse impact to vegetation because it would require clearing an area approximately 150 to 200 feet wide. An overhead line on the other hand, only requires one pole every 450 feet along the right-of-way. Each pole location disturbs about a 6 foot area. The remaining area can stay vegetated for wildlife use, visual benefits, and soil erosion prevention.

   Western plans to use existing roads, access roads, and the aqueduct right-of-way access roads wherever possible to reduce adverse impacts to the vegetation. Disturbances will be held to a minimum. Impacts would be similar for both types of transmission system.

Page 36; paragraph 3: Add a sentence to read. "A transmission line used by the Western Area Power Administration meets the accepted criteria established and approved by the U.S. Fish and Wildlife Service and the Bureau of Land Management for the protection and prevention of electrocution to raptors. Other bird species are too small for their wings to touch two conductors at the same time. Transmission lines rated at 115-kV and above do not present a problem to raptors since spacing between conductors is wider than the wingspan of most raptors." **5**

What would the monitoring plan for the protection of raptors consist of? This section should be expanded to describe when and where the monitoring plan would be instituted. **6**

Chemical herbicides and pesticides are not generally used in Arizona. Should it be necessary, however, agents used by Western are those registered with the Environmental Protection Agency in compliance with the Federal Pesticide Control Act of 1972 and other Federal rules and regulations. If chemical agents should be necessary, their use will be coordinated with the Arizona Game and Fish Department as required.

Sincerely,

Thomas A. Hine

Thomas A. Hine
Area Manager

Enclosures
1. Underground
2. Electrical Effects

UNDERGROUND CONSTRUCTION

Although there has been underground construction of transmission systems in the United States since the late 1920's for lower-voltage distribution lines and some high-voltage (HV) systems, most HV (greater than or equal to 69-kV) installations have been constructed in congested urban areas, or as leads from generating plants or to substations. It is important to note that technological requirements for underground HV transmission lines are markedly dissimilar to those for lower-voltage distribution transmission lines. Undergrounding of HV transmission lines is vastly more complex and costly, primarily because of problems associated with dissipating cable heat.

Design parameters and thermal limitations prohibit the use and application of underground transmission cable systems for long-distance transmission. For these reasons alone, without consideration of the cost factor, with notable exceptions (submarine), there are few underground transmission systems in the United States at voltages 115-kV and above exceeding approximately 15 miles.

Of the underground transmission cable systems in service, or concepts under development, only two cable systems are feasible (or viable) for installations of approximately 15 miles. These are the high-pressure oil-filled pipe-type (HPOF) and low-pressure oil-filled self-contained (SCOF) cable systems. The preference in the United States for HPOF cable systems is based on their relative ruggedness, lower installation costs, reduced obstruction of vehicular and pedestrian traffic, and avoidance of congestion during installation.

The basic cost of undergrounding a 115-kV line using an HPOF cable system would be approximately $1.3 million per mile. In addition to the cable, pipe and oil, ancillary facilities (such as cable terminators, oil-pressurizing and pumping stations, and reactor stations) would be required to complete the underground system. Oil-pressurizing and pumping-plant facilities that would be required every 7 to 10 miles along the transmission route would cost approximately $233,000 per station (in 1981 dollars), and termination stations at each of the two substations would cost approximately $106,000 per station. In brief, total estimated costs for undergrounding a 115-kV transmission line would be roughly 8 to 10 times the cost of constructing an overhead system of comparable capability.

Considering the technical complications, economic and environmental costs, and accessibility, an underground ac system was rejected as an alternative transmission system.

ELECTRICAL EFFECTS

Various types of effects have been attributed to transmission lines due to their electrical charge, including electrical and magnetic field effects, audible noise, radio and television interference, and the production of oxidants. The Phase B transmission line will be designed to meet Federal Communications Commission (FCC) and National Electrical Safety Code standards, which are set to minimize these electrical effects.

Radio and television interference, audible noise, and the production of oxidants result from a phenomenon called corona. When the natural insulating quality of the air around a conductor breaks down, an electrical discharge occurs. This breakdown can occur when the stress caused by the electrical field (a function of the operating voltage and the diameter, height, spacing, and geometric arrangement of the conductors) exceeds the breakdown gradient of air, which is a function of air density. Transmission lines are designed to comply with FCC standards to minimize corona; however, atmospheric conditions and foreign matter such as dust, insects, and raindrops can increase the voltage gradient by shortening the electrical distance, and produce a corona discharge.

Audible Noise

The corona discharge produces an audible low level crackling or buzzing sound. The intensity of the noise level is dependent on weather conditions. In fair weather, the noise level is generally undetectable. During foul weather conditions of rain or heavy fog, the noise level at the edge of the transmission line right-of-way (25 feet from transmission center line) would be 30 decibels (dbA), a level which is slightly audible and comparable to the noise level in a library.

Radio and Television Interference

Corona discharges act as miniature spark transmitters to cause radio interference. This interference is dependent on the same factors which cause corona, such as line voltage, atmospheric conditions, and spacing of the conductors; plus other factors including the distance between the transmission line and the point of interference, and the electrical frequency of the equipment being interfered with. Corona noise is generally not a problem when the transmission line voltage is below 130-kV. AM radios are most susceptible to radio interference while FM and TV frequencies (above 10 Mhz) are negligibly affected.

Gap-Type Noise

Poorly contacting transmission line hardware with an oxidized film on their contact surfaces can cause radio interference known as gap-type noise. The oxidized film acts as an insulator to create a voltage distance between the two metallic objects, which results in the creation of microarcs. This gap-type noise is essentially constant regardless of frequency. Gap-type noise is generally not a problem with well-maintained transmission lines; if it occurs, it is an abnormality which can be pinpointed and readily corrected.

Electric and Magnetic Fields

Electric and magnetic fields (measured in units of kilovolts per meter and Gauss, respectively) are responsible for induced voltages and currents in conductive bodies.

Voltages can be induced in ungrounded metal objects located in an electric field, such as under a transmission line. These metal objects can, in turn, produce an electrical shock in a person who touches them and provides a path for the current to ground. Typical types of ungrounded objects are wire fences having dry wood posts, vehicles with rubber tires, and wooden barns with large metal roofs. The electrostatic voltages induced on an ungrounded metal object are dependent upon the surface area of the object, the distance of the metal surface from the transmission line conductors, and the height of the object above ground. The magnitude of the discharged currents from these induced voltages depend on the transmission line voltage, the object size and shape, and the impedance of the current's path through the person touching the object to the ground (which varies according to the individual and manner in which the person is grounded). The threshold of shock recognition in most people is between 0.9 and 2.5 Milliampers (ma).

The transmission line would be designed to meet or exceed the safety requirements of the National Electrical Safety Code (NESC). The NESC states that the design of the line shall be such that "the electric field, or the effects thereof, shall be reduced..., as required, to limit the current due to electrostatic effects top 5.0 ma, if the largest anticipated truck, vehicle, or equipment under the line were short-circuited to ground." The 5.0 ma current is commonly acknowledged to be the "let-go" threshold for a small child.

A field of 25 kV/m is necessary to produce a 5 ma tough current from an ungrounded automobile through a normally dressed person under average conditions. The field maximum from the proposed transmission line is substantially less than 25 kV/m and therefore would not cause problems of this nature.

Fuel ignition and interference with cardiac pacemakers are other areas of concern associated with electric fields. Field strengths from the proposed transmission line are well below the field levels required to cause a spark of sufficient energy to cause fuel ignition. The conclusion drawn from available research on possible field effects on pacemakers is that the overall risk to pacemaker wearers from transmission lines is minimal. The threshold for interference to the most sensitive pacemakers is estimated to be 3.4 kV/m. Reversion of pacemakers is the most substantial effect noted to wearers of pacemakers and is not considered a serious problem. To date, no evidence that a transmission line has caused a serious problem to the wearer of a pacemaker has been found (Bracken, 1982).

Biological effects resulting from long-term exposure to electrical and magnetic fields generated by a 115-kV transmission line have not been reported. Research addressing the existence and implications of possible long-term effects is being conducted with humans and animals. In the past several years, several independent reviews of the research literature on effects of exposure to power-frequency electric fields have been performed. It is generally concluded from these reviews that there is no apparent hazard to human health from exposure to electric fields found under transmission lines. This is especially true for fields of less than 10 kV/m. Long-term exposure to magnetic fields generated by transmission lines has received less attention, but this is due to the fields being of a very low magnitude.

Exposures in the home from appliances are comparable to or greater than those from transmission lines (Bracken, 1982). Based upon the very low levels of electrical and magnetic fields expected to be generated by the 115-kV transmission line, and upon its proposed location, which would be away from occupied residences, it appears highly unlikely that long-term biological effects would occur.

Response to Comments
Department of Energy

32-1 These changes have been made in the final EIS.

32-2 We concur. A new section has been added to Chapter II as suggested.

32-3 These changes have been made in the final EIS.

32-4 See response to comment 32-2

32-5 The addition has been made.

