BUFFALO BAYOU AND TRIBUTARIES, WHITE OAK BAYOU, TEXAS

LETTER

FROM

THE SECRETARY OF THE ARMY

TRANSMITTING

A LETTER FROM THE CHIEF OF ENGINEERS, DEPARTMENT OF THE ARMY, DATED SEPTEMBER 3, 1964, SUBMITTING A REPORT, TOGETHER WITH ACCOMPANYING PAPERS AND ILLUSTRATIONS, ON AN INTERIM REPORT ON THE BUFFALO BAYOU AND TRIBUTARIES, WHITE OAK BAYOU, TEXAS, REQUESTED BY A RESOLUTION OF THE COMMITTEE ON PUBLIC WORKS, HOUSE OF REPRESENTATIVES, ADOPTED APRIL 20, 1948

MAY 11, 1965.—Referred to the Committee on Public Works and ordered to be printed with four illustrations

U.S. GOVERNMENT PRINTING OFFICE
WASHINGTON : 1965

47-542 O

CONTENTS

ILLUSTRATIONS ACCOMPANYING THE REPORT OF THE DISTRICT ENGINEER

(Only Plate 3 not printed)

APPENDIXES ACCOMPANYING THE REPORT OF THE DISTRICT ENGINEER

LETTER OF TRANSMITTAL

DEPARTMENT OF THE ARMY
WASHINGTON 25, D.C.

IN REPLY REFER TO:

May 4, 1965

Honorable John W. McCormack

Speaker of the House of Representatives

Dear Mr. Speaker:

I am transmitting herewith a favorable report dated 3 September 1964, from the Chief of Engineers, Department of the Army, together with accompanying papers and illustrations, on an interim report on the Buffalo Bayou and Tributaries, White Oak Bayou, Texas, requested by a resolution of the Committee on Public Works, House of Representatives, adopted 20 April 1948.

The views of the Governor of Texas, and the Departments of the Interior and Agriculture are set forth in the inclosed communications.

The Bureau of the Budget advises that there is no objection to the submission of the proposed report to the Congress; however, it states that no commitment can be made at this time as to when any estimate of appropriation would be submitted for construction of the project, if authorized by the Congress, since this would be governed by the President's budgetary objectives as determined by the then prevailing fiscal situation. A copy of the letter from the Bureau of the Budget is inclosed.

Sincerely yours,

STEPHEN AILES
Secretary of the Army

1 Incl
Report

COMMENTS OF THE BUREAU OF THE BUDGET

EXECUTIVE OFFICE OF THE PRESIDENT
BUREAU OF THE BUDGET
WASHINGTON, D.C. 20503

April 22, 1965

Honorable Stephen Ailes
Secretary of the Army
Washington, D. C. 20310

Dear Mr. Secretary:

Mr. Alfred B. Fitt's letter of February 12, 1965, submitted the proposed report of the Chief of Engineers on the Buffalo Bayou and Tributaries, White Oak Bayou, Texas, requested by a resolution of the Committee on Public Works, House of Representatives, adopted April 20, 1948.

I am authorized by the Director of the Bureau of the Budget to advise you that there would be no objection to the submission of the proposed report to the Congress. No commitment, however, can be made at this time as to when any estimate of appropriation would be submitted for construction of the project, if authorized by the Congress, since this would be governed by the President's budgetary objectives as determined by the then prevailing fiscal situation.

Sincerely yours,

Carl H. Schwartz, Jr.
Chief, Resources and
Civil Works Division

COMMENTS OF THE GOVERNOR OF TEXAS

EXECUTIVE DEPARTMENT
AUSTIN 11, TEXAS

JOHN CONNALLY
GOVERNOR

July 30, 1964

Major General R. G. MacDonnell
Acting Chief of Engineers
Department of the Army
Office of the Chief of Engineers
Washington, D. C. 20315

Dear General MacDonnell:

This is in regard to the proposed interim survey report of the Buffalo Bayou and Tributaries - White Oak Bayou Flood Control Project as submitted in your letter dated May 1, 1964. In accordance to Texas statutes, I requested that the Texas Water Commission hold a public hearing and make feasivility recommendations.

I quote the following recommendations which the Texas Water Commission has submitted to me:

(1) "That the proposed project as recommended in said report by the U. S. Corps of Engineers relating to flood prevention in sections of Houston, Texas, by enlargement and rectification of a portion of the channel of White Oak Bayou be approved;

(2) "That the Congress of the United States take action as expeditiously as possible to authorize and fund this urgently needed project to protect existing and future facilities in this important and rapidly developing area;

(3) "That ownership by the State of Texas of the waters involved be fully recognized by all interested parties and that lawful rights to the use of such water, vested pursuant to State law, be respected, protected and preserved."

I hereby approve, on behalf of the State of Texas, the White Oak Bayou Flood Control Project as being feasible and in best public interest.

Sincerely,

John Connally

John Connally

COMMENTS OF THE DEPARTMENT OF THE INTERIOR

UNITED STATES
DEPARTMENT OF THE INTERIOR
OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20240

July 2, 1964

Dear General Wilson:

This is in reply to your letter of May 1, 1964, requesting our views on an interim report on the Buffalo Bayou and Tributaries, White Oak Bayou, Texas.

The proposed development would not adversely affect any existing or proposed projects of the Bureau of Reclamation.

The Bureau of Sport Fisheries and Wildlife advises that the proposed project would have no significant effect on fish and wildlife resources and does not afford opportunities for improvement of these resources.

Thank you for the opportunity of commenting on the recommended improvements.

Sincerely yours,

Robert W. Nelson

Deputy Assistant Secretary of the Interior

Lt. General Walter K. Wilson, Jr.
Chief of Engineers
Department of the Army
Washington, D. C. 20315

47-542 O-65—2

COMMENTS OF THE DEPARTMENT OF AGRICULTURE

DEPARTMENT OF AGRICULTURE
WASHINGTON 25, D.C.

August 25, 1964

Honorable Stephen Ailes
Secretary of the Army

Dear Mr. Secretary:

This is in reply to the Chief of Engineers' letter of May 1, 1964, transmitting for our review and comment his proposed interim review survey report on White Oak Bayou, Texas.

The report recommends that the Federal flood control project for Buffalo Bayou and Tributaries, Texas, be modified to extend the upper limit of the White Oak Bayou portion of the project upstream about 2.1 miles from the Burlington-Rock Island Railroad bridge to the mouth of Cole Creek. The estimated first cost of the project is $2,470,000, of which $1,800,000 would be the Federal cost for construction, and $670,000 would be the non-Federal cost for lands, easements, rights-of-way, and relocations. The benefit-cost ratio is estimated to be 1.2.

Development within the flood plain includes commercial and residential properties, streets and bridges, utilities and parks. Based on expected growth rate of the area, it is estimated that the entire flood plain would be substantially developed during the life of the project. This development would further increase the flood damages potential.

The benefits which are expected to accrue from the project would consist of prevention of flood damage to existing and future urban developments. According to the report, much of development in the flood plain has taken place subsequent to studies leading to authorization of the existing project. We concur with the view of the Chief of Engineers that responsible local interests should exercise to the full extent of their legal capabilities the establishment of flood plain zoning and other flood zone restrictions; and if those areas are developed, responsibility for flood protection should rest with the developer or other local interests.

In view of the predominance of urban development within the watershed, the project will not affect the local agricultural resources nor will it adversely affect programs and projects of this Department.

We appreciate the opportunity afforded us to review the report.

Sincerely yours,

John A. Baker
Assistant Secretary

BUFFALO BAYOU AND TRIBUTARIES, WHITE OAK BAYOU, TEXAS

REPORT OF THE CHIEF OF ENGINEERS, DEPARTMENT OF THE ARMY

HEADQUARTERS
DEPARTMENT OF THE ARMY
OFFICE OF THE CHIEF OF ENGINEERS
WASHINGTON 25, D.C.

IN REPLY REFER TO

ENGCW-PD 3 September 1964

SUBJECT: Buffalo Bayou and Tributaries, Texas - White Oak Bayou

TO: THE SECRETARY OF THE ARMY

1. I submit for transmission to Congress the interim report of the Board of Engineers for Rivers and Harbors, accompanied by the reports of the District and Division Engineers, in partial response to a resolution of the Committee on Public Works of the House of Representatives, United States, adopted 20 April 1948, requesting a review of reports on the Houston Ship Channel and Buffalo Bayou, Texas, with a view to determining a comprehensive plan for the betterment of navigation and for the control of floods throughout the Buffalo Bayou watershed including modifications, if any, of the presently approved plan of improvement and of the requirements for local cooperation in order to meet the materially changed conditions resulting from the rapid industrial expansion and growth of the city of Houston, Texas, and contiguous areas. This report is limited to consideration of an extension of the authorized project for White Oak Bayou, a tributary of Buffalo Bayou, in the interest of flood control. A final report on Buffalo Bayou and Tributaries will be submitted later.

