CENTRAL ARIZONA PROJECT

TUCSON AQUEDUCT PHASE B

COSTS, BENEFITS, AND LIMITS TO THE FLOW

'87

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History

As populations and irrigated acreage increased in the Southwest in the early 1900's, interstate political manuevering to obtain Colorado River water began. The river moves an average virgin flow of 15 million acre-feet annually, through a river basin that includes California, Nevada, Utah, Wyoming, Colorado New Mexico, Mexico, and most of Arizona. In 1922 all basin states, except Arizona, ratified the Colorado River Compact which allotted 7.5 million acre feet to the lower river basin, divided between Calfornia, 4.4 MAF, Arizona, 2.8 MAF, and Nevada .3 MAF. 22 years later Arizona agreed to ratify the treaty, promising California its 4.4 MAF even in shortage years, in exchange for a political move in Congress which guaranteed development of a delivery system. The Central Arizona Project was proposed, and ratified in 1968 by President Johnson, as an aqueduct plan to move water from the Western border of the state, east through Phoenix, to the southeast and city of Tucson.(Map A)

Tucson is the largest city in the United States completely reliant on groundwater supplies. In the years between 1950 and 1970 the city experienced a 177% population increase which spurred demand for CAP water deliveries. Consruction of the aqueduct, divided into phases, began at the northern startup in 1978. Two phases of aqueduct construction, from the end of the Phoenix area canal, must be built to reach Tucson.(Maps B & C) Phase A consruction was initiated in 1984. The last link of the canal, Tucson Agueduct Phase B, the subject of this paper, has

a projected start up construction date of 1986, with completion and water delivery in 1991. The Department of the Interior, Bureau of Reclamation, holds responsibility for engineering and construction of the entire CAP project, and unless stated otherwise, all information and data cited, originate from the Tucson Aqueduct Phase B Draft Environmental Impact Statement filed in 1984.

Activity

The planned Phase B aqueduct runs from near Marana, Arizona, in Pima County, to the southern portion of the county and the San Xavier Indian Reservation. The agency proposed route is designated the West Side PLan, as it runs west of the Tucson Mountains. The activity planned is delivery of water from the Colorado River to the Tucson Metropolitan Area for agricultural, municipal, industrial and Indian users. The potential receptors of the flow include 15 municipalities, such as Tucson, Nogales and Green Valley, three irrigation districts, including the Avra Valley district, and three Indian communities, the Papago, Pasqua Yaqui and San Xavier reservations.

Construction entails a total canal line of 47.5 miles, with 32.3 miles of concrete lined aqueduct, 15.2 miles of pipeline, and six pumping plants with power transmission lines of 27 miles. Additionally, listed as facets of the construction, are overchutes and culverts, bridges, fencing and ladders, wildlife crossing,

watering sites , wildlife fencing, and further barriers to mitigate wildlife effects. The plan also includes an undeveloped wildlife corridor and calls for revegetation of disturbed areas. The right of way required for contruction equals 2511 acres for the main Phase B aqueduct. Power requirements for the pumping facilities on the main canal are estimated at 171 gigawatt hours per year. Conveyance facilities are sized to accomodate flows between 750 and 850 cubic feet per second. The status of final CAP allocations remains disputed in the courts, however, currently estimated deliveries of acre-feet per year range from 135,644 in 1985 to 274,975 in 2034. (One acre-foot equals 325,850 gallons.)

The scope of this last phase of the CAP project covers land area classified as Sonoran Desert, with desert mountain ranges with sloping basins. Rainfall is sparse, 10-15 inches per year, with vegetation of mixed shrub, cacti, Mesquite and Paloverde trees and grasslands in the southerly route area. Land uses affected by the Phase B canal include agriculture, grazing, residential and National Land Preserve areas.

Beneficial Effects

Proposed beneficial effects of the Phase B CAP project aim toward augmenting current water supplies to relieve the groundwater overdraft in the study area. Pumping in excess over groundwater recharge levels causes land subsidence, surface fissures, and

increased pumping costs. Additionally, the canal water is to be provided at varying costs to different users. As the rates now stand. farmers and Indian lands recieve lower cost subsidized CAP water. For non-Indian irrigators, a guaranteed surface flow may benefit land values and allow farms to continue cultivation, preserving their culture and income. A CAP flow of water to the Indian reservations represents an added source of income and employment. Finally, benefits to the Phase B Tucson-Pima County area from increased flows, include conserving a dependable supply for the future, and providing water conservation incentive.

