YAZOO RIVER NAVIGATION PROJECT

by

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INTRODUCTION

The Yazoo River Navigation Project study conducted by the Corps of Engineers was made in response to a resolution of the Committee on Public Works of the House of Representatives, United States, to determine the justification of a year-round 9-foot navigation channel on the Yazoo River.

SCOPE OF PROJECT

In 1962 the District Engineer held a public hearing in Greenwood, Miss., to ascertain the views and desires of local interests regarding improving the Yazoo River for navigation. During the hearing, local interests expressed their desire for a year-round 9-foot navigation channel from Vicksburg to Greenwood. They pointed out that even under unfavorable conditions, traffic had increased during recent years. They stated that greater use would have been made of the waterway had a dependable 9-foot navigation channel been available.

The primary objective of any navigation plan considered for the Yazoo River was to develop the most feasible plan, both from an engineering and economic standpoint, that would provide a suitable waterway from which a maximum amount of transportation savings would accrue. However, in arriving at any plan, consideration was given to other factors; i.e., flood control, water supply, pollution control, power, recreation, fish and wildlife, so that any plan would fit well into the total longrun development of the water resources of the basin.

DESCRIPTION OF WATERWAY AND PROJECT AREA

a. Waterway. The Yazoo River is formed by the junction of the Tallahatchie and Yalobusha Rivers at Greenwood. It flows in a generally southwesterly direction approximately 170 miles where it enters the Mississippi River at Vicksburg. The location of the river is shown on Figure 1. The channel is deeply entrenched throughout its length with bank heights ranging from about 30 feet in the vicinity of Greenwood to about 45 feet in the vicinity of Satartia (see Figure 2). The channel widths vary from about 300 to 500 feet and stream slopes average from 0.2 to 0.3 feet per mile. The slopes in the lower reaches below Yazoo City are controlled to a large extent by stages in the Mississippi River. During the low water periods the water depths range from 3 to 4 feet over the bars.

From a geologic standpoint, the river flows through recent alluvial deposits consisting of a relatively thin deposit of fine-grained materials overlying about 150 feet of coarsegrained sands and gravels.

At the present time, shallow draft towboats towing one or two barges loaded from 800 to 1,600 tons at 5- to 8-foot drafts depending on river stages, are using the waterway. Navigation on the river is being limited due to: (1) Minimum depths of 9 feet or greater are available for only 46 percent of the time; (2) numerous sharp bends restrict the movement of tows; (3) the fixed highway bridge at Belzoni; and (4) the lack of public terminals on the waterway.

b. Terminal and warehouse facilities. The only public terminal and warehouse facilities now in use on the waterway above the Vicksburg terminal are located at Yazoo City. These modern facilities also have access to rail and highway transportation. Private facilities for handling grain are now in operation at Greenwood, Belzoni, Yazoo City and near Satartia. Also, facilities for unloading raw materials for manufacturers of cement are located approximately 20 miles upstream from Vicksburg. It is expected that the papermill now under construction some 20 miles upstream from Vicksburg will construct facilities on the waterway as the need develops.

c. Navigation tributary area.

(1) General. The tributary area, shown on Plate 1, consists of 14 counties and is located in the northwest portion of Mississippi. The estimated 1965 population of the area was approximately 362,000.

(2) Agricultural Development. Cotton has long been the number one crop grown in the tributary area. However, acreage controls on cotton during recent years and demonstrated adaptability of recently cleared delta soils to the production of soybeans and small grains have resulted in significant increases in production of these commodities. For example, cotton acreage decreased from about 600,000 acres in 1954 to 490,000 acres in 1964, or a decline of 18 percent. On the other hand, the acres planted in soybeans increased from 280,000 in 1954 to 620,000 in 1964 or an increase of 122 percent. Cattle-raising is also increasing throughout the area. Production of hardwood timber in the alluvial valley and pine in the hill section is now largely from managed woodlands and is an increasingly important source of revenue.

(3) Industrial development. Industrial development is playing a significant role in the economy of the tributary area. The principal industries included in this development are: (a) processing and distribution of agricultural products; (b) manufacturing of industrial chemicals and fertilizers; (c) processing timber products; (d) manufacturing of portland cement; (e) production, refining, and distribution of petroleum products; and (f) production of paper products. A number of these installations now have ready access to the Yazoo River. Also, there are numerous industrial concerns in convenient haul distances from the river. In the last decade, 42 new industries have settled in the tributary area, a large portion of which are on or near the Yazoo River. Furthermore, there have been 42 plant expansions during this same period.

(4) Communications and transportation. Networks of railroads and Federal and State highways, air lines, power and telephone lines, and natural gas and petroleum-distribution lines which currently serve the area are adequate for present development, but any significant increase in industrial development would require expansion of these facilities.