2. The District and Division Engineers recommend that the Federal flood control project for Buffalo Bayou and Tributaries, Texas, be modified to extend the upper limit of the White Oak Bayou portion of the project upstream about 2.1 miles from the Burlington-Rock Island Railroad bridge to the mouth of Cole Creek. They estimate the first cost at $2,470,000, of which $1,800,000 would be the Federal cost for construction, and $670,000 would be the non-Federal cost for lands, easements, rights-of-way, and certain modifications and relocations of highway bridges, utilities and related facilities made necessary by construction of the project. The benefit-cost ratio is 1.2.

3. The Board concurs generally in the findings of the reporting officers. It notes that development in the flood plain in the study area has taken place subsequent to studies leading to authorization of the existing project, apparently without consideration of the flood hazards involved. It is the Board's view that responsible local interests should exercise to the full extent of their legal capabilities the establishment of flood plain zoning and building restrictions to prevent development in the unprotected areas in the flood plain upstream from Cole Creek; and if those areas are to be developed, responsibility for flood protection should rest with the developer or other local interests. The Board recommends authorization of the proposed improvement, subject to local cooperation.

4. I concur in the views and recommendations of the Board. Use of the recently prescribed interest rate of 3-1/8 percent in computing annual charges and benefits would result in no appreciable change in the benefit-cost ratio.

W. K. WILSON, JR.
Lieutenant General, USA
Chief of Engineers

REPORT OF THE BOARD OF ENGINEERS FOR RIVERS AND HARBORS

CORPS OF ENGINEERS, U.S. ARMY
BOARD OF ENGINEERS FOR RIVERS AND HARBORS
WASHINGTON, D.C. 20315

ENGBR

24 March 1964

SUBJECT: Buffalo Bayou and Tributaries, Texas - White Oak Bayou

TO: Chief of Engineers
Department of the Army

1. Authority.--This interim report is in partial response to the following resolution adopted 20 April 1948:

> Resolved by the Committee on Public Works of the House of Representatives, United States, That the Board of Engineers for Rivers and Harbors be, and is hereby, requested to review the reports on Houston Ship Channel and Buffalo Bayou, Texas, contained in House Document No. 456, 75th Congress, 2nd session, with a view to determining a comprehensive plan for the betterment of navigation and for the control of floods throughout the Buffalo Bayou watershed including modifications, if any, of the presently approved plan of improvement and of the requirements for local cooperation in order to meet the materially changed conditions resulting from the rapid industrial expansion of the City of Houston, and contiguous areas.

It is limited to consideration of an extension of the authorized project for White Oak Bayou, a tributary of Buffalo Bayou, in the interest of flood control. A final report on Buffalo Bayou and its tributaries will be submitted later.

2. Basin description.--White Oak Bayou is a tributary of Buffalo Bayou in the San Jacinto River basin located on the upper Gulf coast of Texas. The land surface of the White Oak Bayou watershed slopes gently from a maximum elevation of about 140 feet to about 30 feet above mean sea level. The only significant irregularities in the gentle slope are the valleys cut by the bayou and its tributaries. The watershed, containing about 113 square miles, lies entirely within Harris County, Texas. The bayou rises in west-central Harris County and, until the 1950's, flowed southeasterly in a tortuous channel for about 34 miles to its junction with Buffalo Bayou near the center of Houston. In recent years local interests have rectified the channel alignment of the bayou so that its present length is about 25 miles.

3. Economic development.--A Federal flood protection project on White Oak Bayou is authorized from its mouth to the Burlington-Rock Island Railroad bridge at mile 8.5. Since 1950 there has been rapid development within the White Oak Bayou watershed between the upper limit of the authorized project and the Houston city limits at channel mile 10.4. Development in this reach is almost entirely residential and commercial. The population of the flood plain within the reach increased from about 100 in 1950 to about 4,800 in 1963. The watershed area outside of the city limits and upstream from mile 10.4 is rural and, in general, is undeveloped.

4. Existing and authorized improvements.--The Harris County Flood Control District enlarged and rectified the channel of White Oak Bayou between the Burlington-Rock Island Railroad bridge and Cole Creek in 1954 and 1955 at an estimated cost of $63,500. The existing Federal flood-control project for Buffalo Bayou and its tributaries above the Houston turning basin provides for the construction of Barker Dam and Reservoir and Addicks Dam and Reservoir near Houston; and for rectification of the channels of Buffalo, Brays, and White Oak Bayous in Houston. The authorized channel rectification of White Oak Bayou from its mouth to channel mile 8.5 is in the preconstruction planning stage. An existing navigation project for the Houston Ship Channel provides for a deep-draft channel, 300 to 400 feet wide and 36 to 40 feet deep, extending from Bolivar Roads at the lower end of Galveston Bay, via the San Jacinto River and Buffalo Bayou, to the Houston turning basin, about 55 miles inland from the Gulf of Mexico.

5. Floods and damages.--The present channel capacity of White Oak Bayou at the Burlington-Rock Island Railroad bridge is estimated at 10,000 cubic feet per second. The largest flood of record in December 1935 produced a discharge of 14,750 cubic feet per second, which is estimated to have a frequency occurrence of once in about 50 years. The occurrence of a standard project flood, caused by the most severe combination of meteorological conditions reasonably characteristic of the region, would produce an estimated discharge of 36,000 cubic feet per second at the Burlington-Rock Island Railroad bridge. Damages in the project area under existing conditions from the occurrence of such a flood are estimated at $5,650,000. The average annual damages under existing conditions are estimated at $91,000 and for conditions of full development, at $113,000.

6. Improvements desired.--Local interests desire that the authorized Federal flood-control project for Buffalo Bayou and tributaries be modified to extend the upper limit of the White Oak Bayou portion of the project upstream about 2.1 miles from the Burlington-Rock

Island Railroad bridge to the mouth of Cole Creek. They have expressed willingness to cooperate in the improvements.

7. Plan of improvement.--The plan of improvement for the 2.1-mile reach of White Oak Bayou from the Burlington-Rock Island Railroad bridge to Cole Creek would provide for enlargement and partial concrete lining of the channel to contain the runoff resulting from the occurrence of a standard project flood. The proposed plan would provide the same degree of protection to this portion of the urban area of Houston as now authorized for the Federal flood-control projects for Buffalo Bayou, Brays Bayou, and the lower reach of White Oak Bayou. Damages from floods larger than the design flood would be substantially reduced. The work would include alteration of 1 highway bridge and 1 footbridge; construction of 2 new highway bridges; and relocation of 6 pipelines and sewer lines, 1 telephone conduit structure, and 22 drainage structures.

8. Economic evaluation.--Using December 1963 prices, the District Engineer estimates the first cost of the proposed channel improvement on White Oak Bayou at $2,470,000, of which $1,800,000 would be Federal, and $670,000 would be non-Federal for lands, rights-of-way, and relocations. The annual charges are estimated at $82,000 including $4,000 for non-Federal maintenance and operation. He finds that prospective annual benefits estimated at $100,000, primarily for flood damage prevention, justify the proposed work. The benefit-cost ratio is 1.2 based on a 100-year period of analysis. He recommends improvement for flood control in accordance with his plan, subject to certain local cooperation. The Division Engineer concurs.

9. Public notice.--The Division Engineer issued a public notice stating his recommendations and affording interested parties an opportunity to present additional information to the Board. No communications have been received.

Views and Recommendations of the Board of Engineers for Rivers and Harbors.

10. Views.--The Board of Engineers for Rivers and Harbors concurs in general in the views and recommendations of the reporting officers. The recommended work is economically justified and the requirements of local cooperation are appropriate. The Board notes that development in the flood plain upstream from the Burlington-Rock Island Railroad bridge has taken place subsequent to studies leading to authorization of the existing project in 1954, apparently without consideration of the flood hazards involved. It is the Board's view that responsible local interests should exercise to the full extent of their legal capabilities the establishment of flood plain zoning and

47-542 O—65-3

building restrictions to prevent development in the unprotected areas in the flood plain upstream from Cole Creek; and if those areas are to be developed, responsibility for flood protection should rest with the developers or other local interests.