Currently, Phase B area pumpage is used 56% by agriculture, whose share is declining, 21% by mining and industry, and 23% by municipalities, whose demand is increasing. Link B of the CAP proposes an average delivery of 161,900 acre-feet per year. Tucson Basin overdraft each year is estimated at 261,000 acre-feet,(Az. Republic, Pg.9) Thus, in 2025, when the city expects to use 60-65% CAP water, the overdraft will continue at 66,000 acre-feet. In theory, the project is in accordance with and a tool with which to accomplish the goals of the 1980 Groundwater Management Act which calls for conservation, with a safe yield balance between groundwater recharge and pumping by early in the next century. Under the act, non-Indian irrigators, who recieve CAP water wiil be required to reduce groundwater pumping on an equal acre-foot basis. Further, the water is

delivered only to land with irrigation history in the 1958-1968 period. Indian irrigators, however, are allowed to use CAP water as an augmentation to current levels of groundwater pumping. Municipalities may use the flows to "help mitigate the depletion of the State's groundwater resources." (IES, Pg.2) Municipal, industrial and Indian users have priority over the flow, followed by irrigation districts.

Balancing the yield of groundwater, reducing overdraft, and consequential reductions in land subsidence holds both environmental and monetary benefits. Damage to underground utilities and surface structures may cause economic damage to the Tucson area and may subject the city to financial liability for damages indirectly caused by pumping from the cities wells. (IES Phase A, Pg.5) Evaluating possible gains of using 62% CAP water, and gains of subsequent reduction in land drop could be done through a ratio method: Cost/year= $damage/ft. of subsidence x ft. of subsidence/acre-foot withdrawn x acre-foot withdrawn/year , assuming a compartment where ratios are stable, so land areas where geology is identical. This method, then, assumes that each amount of water withdrawn causes the same amount of land subsidence and that any sinking of land causes the same damage. In addition to such possibly quantifiable benefits, non-monetary environmental and aesthetic benefits occur from reduced land subsidence.

Beneficial added availibility of water will come at a higher

price to the aqueduct region. In 1992, Tucson water rates are planned to increase by 19%, rising 37.5% by 2025, to pay for the CAP. Tucson's cost for groundwater acre-feet is $400, the same project amount equals $626.(Az.Republic, Pg.9) Projected resale costs of the water vary; As determined by the Bureau of Reclamation in 1983, there will be a $53.00 operation and maintenance charge per acre-foot for municipal and industrial users,plus a $5.00 to $40.00 water charge, reaching the maximum total of $93.00 in 2025.(CAPA,Brochure) Non-Indian irrigators will be charged on the basis of "what they can pay," which was determined as $2.00 per acre-foot plus the $53.00 operation charge. Thus, although irrigators cannot demand water past 1968 acreage levels, they can be subsidized by M&I users. Revenues for payment of the canal also come through the tax authority of the Central Arizona Water Conservation District over all real property in counties in the study area, including the Phase B counties, which are subject to a maximum tax of $.10 per $100 of land.(Current taxes are $.05) Reimbursable federal government costs of the project construction placed on M&I users are to be repaid at 3.4% interest. Non-Indian irrigation delivery and construction costs are to be repaid with no interest charge, and all further non-reimbursable costs (15.2% of total) and cost of delivery and consruction to the Indian reservations (15.6%) are the federal governments responsibility.

The structure of costs places the burden of the Phase B

aqueduct on certain groups,the M&I users, allowing benefits to be racked up by the farmers and Indian users including irrigators. Farmers in Southern Arizona will recieved subsidized CAP water, in general at a lower cost than electricity groundwater pumping costs will allow, which enables them to keep acreage under crops. An irrigator located near the Tucson Aqueduct believes CAP water will increase land values due to a surface supply, (in this irrigation district the groundwater level has dropped 600ft.), and allow currently unused land to be recultivated.(Az.Republic,-Pg.8) Monetary benefits of saved farm land and revenues and social and phsychological strains to unemployed farmers are benefits of the project.(Unemployment due to water costs would start with low valued crops, in Pima county, Alfalfa.) The water management district in the Phase B area has declared a moratorium on expanding agricultural acreage, yet, the CAP may preserve the existing farm life in Southern Arizona and has political support to do so.

Indian reservations have been guaranteed a flow of water in the 1982 Water Rights Settlement Act, but debates continue over grounwater ~~and~~ allocation rights. The act gives 27,000 acre-feet per year to the San Xavier Reservation, 10,800 to the Schuk Toak Papago Reservation. Increased revenues and employment on the Indian lands may occur whether or not the extra water is used to develop agriculture, as multiplier effects of increased employment should occur in the poverty stricken lands.(It should be noted

that the act restricts reservation groundwater pumping and provides for effluent to be transferred from the City of Tucson.)