32-6 The monitoring plan will probably consist of checking under power poles for electrocuted raptors, especially during wet periods. See response to comment 22-1 for the monitoring plan discussion.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
215 Fremont Street
San Francisco, Ca. 94105

OFFICIAL FILE COPY
U.S. Bureau of Reclamation
Lower Colorado Region

RECEIVED FEB 19 1985

Action
Action Taken Initials

Date	Initial	To
		150
File		

15 FEB 1985

Mr. Bruce Ellis, Chief
Environmental Division
Arizona Projects Office
Central Arizona Project
U.S. Bureau of Reclamation
P.O. Box 9980
Phoenix, AZ 85068

Dear Mr. Ellis:

The Environmental Protection Agency (EPA) has reviewed the Draft Environmental Impact Statement (EIS) titled TUCSON AQUEDUCT-PHASE B, CENTRAL ARIZONA PROJECT. We have the enclosed comments regarding this Draft EIS.

We have classified this DEIS as Category EC-2, Environmental Concerns - Insufficient Information (see attached "Summary of Rating Definitions and Follow-Up Action"). This Draft EIS is rated EC-2 because of questions we have regarding water quality, air quality and biological impacts. The classification and date of EPA's comments will be published in the Federal Register in accordance with our public disclosure responsibilities under Section 309 of the Clean Air Act.

We appreciate the opportunity to review this document. Please send five copies of the Final EIS to this office at the same time it is officially filed with our Washington, D.C. office. If you have any questions, please contact Roberta Blank, Federal Activities Branch, at (415) 974-8187 or FTS 454-8187.

Sincerely yours,

Charles W. Murray

Charles W. Murray, Jr.
Assistant Regional Administrator
for Policy and Management

Enclosure

Water Quality Comments

1 1. From the standpoint of water quality, buried pipeline is preferable to open canal. Open canal could result in: 1) contamination of open waters from animals, refuse and sediments, 2) a build up of total dissolved solids (TDS) in the canal due to evapotranspiration, 3) seepage of saline CAP water to the aquifer, and 4) downstream impacts due to altered drainage conditions. We recommend selection of an alternative that would maximize the use of buried pipeline, such as the Sandario-San Joaquin Plan.

2 2. The Draft EIS states that the interaction between the aqueduct and local surface drainage will be confined to providing cross drainage via overchutes. The Final EIS should discuss the potential downstream impacts of increased flow volume in the channels which receive the overchute drainage. Would flood control measures be required to protect existing or future development downstream of the aqueduct? If so, the cost of such flood control measures should be considered in the total project cost, and used when comparing the cost of open canal with that of buried pipeline.

3 3. Three open pit copper mines and three tailing ponds exist in the vicinity of the proposed aqueduct. The Final EIS should address impacts to water quality associated with the dispersal of tailings due to winds, specifically in areas where open canals are proposed.

4 4. The Final EIS should discuss how potential leakage from the buried pipeline portions of the aqueduct would be detected, to determine if saline CAP water was seeping into the surrounding soils and potentially into the underlying aquifer.

Clean Water Act, Section 404(b) Comments

5 1. The discussion on page 34, paragraph 1, identifies the mesquite bosque community as a wetland habitat occurring along the Santa Cruz River and in the Brawley Wash. However, in Appendix C, the discussion of Executive Order 11990 (Wetlands Protection) states that no wetlands occur in the Phase B vicinity. If the mesquite bosque community (containing three riparian plant associations) is a wetland (seasonal or otherwise), then the discussion of EO 11990 in Appendix C should reflect this. Should this wetland community be impacted by any of the alternatives, the project must comply with Sections 230.10(a)(3) and 230.10(c)(1-3) of the 404(b)(1) Guidelines.

2. Several species of waterfowl are identified on page 34 as occurring in the Phase B area. However, Appendix D states that no waterfowl migration, breeding or nesting areas exist along the alinement of the West Side Plan. The discussion of impacts to waterfowl habitat should include an analysis of all alternatives, not just the agency proposed action. **6**

3. On page 34, under Construction Impact Analysis, paragraph 3 states that desert wash vegetation downstream of the aqueduct would be lost, due to loss or reduction of flood flows from drainage protective structures. It is not clear which vegetative associations would be impacted. An estimate of the amount (in acres) of vegetation potentially lost from flood flow reduction should be presented. **7**

4. On page 34, under Construction Impact Analysis, and page 42, under Comparative Analysis of Alinements, the discussion of impacts should identify the loss of vegetation (in acres) for each of the seven natural vegetative communities, and for all alternatives. This is especially important under Section 404, for the mesquite bosque and mixed riparian associations. **8**

5. Section 230.10(c)(1-3) of the 404(b)(1) Guidelines prohibits the discharge of fill material which will have significant adverse effects on fish and wildlife or which will result in significant loss of their habitats. The mixed riparian woodland river habitat has been identified in the Draft EIS as having the greatest songbird density and greatest number of species. However, the amount (in acres) of riparian vegetation lost where the project alinement crosses the Santa Cruz River has not been identified, but should be in the Final EIS. **9**

   Section 230.10(d) of the Guidelines prohibits placement of fill unless appropriate and practicable steps have been taken which will minimize potential adverse impacts. Mitigation which would minimize adverse impacts to riparian vegetation and associated wildlife habitat along the Santa Cruz River should be included in the Final EIS.

6. On page 89, under Construction Materials, the potential impact to riparian or wetland communities from the mining of construction materials in borrow areas along the Santa Cruz River should be discussed. **10**

Air Quality Comments

1. The Draft EIS does not adequately portray existing air quality in the Tucson Area. An accurate description of existing air quality conditions is important in evaluating the potential significance of project related emissions. The Final EIS must include: **11**

a. At a minimum, numerical data on pollutant concentrations for: total suspended particulates (TSP), carbon monoxide (CO), nitrogen dioxide (NO_2), sulfur dioxide (SO_2) and hydrocarbons (HC), for the three most recent years.

b. The National Ambient Air Quality Standards (NAAQS) (including the averaging period) for each of these pollutants, and the number of times each standard was violated in the three most recent years.

2. Regarding the discussion in the Draft EIS on TSP, the following issues must be addressed:

a. The 1983 annual network geometric mean for TSP in the Tucson area was stated as 53 ug/m^3. "Network" mean should be defined. The Final EIS should also include the 24 hour TSP standard, as well as the annual geometric mean TSP standard.

b. While the DEIS does predict an increase in ambient particulate concentrations of 12 to 17 ug/m^3, it does not indicate what project TSP emissions will be. Also, it is not clear whether the predicted increase is with or without mitigation.

c. The DEIS recommends that dust control measures be implemented by the construction contractor. The level of dust control is not addressed. In view of the potential increase of 12 to 17 ug/m^3 predicted in the Draft EIS, an intensive level of dust control may be necessary to avoid further violations of the Federal primary and secondary standards. The Final EIS should describe the level of dust control necessary to comply with the TSP standards.

3. The incremental emissions of other NAAQS pollutants from construction (CO, NO_2, HC and SO_2) should be assessed. If determined not to be significant, the Final EIS should support this conclusion. When assessing the significance of the project's impacts on air quality, consideration should be given to: 1) the proximity of construction to the Tucson Metropolitan Area - construction close to the city having greater impact, 2) the wind direction and wind speed in the area, 3) the amount of each project related pollutant, 4) the attainment status of each pollutant, and 5) the probability of standards violations resulting from project emissions.

12

4. The Draft EIS does not address emissions from the generation of power required for pumping. The Final EIS should indicate where the power source is located in relation to the Tucson area. Is there an expected increase in fuel consumption to provide the increased electrical power? If so, what is the increase expected to be? If a significant increase is

expected, then the Final EIS should quantify the emissions increase in SO_2 and TSP.

5. The Final EIS should document contact with the Pima Association of Governments regarding the consistency of the project with the assumptions for population, emissions and transportation used in the State Implementation Plan, the Nonattainment Area Plan and the Regional Transportation Plan. The population, industrial development and commercial activity that will be served by CAP water must be taken into account in air quality planning assumptions for the area. **13**

SUMMARY OF RATING DEFINITIONS AND FOLLOW-UP ACTION*

Environmental Impact of the Action

LO—Lack of Objections

The EPA review has not identified any potential environmental impacts requiring substantive changes to the proposal. The review may have disclosed opportunities for application of mitigation measures that could be accomplished with no more than minor changes to the proposal.

EC—Environmental Concerns

The EPA review has identified environmental impacts that should be avoided in order to fully protect the environment. Corrective measures may require changes to the preferred alternative or application of mitigation measures that can reduce the environmental impact. EPA would like to work with the lead agency to reduce these impacts.

EO—Environmental Objections

The EPA review has identified significant environmental impacts that must be avoided in order to provide adequate protection for the environment. Corrective measures may require substantial changes to the preferred alternative or consideration of some other project alternative (including the no action alternative or a new alternative). EPA intends to work with the lead agency to reduce these impacts.

EU—Environmentally Unsatisfactory

The EPA review has identified adverse environmental impacts that are of sufficient magnitude that they are unsatisfactory from the standpoint of public health or welfare or environmental quality. EPA intends to work with the lead agency to reduce these impacts. If the potential unsatisfactory impacts are not corrected at the final EIS stage, this proposal will be recommended for referral to the CEQ.

Adequacy of the Impact Statement

Category 1—Adequate

EPA believes the draft EIS adequately sets forth the environmental impact(s) of the preferred alternative and those of the alternatives reasonably available to the project or action. No further analysis or data collection is necessary, but the reviewer may suggest the addition of clarifying language or information.