EXISTING NAVIGATION PROJECT AND PRIOR REPORTS

The River and Harbor Act of 3 March 1875 authorized improvement on the entire length of the river by removal of snags, wrecks, submerged logs, overhanging trees and any other obstruction in the channel. No minimum depth was set forth in the legislation. The Corps of Engineers completed the initial plan of improvement in 1888 and since that time has maintained the channel to a limited degree, depending on the demands for navigation.

Back in 1931 a detailed study of navigation on the Yazoo River was made. It considered two plans for providing 6-foot minimum depths between Vicksburg and Greenwood. One plan involved construction of four locks and dams and the other, provision of reservoir storage to provide sufficient flow for open-river navigation. Neither of these plans was economically justified at that time.

PLANS CONSIDERED

In order to provide a reliable 9-foot navigation channel on the Yazoo River, four alternative plans of improvement were considered.

a. Open-river plan to Greenwood. One approach to navigation on a stream such as the Yazoo River is to provide an open river channel by dredging. Normally, providing a channel without the expense of locks and dams will be the least expensive plan. Such a plan, however, is subject to extensive maintenance dredging throughout its life and may well be affected by actual physical capability. Consideration was given to an open-river project which consisted of the following principal elements: (1) Realignment of existing channel at numerous locations to eliminate sharp bends; (2) extensive initial dredging to obtain 9-foot minimum depth and 150-foot minimum bottom width (see Fig. 3); (3) provision for an additional 600,000 acre-feet of storage in Sardis Reservoir to provide the necessary 6,000 c.f.s. flow; and (4) provisions for public-use facilities for recreational use. In addition to extensive initial dredging, this plan would involve annual maintenance dredging of such magnitude that its annual cost would be substantially greater than its benefits. Furthermore, it was determined that this plan would not be sound from an engineering standpoint because the relationship between the lower portion of the Yazoo River and the Mississippi River at low stages is such (about 40 percent of the time) that it would be virtually impossible to provide a 9-foot depth in the lower portion of the Yazoo River. This clearly pointed out that a successful open-river scheme could not be provided.

b. Four-lock plan to Greenwood. The next consideration was given to a canalized waterway with locks and navigation dams. The principal features of this plan were: (1) four locks and navigation dams located near Vicksburg, Satartia, Yazoo City, and Belzoni, (2) channel realignment at numerous locations to eliminate sharp bends, (3) channel dredging where required to obtain 9-foot minimum depths and 150-foot minimum bottom width (see Fig. 3); and (4) provision for public-use facilities along the river for recreational use.

This plan would provide the desired 9-foot depth channel 100 percent

of the time and was found to be feasible from an engineering standpoint. A disadvantage of this plan was the early investment of a large amount of money which would bring in small returns for the years prior to full development of traffic on the waterway.

c. One-lock plan to Yazoo City. A third plan studied was one to provide a full-time 9-foot navigation channel to the vicinity of Yazoo City. This plan consisted of: (1) One lock and navigation dam located near Vicksburg; (2) realignment of existing channel at numerous locations to eliminate sharp bends; (3) channel dredging where required to obtain 9-foot minimum depth and 150-foot minimum bottom width (see Fig. 3); (4) public-use facilities along the river for recreational use. From an engineering standpoint, it was a sound plan. It would provide the excellent potential industrial sites along the river between Vicksburg and Yazoo City with a ready access to water transportation but would not meet the need for a navigable channel between Yazoo City and Greenwood.

d. One-lock plan to Greenwood. In an effort to investigate all alternatives for maximum development in the area, this plan was conceived. The principal elements of this plan were: (1) One lock and navigation dam near Vicksburg; (2) channel realignment at numerous locations to eliminate sharp bends; (3) channel dredging where required to obtain 9-foot minimum depth and 150-foot minimum bottom width; (4) modification of Sardis Reservoir to provide an additional 600,000 acre-feet of storage, and (5) public-use facilities along the navigation pool reach of the river and at Sardis Reservoir. By making use of additional storage in the existing Sardis Reservoir and adjustment of rule-curve operating schedules for other flood control reservoirs in the Yazoo headwater area, the base flow of the river at Greenwood could be increased from 1,000 c.f.s. to 6,000 c.f.s. This increase in base flow would make it possible to have a practically open-river channel between Greenwood and Yazoo City. This open-river channel, together with the lock and navigation dam near Vicksburg, would provide 9-foot navigation from Vicksburg to Greenwood 97 percent of the time. These infrequent periods of several weeks duration (about once in ten years) in which depths of less than 9 feet will be available above the upper limits of the navigation pool could be foreseen some 3 or 4 months ahead and shippers would have ample time to make other arrangements during these periods. The increased storage in Sardis Reservoir would make possible hydroelectric power development, when needed and economically justified, as well as additional recreational developments around the reservoir.