11. Recommendations.--Accordingly, the Board recommends that the flood-control project, Buffalo Bayou and Tributaries, Texas, be modified to provide for extension of the project on White Oak Bayou, by means of channel enlargement and partial paving, between the Burlington-Rock Island Railroad bridge and the mouth of Cole Creek, generally in accordance with the plan of the District Engineer and with such modifications thereof as in the discretion of the Chief of Engineers may be advisable, at an estimated cost to the United States of $1,800,000 for construction: Provided that, prior to construction, local interests give assurances satisfactory to the Secretary of the Army that they will:

a. Provide without cost to the United States all lands, easements, rights-of-way, and spoil-disposal areas necessary for construction of the project;

b. Provide without cost to the United States, all relocations and alterations of bridges, except railroad bridges, and of all buildings, structures, pipelines, sewers and utilities made necessary by construction of the project;

c. Hold and save the United States free from damages due to the construction works;

d. Maintain and operate all the works after completion in accordance with regulations prescribed by the Secretary of the Army; and

e. Establish and enforce building limit lines approved by the Chief of Engineers along the improved channel.

FOR THE BOARD:

R. G. MacDONNELL
Major General, USA
Chairman

REPORT OF THE DISTRICT ENGINEER

INTERIM REVIEW OF REPORTS ON
BUFFALO BAYOU AND TRIBUTARIES, TEXAS
WHITE OAK BAYOU

SYLLABUS

This report comprises the results of an investigation of the flood problems along 2.1 miles of White Oak Bayou, immediately upstream from the upper limit of the presently authorized Federal flood control improvement project for White Oak Bayou, in Houston, Texas. It was found that:

a. Flooding of the investigated reach of White Oak Bayou causes extensive damages to existing residential areas. Damages from the occurrence of a standard project flood are estimated at $5,650,000, and average annual damages from flooding under existing conditions are estimated at $91,000.

b. Channel improvements recommended in this report would eliminate all damages from floods as large as the standard project flood and would materially reduce damages from larger floods. Average annual benefits during the life of the project are estimated at $100,000 and the proposed improvements would be justified with a benefits to costs ratio of 1.2.

Accordingly, it is recommended that the Federal flood control project for Buffalo Bayou and Tributaries, Texas, be modified to extend the upper limit of the White Oak Bayou portion of the project upstream about 2.1 miles from the Burlington-Rock Island Railroad bridge to the mouth of Cole Creek. The improvements recommended for this reach include enlargement and partial concrete lining of the channel, generally as described in this report. The estimated first cost to the United States of the recommended new work is $1,800,000. The recommendation is subject to certain provisions of local cooperation.

U. S. ARMY ENGINEER DISTRICT, GALVESTON
CORPS OF ENGINEERS
GALVESTON, TEXAS

January 28, 1964

SUBJECT: Interim Review of Reports on Buffalo Bayou and Tributaries, Texas - White Oak Bayou

THROUGH: Division Engineer
U. S. Army Engineer Division, Southwestern
Dallas, Texas

TO: Chief of Engineers
Department of the Army
Washington, D. C.

INTRODUCTION

1. Scope.- This investigation comprises a study of survey scope to determine the advisability of additional flood control improvements for the White Oak Bayou watershed from the present terminus of the authorized Federal project to Cole Creek. Consideration is given to the main watershed area of Buffalo Bayou and to the authorized improvements in the lower reach of White Oak Bayou, to the extent necessary to insure compatibility of additional improvements on White Oak Bayou. Detailed field surveys and office studies were made to determine the most practical plan of improvement. The detailed field investigations consisted of surveys for delineation of the flood plain; surveys to obtain the channel profile and cross sections; surveys to obtain details of bridges, drainage outfalls, utilities and other channel crossings; borings to determine subsurface conditions for proposed channel improvements; and an economic survey to determine the character and value of the physical property in the flood plain and the damages resulting from floods. Extensive use was made of available survey and design data of the authorized flood control project for White Oak Bayou.

2. Purpose of the investigation.- A flood protection project on White Oak Bayou has been authorized from its mouth to the Burlington-Rock Island Railroad bridge at stream mile 8.5. In recent years, rapid residential and commercial development has occurred upstream from the authorized project. This investigation was made to determine the extent of flood damages and the feasibility of affording protection from floods in the reach of White Oak Bayou extending from the upstream end of the presently authorized improvement to Cole Creek, a distance of approximately 2.1 miles.

3. Arrangement of report.- The following sections of this report contain the results, conclusions and recommendations, of the Galveston District Engineer, based upon analysis of detailed technical data and investigations reported in the following appendixes to this report:

Appendix I - Hydrology and Hydraulics

Appendix II - Economic Evaluation

Appendix III - Engineering and Cost Data

Appendix IV - Comments by Other Agencies

4. History of investigations.- The congressional authorization, under which this interim review of reports is made, requests a review of the report contained in House Document No. 456, 75th Congress, 2d session. That report recommended improvements to Buffalo Bayou and its tributaries upstream from the Houston turning basin for the control of floods, the protection of the city of Houston from flood damages, and the prevention of silt deposition in the turning basin. The existing project for Buffalo Bayou, Texas, was authorized by the Flood Control Acts of August 11, 1939 and September 3, 1954 (H. Doc. 250, 83rd Cong., 2d sess.) which provide, in lieu of features authorized by the River and Harbor Act of June 20, 1938 (H. Doc. 456, 75th Cong., 2d sess.) for Barker and Addicks Reservoirs on Buffalo Bayou and for clearing, straightening, enlarging, and lining where necessary the channels of Buffalo, Brays, and White Oak Bayous. The prior reports did not recommend improvements to White Oak Bayou above the Burlington-Rock Island Railroad bridge since the flood plain above that point contained little development at that time and there was no serious flood problem.

5. Other reports.- A review of reports on Houston Ship Channel and Buffalo Bayou (Vince and Little Vince Bayous), Texas, (House Document No. 441, 87th Congress, 2nd session) recommended enlargement and rectification of Vince and Little Vince Bayous to afford flood protection to Pasadena and vicinity, Texas. The recommended improvements were authorized by the Flood Control Act of October 23, 1962. All other reports on Buffalo Bayou and tributaries and the Houston Ship Channel which have been submitted to Congress subsequent to House Document No. 250, 83rd Congress, 2nd session, consider only navigation improvements and are not pertinent to this interim report.

6. Authority for this investigation.- This interim report on White Oak Bayou, Buffalo Bayou and Tributaries, Texas, is submitted pursuant to a resolution adopted April 20, 1948 by the Committee on Public Works, House of Representatives, United States:

"Resolved by the Committee on Public Works of the House of Representatives, United States, That the Board of Engineers for Rivers and Harbors be, and is hereby, requested to review the reports on Houston Ship Channel and Buffalo Bayou, Texas, contained in House Document No. 456, 75th Congress, 2nd session, with a view to determining a comprehensive plan for the betterment of navigation and for the control of floods throughout the Buffalo Bayou watershed including modifications, if any, of the presently approved plan of improvement and of the requirements for local cooperation in order to meet the materially changed conditions resulting from the rapid industrial expansion of the City of Houston, and contiguous areas."

7. On January 26, 1961, the Chief of Engineers approved preparation of an interim report on Buffalo Bayou and Tributaries, Texas - White Oak, to consider extension of the authorized project in the interest of flood control and major drainage.

8. Public hearing.- A public hearing was held at Houston, Texas, on September 8, 1961, to ascertain the desires and views of local interests regarding improvements for flood control on the White Oak Bayou watershed. There were 16 persons present including Federal, County, and local officials, representatives of business interests and other interested persons.

9. Improvements desired.- At the public hearing, the Harris County Flood Control District requested that improvements for flood control on White Oak Bayou be extended upstream from the presently authorized project terminus of the Burlington-Rock Island Railroad bridge to Cole Creek. In addition, it was requested that a comprehensive survey on White Oak Bayou and tributaries be initiated. In support of their request, local interests state:

a. In recent years, extensive residential and commercial development above the BRI Railroad bridge has increased the land value of the flood plain and extensive damage has resulted from flooding following frequent heavy rainfall.

b. The existing channel of White Oak Bayou has been eroding due to high stream velocities and has caused a maintenance problem of major proportions.

10. In its brief, the Harris County Flood Control District recommended that adequate channel capacity be provided by enlargement and partial concrete lining of the White Oak Bayou channel from Burlington-Rock Island Railroad bridge to Cole Creek.