Additional benefits to CAP delivery to the Phase B southern area come from focusing concerns on future supplies of water and conservation. First, by reducing groundwater pumping the project may extend the dependibility of groundwater suppliies indefinitly into the future. An early 1960's geological report estimated recoverable volume of water in storage, to a depth of 1,000 feet below the 1966 water table, equaled 52 MAF. The economic feasibility of recovery and the quality of the water is questionable. (Berkman, Pg. 258)

With delivery of high cost CAP water, the role of price in water conservation efforts is stressed. A user supplied with low cost water supposedly misinterperts its value and wastes. In fact, esimated price sensitivities, for the category of summer outdoor watering use, have found a 1% increase in price can decrease flow usage by an egual 1%.(Zamora, Pg.91) The question of whether a high cost acre-foot of Colorado River water will further the cause of conservation is, of course, debatable.

The actual construction of more than 40 miles of canal will provide short term employment and economic benefits. The IES describes, "Construction of the aqueduct is not expected to change the population size or the racial or age disribution 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 Arizona ... is anticipated." (Pg.15)

Residuals

Residuals generated through the CAP Phase B construction of aqueducts, transmission lines and access roads consist of noise and air pollution . The production of added electricity generation to pump CAP water through the six pumping plants, creates further pollution externalities. Further residuals deal with negative effects of water quality. The delivered water will be of lower quality and subject to treatment methods.Assuming that without construction of the Phase B aqueduct to Tucson, the allotted acre-feet will be reallocated to northern receptors, the Phase B canal itself has no residual water quality effects on the Colorado River.

Minor adverse air quality effects would be expected for construction generated suspended particulates during the building phase. The contractor would be required to "carry out proper and efficient measures (such as watering) to reduce dust nuisances." (IES, Pg.11) Estimated contributions of Phase B construction to pariculate concentration range from 12 to 17 ug/m3. A study for the Phase A aqueduct relating air quality analysis of Sulphur Dioxide, Carbon Monoxide, Hydrcarbons, Nitrogen Oxides and Particulates averaged over the construction period for each type of equiptment and process in a six mile long construction zone

demonstrated that the impacts of the construction period were insignificant.(IES Phase A, Pg. 67) Furthermore, a maximum of 2,000 acre-feet of water were estimated as the groundwater supplies needed for construction and dust control. An air quality change with direct effects on humans, is the possible increase in airborne coccidioidonycosis spores caused by soil disturbance. This endemic fungal disease, Valley Fever, causes a flu like illness, which in some instances may be life threatening. During construction monitoring of the soil is planned to take place and the IES suggests control measures (fungicides) if necessary to protect local residents and construction workers. Air quality effects derived from energy generation are also residuals of the CAP project. The Phase B route requires 171 gigawatts of energy, and, depending on the source of those supplies, whether coal, natural gas or oil burning plants, the increase in air pollution emissions will vary.

Noise residual from construction will occur for equiptment operation, vehicle access, and route blasting. Also disturbing the residents and wildlife near the canal will be the operation of the pumping plants. Estimates of construction sound levels do not exceed 75-80 decibels, measured from points considered sound sensitive along the route. Pumping plant noise will also contribute to noise pollution. Estimated operational decibels will be 48, not significantly different from the 45 decibels of normal conversation.

Water quality effects of the CAP concern changes in the concentrations of salinity , dissolved solids, in the soil and groundwater in the Tucson area with the application of Colorado River water. Current groundwater salinity in Phase B service wells averaged slightly over 200mg. The average total dissolved solids of river water to be delivered to the area is estimated at 700mg., higher than the EPA recommends for a source of drinking water. Salinity in CAP water applied in the Phase B area, most from irrigated agriculture, may result in concentrated ground salt quantities due to evaporation, which, in turn, may leach into, and contaminate, remaining groundwater aquifers. An analysis performed, using the mass balance approach, determined impacts of 50 years of CAP use on the remaining groundwater. Tucson Basin concentrations increased 51mg., and the Avra Valley aquifer concentrations gained 24mg. of total dissolved solids.

Adverse Environmental Effects

Adverse environmental quality effects for the Phase B canal are concentrated on the biological, visual and land resources of the Southwestern desert. Permanent changes in the aesthetic and ecological qualities of the route, surpass any construction phase disturbances and, consequently, mitigation efforts have been incorporated into the project plan. The Arizona Game and Fish Department performed a three year survey and summarized all biological resorces to be affected by the aqueduct, including

vegetation, wildlife, and species designated as rare on Threatened or Endangered species lists.

Major construction and canal operation impacts are the disruption of vegetation, habitat degredation, severance of animal movement routes and the direct loss of wildlife in open canal sections. Permanent removal of all habitat as wide as the canal and access roads is necessary. Additionally, even with revegetation, recovery of disturbed areas is not likely within the 50 year life period of the project. The slow growth of desert plants, few pioneer species, and difficulties of root transplantation of desert vegetation will scar a path around the canal. Also, the IES allows that desert vegetation downstream of the aqueduct would incur losses due to reduction in flood flows redirected by the aqueduct.