FACTORS CONSIDERED

a. Navigation. In order to determine the need for water transportation on the Yazoo River, the following procedure was followed: (1) Examined the general economy of the tributary area (population, resources, agricultural development, industrial development and existing transportation facilities available); (2) estimated the potential tonnage for the proposed project in the base year. A detailed study was made to determine the type, quantity, and present mode of transportation for commodities likely to move via an improved waterway. Potential waterway traffic was determined by interviews with both present and prospective shippers on the

waterway. (3) Estimated the prospective savings to the base-year traffic. These savings represent the difference between (a) freight rates or charges presently incurred for movement of goods by the alternative means of transportation actually being used and (b) estimated rates or charges applicable to movements via an improved Yazoo River Navigation channel and on connecting waterways. (4) Projected the traffic and savings over the economic life of the project (50 years). This was accomplished by applying index factors developed for population, agriculture and manufacturing to their related commodities.

b. Recreation. The Federal Water Projects Recreation Act of 1965 established that full consideration would be given to the opportunities for inclusion of outdoor recreation and fish and wildlife enhancement at certain Federal water development projects. The Yazoo River area is undeveloped insofar as esthetics and recreational opportunities are concerned. There is presently a limited recreational use of this river, this being hunting and fishing activity. Sardis Reservoir is one of four Corps of Engineer reservoirs located on the principal hill tributaries of the Yazoo River. Although originally constructed for flood control purposes, all of these have been developed for recreational use. Recreational development and use of Sardis Reservoir is limited by the shallow depths and mud flats that exist during the recreation season. Modification of the existing Sardis Reservoir to provide additional storage for navigation would permit the addition of new access areas and would allow expansion to existing ones. The higher pool would afford natural beaches and sheltered creek embayments suitable for boat harbors. In order to evaluate the recreational values of the project, the following steps were taken. Recreation market areas for both the Yazoo River and Sardis Reservoir were determined. These areas encompassed the counties within a 50-mile radius of the center of the project. Population and per capita income projections were used in developing the demand for outdoor recreation within the project area. The demand was compared with the existing supply of recreation resources in the market areas and the results indicated a large deficit of recreation facilities at the present and an increasing deficit throughout the life of the project. This unsatisfied demand expressed in activity occasions was then converted to recreation days which could be assigned a monetary value. The development of the Yazoo River and modification of Sardis would substantially increase their recreational potential.

c. Flood control. Modification of the rule curves for operation of the reservoirs in the Yazoo Basin and additional storage in Sardis Reservoir will cause minor reductions in flood stages, affording some incidental flood control benefits.

d. Water supply. The supply of ground water in the Yazoo Basin is adequate for all foreseeable needs. The increased base flow in the river required for navigation in several plans will not be available for withdrawal for water supply purposes. However, if future commerce on the waterway developed to the extent that it justified expansion to a four-lock plan, a substantial part of the base flow would be available for other purposes.

e. Pollution control. Pollution on the Yazoo River is not a serious problem at this time. With continuation of industrial development along the river, the increased base flow required for the one-lock plan would help to maintain the water quality in the river.

f. Hydroelectric power. The additional storage in Sardis Reservoir for navigation would make possible a power installation at the reservoir. Power releases would generally be in accord with normal flood control and navigation releases. Economic analysis shows that the power feature is not economically justified at this time. If a later study proved that the power installation was financially feasible, its installation would not require major changes in other features of the project.

DESIGN CRITERIA

a. Channel. All the plans studies considered a channel with a minimum depth of 9 feet and a minimum bottom width of 150 feet. Estimates for corrective dredging and for construction of cutoffs contemplate (1) over-depth dredging of 3 feet to insure against the inaccuracies of the dredging process, and (2) channel realignment to provide a waterway with a minimum radius of bends of 1,200 feet which is considered satisfactory for the typical tow expected to use the waterway. The channel realignment will shorten the channel about 9 miles. The natural channel provides ample width at most places to permit the easy passage of tows.

b. Pool levels. The land adjacent to the river throughout most of its length consists of natural levee formations that average several feet higher than the lands some distance back from the banks of the stream. Runoff from these low areas drain into the river through depression in the natural levee. Flood gates are necessary on all of these locations that drain areas protected by levees. The relation of invert elevations of these drainage structures to pool elevations are the controlling factors in establishing the maximum pool height (one that does not cause serious adverse effect on drainage of the low-lying areas). Maximum practical pool height is essential to hold both initial and maintenance dredging to a minimum.

c. Lock.

(1) The principal consideration in arriving at the optimum size of locks for the project was to provide adequately for handling anticipated traffic. A lock size of 84 feet by 600 feet is considered the best, not only to take care of initial needs but also to accommodate increases in traffic which might occur as the tributary area continues to develop. This lock could handle in a single lockage the typical tow expected to use the waterway (a towboat and three barges, 35 feet by 195 feet).