WATERSHED DESCRIPTION

11. General location and size.- White Oak Bayou is a tributary of Buffalo Bayou in the San Jacinto River basin located on the upper Gulf coast of Texas. The watershed of White Oak Bayou, with an area of about 113 square miles, lies entirely within Harris County, Texas. The bayou rises in west central Harris County and, until the 1950's, flowed southeasterly in a tortuous channel for a distance of about 34 miles to its junction with Buffalo Bayou. In recent years local interests have rectified the channel alignment of the bayou to where its length now is about 25 miles. Enlargement and channel lining for the rectified reach between the mouth and mile 8.5 (Burlington-Rock Island Railroad bridge) is authorized as a Federal project and these improvements are now in the preconstruction planning stage. The bayou is affected by tidal conditions for a distance of about 2 miles above its mouth. The more important tributaries of the stream are Little White Oak bayou which enters from the north at mile 1.3, Brickhouse Gully which enters from the west at mile 8.9, Cole Creek which enters from the west at mile 10.6, and Vogel Creek which enters from the north at mile 12.4. The location of White Oak Bayou and the extent of its watershed are shown on plate 1.

12. Physical characteristics of the watershed.- The land surface of White Oak Bayou watershed slopes gently in a southeast direction from a maximum elevation of about 140 feet to about 30 feet above mean sea level. In the reach of White Oak Bayou considered for improvement in this report, the land surface varies in elevation of from 65 feet to about 90 feet. The only significant irregularities in the gentle slope are the valleys cut by the bayou and its tributaries. All elevations in this report refer to U. S. Coast & Geodetic Survey mean sea level datum.

13. White Oak Bayou as enlarged and rectified by local interests has an average fall of 5.4 feet per mile. The streambed has a minimum bottom width of about 20 feet. The height of the banks above the streambed varies from 15 feet to 20 feet in the lower reaches, and from 8 feet to 10 feet in the upper reaches. The top width between banks averages about 120 feet in the lower reaches and about 75 feet in the upper reaches. The present bank full stage flow capacity at the Burlington-Rock Island Railroad bridge, mile 8.5, is estimated at 10,000 cubic feet per second. A profile of White Oak Bayou is shown as an exhibit in appendix III. Profiles and typical section between mile 8.5 and mile 10.6, the reach under investigation in this report are shown on plate 3.

14. Climatological data.- White Oak Bayou watershed lies in a humid region with warm summers and mild winters. The proximity of this watershed to the Gulf of Mexico, the prevalence of southerly winds, and the absence of marked topographic relief features result in high relative humidity and uniformity in climate. Freezing temperatures are infrequent and of short duration. Data from the city station of the United States Weather Bureau, Houston, Texas, which is located about 8 miles southeast of the mouth of Cole Creek, indicates that the mean annual temperature is about 70 degrees Fahrenheit. Temperatures at this station have ranged from a summer maximum of 108 degrees to a winter minimum of 5 degrees. January, the coldest month, has an average mean temperature of 53.8 degrees, and August, the warmest month, has an average mean temperature of 84.2 degrees.

15. The prevailing winds are from the south or southeast during all but the winter months when high pressure air masses approaching from the north cause the winds to shift and come from that direction.

16. Precipitation.- The mean annual precipitation at Houston is 45.37 inches, based on 76 years of records for the city station from 1885 through 1961. The annual precipitation has ranged from a maximum of 72.86 inches in 1900 to a minimum of 17.66 inches in 1917. The maximum 24 hour rainfall recorded in the vicinity was 15.65 inches at the U. S. Weather Bureau Airport Station in 1945. The area is subject to intense local thunderstorms of short duration, general storms which extend over a period of several days, and to torrential rainfall associated with hurricanes and other tropical disturbances. Maximum precipitation recorded at Houston for selected durations is shown in the following tabulation:

TABLE A

MAXIMUM RECORDED RAINFALL INTENSITIES (1)
AT U.S.W.B. CITY STATION, HOUSTON, TEXAS

Date	Duration period	Rainfall in inches	Rainfall intensity in inches/hour
Aug 11, 1926	5 minutes	0.84	10.08
Aug 11, 1926	10 minutes	1.52	9.12
Aug 11, 1926	15 minutes	2.00	8.00
Dec 10, 1923	30 minutes	2.92	5.84
Nov 1, 1943	1 hour	4.36	4.36
Nov 1, 1943	2 hours	6.05	3.02
Nov 1, 1943	3 hours	6.62	2.21
Nov 1, 1943	6 hours	8.67	1.44
Nov 1, 1943	12 hours	10.02	0.83
Nov 1, 1943	24 hours	10.83	0.45

(1) Record period extends from 1900 through 1959. Duration periods of less than 24-hours have been analyzed only through 1945.

17. Runoff.- The only stream gaging station on White Oak Bayou is the U. S. Geological Survey gage located on the Yale Street bridge, approximately 5 miles downstream from the reach under study in this report. The gage is an automatic recording type, and records from the station extend over a 27-year period. Urban development of the watershed in recent years has greatly increased the amount of roof and paved areas. During 1956 through 1962 local interests constructed channel rectification, clearing and excavation improvements throughout the entire length of the bayou. Although these improvements partially offset the higher stages that increased runoff would produce under present conditions, a recurrence of the December 1935 storm would cause a discharge much higher than that which occurred at that time. Because of the probability of complete urban development of the watershed within a comparatively short time, a low infiltration index of 0.05 inch per hour with initial loss of 1.00 inch was adopted for hydrologic studies.

18. Flood history.- The largest flood flow actually recorded at the Yale Street gage occurred on November 2, 1943, with a peak discharge rate of 8,600 cubic feet per second. The December 9, 1935 flood was estimated to have a peak discharge of 14,750 cubic feet per second at Yale Street. Local interests report that serious damage occurs when discharges in excess of 4,000 cubic feet per second are experienced. Peak discharges recorded on the gage at Yale Street bridge for a number of large storms are shown in table B.

TABLE B

ANNUAL MAXIMUM RECORDED PEAK DISCHARGES
AT
U.S.C.G.S. YALE ST. GAGE-HOUSTON, TEXAS

1929 THROUGH 1960

Date	Peak discharge in c.f.s.
December 9, 1935	14,750 (Estimated)
May 25, 1936	4,020
September 24, 1941	5,100
July 6, 1942	4,400
November 2, 1943	8,600
August 28, 1945	4,330
November 6, 1946	4,120
July 31, 1954	3,890
October 15, 1957	5,320
August 26, 1959	4,510
June 26, 1960	4,380
February 17, 1961	7,380

47-542 O-65--4

19. Flood frequencies.- Flood frequency studies were also based on discharge records of the stream gaging station at Yale Street. The frequencies of floods of various magnitudes were determined and stage-frequency relationships were established, as described in appendix I. Floods equal to the December 1935 flood of record are estimated to have a frequency occurrence of once in about 50 years.

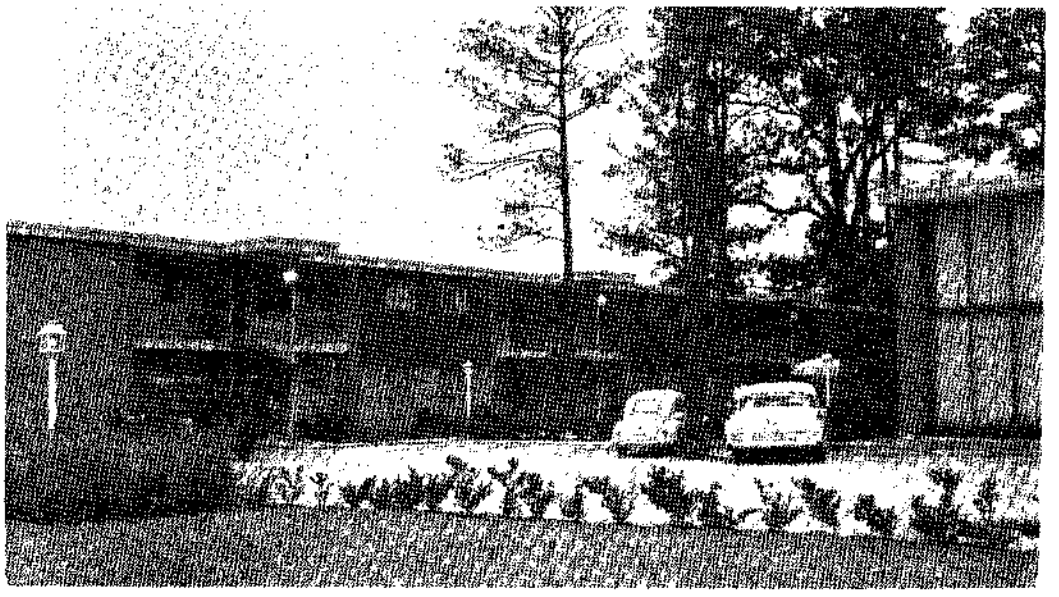
20. Standard project flood.- Computations of a standard project flood for the White Oak Bayou watershed were made. A standard project rainfall totaling 24.6 inches over a four-day period was estimated for the 75 square mile watershed immediately upstream from the confluence of Brickhouse Gully and White Oak Bayou, with a maximum 24-hour rainfall of 20.12 inches occurring on the third day. Based on this rainfall, the peak discharge of the standard project flood was estimated at 36,000 cubic feet per second at the Burlington-Rock Island Railroad bridge.