Specifically, five plant species under consideration for listing under the Endangered Species Act inhabit the Phase B area. Major discussion of the Tucson Aqueduct concerns two of the species: Thornbers Fishook Cactus, and the Tumamoc Globe-Berry. The proposed aqueduct, cutting through prime desert habitat west of the Tucson Mountains, may destroy 19,000 of the cacti and six of 38 known Globe-Berries, close to 16% of the population. In this case, mitigation measures proposed are revegetation and acquisition of four square miles, 2,530 acres, to serve as preserve land of the Fishook plant. Here, though, the IES warns, "If formal consultation on the Tumamoc Globe-Berry results in

significantly different measures and costs being required to avoid jeopardizing this species....This may require a trade-off where most of the mitigation and conservation funds may be used to minimize impacts to the most critical species and habitat (Tumamoc Globe-Berry) and less funds may be available for aquisition of a wildlife movement corridor and Thornbers cactus habitat." (IES, Pg.38) The total Phase B biological mitigation funds are $5,105,000.

Actual amounts of land lost to the canal aqueduct, are 2,005 acres, classified as 20-30 years losses, and 345 acres of wildlife habitat. Total acres crossed by the canal are 2,307 desert, 96 agricultural and 108 residential. Of these acres, 35 are under Federal ownership, 1,222 State owned, 712 private holdings and 536 Indian owned acres. The aquisition of land will result in the loss of tax revenues from the privately held acres, and will result in restricted access to certain lands and residences resulting in lower real estate values.

Wildlife loss, individual losses due to drowning, electrocution and movement pattern disruption, and habitat losses to the canal, transmission lines, and access roads is substantial. The agency proposed route's miles of open canal, affects animals including mule deer, javelina, coyotes, kit fox, rodents, birds, reptiles and amphibians. Effects of the canal on threatened species in the Phase B area, concentrate on the Ferruginous Hawk, desert tortoise, and the reptilian Gila Monster. The Kit Fox also

is listed as rare by the Bureau of Land Management and recieves major habitat disruption from the canal alingment.

The barrier effect of a man-made uncrossable canal, across a species habitat, can isolate seasonal or limited resources. Studies in the Phase B alingment found the majority of deer, bobcat, and gray fox inhabitants crossed the canal route, and the barrier there would result in population losses. However, mitigation plans include aquisition of land crossing the canal to provide a bridge in an existing wildlife movement corridor. Other wildlife crossings could not be placed in areas guaranteed free of development, and, additionally, the chances of species recognizing and utilizing a crossing, as such, are questioned. Wildlife watering spots, away from the canal, are to be constructed to minimize drownings, as are wildlife proof fencings and low-walled barriers.

The proposed agency plan effects a localized distribution of Kit fox, whose dens cannot be relocated and may be cut off or destroyed by the canal. Substantial loss of Kit Fox foraging areas is expected and declines in the population follow. A study to monitor fox populations, and their response to the aqueduct, after construction, is to be implemented.

Changes in the visual resorces of the canal area are expected in both the long and short terms. Obviously, the intial contruction phase obstructs and distorts natural scenes. The agency proposed route also poses permanent aesthetic problems as

it passes high visual sensitivity areas, indexed according to user interest in scenic quality of a site and concern for proposed landscape changes of the area. Locations of top visual sensitivity and scenic quality are the Saquaro National Monument, Tucson Mountain Park, and the Arizona Sonora Desert Museum. Open canals and tanks, up to 100 feet in height, would be visible for miles from these natural areas, as would the transmission lines along the canals. There are no topographic or natural barriers to mitigate the scenic disruption.

Decision

The total cost of the agency proposed route for the Phase B Tucson Aqueduct, in 1982 prices, equals $346,681,000 for capital construction costs and an annual $8,197,000 for operation, maintenance and power. The cost of the CAP projects completion, since its initiation in 1968, has increased from a total legislative allocation of $832,180,000, to an estimated total cost of 3.5 billion in 1984. The Federal Governments share, 30.8%, of just Phase B aqueduct capital costs reaches over $102,000,000.

Total Phase B water deliveries of 161,900 acre-feet per year,over the projected 50 year repayment period, equals a supply of 8,095,000 acre-feet. The calculation of the CAP cost of a raw acre-foot of water comes close to $100. This cost does not include any additional local delivery, treatment,energy or construction costs which represent the majority of charge on

a water users utility bill.