(2) Minimum depths of 13 feet over the lock sills should be available to facilitate passage of tows through the lock and to permit deepening the waterway if needed.

(3) The lock and guide walls would be of gravity construction.

(4) Filling and emptying systems would be of the side port type.

(5) Horizontally framed miter gates and reverse tainter culvert valves with hydraulically operated machinery would be provided.

(6) Operating buildings would be located above the project flow line.

d. Dam. The navigation dams would have a tainter-gated control section with an uncontrolled navigation pass. The dam should have bearing-pile foundations and steel sheet-piling cutoffs to minimize under-seepage. Tainter-gate hoist equipment and service bridge for operation and maintenance should be located on the piers above the project flow line.

e. Modification to Sardis Reservoir. Addition of 600,000 acre-feet of navigation storage would require alteration of the existing spillway structure by removal of the existing weir and construction of a gated structure. The gated structure would be located in the existing spillway approach channel and would be controlled by tainter gates. This modification would permit utilizing part of the existing surcharge pool in the reservoir for navigation without jeopardizing the safety of the dam. No increases in the height of the dam would be necessary.

f. Lands and relocations.

(1) Yazoo River. Lands will be required for the construction of the lock and dam, cutoffs, recreation facilities, and for spoil disposal areas for both initial and maintenance dredging. Also, flowage easements will be acquired on land lying below a line 3 feet above the flat pool which will be damaged by saturation and wave action from propeller wash. Essentially all of the lands required are now either in timber or are marginal lands located below top bank of the channel.

(2) Sardis Reservoir. Additional lands required around Sardis Reservoir are based on blocking the area included in a contour 5 feet above the top of the new flood control pool. The modification to the reservoir will necessitate relocation of existing recreation and public-use facilities around the reservoir and raising portions of the Illinois Central Railroad and State Highway No. 7 and several miles of county roads. The land presently owned by the Federal government, together with that to be purchased as stated above, is sufficient to accommodate the relocated and additional recreation facilities.

g. Bridge alterations. All of the bridges over the waterway meet clearance requirements for a modern navigation channel except the fixed bridge at Belzoni and the new Sheppardtown bridge. Both of these bridges will require alterations.

h. Aids to navigation. The plan will include modern lighting and signal facilities for locks, dams, and bridges, and a system of buoys and other markers adequate to define the channel.

ESTIMATES OF COST

The following tabulation presents a comparison of first cost and

annual cost for the one-lock to Greenwood plan, the four-lock to Greenwood plan, and the one-lock to Yazoo City plan. No estimates were prepared for the open-river plan since this plan is engineeringly unsound.

TABLE 1
COMPARISON OF COST

Item	One-lock to Greenwood	Four-lock to Greenwood	One-lock to Yazoo City
	$	$	$
First cost	53,000,000	85,890,000	29,970,000
Annual cost (1)	2,826,000	4,266,000	1,717,000

(1) Includes annual interest, amortization, operation and maintenance, and major replacements cost.

ESTIMATES OF BENEFITS

a. General. In order to evaluate the extent to which a project accomplishes the aim of satisfying human needs, the physical effects of each plan must be measured and translated into benefits.

b. Transportation savings. These savings were based on a comparison of the estimated rates via the improved waterway with the modes of transportation actually moving the traffic today, recognizing current rates. It was estimated that 1975 will be the first year of project operation and benefits were calculated for a 50-year period, 1975-2025. Tonnage and savings were estimated for the base year (1966), 1975 and 2025. Based on these savings, annual benefits were determined.

c. Recreation benefits. Recreation benefits were developed using the unsatisfied demand determined for the project areas for a 50-year period. This demand was converted to recreation days and assigned a unit value of $1.25 per recreation day. These benefits were then discounted to a common time base giving an annual benefit.

d. Fishery benefits. The increase in fishery values for the plans considered was based on conditions before and after project completion.

e. Economic development effects. All the counties except Grenada and Warren through which the project would be constructed are designated as eligible for assistance under the Public Works and Economic Development Act of 1965. The economic development benefits were estimated using construction expenditure and operation and maintenance expenditure for local labor expected to come from the unemployed or underemployed in the eligible counties.

f. Summary of benefits. Table 2 summarizes the total annual benefits for the plans considered.

TABLE 2
SUMMARY OF TOTAL BENEFITS

Benefits	One-lock to Greenwood	Four-lock to Greenwood	One-lock to Yazoo City
	$	$	$
Transportation savings	3,169,500	3,267,500	2,326,100
Recreation - Yazoo River	490,000	980,000	490,000
Additional recreation, Sardis Reservoir	567,000	-	-
Increase in F&WL values	57,000	80,000	4,000
Economic development	334,000	539,000	192,000
Total	4,617,500	4,794,500	3,012,100

PROJECT FORMULATION

In selecting the most feasible plan, the annual benefits, annual charges, benefit-cost ratios and the excess of benefits over costs for the three alternative plans were compared.