21. Other floods investigated.- Flows from floods experienced and recorded on the Yale Street gage, during the last decade on White Oak Bayou were investigated for determining coefficients and infiltration values.

EXTENT AND CHARACTER OF FLOODED AREA

22. Area subject to flooding.- The flood plain of the standard project flood on White Oak Bayou between Burlington-Rock Island Railroad bridge and Cole Creek totals about 1,200 acres and is practically all within the city limits of Houston. Development within the flood plain includes commercial and residential properties, streets and bridges, utilities and parks. Based on expected growth rate of the area, it is estimated that the entire flood plain would be substantially developed during the life of the project. This development would further increase the flood damages potential.

23. The flood plain was investigated in detail and inspections were made of all property subject to flood damage. The value of all existing physical property in the flood plain of the standard project flood was estimated in December 1963 to be $31,119,000. A breakdown of this value by principal classes is given in table C. When the expected growth will have substantially occupied the flood plain, the total value of all physical property therein, based on 1963 price levels, will be about $41,500,000.



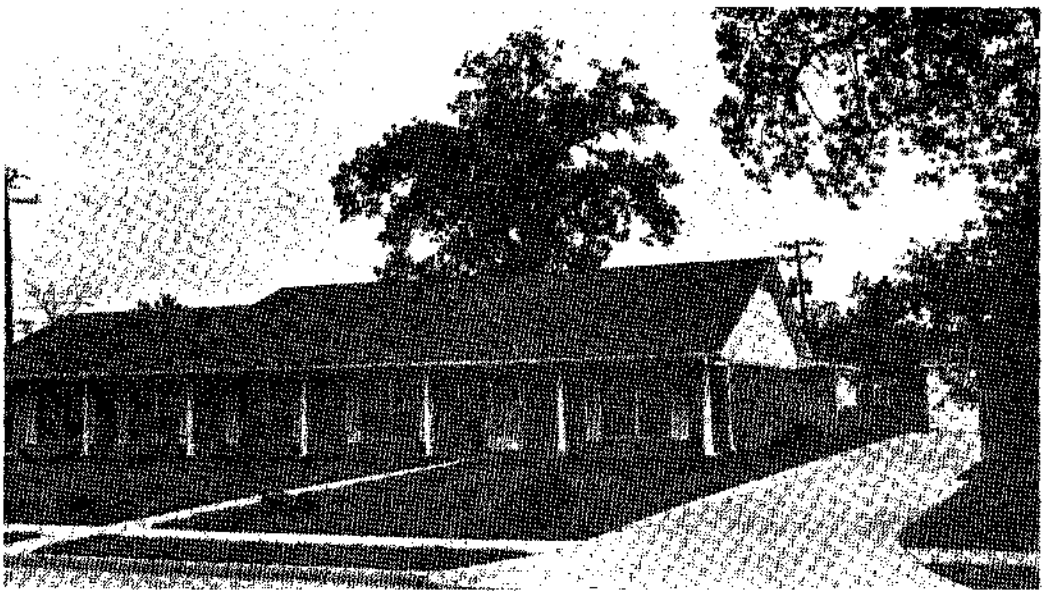


FIGURE 1

EXISTING RESIDENTIAL DEVELOPMENT
WITHIN THE STANDARD PROJECT FLOOD PLAIN

TABLE C

ESTIMATED PROPERTY VALUES WITHIN THE FLOOD
PLAIN OF STANDARD PROJECT FLOOD
(STATE OF DEVELOPMENT - DECEMBER 1963)

Classification of property	Property value
Residential	$29,888,000
Commercial and industrial	465,000
Churches and schools	300,000
Utilities	101,000
Municipal	365,000
	31,119,000

24. Flood damages.- The flood damage data obtained through the field economic survey formed the basis for estimating the average annual damages. The damages that would result from occurrence of a standard project flood under the present flood plain development are estimated at $5,650,000. Based on damages at various elevations of flooding, stage-damage relationships were developed. Stage-frequency relationships were established by computations based upon discharge records, as described in appendix I. Damage-frequency curves were constructed by plotting damage-frequency coordinates, which were determined from the mutual stage relationships of the stage-damage curves and the stage-frequency curves. The average annual damages were then computed from the damage-frequency curves. The average annual damages under existing conditions are estimated at $91,000. Details of these damages are shown in appendix II.

ECONOMIC DEVELOPMENT

25. Early development.- The White Oak Bayou watershed between Burlington-Rock Island Railroad bridge and Cole Creek remained largely undeveloped and was used mostly for grazing and timber production until residential developments began to spread into the area about 1950.

26. Recent development.- The watershed of White Oak Bayou below Creekmont Drive at mile 10.4 is within the city limits of Houston. In 1950, practically all developments within the White Oak Bayou watershed were located in the area downstream from mile 8.5, the upstream limit of the authorized Federal project. Since 1950 there has been rapid development within the watershed area between mile 8.5 and the Houston city limits at mile 10.4. The population within the standard project flood plain in this reach, estimated at 100 in 1950, has increased to about 4,800 in 1963. The watershed area outside of the city limits and upstream from mile 10.4 is rural and, in general, is undeveloped.

27. Character of physical development.- The developments in the 2.1-mile reach of White Oak Bayou above Burlington-Rock Island Railroad bridge is almost entirely residential and commercial. The commercial development comprises the normal concentration of shops, stores, service establishments, motels and small businesses which accompany residential development. The residences, however, are of comparatively high value and the area presents a general picture of attractive, well-maintained homes, largely owner-occupied.

EXISTING CORPS OF ENGINEER'S PROJECTS

28. Existing flood control project.- The existing project for improvement of Buffalo Bayou and its tributaries above the Houston turning basin to protect the city of Houston from floods and prevent deposition of silt in the turning basin was authorized by the River and Harbor Act approved June 20, 1938, and modified by the Flood Control Acts approved August 11, 1939, and September 3, 1954. The existing project includes the following elements: Barker Dam and Reservoir, Addicks Dam and Reservoir and rectification of the channels of Brays Bayou, White Oak Bayou, and Buffalo Bayou. On June 30, 1963, the total estimated Federal cost of the project was $95,500,000 including $55,800,000 Federal cost and $39,700,000 non-Federal cost. On June 30, 1963, the existing project was 54 percent completed. Barker Dam was completed in February 1945. Addicks Dam and 7.4 miles of channel rectification downstream from Addicks and Barker Dams, including 6.2 miles on Buffalo Bayou and 1.2 miles on South Mayde Creek, were completed in October 1948. Channel rectification of Brays Bayou was started in May 1956 and is scheduled for completion in 1965. Work remaining under the existing project consists of completing the construction in Brays Bayou and completing the design and construction of channel rectification for White Oak and Buffalo Bayous. The average annual Federal cost of maintenance and operation of Barker and Addicks Dams and Reservoirs, during the 5-year period ending June 30, 1963, was $62,000. The improvement of White Oak Bayou from the Burlington-Rock Island Railroad bridge

to Cole Creek would have no adverse effects on the existing flood control project for Buffalo Bayou and Tributaries, Texas. The location of that portion of White Oak Bayou considered in this report with respect to the existing flood control project is shown on plate 1.

29. Existing navigation project.- The existing navigation project for the Houston Ship Channel, Texas, provides generally for a deep-draft navigation channel, 300 to 400 feet wide and 36 to 40 feet deep, extending from Bolivar Roads, at the lower end of Galveston Bay, via the San Jacinto River and Buffalo Bayou to the Houston turning basin about 55 miles inland from the Gulf of Mexico. Numerous other smaller channels and basins are also in the navigation project, including a light-draft channel 10 feet deep and 60 feet wide extending in Buffalo Bayou from the Houston turning basin to the mouth of White Oak Bayou. On June 30, 1963, the existing navigation project was 69 percent completed. The flood control improvement considered in this report would have little or no effect on the navigation project for Houston Ship Channel, Texas.

IMPROVEMENTS BY OTHER FEDERAL AND NON-FEDERAL AGENCIES

30. Improvements by other Federal agencies.- No improvements have been constructed by other Federal agencies in the White Oak Bayou watershed in the interest of flood control, drainage, navigation, or other related purposes.