The overall benefits and costs associated with the Phase B aqueduct cannot be monetized or quantified, as the total repercussions of water delivery are unknown and still disputed in the courts. Primary, also, are the environmental, biological, and aesthetic problems associated with the aqueduct. The intial study of CAP feasibility was criticized as using inflated gross crop figures, neglecting the high cost of electric power, and using the lowest discount rate allowed in the Federal Government, 4-5%, in its cost-benefit analysis. Other criticisms of the CAP originated from the State of Nevada, which questioned the spending of thousands of dollars on net irrigation costs to salvage farmland valued at $300 per acre. (Berkman. Pg.109) Finally, critics asked,"Why a largely unecessary project was planned, authorized, and soon will be built at great expense to the nations taxpayers, and why a small number of irrigators, politicians, and bureaucrats, not the majority of Americans or even Central Arizonans, will be the projects chief beneficiaries." (Berkman, Pg.106) The environmental ramifications, or the total projected benefits, of CAP water supplies have not been the highly weighted criteria for the planners of the aqueduct. Instead, the motivators behind the plan have compared reduced groundwater depletion against loss of vegetation, wildlife, and land. Comparison also was made between the benefits of low cost water supplies to irrigators and Indian Reservations against the

costs to municipal and industrial users and the cost to the Federal government.

However, the benefits which the Phase B area of Tucson, and Pima County, will recieve from the water flow are limited entirely by two factors: the limits of economic benefits gained from supplying subsidized water and the limits on the flow of water itself.

As discussed previously, the cost distribution of the CAP favors non-Indian irrigators and the Indian reservations. A 1974 CAP report told "that unless additional irrigation water is made available to the project area, the equivalent of a 30% reduction in the presently cultivated lands in the area must eventually be effected," and, it was proposed that the CAP, including the Phase B aqueduct to Tucson, is needed to sustain the agricultural economy of the area and maintain a healthy economy in Central Arizona. (Berkman, Pg.124) Yet, the limit on benefits appears by observing that, at that time, crops provided 12% of the personal income in the state while using 90% of it water. In the Tucson Basin, including the agricultural Avra Valley, 64% of annual pumpage is devoted to agriculture.(Martin, Pg.2) Recently, the City of Tucson has acquired agricultural acreage in Avra Valley, converting it to groundwater supplies.

The negative effect to the economy of the Phase B area due to a loss of agriculture, without additional water supplies (the CAP), was calculated for the period 1966 to 2015, by a study

group at The University of Arizona. That study found, for Pima County, net farm revenues would decline only 1.1 million dollars, due to increases in water costs, smaller quantities of water applied to acreage, and consequent reductions in physical output. (Kelso, Pg.116) The CAP cost to the study area outweighs monetary gains from keeping land under cultivation. The study also estimated the present value of water development to keep all Arizona farm crop sectors at the 1966 level, to 2015. A total of 906,000 acre-feet per year was estimated to be the needed supply to support that level of crop production. Assuming all revenue linkages associated with farm employment and income would be affected by a decline in farm land, using an 8% discount rate, the present value equaled $1,504,154.(Kelso, Pg.154) The total added to gross state product is far less than the CAP cost to the economy and, "the gross value of an additional acre-foot of water to the Az. economy is much less than possible development costs." (Kelso, Pg.159)

Finally, the next limit of the projected benefits of the CAP is the limited flow of the Colorado River itself. Arizona's entitlement of 2.8 MAF is strictly a theoretical one. A 1972 report from the Arizona Water Commission estimates that 1.7 MAF will actually be available for use in 1980, and with system losses, such as leakage and evaporation, only 1.6 MAF could be delivered in that year. As the Upper Basin develops its allotted supplies, estimates of water availibility to Arizona decline to

1.2 MAF in the year 2000 to 1.1 MAF in 2020.(Kelso, Pg.215) However a Bureau study estimated 1.1 MAF available in 1979, decreasing to .5 and a low of .28 MAF in 2030. The same study told that the economic feasibility of the CAP required an average flow of .45 MAF, this average being reached only during the first twenty years of deliveries.(Berkman, Pg.120) Thus, the physical base for water flow is declining, straining the legislatively over-allocated Colorado. In sum, also, it is true that, "at the most optimistic predicted level of water delivery , the project will supply only half the present 1983 groundwater overdraft," and, although Tucson Basin flows of CAP water are aimed at reducing groundwater pumping and achieving a safe yield, "there is no pressing physical or economic need to achieve this mandated balance." (Martin, Pg.3)

In summary, the high costs of the Bureau of Reclamation's aqueduct plans are not justified by the estimated economic gains from the support of agriculture. Total benefits to Indian reservations in the Phase B area are unknown, as are the benefits from reducing land subsidence. Construction of the Phase B aqueduct, delivering water to Pima County, generates air,noise and water pollution residuals and unmitigable environmental effects, which, again, are not quantifiable. The entire base of projected benefits to the Phase B area rely on a guaranteed flow level from the source Colorado River, which may not be able to provide its fully allocated acre-feet.