TABLE 3
COMPARISON OF PLANS

Item	One-lock to Greenwood	Four-lock to Greenwood	One-lock to Yazoo City
	$	$	$
Annual benefits	4,617,500	4,794,500	3,012,100
Annual charges	2,826,000	4,266,000	1,717,000
Benefit-cost ratio	1.63	1.12	1.75
Excess of benefits	1,791,500	528,500	1,295,100

Although the one-lock plan to Yazoo City has the highest benefit-cost ratio, the one-lock plan to Greenwood clearly meets the criteria set forth in the maximization principle; i.e., the largest excess of benefits over cost.

To test further the economic feasibility of the one-lock plan to Greenwood, this plan was divided into two increments: increment No. 1 from Vicksburg to Yazoo City, and increment No. 2 from Yazoo City to Greenwood. In relation to scale of development, the maximization principle requires that an increment to a project shall be added as long as the benefits to that increment exceed its costs. The benefits to increment No. 2 exceeded its costs by approximately $500,000. In light of the foregoing, the one-lock plan to Greenwood was selected as the optimum plan.

CONCLUSIONS

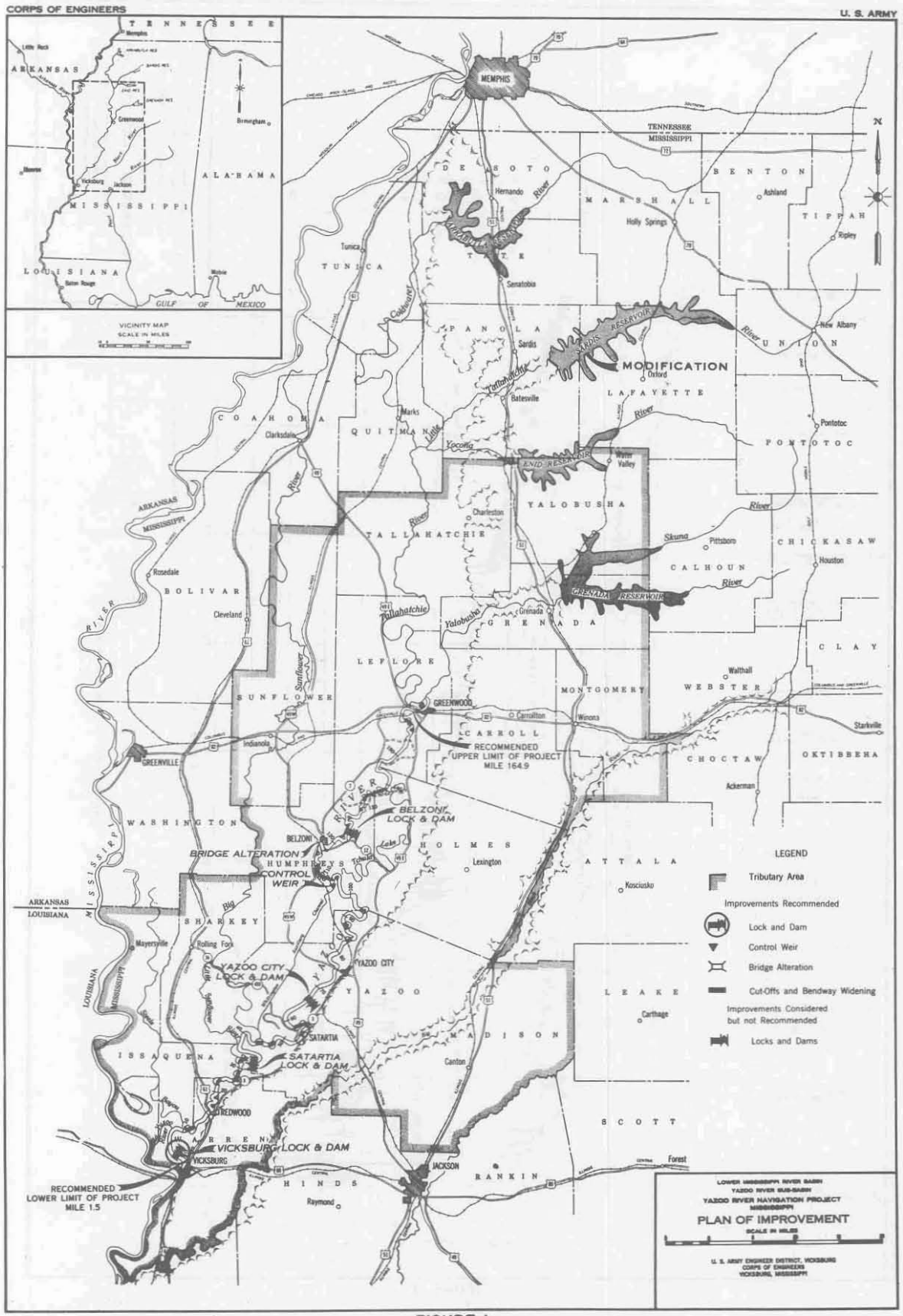
The following conclusions were reached as the result of the findings of this investigation:

a. The most practicable plan for providing a dependable 9-foot navigation channel on the Yazoo River to Greenwood is the one-lock plan.

b. The navigation pool and modification of Sardis Reservoir would substantially increase the recreational potential of the area. The construction of public-use facilities would produce significant recreation benefits.

c. In the event that future commerce on the waterway developed to the extent that expansion to the four-lock plan was justified, the one-lock plan could be easily expanded. The added base flow required for navigation in the one-lock plan could be used for other useful purposes.

d. Because of economic and social consequences involved, construction of this project would be in the national interest. It would tend to increase regional and national income, growth and stability. It would definitely improve the national transportation system and be a significant development of the natural, human and water resources of this region.


CORPS OF ENGINEERS
U. S. ARMY
VICINITY MAP
SCALE IN MILES
MEMPHIS
TENNESSEE
MISSISSIPPI
DE SOTO
BENTON
MARSHALL
TIPPAH
TUNICA
PANOLA
UNION
LAFAYETTE
COAHOMA
QUITMAN
PONTOTOC
YALOBUSHA
TALLAHATCHIE
CHICKASAW
CALHOUN
BOLIVAR
GRENADA
CLAY
LEFLORE
WEBSTER
SUNFLOWER
MONTGOMERY
CARROLL
CHOCTAW
OKTIBBEHA
WASHINGTON
HOLMES
ATTALA
SHARKEY