31. Improvements by non-Federal agencies and others.- The Harris County Flood Control District enlarged and rectified the channel of White Oak Bayou between Burlington-Rock Island Railroad bridge and Cole Creek in 1954 and 1955 to increase its discharge capacity. The improved channel has a fairly uniform cross section with a top width of about 120 feet and a depth of about 20 feet. The flood control district reports it has spent about $63,500 for the improvement of White Oak Bayou in the reach considered by this report. Since that time, the remainder of the bayou channel to the head waters has been enlarged and rectified by the flood control district.

FLOOD PROBLEMS AND SOLUTIONS CONSIDERED

32. Flood problems.- The principal flood problem in the 2.1 miles reach above Burlington-Rock Island Railroad bridge on White Oak Bayou results from residential and commercial developments in the flood plain. Flooding in this area results principally from inadequate capacity of the existing channel to contain floods originating on the watershed. The bayou is crossed by bridges and pipelines which restrict the passage of flood waters and materially increase flood stages.

33. Solutions considered.- The relatively flat terrain and the high degree of development in the White Oak Bayou watershed as shown on exhibits 4 and 5 of appendix III preclude the use of storage or detention reservoirs as a practicable means of flood control within the watershed. The absence of adequate, well-defined runoff channels in adjacent areas and extensive development along possible channel routes preclude diversion of flood waters as a practicable measure. As this portion of the urban area of Houston has developed, practically all surface and underground drainage facilities have been designed and constructed to use the channel of White Oak Bayou as an outlet. Accordingly, the only practicable solution to the flood problem on White Oak Bayou watershed would be through improvement of the existing channel to secure better flow characteristics and control erosion problems.

34. The most feasible plan of improvement for the authorized flood control project for White Oak Bayou from the mouth to Burlington-Rock Island Railroad bridge has been determined through detailed design studies to be enlargement, rectification and partial concrete lining of the channel. The 2.1 miles reach above Burlington-Rock Island Railroad bridge considered in this report is practically identical in character to the downstream reach and the same type of improvement was found to be the most feasible for this reach also.

PROJECT FORMULATION

35. Project formulation.- Floods occurring in relatively flat, coastal watersheds, such as that of White Oak Bayou usually follow extended periods of heavy rainfall ranging up to 24 or more hours. Runoff to the stream channel develops at a slowly increasing rate and produces a correspondingly slow rise in flood stages. Residents in the flood plain usually have ample warning during the precedent period of rainfall. The flood plain in the reach considered in this report lies almost entirely within an urban area and is expected to be fully utilized with urban development during the life of this project.

36. The flood control projects authorized for Brays, Buffalo and lower White Oak Bayous, which are in the Houston area and have similar character of watershed development as that of White Oak Bayou between Burlington-Rock Island Railroad bridge to Cole Creek, provide for standard project flood protection. It is believed that no lesser degree of protection should be provided for this reach of White Oak Bayou than for the other projects in the area. Accordingly, since protection from a standard project flood was found to be fully justified, this degree of protection was adopted as the plan of improvement. The plan of improvement would provide sufficient capacity to contain within banks the standard project flood with a discharge of about 36,000 cubic feet per second at the Burlington-Rock Island Railroad bridge.

PLAN OF IMPROVEMENT

37. Plan of improvement.- The plan of improvement provides for enlargement and partial concrete lining of the channel of White Oak Bayou from Burlington-Rock Island Railroad bridge to Cole Creek, a distance of about 2.1 miles. The proposed improved channel would be trapezoidal in cross section with a bottom width of 50 feet. The bottom of the channel and the 1 vertical on 2 horizontal side slopes would be lined with concrete to an elevation slightly above the water surface profile of the 10-year frequency flood. The concrete lining on the side slopes would extend from 13 to 15 feet above the bottom. Above the concrete, the banks would be sodded and overseeded on a slope of 1 vertical on 2.5 horizontal. The general plan of improvement is shown on plate 2. Pertinent data on design criteria, principal features, and requirements of the proposed plan are presented in appendix I. Profiles of the proposed channel improvements and a typical cross section are shown on plate 3.

38. Construction of the plan of improvement would require two new highway bridges to replace existing bridges, and alteration of one highway bridge, one foot-bridge, one 9-conduit telephone duct structure, 22 drainage structures, and 6 pipelines and sewer lines. Four of the pipelines are underground and two cross the bayou on existing bridges.

ECONOMIC EVALUATION OF PROJECT

39. Estimates of first cost of plan of improvement.- Detailed estimates of first cost for constructing the proposed plan of flood protection for White Oak Bayou from Burlington-Rock Island Railroad bridge to Cole Creek are summarized in the following table D. The estimates are based on December 1963 price levels. The division of first costs is based on the requirements of local cooperation set forth in paragraph 46.

TABLE D

ESTIMATES OF FIRST COSTS
WHITE OAK BAYOU
BURLINGTON-ROCK ISLAND RR BRIDGE TO COLE CREEK

Item	Costs
Federal first cost	
Channels	$1,617,000
Engineering & design	81,000
Supervision & administration	102,000
Total Federal first cost	1,800,000
Non-Federal first cost	
Lands & damages	380,000
Relocations (utilities & bridges)	290,000
Total non-Federal first costs	670,000
TOTAL ESTIMATED FIRST COSTS	$2,470,000

40. Estimate of annual charges.- Detailed estimates of investments and annual charges for the plan of improvement are summarized in table E.

TABLE E

ESTIMATES OF INVESTMENT AND ANNUAL CHARGES
WHITE OAK BAYOU
BURLINGTON-ROCK ISLAND RR BRIDGE TO COLE CREEK

Item	Total
Investment	
Federal investment	$1,800,000
Non-Federal investment	670,000
Annual charges	
Federal	
Interest & amortization	57,000
Maintenance & operation	None
Subtotal, Federal	57,000
Non-Federal	
Interest & amortization	21,000
Maintenance & operation	4,000
Subtotal, non-Federal	25,000
Total annual charges	82,000

41. Benefits.- The benefits to be derived from the proposed flood control improvement would consist of the prevention of flood damages to existing property and to that which will be developed in the 2.1 miles reach of White Oak Bayou flood plain.

42. Prevention of damages.- The average annual damages from flooding, under existing conditions of protection and development in the 2.1 miles reach of White Oak Bayou above BRI RR bridge in Houston, are estimated at $91,000. This estimate includes the primary physical damages to property from flood inundation and the non-physical losses incurred, including interruption to traffic and costs related to recovering from flood emergencies. The proposed project would prevent most of these damages in the area to be protected. There would be some residual damages from inundation, scour and interruption to traffic resulting from floods exceeding the standard project flood. The residual damages that would remain after construction of the plan of improvement are estimated at $13,000 annually. The difference in the estimated damages that would be expected under existing channel conditions and the damages that would be expected under improved channel conditions is the estimate of damages that would be prevented by the proposed improvement. The prevention of these damages is a benefit that would accrue to the proposed improvement, and is estimated at $78,000 annually. The estimated benefits from the

47-542 O-65—5

prevention of damages would be increased by the prevention of damages to the additional properties that would be constructed in the flood plain during the life of the project. The benefits from prevention of damages to future developments, based upon a 100-year period of economic analysis and expressed in terms of annual equivalent benefits, are estimated at $22,000.

43. Summary of benefits.- The average annual benefits that would accrue from the proposed flood protection improvements proposed in this report, including the benefits attributable to the normal future growth and development are estimated at $100,000.

44. Comparison of benefits and costs.- The estimated average annual benefits, the annual charges, and the ratio of benefits to charges for the proposed improvement to White Oak Bayou, based on December 1963 price levels, are given below:

Average annual benefits	$100,000
Annual charges	82,000
Ratio of benefits to charges	1.2

APPORTIONMENT OF COSTS

45. Apportionment of costs among interests.- The apportionment of first costs of the proposed improvements between the Federal Government and the local interests would be in accordance with Federal law applicable to local flood protection projects and with the proposed requirements of local cooperation set forth in paragraph 46. Under these requirements, the first costs of all lands, easements and rights-of-way necessary for construction of the project would be borne by local interests. The costs of all necessary relocations and alterations of structures, including buildings, pipelines, sewers, utilities, and bridges, except railroad bridges, would be borne by local interests. No land enhancement would result from the proposed plan of improvement. All first costs for construction of the proposed improvements and all preauthorization survey costs would be borne by the Federal Government. All costs of maintenance and operation of the proposed improvements would be borne by local interests. The proposed apportionment of the estimated first cost and annual maintenance cost of the proposed improvements is shown in table F.