Category 2—Insufficient Information

The draft EIS does not contain sufficient information for EPA to fully assess environmental impacts that should be avoided in order to fully protect the environment, or the EPA reviewer has identified new reasonably available alternatives that are within the spectrum of alternatives analyzed in the draft EIS, which could reduce the environmental impacts of the action. The identified additional information, data, analyses, or discussion should be included in the final EIS.

Category 3—Inadequate

EPA does not believe that the draft EIS adequately assesses potentially significant environmental impacts of the action, or the EPA reviewer has identified new, reasonably available alternatives that are outside of the spectrum of alternatives analyzed in the draft EIS, which should be analyzed in order to reduce the potentially significant environmental impacts. EPA believes that the identified additional information, data, analyses, or discussions are of such a magnitude that they should have full public review at a draft stage. EPA does not believe that the draft EIS is adequate for the purposes of the NEPA and/or Section 309 review, and thus should be formally revised and made available for public comment in a supplemental or revised draft EIS. On the basis of the potential significant impacts involved, this proposal could be a candidate for referral to the CEQ.

*From: EPA Manual 1640 Policy and Procedures for the Review of Federal Actions Impacting the Environment

Response to Comments
U. S. Environmental Protection Agency

33-1 Reclamation is fully aware of and has investigated the advantages, in terms of water quality, of buried pipeline in comparison to open canal. These advantages however, do not justify the additional expense involved in maximizing the use of buried pipe. Extensive investigations by Reclamation, taking into account all factors including economic justification, has lead Reclamation to choose the proposed action presented in the Tucson Aqueduct Phase B Environmental Impact Statement.

33-2 The design for conveying surface water across the canal is to use the dike system to detain and regulate the flows at the overchutes to outflow that could be expected on the site without the canal, for a 100-year 6-hour storm or a 3-hour thunderstorm which ever has greater run-off. The outlets from the overchutes will have energy dissipators constructed to bring the water to a velocity that is not conducive to downstream erosion. This design would preclude any cost of flood control being a direct result of the canal construction while providing flood control for these areas between the overchute structures and downstream of the canal.

33-3 A decision has been made to put that portion of the aqueduct from the last pumping plant to the aqueduct terminus into pipeline. This will eliminate any possibility of contaminants being blown into an open canal from the three open pit copper mines and three tailings ponds located near the end of Phase B of the Tucson Aqueduct.

33-4 Concrete pipe, which is planned to be used for all sections requiring pipe on Phase B of the Tucson Aqueduct, has very low potential for leakage. Usually any leakage is restricted to the pipe joints and current construction methods limit normal leakage to very minimal amounts. For all practical purposes, leakage from any buried pipe along the aqueduct may be assumed to be zero during normal operation. Should unusual leakage occur, such as joint separation or pipe failure, the sophisticated flow monitoring system along the canal will be able to detect the loss of abnormal amounts of water. Early detection will allow the situation to be rectified before a significant quantity of water would be lost.

33-5 Brawley Wash does not meet the criteria of a wetland. It does not support predominantly hydrophytes, the substrate is not predominantly undrained hydric soil nor is the substrate non-soil that is saturated with water or covered by shallow water at some time during the growing season of each year, (Executive Order 11990). In addition, no alternatives cross Brawley Wash and sheet flow and desert wash flow into Brawley will be maintained with cross-drainage structures. No impacts will occur to Brawley Wash. The Santa Cruz River south of Tucson is an intermittently flowing waterway, dependent upon seasonal rainfall. North of Tucson, where the CAP crosses it, it becomes a perennial stream because of sewage effluent discharged from the sewage treatment plant. Although only a narrow strip of habitat exists now which is greatly impacted by land alterations, this vegetation has potential to become high value habitat if the sewage effluent flows are maintained. All alternatives except the no Federal action plan involve a pipeline under the Santa Cruz River. The aqueduct will pass under the Santa Cruz River. Several dozen small trees and one large cottonwood would be impacted. Mitigation commitments will include the revegetation of any habitat disturbed by construction. The flows in the river may be temporarily disrupted by aqueduct construction but will not be altered permanently. Any riparian vegetation that is lost during construction will be re-established through suitable revegetation techniques. No permanent or long-term impacts will occur to this wetland habitat.

33-6 The water birds listed in Chapter III occur only sporadically in the Phase B area, usually at waste water treatment ponds in the area. These ponds will not be affected by any of the alternatives.

33-7 All vegetation associations would be impacted. Vegetation potentially lost has not been quantified. However, it is estimated that the loss of habitat quality downstream of the aqueduct caused by temporary retention of flood flows behind aqueduct dikes will be compensated for by an increase in habitat quality upstream due to the extra moisture provided in this area. State and Federal wildlife agencies have recommended that this "green-up" area upstream of the dikes be fenced to preclude cattle grazing and further offset the downstream impacts.

33-8 A table was included in the Fish and Wildlife Coordination Act Report which displayed areas of habitat types permanently lost to project alternatives. The data was used to determine project impacts and is on file at Reclamation and FWS.

33-9 The amount of riparian vegetation impacted by the pipeline under the Santa Cruz will be less that 1 acre and includes one large cottonwood tree and several dozen small salt cedar and willow trees.

33-10 If borrow areas are selected along the Santa Cruz River they will be confined to the river bed and will not impact adjacent bankline riparian habitat.

33-11 The air quality section has been rewritten to address comments 1, 2, 3, and 5.

33-12 The Navajo Generating Station is an authorized feature of the CAP to provide the electrical power needed to pump Colorado River water form Lake Havasu to central and southern Arizona. This plant is located at Page, Arizona and consists of three 750 megawatt coal-fired generating units. Navajo is co-owned by 5 utilities and the United States, with Salt River Project being the operating agent. Federal ownership is 24.3 percent of plant output, both energy and capacity. The plant is presently in full service. Environmental impacts of the generating station are addressed in the _Final Environmental Statement_, _Navajo Project_, FES 72-1, dated February 4, 1972.

33-13 See response to comment 33-11.

34

Rt 9 Box 820
Tucson
Az 85743

Feb 7th

OFFICIAL FILE COPY
U.S. Bureau of Reclamation
Lower Colorado Region

RECEIVED A	FEB 11 1985	
Action		
Action Taken		Initials
Date	Initial	To
		140
File		

United States Dept of Interior
Bureau of reclamation
Boulder City
Nevada

Dear Sir or Madam,

I recently received the publication of the Pipeline + Canal line plans from the Colorado River to Tucson. Thank-you for letting me know whats going on.

I was most distressed that I could not make it to either meeting about these plans which was to hear how the public felt. Still even though I hear the meeting was poorly attended (I'm sad to hear), there are a great many people in this area who are very concerned + anxious about the proposals you put forward.

My main feeling is of the distribance of the very delelcate desert which we live with in the Tucson area. Already there are alot of dwellings popping up left, right and centre, this also is distressing. Already alot of wild life is disappearing as we populate the countryside - especially the desert - the desert is very different to everywhere else which I'm sure you are aware of. As soon as a scar is made in the desert it takes many years for it to heal, alot longer than other places. Please keep this in mind.

I wonder why don't you bring the pipe line south along the Freeway called I-10. This area is already changed + built on + would bring alot less attention to itself. This too would not interfer with animals like the Mountain Lion's migration. +

1

Please bring me up to date as to the future plans and the final decisions that are made. I am very anxious to know.

Yours faithfully

Juliet Stanley.

Also in support of this letter:

Diana Kouvel

Sue Moon.

Klaus A. Yasko

[illegible]

Bettina Foote

Responses to Comments
Juliet Staveley

34-1 There were many alternatives studied for delivery of water to Tucson with one of the first studies being along the old highway before the freeway. When the economics of all plans are compared the open canal generally is the most cost effective. The environmental aspects are included in this comparison to the best of our ability. Although it appears that the pipeline should be cheaper due to the lack of evaporation, maintenance and cross drainage the cost is reflected in the pumping head required to push the water through the pipe which is roughly 15 times greater than through a canal.

35

THE ARIZONA-SONORA DESERT MUSEUM

— A Living Museum —

ROUTE 9, BOX 900 TUCSON, ARIZONA 85743 TEL. (602) 883-1380

DAN DAVIS, Director

OFFICIAL FILE COPY
U.S. Bureau of Reclamation
Lower Colorado Region
RECEIVED A FEB 11 1985

Action		
Action Taken		Initials
Date	Initial	To
J-A	WR	150
File		

February 7, 1985

Regional Environmental Officer
Lower Colorado Region
U.S. Bureau of Reclamation
Box 427
Boulder City, Colorado 89005

Re: TUCSON AQUEDUCT - PHASE B
CENTRAL ARIZONA PROJECT
INT DES 84-68

Dear Sir:

Thank you for supplying us with a copy of subject document. We appreciate the opportunity to comment.

The agency proposed action (West Side Plan) obviously has the positive attribute of conflicting least with the interests of private landowners and public land managing agencies in the area. It also has the negative aspect of resulting in very serious impacts on wildlife and rare or endangered plants. Other alternatives create less serious impacts primarily because more pipeline is proposed instead of aqueduct, permitting much less habitat destruction along the right-of-way and the eventual restoration of vegetation.