YAZOO
LEAKE
ISSAQUENA
MADISON
SCOTT
RANKIN
HINDS
ARKANSAS
LOUISIANA
ALABAMA
GULF OF MEXICO
Hernando
Ashland
Holly Springs
Ripley
Tunica
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Oxford
New Albany
Batesville
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Pontotoc
Water Valley
Charleston
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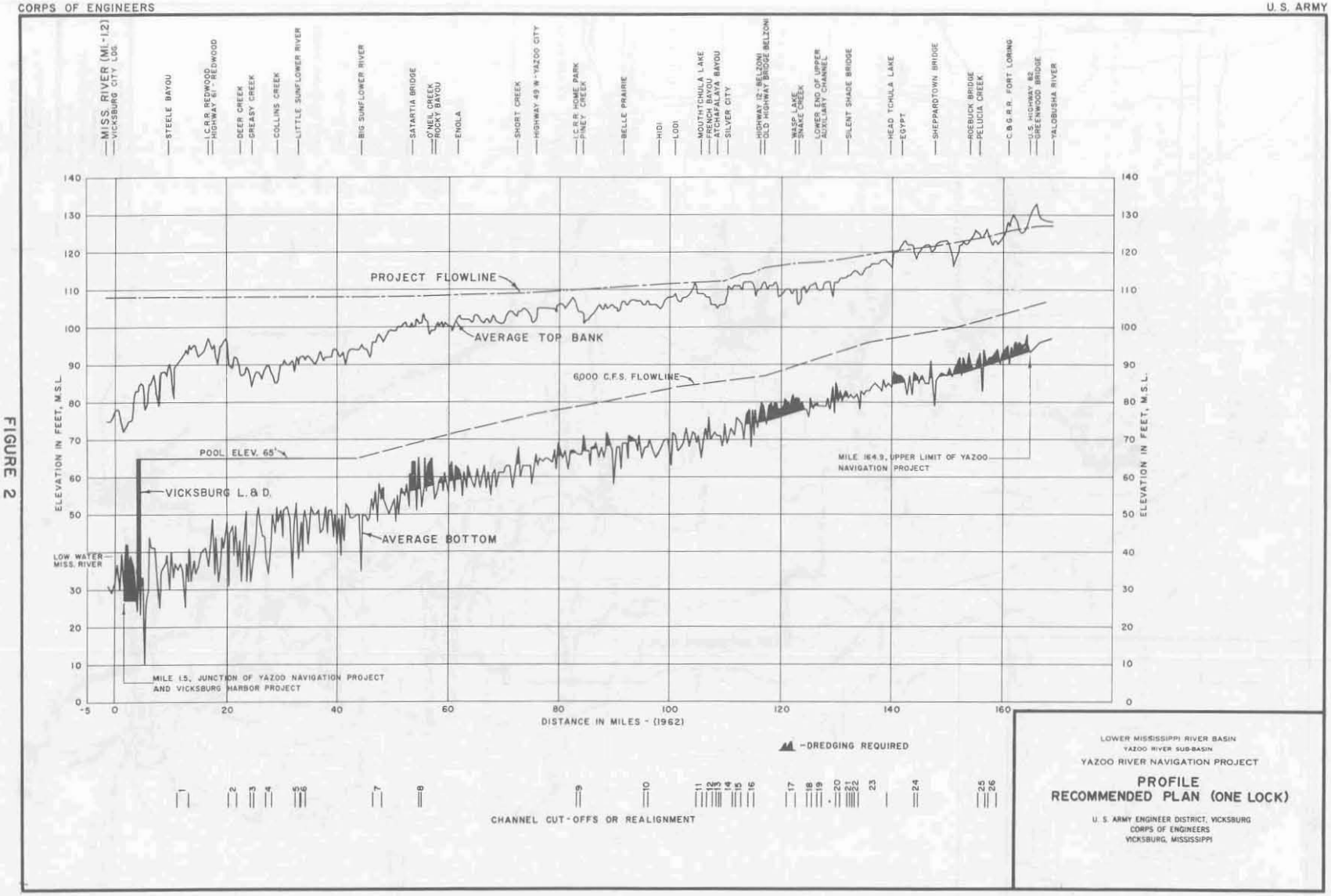
Pittsboro
Houston
Rosedale
Cleveland
Grenada
Walthall
Greenwood
Carrollton
Winona
Starkville
Indianola
Greenville
Lexington
Kosciusko
Belzoni
Mayersville
Rolling Fork
Yazoo City
Satartia
Redwood
Vicksburg
Canton
Carthage
Forest
Jackson
Raymond
Ackerman
SARDIS RESERVOIR
MODIFICATION
ENID RESERVOIR
GRENADA RESERVOIR
RECOMMENDED UPPER LIMIT OF PROJECT MILE 164.9
BELZONI LOCK & DAM
BRIDGE ALTERATION
HUMPHREYS CONTROL WEIR
YAZOO CITY LOCK & DAM
SATARTIA LOCK & DAM
VICKSBURG LOCK & DAM
RECOMMENDED LOWER LIMIT OF PROJECT MILE 1.5
LEGEND
Tributary Area
Improvements Recommended
Lock and Dam
Control Weir
Bridge Alteration
Cut-Offs and Bendway Widening
Improvements Considered but not Recommended
Locks and Dams
LOWER MISSISSIPPI RIVER BASIN
YAZOO RIVER SUB-BASIN
YAZOO RIVER NAVIGATION PROJECT
MISSISSIPPI
PLAN OF IMPROVEMENT
SCALE IN MILES
U. S. ARMY ENGINEER DISTRICT, VICKSBURG
CORPS OF ENGINEERS
VICKSBURG, MISSISSIPPI