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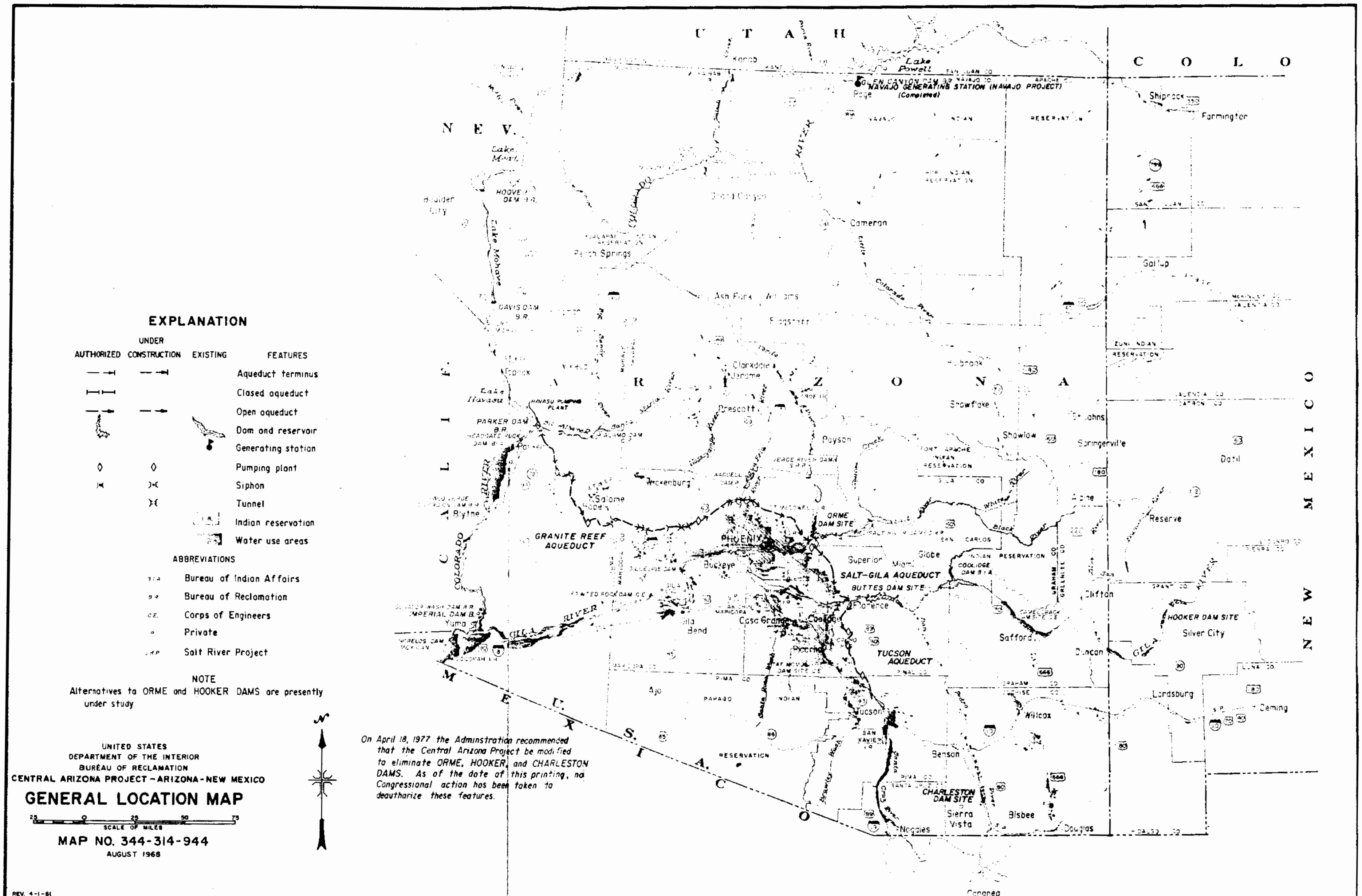
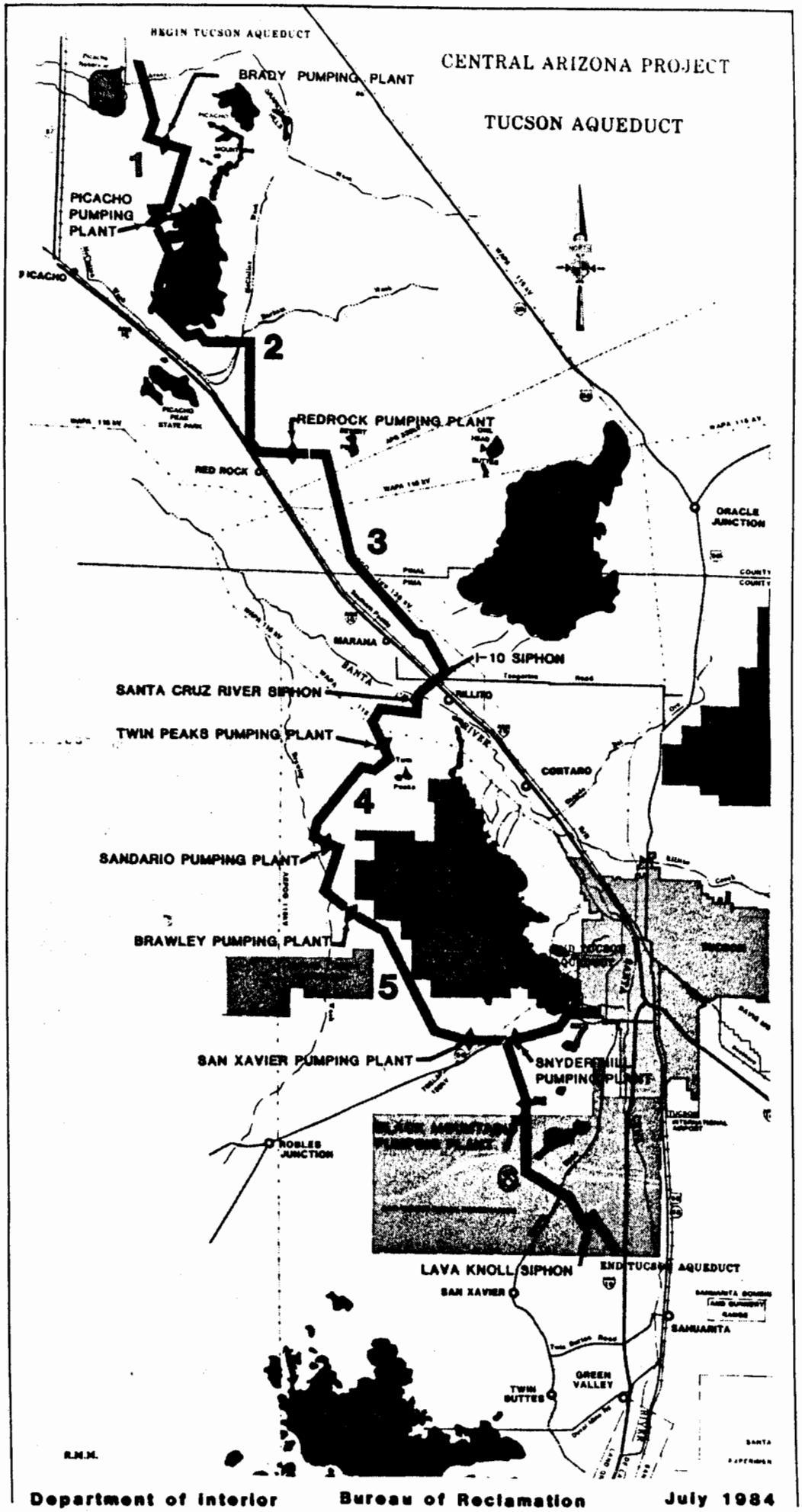