We believe that greater consideration should be given to the use of pipeline in the agency proposed action.

Our specific comments follow:

1. We strongly object to the construction of an above-ground surge tank at or near the proposed location of the Brawley Pumping Plant. A surge suppression system constructed adjacent to the pumping plant structure and which is not visible to the Desert Museum by virtue of its being constructed below natural grade is much preferable. It is our understanding that such a system has been preliminarily designed and will function appropriately. **1**

2. We are extremely concerned about the visual impact of the open canal leading to the Brawley pumping station, particularly the area of significant cut and spoil disposal. Our primary concern is in the method of disposal of spoil material adjacent to the excavations and its aesthetic impact on the view from the Desert Museum. We would much prefer that most or all of the spoil material be removed from the site and disposed of elsewhere. Any spoil material left on site and exposed surfaces of the cut slopes visible to the Museum or Saguaro National Monument should be constructed so as to be conducive to revegetation. **2**

The revegetation provided as a part of the project should be significantly enhanced over that used in the past. The Desert Museum's staff stands ready to assist the Bureau in any way it can to reach these objectives. **3**

CONSERVATION • EDUCATION • RESEARCH • RECREATION

4 3. Mechanical and electrical equipment, including power lines, and any concrete structures or buildings exposed to view should be painted in a manner to minimize their visual impact.

5 4. We strongly advocate the purchase of the four and one-quarter square mile wildlife corridor as proposed. In order to be an effective migratory route for wildlife, the open canal through the wildlife corridor must be replaced with pipeline.

6 5. We do not support any canal alignment which might cause the disruption or modification of existing traffic routes in the area west of the Tucson Mountains so as to cause additional traffic to be placed on Kinney Road. Kinney Road is a low speed scenic route primarily for access to Tucson Mountain Park, Saguaro National Monument, Old Tucson and the Desert Museum and should not be required to accommodate additional through traffic.

7 6. The Desert Museum requests the inclusion of additional wildlife crossings on all of the reaches of open canal. We support construction of additional wildlife watering locations as mitigation for the disruption caused by the canal.

8 7. We support the inclusion of a trail system along the project right-of-way.

We will appreciate your careful consideration of these points, and trust that you will make the final decisions on the basis of what is best for all concerned rather than on cost alone. The Board of Trustees and Advisory Council of The Arizona-Sonora Desert Museum unanimously approved the enclosed Resolution at its January 22, 1985 meeting.

Sincerely yours,

Dan Davis, Director

Bernard L. Fontana
President
Board of Trustees

DB/PC:jtm

Enc.

RESOLUTION

ARIZONA-SONORA DESERT MUSEUM
BOARD OF TRUSTEES' MEETING
JANUARY 22, 1985

WHEREAS The Arizona-Sonora Desert Museum is known nationally and abroad as a unique exposition of the beauty of the Sonoran Desert in Arizona and Mexico, and

WHEREAS maintaining the quality of its natural setting in Tucson Mountain Park and adjacent to Saguaro National Monument is essential to effective accomplishment of its education and conservation mission, and

WHEREAS the Tucson Aqueduct, PHASE B, of the Central Arizona Project will permanently affect the vistas from the Museum grounds and strongly impact wildlife of the area and native vegetation,

NOW THEREFORE BE IT RESOLVED that the Board of Trustees of The Arizona-Sonora Desert Museum requests the U.S. Bureau of Reclamation to carefully weigh the consequences of its proposed actions to the environment of Avra Valley and the Desert Museum and favorably consider placing that portion of the project which traverses the corridor proposed for wildlife and plantlife impact mitigation in underground pipeline so as to permit the free movement of wildlife across the corridor between Tucson Mountain Park and the Papago Indian Reservation.

AND BE IT FURTHER RESOLVED that in planning the Brawley Wash pumping station serious efforts be made to harmonize the installation with its environment and reduce its visual impact as seen from the vicinity of the Desert Museum.

Responses to Comments
The Arizona - Sonora Desert Museum

35-1 The present design is to use an air chamber surge control at the Brawley pumping plant in place of the tall surge tank on the discharge line downstream of the pump plant. This system would not be visible from the surrounding area. This type structure is planned for Snyder Hill, Black Mountain, and San Xavier. Pumping Plants also. Twin Peaks and Sandario Pumping Plants will not require surge control.

35-2 The plan to dispose of the spoil from the pumping plant excavations is to use it in the construction of the canal and dikes adjacent to the excavation. That material in excess of that required would be wasted by widening the maintenance road and dike rather than building a large embankment adjacent to the excavation site. The dikes and outside of the road areas that are used for spoils would be left in a roughened and/or grided condition to control the runoff and erosion and to facilitate the natural revegetation.

35-3 See response to comment 20-9.

35-4 We agree with this suggestion and will paint or stain highly visible concrete canal structures such as bridges, and overchutes, and steel structures such as pipe overchutes, check gates, etc.. The power transmission lines will use wood-pole structures, which experience has taught are better left unpainted. (see response to comment 20-7).

35-5 Your support for the wildlife corridor has been noted and the comment is available to decisionmakers. See response to Comment 23-2 regarding pipeline and the wildlife corridor.

35-6 The design of the aqueduct through the area has been coordinated with the Pima County Highway Department with all major roads being kept open. There is also provision for additional crossings in the future should the need arise. With these provisions there should be no increase in the traffic along Kinney Road as a result of the Tucson Phase B.

35-7 See response to comment 18-7.

35-8 Your support of the trial system has been noted and the comment is available to decisionmakers.

36

PIMA COUNTY
PLANNING AND ZONING DEPARTMENT
131 WEST CONGRESS STREET
TUCSON, ARIZONA 85701

FEB 14 1985

ROBERT C. JOHNSON
DIRECTOR

PH. 792-8361

2/14 /50 BBE

February 13, 1985

Bruce Ellis
United States Bureau of Reclamation
P O Box 9980
Phoenix, AZ 85068

RE: Comments on the Draft Environmental Statement, Phase B.

Dear Mr. Ellis,

The following are comments on the Draft Environmental Statement for Phase B of the Central Arizona Project that express concerns and issues affecting Pima County.

1. A more complete and detailed breakdown of costs needs to be provided. This should include not only breakdowns as to the costs for particular aspects (i.e. acquisition costs, aqueduct costs, pipeline costs, mitigation measures, etc.), but should also discuss the costs related to vegetative and cultural losses, evaporation, and transportation/access disruption. While these latter are admittedly difficult to quantify, they do represent actual costs of the project and should be discussed in that light. A more detailed cost breakdown is essential to better analyze the impacts of the project and the advantages and disadvantages of the various alternatives. 1

2. There needs to be a cost/benefit analysis done on the use of a pipeline along Sandario Road versus the open aqueduct through the Avra Valley. 2 Furthermore, the Sandario-San Joaquin alternative shows the pipeline going through the Saguaro National Monument, but no reason is given why this portion could not be built on the same route as the West Side Plan which skirts the monument. The impacts on the residents in the Avra Valley could be greatly reduced. 3

3. The West Side Plan does show a pipeline running from the Brawley Pumping Station (approximately 3 miles northwest of Mile Wide Road) to a point just south of Mile Wide Road near Sandario Road. From here, it would become an open canal. The canal would run through the proposed wildlife movement corridor which is about 1/2 mile south of where the canal begins. 4

Impacts to wildlife would clearly be reduced if the pipeline was extended through the corridor, yet the draft Environmental Impact Statement gives no reason why the pipeline could not be extended.

5 4. A distribution system will need to be constructed. The draft E.I.S. does not describe the system, nor its impacts or costs.

6 5. The proposed alternative will seriously disrupt access in the Southwest Area and will effectively cut the area in half. Access to the western half of the area will be possible only along Valencia Road, Ajo Highway and Bopp Road (the latter only to about 1 mile east of San Joaquin Road). Los Reales Road will be cut off 1/2 mile west of Mark Road as no bridge is planned.The canal will cross and run along Snyder Hill Road just east of San Joaquin Road, making access to both the Avra Valley WWTF and the Industrial-zoned land north of Ryan Airfield possible only from the west.

7 6. The proposed alternative will permanently destroy more vegetation and affect 18,000 more Thornber's cactus (a threatened specie) than the Sandario-San Joaquin alternative; and, in fact, the proposed alternative will affect the densest stand of cactus in the area.

8 7. The breakdown of costs states that the sum to be spent for biological mitigation is the "maximum mitigation expenditure." This is important not only because it means that some impacts may not be mitigated but, more importantly, means that the wildlife corridor may not be purchased. The draft E.I.S. states that if additional funds must be spent on protecting threatened and endangered species, then other measures including the wildlife corridor may have to be sacrificed. The two issues are separate. Threatened and endangered species should be protected, and wildlife should be protected. One should not be sacrificed for the other. Any necessary additional funds to protect endangered species and provide a wildlife movement corridor would be well spent.

9 8. The draft E.I.S. states that revegetation will take up to 30 years in most areas, while some areas will not revegetate for substantially longer periods of time. These latter areas need to be delineated. Further, if mitigation funds run out or priorities change, does this mean that vegetation efforts will stop (with the result that invader species such as the Russian thistle will dominate)? The proposed alternative will disturb more land than the other alternatives, and the impacts will be far greater. Disturbance will be increased since five spoils areas will be created (8 feet high and up to 2.5 miles long and 560 feet wide). These areas are historically far more difficult to revegetate.