TABLE F

APPORTIONMENT OF FIRST COST AND ANNUAL MAINTENANCE

Item	Federal	Non-Federal	Total
First cost			
Construction	$1,800,000	None	$1,800,000
Lands	None	$380,000	380,000
Relocations	None	290,000	290,000
Total first cost	1,800,000	670,000	2,470,000
Annual cost of maintenance and operation	None	4,000	4,000

LOCAL COOPERATION

46. Proposed local cooperation.- The improvement of White Oak Bayou proposed herein would be a local flood protection project subject to the requirements of local cooperation generally specified by law for such projects. It is proposed that local interests shall be required to participate in the project as follows:

a. Provide without cost to the United States all lands, easements, and rights-of-way necessary, and spoil-disposal areas for construction of the project;

b. Provide without cost to the United States all relocations and alterations of bridges, except railroad bridges, and of all buildings, structures, pipelines, sewers, and utilities made necessary by construction of the project;

c. Hold and save the United States free from damages due to the construction works;

d. Maintain and operate all works after completion in accordance with regulations prescribed by the Secretary of the Army, and

e. Establish and enforce building limit lines approved by the Secretary of the Army along the improved channel.

COORDINATION WITH OTHER AGENCIES

47. Initiation of studies.- Copies of the notice of public hearing, held in Houston, Texas on September 8, 1961, were sent to all known Federal, State and local agencies that were believed to have a possible interest in flood control improvements for White Oak Bayou.

48. The Bureau of Sport Fisheries and Wildlife of the United States Fish and Wildlife Service and the Texas Game and Fish Commission were advised by letters of the proposed improvements and the views and comments of those agencies were requested.

49. Bureau of Sport Fisheries and Wildlife.- The Southwest Regional Director, Bureau of Sport Fisheries and Wildlife, in a letter report dated June 20, 1962, stated that the proposed improvements would not affect adversely nor offer opportunities for enhancement of the fish and wildlife resources in the area. A copy of the Bureau of Sport Fisheries and Wildlife letter is included in appendix IV of this report.

50. Texas Game and Fish Commission.- The Director, Program Planning, Texas Game and Fish Commission in a letter dated July 3, 1962, stated that the proposed improvements would have no appreciable detrimental or beneficial effects on fish and wildlife. A copy of the Texas Game and Fish Commission letter is included in appendix IV of this report.

51. Department of Health, Education, and Welfare.- The Regional Program Director, Water Supply and Pollution Control, of the Public Health Service in a letter dated January 7, 1964, stated that the proposed extension of the authorized project would create a better environment for good public health.

52. Department of Agriculture.- The State Conservationist of the United States Department of Agriculture, Soil Conservation Service, in a letter dated January 10, 1964, stated that the plan of improvement would have no detrimental effect on any projects, existing or anticipated under programs administered by the Soil Conservation Service.

53. Department of Interior.- The Acting Area Director, Area IV, Bureau of Mines, Department of Interior, in a letter dated January 13, 1964, stated that the plan of improvement in this report would have no adverse effect on mineral resources in the area.

DISCUSSION

54. This report comprises the results of an investigation of the flood problems along a 2.1-mile reach of White Oak Bayou from Burlington-Rock Island Railroad bridge to Cole Creek, in the city of Houston, Harris County, Texas. This reach is immediately upstream from the upper end of the presently authorized Federal project for flood control improvements on White Oak Bayou, a part of the Buffalo Bayou and Tributaries, Texas, project. Preconstruction planning for the White Oak Bayou improvement is now underway. The watershed of the area considered in this report comprises mostly an urban area in the northwest section of Houston which has about 75 percent of the flood plain developed by residential and commercial use at this time. The remaining areas in the flood plain generally are being held for residential, commercial and recreational purposes and it is expected that development will occupy all the area during the life of the project.

55. The largest known flood occurring on White Oak Bayou was that of December 1935. Flood damages in the 2.1 miles reach at that time were not large, since the area was generally wooded and undeveloped and subject to very little flood damage. Extensive development of the flood plain has taken place since 1950 and local interests have constructed some channel improvement for the bayou which serve to alleviate flooding from small storms. It is estimated that occurrence of a flood equal to that of December 1935 would cause damages of about $258,000 in the 2.1-mile reach under present conditions, while a standard project flood would produce damages estimated at $5,650,000. Average annual damages under existing conditions are estimated at $91,000.

56. It is apparent from consideration of the topography and development of the watershed of White Oak Bayou that the only practicable means of affording flood control to the area would be by channel enlargement. The authorized project for the lower 8.5 miles of White Oak Bayou provides for protection against the standard project flood. The proposed extension is in an urban area of similar characteristics and should be afforded the same degree of protection. The plan of improvement proposed herein would provide protection against a standard project flood with an estimated discharge of 36,000 cubic feet per second at Burlington-Rock Island Railroad bridge and would be essentially an extension of the authorized project to the present limit of development of the flood plain. Authorization of this extension would permit planning and construction to be coordinated with the downstream reach and result in lesser overall costs, than if performed separately. Investigation of White Oak Bayou above Cole Creek and the remainder of its tributaries will be considered in the comprehensive investigation of the entire Buffalo Bayou watershed, which is underway and scheduled for completion within the next few years.

57. The total first cost of the proposed improvements is estimated at $2,470,000 of which $1,800,000 would be Federal cost and $670,000 would be non-Federal, in accordance with the apportionment of costs described in paragraph 45. The total annual charges are estimated at $82,000. The proposed improvements would prevent practically all of the flood damages which now occur within the flood plain of this reach. Small amounts of residual damages would still be experienced from floods larger than the standard project flood. Total average annual benefits from the proposed improvements are estimated at $100,000. The benefits to costs ratio is estimated at 1.2.

58. The requirements of local cooperation are described in paragraph 46. The Harris County Flood Control District has indicated its willingness to meet the requirements of local cooperation.

59. Additional information called for by Senate Resolution 148, 85th Congress, adopted January 28, 1958, is contained in an attachment to this report.

CONCLUSIONS

60. Based upon the findings of this investigation, it is concluded that:

a. A serious flood problem exists on the White Oak Bayou watershed between Burlington-Rock Island Railroad bridge and Cole Creek where existing residential and commercial areas of Houston, Texas, are subject to extensive damages from flooding of White Oak Bayou.

b. Extension of the authorized Federal flood control project for White Oak Bayou by enlargement and partial concrete lining of the existing channel of White Oak Bayou, as described in the plan of improvement proposed in this report, would provide a high degree of protection to a portion of the city of Houston. Damages from floods larger than a standard project flood would be substantially reduced.

c. The improvements proposed herein would have estimated total annual charges of $82,000, annual benefits of $100,000 and a benefits to cost ratio of 1.2 based on December 1963 price levels.

d. The total first cost of the improvements proposed herein is estimated at $2,470,000, of which the Federal share would be $1,800,000. The non-Federal share would be $670,000. The total annual cost of maintenance and operation, estimated at $4,000 would be assigned to the local interests.

RECOMMENDATIONS

61. Accordingly, it is recommended that the Federal flood control project for Buffalo Bayou and Tributaries, Texas, be modified to extend the upper limit of the White Oak Bayou portion of the project upstream about 2.1 miles from the Burlington-Rock Island Railroad bridge to the mouth of Cole Creek, generally as described in the plan of improvement section of this report, and with such modifications thereof as in the discretion of the Chief of Engineers may be advisable, at an estimated total first cost to the United States of $1,800,000 for new work, and subject to the condition that the local interests agree to:

a. Provide without cost to the United States all lands, easements, and rights-of-way necessary, and spoil disposal areas for construction of the project;

b. Provide without cost to the United States, all relocations and alterations of bridges, except railroad bridges, and of all buildings, structures, pipelines, sewers and utilities made necessary by construction of the project;

c. Hold and save the United States free from damages due to the construction works;

d. Maintain and operate all works after completion in accordance with regulations prescribed by the Secretary of the Army, and

e. Establish and enforce building limit lines approved by the Secretary of the Army along the improved channel.