EXPLANATION
UNDER
AUTHORIZED CONSTRUCTION EXISTING FEATURES
Aqueduct terminus
Closed aqueduct
Open aqueduct
Dam and reservoir
Generating station
Pumping plant
Siphon
Tunnel
Indian reservation
Water use areas
ABBREVIATIONS
Bureau of Indian Affairs
Bureau of Reclamation
Corps of Engineers
Private
Salt River Project
NOTE
Alternatives to ORME and HOOKER DAMS are presently under study
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CENTRAL ARIZONA PROJECT - ARIZONA - NEW MEXICO
GENERAL LOCATION MAP
SCALE OF MILES
MAP NO. 344-314-944
AUGUST 1968
REV. 4-1-81
On April 18, 1977 the Administration recommended that the Central Arizona Project be modified to eliminate ORME, HOOKER, and CHARLESTON DAMS. As of the date of this printing, no Congressional action has been taken to deauthorize these features.
UTAH
COLO
NEV.
CALIF.
ARIZONA
NEW MEXICO
MEXICO
Lake Powell
NAVAJO GENERATING STATION (NAVAJO PROJECT)
(Completed)
Page
Kanab
Shiprock
Farmington
Lake Mead
HOOVER DAM
Boulder City
Lake Mohave
DAVIS DAM
Cameron
Peach Springs
Gallup
Ash Fork
Flagstaff
Lake Havasu
HAVASU PUMPING PLANT
PARKER DAM
Clarkdale
Jerome
Prescott
Holbrook
Snowflake
Show Low
St. Johns
Springerville
Datil
Payson
Wickenburg
Salome
Blythe
COLORADO
RIVER
GRANITE REEF AQUEDUCT
PHOENIX
ORME DAM SITE
SAN CARLOS
Globe
Miami
Superior
SALT-GILA AQUEDUCT
BUTTES DAM SITE
Buckeye
Florence
Casa Grande
Coolidge
GILA
Yuma
IMPERIAL DAM
Reserve
Alpine
Clifton
HOOKER DAM SITE
Silver City
Safford
Duncan
TUCSON AQUEDUCT
Ajo
PAPAGO
INDIAN
RESERVATION
Tucson
SAN XAVIER
Willcox
Lordsburg
Deming
Benson
CHARLESTON DAM SITE
Sierra Vista
Bisbee
Douglas
Nogales
Cananea