10 9. The negative impacts related to aesthetics will be far greater with the proposed alternative. The canal will be lined with barbed wire-topped chain link fences, earthen dikes, and spoils areas.

This is important for both aesthetic values and for the effects it may have on the quality, type and marketability of development in the vicinity. In addition, all alternatives will require power transmission lines. No study is done to determine if these could be placed underground.

---

10. Floodwater retarding structures will create flooding impacts, including damage to natural channels and drainageways. These impacts are never described. A 6 foot high chain link fence (even with overchutes) will create a damming effect with potentially severe impacts. A discussion of this issue, including how the overchutes will provide sufficient cross drainage during major flood events, should be provided. **11**

---

11. The draft E.I.S. states that opportunities for recreation will be better with the proposed alternative because adjacent property can be used in conjunction with rights-of-way not used for roads, dikes or the canal. However, the pipeline will necessitate less right-of-way and the land can be used for recreation regardless of ownership (also, more land for recreation would be available with the pipeline). Further, recreation values will likely be less near a canal because of its unattractiveness, the presence of dikes and spoils areas and the frequent unsuitability of detention basins as recreation areas. In addition, hiking and equestrian trails will be disrupted. **12**

---

12. The proposed alternative will require open aqueducts crossing major highways, particularly Ajo Highway and, to a lesser degree, Valencia Road. As the area develops, particularly in the vicinity of Ryan Airfield, traffic will include that carrying hazardous materials. While the chances of an accident may be slight, they are not non-existent and such spills or accidents could have disastrous impacts. Measures to protect C.A.P water from such an occurrence need to be addressed. **13**

---

13. The proposed alternative will affect two times more the cultural sites as will the Sandario-San Joaquin alternative. However, the draft E.I.S. shows that the expenditure to mitigate the impacts to cultural resources is the same for all the alternatives. Assurances that the West Side Plan will adequately mitigate the impacts to cultural resources should be provided. **14**

Thank you for you consideration of the above concerns.

Sincerely,

Robert C. Johnson, Director
Planning and Zoning Department

RCJ/MF/cm

Response to Comments
Pima County Planning and Zoning Department

36-1 Detailed costs have been included in the EIS for acquisitions, aqueduct costs, pipeline costs, mitigation measures, etc. In terms of plan formulation, we determined that the most appropriate method for determining cultural and vegetative losses and transportation/access disruptions was to use the cost to mitigate for these; their costs are included in the estimate. The cost of evaporation can be easily determined by multiplying the quantity of water lost (see Table 25) times its value ($59 per acre-foot for M & I water).

36-2 A cost/benefit analysis was done for the overall Central Arizona Project. The decision was made earlier in the planning process not to prepare cost/benefit analysis for each feature of the CAP. Cost estimates have been done and can be compared for each alternative (see Table 2). The benefits of a pipeline along Sandario Road would consist of reduced environmental impacts and these are described in the EIS.

36-3 See response to Comment 9-1. The Sanders - San Joaquin Modification Plan would skirt the west side of Saguaro National Monument.

36-4 The extension of the pipeline through the wildlife corridor is possible but the cost enters into the picture in construction and pumping. If the Bureau invested the additional money needed to bury this section of the aqueduct, we believe we would not have adequate justification to purchase the corridor (see response to comment 23-2).

36-5 The distribution systems are not part of the Tucson Phase B as they are the responsibility of the water users. The project will provide the turnout and measuring system. The users have the responsibility beyond that point. These delivery lines shown on the drawings are for information only.

36-6 The access to the area will be disrupted due to the canal construction. However, on completion of the system most of the roads that are now used will still be available including Snyder Hill Road. As the development continues it will be possible to add more crossings. The crossings would be like any other new road, those that want it would pay for it including the bridges.

36-7 Your statement is true. See response to comment 20-10 regarding the likely conservation measure to offset the loss of Mammillaria Thornberi.

36-8 The terminology "maximum mitigation expenditure" has been deleted. See response to comments 29-2 and 29-3.

36-9 See response to comment 20-9.

36-10 As stated in the EIS, the aesthetic (visual) impacts are greater for the proposed action than for any of the alternatives, since it is predominantly open canal. As to the effect of such aesthetic impacts on future development in the vicinity, we may look at other portions of the CAP aqueduct system which are already in place. In developing areas of north and northwest Phoenix, where the Granite Reef Aqueduct was constructed in the mid-late-1970's, there has been no apparent effect on the rate of, or type of development in the vicinity of the canal.

The feasibility of underground transmission lines has been evaluated in the final EIS (see Chapter II E. 3.).

36-11 The hydrologic designs are using two methods, one to detain and regulate outflow, the other to pass the flood unchanged with respect to size and location. With the detention dikes, the flood water from several channels would be collected behind the dike and the water would be allowed to start flowing through the crossing structures at the beginning of the flood. The structures are sized to reduce the peak of the water flowing into the dike by storing a portion of this water for a short time. The crossing structure is sized to match the largest flow that could be expected from either the 100-year 6-hour general storm or the 3-hour thunderstorm. This should preclude any damage that would not be expected under the natural condition. The chain link fence described in the EIS would not be placed across the inlet or outlets to the crossing structures but tied to the head walls to provide continuity of the wildlife protection. If a fence is required for domestic animal control, a breakaway barbed wire fence would be installed across the structure. Also the chain link fence would normally be placed between the dike and canal for wildlife protection with a standard barbed wire fence on the right-of-way upstream of the dike and the chain link fence on the right-of-way on the downstream side. The downstream fence may be offset if the hiking or equestrian trails are located on that side.

36-12 See response to Comment 22-5.

36-13 The major crossings are such that the canal is protected from contamination should a vehicle carrying these products cause a spill at a crossing. The Ajo Highway will be in pipeline for the crossings near the Tucson treatment plant. The Valencia Road crossing will in all probability be a trapazoidal crossing which will be such that any spills would have to splash several feet up and over the concrete walls of the structure. Most other crossings will be of this same design also.

36-14 Funding for cultural resource mitigative data collection studies may be up to 1 percent of construction costs. This means that about $3.5 million is available to mitigate impacts to significant cultural resources for the proposed West Side Plan.

A mitigation plan is being proposed by the survey contractor, the Arizona State Museum. It will be the basis for our mitigation plan which will be developed in consultation with the State Historic Preservation Office.

37

ARIZONA CHAPTER
THE WILDLIFE SOCIETY
P.O. BOX 11135
PHOENIX, ARIZONA 85017

THE WILDLIFE SOCIETY

OFFICIAL FILE COPY
U.S. Bureau of Reclamation
Lower Colorado Region
RECEIVED A FEB 20 1985

Date	Initial	To
		150
File		

15 February 1985

Mr. William Rinne
Regional Environmental Office
Bureau of Reclamation
Box 427
Boulder City, NV 89005

Dear Bill:

We have reviewed the Draft Environmental Impact Statement, Tucson Aqueduct Phase B - Central Arizona Project, and offer the following comments for your consideration.

Although five alternatives were presented including the required "No Action" alternative, we feel that only 3 of the alternatives are viable. The Sandario and Sandario - San Joaquin alinements as presented are not viable because they pass through National Park Service land which has been committed to preservation, not construction. Therefore, the only viable choices offered in this DEIS are an east route in pipeline, a west route that is primarily aqueduct, and no action. We believe that for such a major federal action as Tucson Aqueduct Phase B, additional viable alternatives should be presented. The Bureau of Reclamation should issue a supplement to this DEIS and present an analysis of impacts and environmental consequences for more than one west side alternative that is outside the boundaries of the Saguaro National Monument. If the transmission line route for Sandario and Sandario - San Joaquin routes can avoid Saguaro National Monument, why can't the water conveyance system also avoid the Monument? 1

We can support none of the construction alternatives as presented. Our preferred construction alternative on the west side of the Tucson Mountains would avoid Saguaro National Monument, include the endangered and threatened species conservation plans, and require all the biological mitigation measures discussed in this DEIS including the land acquisition for a wildlife movement corridor and long-term monitoring of mitigation measures. However, we insist that, at major areas of wildlife movement, the water conveyance structure be a pipeline and not an open aqueduct with scattered wildlife crossings. These pipeline areas would include the west side of Saguaro National Monument, Tucson Mountain County Park, and Black Mountain on the San Xavier Indian Reservation. 2

3 We wish to point out that while fencing has been considered in this DEIS as a mitigation measure to reduce wildlife drowning losses, it is also a required human safety measure to reduce human drowning incidents. Similarly, the locations labeled as wildlife crossings which are along current road alinements will actually be vehicle bridges over the aqueduct which may be used by wildlife. These structures should not be budgeted as wildlife mitigation measures.

Specific Comments

4 Summary, Page 2, Table 1 - The physical characteristics of the Indian delivery line and Avra Valley delivery line are provided but there is no information provided on the delivery line from Tucson Aqueduct Phase B to the water treatment plant for the City of Tucson. Please provide this information.