FIGURE I

CORPS OF ENGINEERS U. S. ARMY

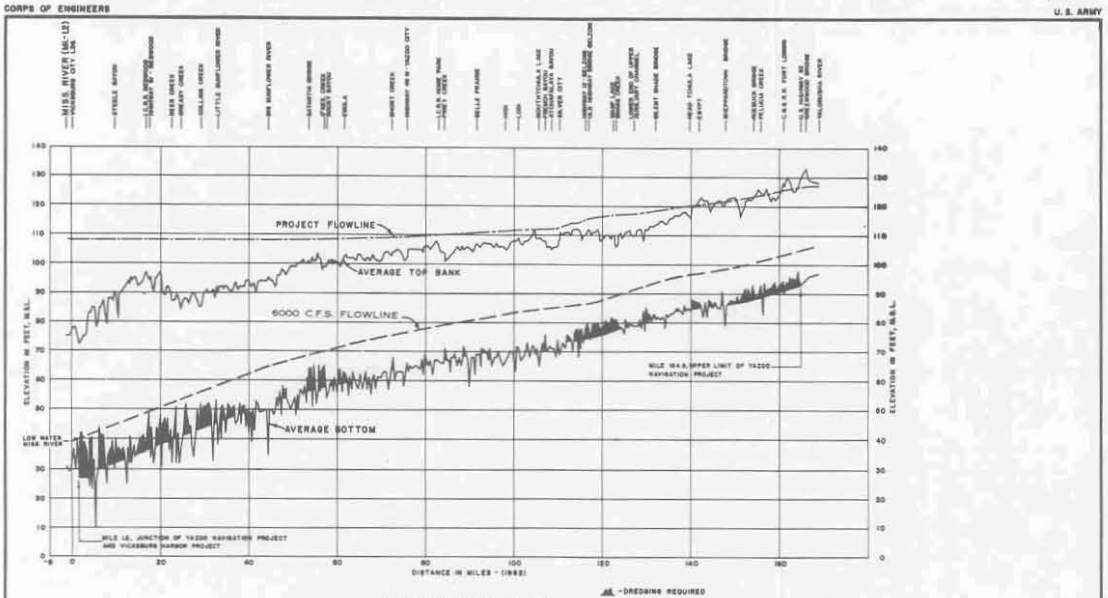


LOWER MISSISSIPPI RIVER BASIN
YAZOO RIVER SUB-BASIN
YAZOO RIVER NAVIGATION PROJECT

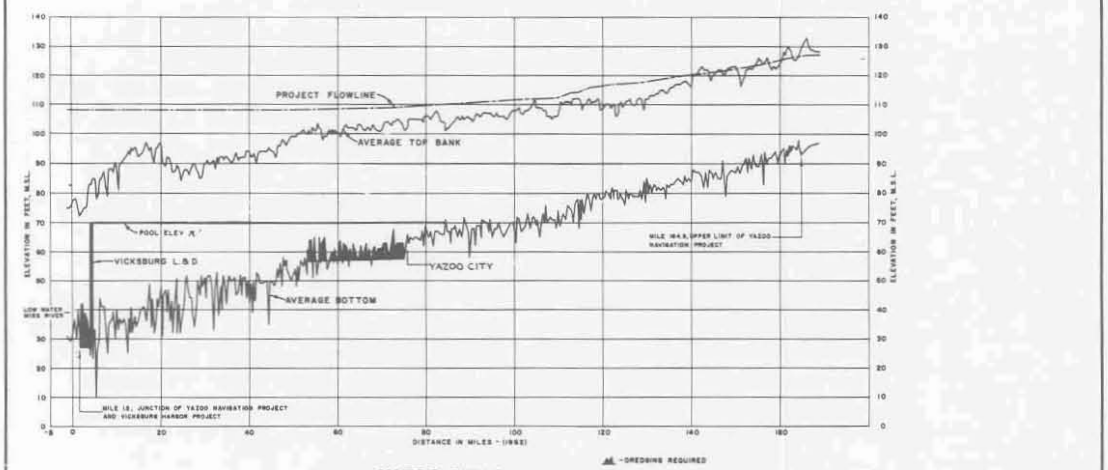
PROFILE
RECOMMENDED PLAN (ONE LOCK)

U. S. ARMY ENGINEER DISTRICT, VICKSBURG
CORPS OF ENGINEERS
VICKSBURG, MISSISSIPPI

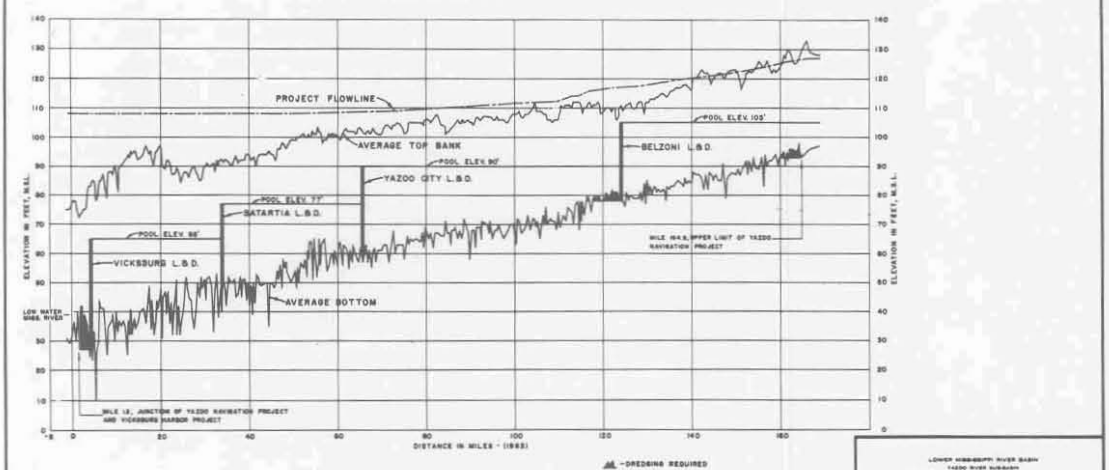
FIGURE 2



OPEN RIVER PLAN



YAZOO CITY PLAN



FOUR LOCK PLAN

LOWER MISSISSIPPI RIVER BASIN
YAZOO RIVER SUBBASIN
YAZOO RIVER NAVIGATION PROJECT

OTHER PLANS CONSIDERED

U. S. ARMY ENGINEER DISTRICT, VICKSBURG
CORPS OF ENGINEERS
VICKSBURG, MISSISSIPPI

FIGURE 3