Tucson Aqueduct

- Final leg of the Central Arizona Project
- 330 mile long total conveyance system

Phase A

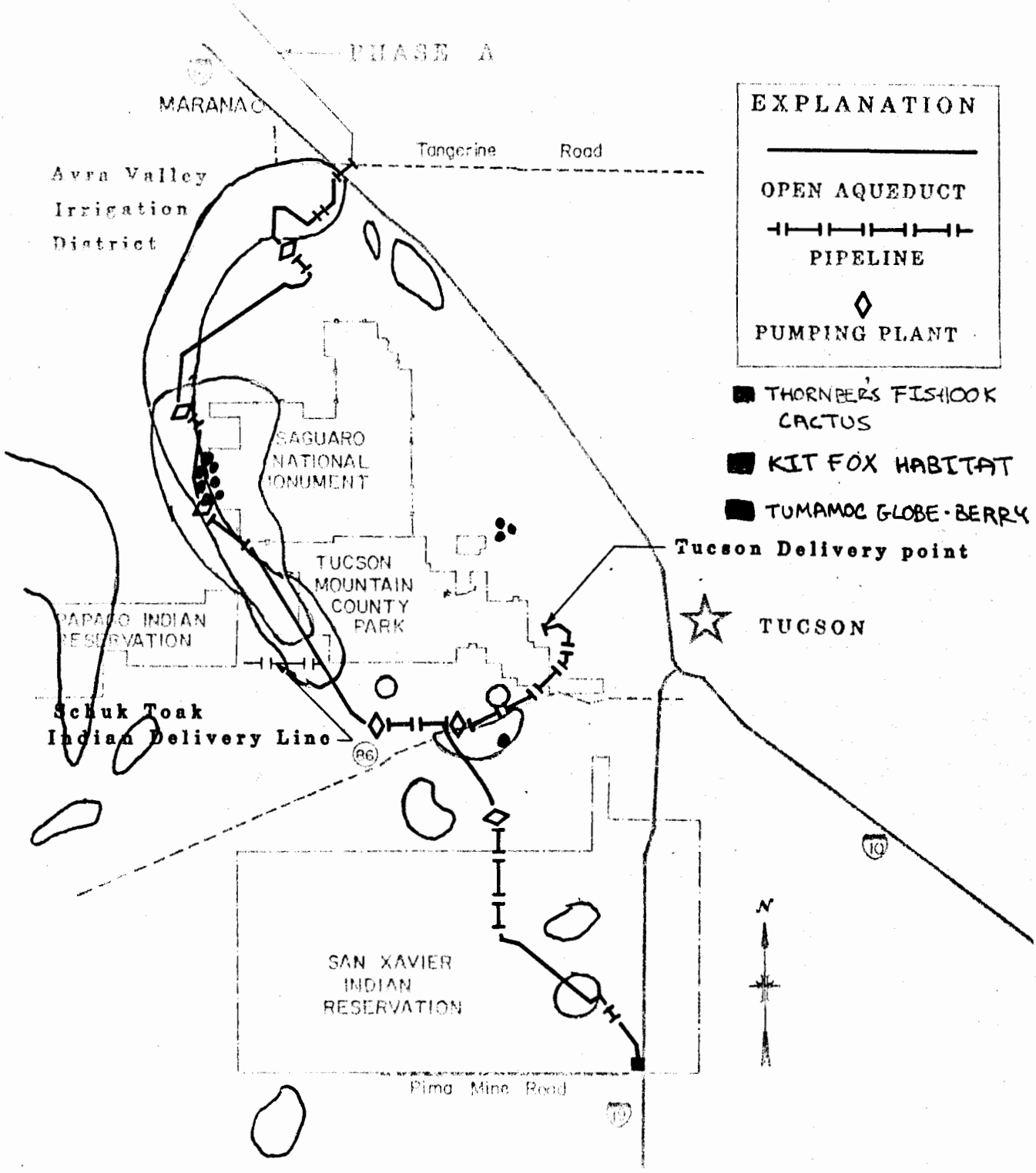
- 42 miles long
- 3 reaches
- 3 pumping plants
- 2 major turnouts for Pinal County
- All under construction by end of 1985

Phase B

- 45 miles long
- Ends at Pima Mines Road
- 3 reaches
- 6 pumping plants
- Serves Tucson Metropolitan Ared,
  Papago Indian Reservation,
  3 agricultural districts,
  the mines, and
  Green Valley and the City of Nogales
- Final selection of route with final E.I.S. August 1985

MAP B

MAPC



WEST SIDE PLAN

CENTRAL ARIZONA PROJECT

TUCSON AQUEDUCT-PHASE B

Figure 3a

Dwn: BJM