5 Summary, Page 3, Table 2 - Footnote 1 does not appear on this Table.

Footnote 3 following "Mitigation - Biological" is incorrect and should be deleated. No maximum limit has been determined by congressional legislation concerning biological mitigation costs for major federal water projects. Instead, a new footnote number should be substituted and followed by the phrase "estimated cost - mitigation plan is currently being developed with appropriate federal and state agencies."

Footnote 4 indicates formulation based on 100-year project life. We were under the impression that CAP, except for Regulatory Storage, had a project life of 50 years. What is the project life of Tucson Aqueduct Phase B, 50 or 100 years? If it is 50 years, this table needs to be revised using 50-year project life.

Footnote 5 indicates this table includes both private and federal expenditures. Please separate and show on this table those costs that are private and those that are federal. Private costs include those initially paid for by small Reclamation loan or similar loan system. Also, please indicate the costs of the delivery line from Tucson Aqueduct Phase B to the Tucson water treatment plant on the east side of the Tucson Mountains.

Mitigation cost for biological and cultural resources is part of the construction cost and should be included as such. In this table it appears as though mitigation is an additional cost besides construction and this is incorrect.

6 Summary, Pages 6-7, Table 3 and Alternatives Including the Agency Proposed Action, Pages 21-22, Table 15 - Because biological mitigation is still in the formulation stages and the Bureau has not committed to its implementation, we do not see how your agency can adequately assess impacts to nonfederal special status species after mitigation. Therefore, the Bureau should amend this table to show impacts with no mitigation and possible impacts after mitigation with the appropriate footnote similar to footnote 1.

Impacts under Special Status Species are not indicated as being adverse or beneficial. Please clarify this.

The heading "Special Status Species Impacts After Mitigation" should be amended to read "Special Status Species Impacts After Mitigation and Threatened and Endangered Species Preservation."

Please include acres of long term vegetation losses of the 5 alternatives which range from 860 to 2005 acres under the heading Biota.

Summary, Page 10, Paragraph 2 - Please provide an estimate of the number of deer and javelina which may be lost to drowning, exposure, and to movement severence on an annual basis and then multiply this by the life of the project. The Bureau should be able to develop a reasonable worst case analysis as required by CEQ based on density and movement data gathered during biological studies on Tucson Aqueduct Phase B. **7**

Summary, Page 11, Paragraph 3 - We were unaware that the purpose of CAP water was to supplement ground water. We thought CAP water was to be used as a substitute for ground water to lessen ground water overdraft. **8**

Summary, Page 12, Paragraph 4 - Please provide a range in decibles of the sounds produced by operational plants and what the acceptable limits are. This and other information we have requested should appear in the Summary as well as the body of the EIS since the decisionmaker may make a selection based on information presented in the Summary. **9**

Purpose and Need, Figure 2, Following Page 2 - The five alternative alinements should be indicated on this figure so the reader can see the aqueduct alinements relative to the location of potential water users. **10**

Alternatives Including the Agency Proposed Action, Figure 3A, Following Page 7 (Also Figures 12A, 18A, and 24A) - Why is the delivery pipeline east of Snyder Hill pumping plant to the City of Tucson water treatment facility shown as part of Tucson Aqueduct Phase B? It is a distribution line from the aqueduct. Also, will the Snyder Hill pumping plant be used for pumping water to the aqueduct's terminus on the San Xavier Indian Reservation or for pumping water to the Tucson water treatment facility? If it will be used only for the latter, it should be omitted from planning and construction costs of Tucson Aqueduct Phase B, and instead, be considered as part of the distribution system to the east side of the valley whose cost is to be paid by those water users who will take delivery. This has been the case with other distribution systems and water users along the CAP. **11**

Please indicate the proposed turnout locations for Avra Valley water users and water nos. 2, 3, and 5 indicated on Figure 2. Also, the Schuk Toak Indian delivery line does not agree with the Schuk Toak Indians location on Figure 2.

Figure 12A, Following Page 11 (also Figures 18A and 24A) - Why is part of the Avra Valley Irrigation District's distribution system shown as part of Tucson Aqueduct Phase B? It appears as though a decision has already been made to build the West Side Plan and that deals have already been made with the Avra Valley Irrigation District and Tucson to deliver CAP water to predetermined locations. We thought the purpose of an EIS was to compare the environmental "costs" and "benefits" of various viable alternatives, and that the decisonmaker would use this information to select an alternative.

---

12 Page 35, Paragraph 3 - Please provide a worst case analysis of numbers of mule deer, javelina, gray fox, Gila monsters, and desert tortoises from crossing the aqueduct both without mitigation and with the proposed fences and wildlife crossings. We believe a worst case analysis should be presented to show the number of animals lost due to indirect impacts.

---

13 Page 37, Paragraph 3 and Page 38, Paragraph 1 - These paragraphs contradict each other. On page 37 mitigation is suggested while on page 38 the mitigation measures and conservation plan will be implemented by the Bureau.

---

14 Page 37, Paragraph 4 - Monitoring should be done but we would like to know when it would begin and for how long.

---

15 Page 38, last half of Paragraph 1 - These last 2 sentences should be omitted from the DEIS. It is neither the requirement or intent of the Endangered Species Act, Fish and Wildlife Coordination Act, National Environmental Policy Act, or Colorado River Basin Project Act to set a spending limit on wildlife mitigation measures or endangered species conservation plans, nor to lump both mitigation measures and conservation plans into one pot and trade-off one or part of one against the other. One of the purposes of the CAP is wildlife enhancement and we have yet to see an indication of this. The EISs issued on the CAP have only discussed wildlife mitigation for project-caused adverse impacts. What are project cost ceilings that are referred to and why were these ceilings not of concern for Granite Reef Aqueduct, Salt-Gila Aqueduct, Tucson Aqueduct Phase A, and Regulatory Storage DEISs?

---

16 Page 39 - Will title to land of wildlife movement corridors include energy, mineral, and water rights?

---

17 Page 41, Paragraph 1 - What would be the duration of phase two of the mitigation?

---

18 Page 48, Paragraph 3 - Please indicate on the figures where the borrow areas would be located.

---

19 Page 48, Paragraph 6 - This paragraph states that the number of wildlife crossings would be determined with Fish and Wildlife Service and Arizona Game and Fish Department. This does not agree with the number of crossings depicted in earlier tables and figures begining with Figure 3.

---

20 Pages 47-49, Short-term and Long-term Effects and Associated Mitigation - This section contradicts the last two sentences on page 38 because it says mitigation would include wildlife crosssings, modified overchutes, land

acquisition and establishment of wildlife movement corridors, watering sites, vegetation monitoring, and monitoring of mitigation structures. There is no trade-off clause with endangered species conservation plans.

Figures 36 and 37, following Page 70 - Please include a legend with this figure. 21

Page 73, Paragraph 1 - Only native plants should be used in revegetation efforts. Executive Order 11987 also discourages the use of non-native plants. 22

What is the maximum height of these dikes from undisturbed ground level? 23

Figure 39, Following Page 80 - It would be helpful to include the proposed alinements on this figure. 24

Page 102, Paragraph 4 - Please explain what is meant by Route 5 and Sanders Route. 25

Thank you for the opportunity to review this environmental document.

Sincerely,

K. Bruce Jones

K. Bruce Jones
President, Arizona Chapter
The Wildlife Society

Response to Comments
The Wildlife Society, Arizona Chapter

37-1 An additional alternative has been added to the final EIS and would be located, in part along the west boundary of the Saguaro National Monument. See response to Comment 9-1.

37-2 See response to comment 23-2.

37-3 Only the additional 2 feet of fence height added to the 6 foot high human safety fence is assessed as a wildlife mitigation cost.

37-4 The aqueduct from the proposed Tucson water treatment plant to the delivery point is an integral part of the Tucson Aqueduct. Therefore, it is included in the line items under "Main Aqueduct" in Table 1.

37-5 This table has been changed in accordance with comments received. In footnote 1, the 100 year project life that is referenced relates to the life of structural measures and benefits. The 50 year project life referred to in other sections of the EIS relates to the repayment period of project. This table is mathematically correct. Additionally, Table 2 is entitled "Summary Alternative Plans Regional Cost", because it is meant to display costs based on a regional basis, not as a cost allocation table. Therefore, when evaluating alternative plans, they are all comparable and the reader is not influenced by what an entity would pay.

37-6 The tables have been changed in the final EIS. Footnote 1 has been added to "Special Status Species." The heading has been changed to read "Special Status[1] Species Adverse Impacts After Mitigation/Conservation Measures."

37-7 See response to comment 31-5.

37-8 The paragraph has been modified by deletion of "to supplement ground water".

37-9 The information has been added to the final EIS as suggested.

37-10 Figure 2 has been modified to show the alternative routes.

37-11 It has been determined that the Tucson Aqueduct would have two termini. One terminus is at the Tucson delivery point. The other is at Pima Mine Road. All alternatives are comparable. The Snyder Hill pumping plant lifts water to the Tucson delivery point. The discussion in Chapter II, alternatives including the Agency Proposed Action, has been modified for clarification.

37-12 See response to comment 31-5.

37-13 The term "suggested" has been deleted.

37-14 See response to comment 22-1.

37-15 The paragraph has been modified as suggested.

37-16 Yes, the title to land of the wildlife corridor will include energy, mineral, and water rights.

37-17 Phase two of the mitigation will continue as long as necessary to determine success of mitigation.

37-18 No borrow areas have yet been identified. To the extent possible, materials from excavation of the aqueduct and pumping plants will be used to build the dikes.

37-19 See response to comment 18-7. The figures have also been modified in the final EIS.

37-20 We concur. The last two sentences have been deleted in the final EIS.

37-21 Legends have been added to these figures.

37-22 See response to Comment 20-9.

37-23 The maximum dike height varies from one area to another ranging from 8 feet to 15 feet. The dike with the 15 feet height is south of Avra Valley Road and upstream of the Twin Peaks Pumping Plant. The majority of the dikes will be in the 3 to 10 foot height range.

37-24 The figure has been modified to include all routes.

37-25 The paragraph has been corrected. Route 5 should have been East Side Plan and Sanders should have been Sandario.

State of Arizona 38

DEPARTMENT OF WATER RESOURCES

99 E. Virginia Avenue, Phoenix, Arizona 85004

OFFICIAL FILE COPY
U.S. Bureau of Reclamation
Lower Colorado Region
RECEIVED FEB 22 1985
CO
Action
BRUCE BABBITT, Governor Initials
~~WESLEY E. STEINER, Director~~

Date	Initial	To
		150
File		

February 20, 1985

Mr. William Rinne
Regional Environmental Officer
Lower Colorado Region
U.S. Bureau of Reclamation
P.O. Box 427
Boulder City, Nevada 89005

Dear Mr. Rinne:

The Department of Water Resources offers the following comments and observations on the draft Environmental Impact Statement, Tucson Aqueduct - Phase B:

1. Page 34 - last paragraph - This paragraph discusses the updated impact on vegetation downstream from the aqueduct. Since some reaches of the Granite Reef Aqueduct have been in place since 1979 it would seem that reference to impacts on vegetation at selected locations along these reaches could be used to verify this assumption. **1**

2. Page 51 - Ground Water - The numbers shown for groundwater overdraft in the Upper Santa Cruz and Avra Valley basins have been revised by the Department. Recent hydrologic studies show that by 1979 the combined overdraft in both basins totals 190,000 acre-feet. Additionally, there are 1982 water level data available for the Upper Santa Cruz basin and 1983 data available for the Lower Santa Cruz basin. **2**

3. Page 52 - first paragraph - The discussion of water level decline should indicate that in recent years rises in water levels have occurred in selected locations in the study area.

William Rinne
February 20, 1985
Page Two

4. Page 52 - Subsection b - Water Quality - The discussion on water quality should be expanded to discuss TCE contamination and the nitrate and sulfate problems in the study area. The mine tailing areas on the Upper Santa Cruz basin have caused a sulfate problem to occur. TCE contamination is occurring further downstream near the Tucson Metropolitan area. Concentrations of nitrates near Marana in the Avra Balley basin is a continuing problem.

3 5. Figure 34 - information outdated - needs to be replaced with contemporary data.

4 6. Page 85 - fourth paragraph - should address sulfate, nitrate and TCE problems.

7. Page 85 - last paragraph - USGS and the Department have developed separate models. Department results have been published and are available.

I hope that the above comments will be helpful. Overall the statement adequately addresses the environmental issues involved.

Sincerely,

Wesley E. Steiner
Director

WES:pj

Response to Comments
State of Arizona
Department of Water Resources

38-1 The assumption has been verified and "mays" have been changed to "wills".

38-2 The suggested changes have been made in the final EIS.

38-3 We considered updating Figure 47 but decided against doing this. We felt that it was important to be consistent with the Tucson Phase A EIS which also contains this figure. Also, Figure 47 still gives a good indication of the range of groundwater depths which can be expected to be encountered in the study area. The extensive effort to update the figure with new data would not significantly impact any discussion, conclusion, or decision in the Tucson Phase B EIS.

38-4 These paragraphs have been modified as suggested.

39

DEPARTMENT OF THE ARMY

LOS ANGELES DISTRICT, CORPS OF ENGINEERS
P.O. BOX 2711
LOS ANGELES, CALIFORNIA 90053-2325

February 15, 1985

REPLY TO
ATTENTION OF:
SPLPD-RP

Regional Environmental Officer
Lower Colorado Region
U. S. Bureau of Reclamation
Box 427
Boulder City, Nevada 89005

Dear Sir:

This is in response to a notice from your office, dated December 18, 1984, which requested review and comments on the Draft Environmental Impact Statement (EIS) for the Tucson Aqueduct Phase B project, a Feature of the Central Arizona Project.

The proposed plan does not conflict with existing or authorized plans of the Corps of Engineers. We concur with your determination that the proposed action would be covered under a Nationwide Permit pursuant to Section 404 of the Clean Water Act. If, however, the Thornbur's fishhook cactus (Mammillaria thornberi), a species proposed for listing as threatened, and/or the Tumamoc globe-berry (Tumamoca macdougalii) a species expected to be proposed as endangered in the near future, becomes listed pursuant to the Endangered Species Act of 1973 (as amended), the Nationwide Permit may no longer apply. 1

Thank you for the opportunity to review and comment on this document.

Sincerely,

for Carl F. Enson
Chief, Planning Division

Responses to Comments
Department of the Army
Los Angeles District
Corps of Engineers

39-1 Formal consultation with the FWS Endangered Species Office will determine if the selected plan will jeopardize the continued existence of any listed species and will develop reasonable and prudent alternatives to prevent a jeopardy if such alternatives exist. If no reasonable and prudent alternatives are available, Federal law could prevent the action from occurring. We recognize that the Nationwide Permit pursuant to Section 404 of the Clean Water Act is valid as long as the project does not jeopardize any threatened or endangered species.

40

BRUCE BABBITT, *Governor*

Commissioners:
FRANCES W. WERNER, Tucson, Chairman
CURTIS A. JENNINGS, Scottsdale
W. N MONTGOMERY, Flagstaff
S. BAKER, Elgin
Y D. ADAMS, Bullhead City

Director
BUD BRISTOW

Assistant Director, Services
ROGER J. GRUENEWALD

Assistant Director, Operations
DUANE L. SHROUFE

ARIZONA GAME & FISH DEPARTMENT

2222 West Greenway Road Phoenix, Arizona 850 FEB 19 1985

February 14, 1985

2/22/150 BAE

Mr. Edward M. Hallenbeck, Project Manager
Bureau of Reclamation
Arizona Projects Office
23636 North 7th Street
P. O. Box 9980
Phoenix, Arizona 85068

RE: Draft EIS-Tucson Aqueduct
Phase B

Dear Mr. Hallenbeck:

The Arizona Game and Fish Department has reviewed the above-referenced document and the following comments are provided.

In general, we found the document's description of the
project area's biotic resources, as well as the project's
subsequent impacts to wildlife and wildlife habitat, to be
adequate. In relation to the mitigation package proposed, we 1
take exception to the suggestion that complete biological
mitigation may not be possible, due to anticipated cost which may
be required in order to comply with the Endangered Species Act.

We would remind you, the Central Arizona Project's previous mitigation goals set by your agency have been designed to be open-ended and to compensate at the 100% level. Our Department feels compensation of wildlife resource losses should not be considered unjustified solely on the basis of monetary benefits.

Furthermore, we wish to note that the Endangered Species Act of 1973, as amended, specifically authorizes land acquisition under Section 5. Section 5 (6) Acquisitions, states; "Funds made available pursuant to the Land and Water Conservation Fund Act of 1965, as amended, may be used for the purpose of acquiring lands, waters or interests therein under subsection (a) of this section".

We do, however, support the mitigation measures presented in the DEIS and we are of the opinion that the mitigation actions will significantly ameliorate the impacts of the project to wildlife populations in the project area.

2 Regarding the proposed action and the alternatives provided, our Department considers the closed pipeline routes as preferable to the West Side Plan.

Specific comments regarding the DEIS are attached to this correspondence. Should you have any questions regarding our review, please contact James E. Burton of our Phoenix Headquarters.

Sincerely,

Bud Bristow

Bud Bristow
Director

BB:JEB:lea

cc: Mr. Gilbert Metz, Field Supervisor
U.S. Fish and Wildlife Service
Phoenix, Arizona

Specific Comments

We suggest that a summary table combining the information located in Tables 1,2,4,7,9,12,14,15,16,17 and 18 be included in the DEIS. The current arrangement of tables makes it exceedingly difficult to compare the alternatives. **3**

The summary section of the document reiterates points which we consider errors in the main text of the document. We recommend that the summary be rewritten to reflect corrections in the DEIS. We have the following specific comments relative to the summary: **4**

- The plants that are proposed, and candidate species for Federal listing as threatened or endangered, are not "special status" in the same sense as Harris hawk, desert tortoise, kit fox and Gila monster. As already stated, a clarification is needed concerning the use of the phrase "special status". Regardless, any species protected by the Federal Endangered Species Act may not be mitigated for in the same manner as other species.

We have the following comments and suggested changes for Chapter II, Alternatives of the DEIS. E.l. West side modification - Sanders Road: **5**

- We recommend that the Sandario and the Sandario-San Joaquin alternatives be evaluated using Sanders Road as the route for the buried pipeline portion rather than Sandario Road.

- It is the understanding of this Department that community support is present for consideration of a Sanders Road alinement, and that Saguaro National Monument has significant concerns about any alinement through U.S. Park Service lands. We do not agree with the rejection of a Sanders Road alternative because it is "...less cost effective than the West Side Plan."

- The Sanders Road alternative is $374,685 in total cost, compared to $360,727 for the preferred West Side Plan. Although it is more expensive than the West Side Plan, Sanders Road is less expensive in terms of capital cost than the Sandario Road alternative ($376,413) or the Sandario - San Joaquin alternative ($421,797); therefore, rejecting Sanders Road due to excessive cost does not agree with the information presented in Tables 2 and 17 in the DEIS.

- Table 2, on page 3 of the summary, gives a total capital cost for the West Side Plan (proposed) as $346,681. Table 17, on page 25 of Chapter II, lists capital cost at $360,727 for the Proposed Plan. Which is the correct estimate?

The following comments pertain to Chapter III, Affected Environment:

6 - The heading "Special Status Species", on page 33, has combined species which require action under the Endangered Species Act and species that are of interest or significance, but lack a legal mandate for protection or specific action. We strongly urge the Bureau to divide "Special Status Species" into two separate headings; (A) Federal threatened, endangered and candidate species, and (B) Arizona threatened and unique species and other Special Status Species. A division within the text is the most direct way to differentiate between mitigation measures for biological impacts and compensation measures for federally protected species, as required by the Endangered Species Act.

7 - On page 33, the second paragraph under "Special Status Species" does not list what species might occur in the project area. We suggest the species be listed and a short paragraph summarizing the Arizona Game and Fish Department assessment of impacts to those species, due to the project, be included.

8 - On page 35, the discussion concerning division of overland flows and the impacts to Flora and Fauna understates the potential impact to vegetation in the Upper Sonoran desert paloverde-mixed cacti vegetation type. Any alteration in the on-site availability of water may have an extreme adverse impact to the cactus communities and those wildlife species dependent upon them. We recommend that in the Upper Sonoran vegetation types that overland flow be disrupted as little as possible. Overchutes and underchutes should be incorporated into the project design, at all possible locations, to minimize the impact to the vegetation.

9 - The first paragraph on page 38 should be deleted from the sentence which begins "However, if formal consultation with the FWS..." to the end of the paragraph.

10 - Figures 36 and 37 do not have a key, a scale, or a north arrow.

- The description of revegetation measures, on page 73, does not mention the use of native plant materials or the salvage and on-site transplant of larger plants. We recommend that all measures be taken to revegetate to as close a proximity to pre-project conditions as possible, particularly in the paloverde-mixed cacti vegetation type. This Department is interested in the development of a revegetation plan for Phase B of the Tucson Aqueduct and would like to be included as an interested agency. 11

Response to Comments
Arizona Game and Fish Deapartment

40-1 We concur. The discussion regarding a possible trade-off between mitigation and project cost ceilings has been deleted.

40-2 Your preference for closed pipeline routes has been noted and the comment is available to decisionmakers.

40-3 The decision was made to include the physical features data in the discussion of each alternative route. To put that information for all alternatives in one table would have required the reader to turn back-and-forth between the table and the discussion. We felt this was a greater nuisance than the present style used.

40-4 See response to comment 29-1.

40-5 See response to comment 9-1. All discussions and tables have been revised to include Sanders - San Joaquin Modification Plan. All costs have also been revised.

40-6 See response to comment 29-1.

40-7 The paragraph has been modified in response to your comment.

40-8 The wording "probably", "may", etc., has been changed to "will" to emphasize these impacts. Additional overchutes have been added to minimize disruption of natural drainage patterns. The proposed method for providing cross drainage facilities is to detain the flows and outlet into the channels downstream at a capacity that will not exceed the flow that could be expected from the 6-hour 100-year general storm or the 3-hour thunderstorm which ever is greater. In areas where it is not practical to dike, the flows are carried across the canal unchanged. The outlet of all structures are provided with energy dissipators to slow the water to the nonscouring velocities and spread to sheet flow where channels are not defined.

40-9 We concur. See response to comment 40-1.

40-10 These figures have been revised in the final EIS.

40-11 See response to comment 20-9.

United States Department of the Interior

OFFICE OF THE DIRECTOR

BUREAU OF MINES
2401 E STREET, NW.
WASHINGTON, D.C. 20241

OFFICIAL FILE COPY
U.S. Bureau of Reclamation
Lower Colorado
RECEIVED
MAR 7 1985

Date	Initial	To

Action
Action Taken ______ Initials

File

FYI

February 20, 1985

Memorandum

To: Commissioner, Bureau of Reclamation

From: Director, Bureau of Mines

Subject: Draft environmental statement, Tucson Aqueduct Phase B, Central Arizona Project (DES 84-68)

Known and potential mineral resources and mineral-production operations in the project area are discussed adequately, but the analysis of mineral-related impacts should be clarified. According to the statement (page 89), "There could be a conflict between project construction and future mine expansion . . ." at three large copper mines near the south end of the proposed aqueduct. This brief statement is inadequate; a discussion should be provided to describe the extent, duration, and magnitude of impacts on the operating mines and to address measures to mitigate potential impacts. 1

Also on page 89 it is stated that, "Mining would not be permitted in the aqueduct right-of-way, but development of mineral deposits adjacent to the aqueduct would be possible." However, the statement regarding Short Term and Long Term Effects (page 93) concludes that, "Commercial mineral deposits . . . beneath the proposed West Side alinement could become uneconomic to develop . . ." and seems an understatement by comparison. Given the "good potential for mineral development" along parts of the proposed and alternate aqueduct corridors (page 89), presumably for large porphyry copper deposits, a mineral survey should be conducted to ensure that valuable mineral deposits do not lie within the project right-of-way. If such a study has been made, the results should be noted in the final statement; presently the draft provides no indication of what minerals might be expected to occur. 2

Thank you for the opportunity to review this draft statement.

Gordon M McMiller

Acting Director

Responses to Comments
USDI, Bureau of Mines

41-1 Although our impact statement identifies that there could be a conflict between project construction and copper mine expansions, a clarification of mineral-related impacts to the southern end of the proposed aqueduct can be answered by considering the extent, duration, and magnitude of mining and whether the mines are in operation. The area impacted could cover about 6 miles of the alinement. This area is approximately 6 miles north, 3 miles northeast, and 4 miles east of the Pima Copper Mine (Mission Unit). The mine dump is about 1.8 miles from the closest point to the proposed West Side alinement and one tailing pond is within 600 feet. South of the Black Mountains the depth to alluvium averages 200 feet but exceeds 600 feet in the southern half of Section 21, T. 16 S., R. 13E. Therefore, any additional expansion of the copper mines in this area would require removal of this thick overburden.

For all intents and purposes, a 100-year project life is assumed. Commonly, concrete water conveyances require periodic maintenance for repair to extend the life span of the canal. So the duration that would impact the "operating" mines could range from 90 to 110 years depending on the final alinement chosen. Using this duration and a proposed 30 plus years for the Mission Unit (under current operating conditions), expansion to the north would not occur until about the year 2010. However, the Asarco Mining Co. (owners of the Mission Unit) have no future plans to expand to the north (oral communication with Scott Burrill, mining engineer/geologist with Asarco), which reduces the likelihood even more that the mineral resources, if present, will not be required for the life of the aqueduct project.

The magnitude of impacts on the "operating" mines is hard to assess because of the poor economic state the copper mines are confronted with at this time. But with the present location of the proposed West Side alinement, copper mines can expand 2.5 to 4 miles to the north without infringing on the alinement right-of-way. Once again, expansion to the north would require the removal of the normally excessive overburden.

41-2 The statement on page 89 of the Draft EIS has been changed to read "Mining would not be permitted in the aqueduct right-of-way, but development of mineral deposits adjacent to the right-of-way, not the aqueduct, would be possible". If commercial mineral deposits exist beneath the proposed West Side alinement, these could become uneconomic to develop due to the excessive thicknesses of alluvium Even so, with the possibility for valuable mineral deposits within the project right-of-way, additional studies were considered to clarify this problem. In December 1983, a request from the Bureau of Reclamation to the Arizona Bureau of Geology and Mineral Technology in Tucson asked this agency to address the mineral deposits pertinent to the

Tucson Aqueduct-Phase B Environmental Impact Statement. Their reply mainly addressed the presence of bedrock shoulders on the west side of the Tucson Mountains but also stated that much of this area although "mineral in character", is located on lands protected by the Saguaro National Monument and the Tucson Mountain County Park. This latter statement is properly addressed in the Phase B EIS. They also considered the resource potential associated with the surface to near surface "alluvial materials". Currently, commercial sources of sand and gravel are confined to the river sources, which are readily accessible. As these sources are depleted, these sand and aggregate companies may decide to evaluate the coarse deposits adjacent to the topographic mountain fronts. However, as more and more land is developed for residential settings, these potential deposits become inaccessible. This problem was thoroughly discussed by the Arizona Bureau of Mines in the December 1973 issue of Field Notes. Based upon this discussion we have concluded that the potential recovery of these mineral sources to be essentially impractical.

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
LOWER COLORADO REGION
P.O. BOX 427
BOULDER CITY, NEVADA 89005

OFFICIAL BUSINESS
PENALTY FOR PRIVATE USE $300

AN EQUAL OPPORTUNITY EMPLOYER