3 Incls
1. Plates
2. Appendixes I thru IV
3. Attachment

JAMES S. MAXWELL
Colonel, CE
District Engineer

SWDGW-4 [First endorsement]

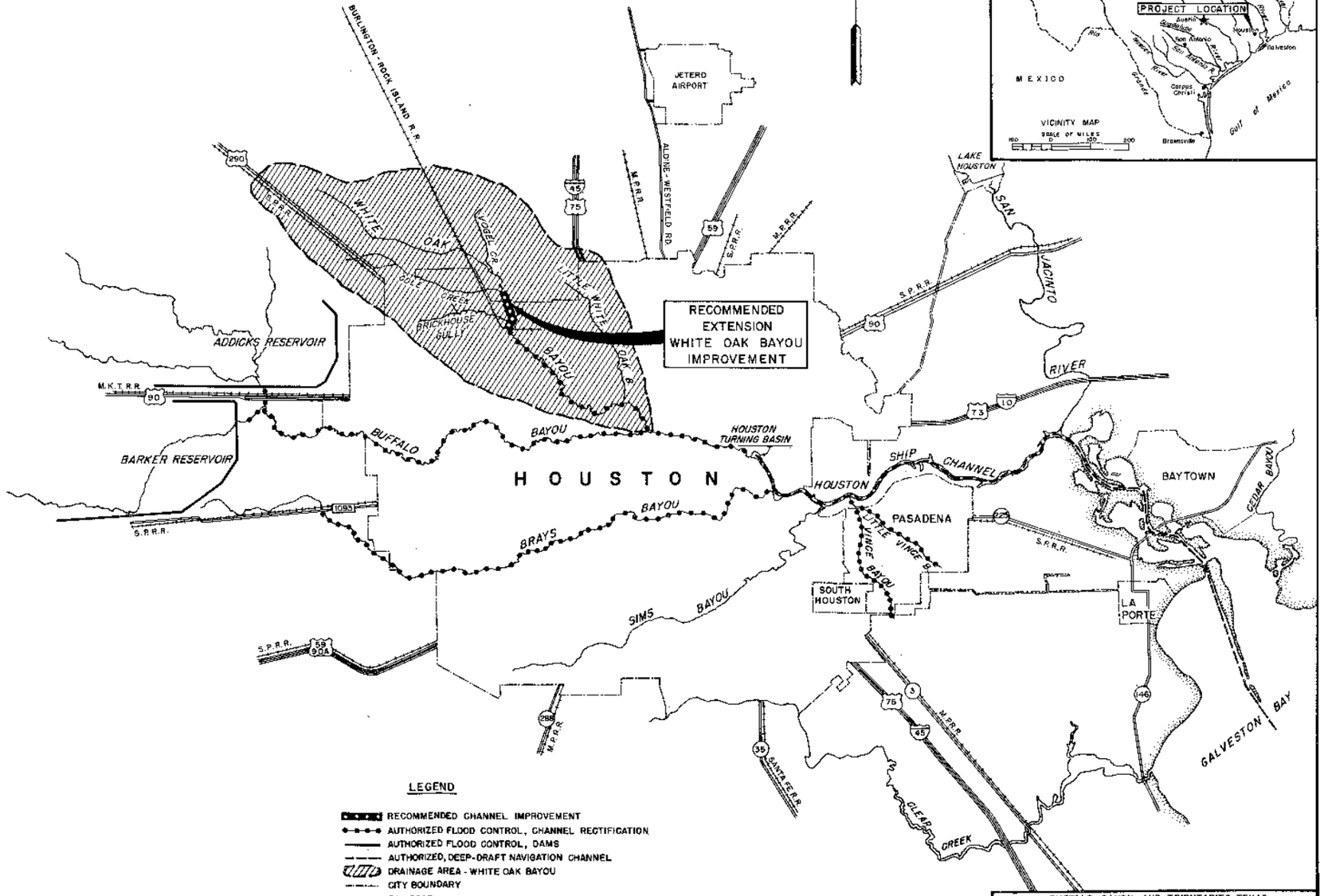
SUBJECT: Interim Review of Reports on Buffalo Bayou and Tributaries, Texas - White Oak Bayou

United States Army Engineer Division, Southwestern, Dallas, Texas
February 7, 1964

TO: Chief of Engineers, Department of the Army, Washington, D. C.

I concur in the conclusions and recommendations of the District Engineer.

C. H. DUNN
Brigadier General, USA
Division Engineer



BUFFALO BAYOU AND TRIBUTARIES, TEXAS
WHITE OAK BAYOU

INDEX MAP

SCALE OF MILES 0 1 2 3 4

U. S. ARMY ENGINEER DISTRICT, GALVESTON, TEXAS JANUARY, 1964

SUBMITTED — ENGINEER
APPROVAL RECOMMENDED — CHIEF, PROJECT PLANNING BR.
APPROVED — CHIEF, ENGINEERING DIVISION

PREPARED UNDER THE DIRECTION OF JAMES S. MAXWELL, COLONEL C. E. DISTRICT ENGINEER

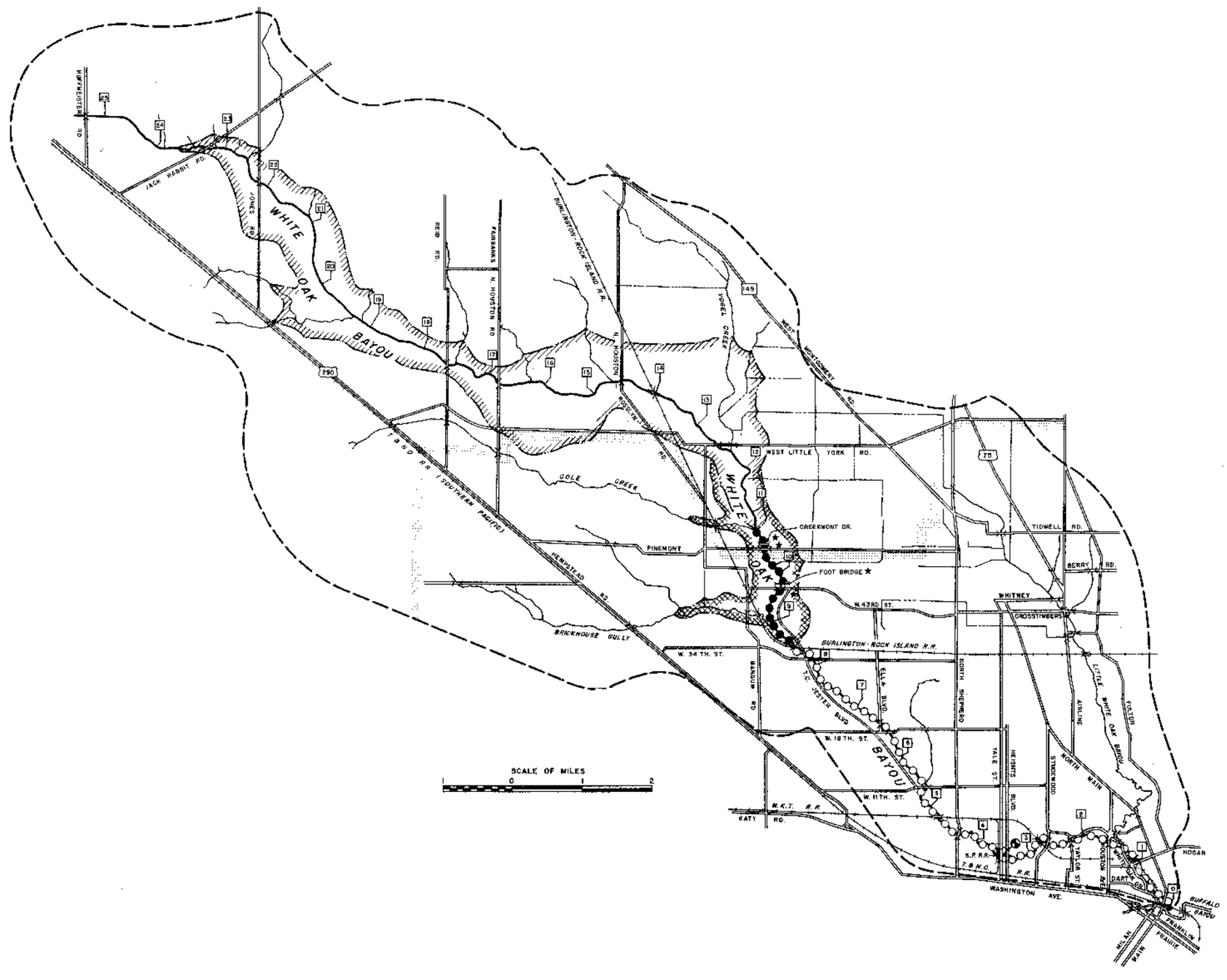
DRAWN BY W.M.C.
CHECKED BY W.L.L.
CHECKED BY W.A.G.

TO ACCOMPANY INTERIM REVIEW REPORT ON WHITE OAK BAYOU DATED JANUARY 28, 1964

FILE: HSG 413-2

PLATE

47-542 O-65 (Face blank p. 30)



BUFFALO BAYOU AND TRIBUTARIES, TEXAS
WHITE OAK BAYOU

PLAN OF IMPROVEMENT

SCALE AS SHOWN

U.S. ARMY ENGINEER DISTRICT, GALVESTON, TEXAS JANUARY 1964

SUBMITTED	APPROVAL RECOMMENDED	APPROVED
H. R. Hazell, ENGINEER	Elbert J. Lyon, ENGINEER, CHIEF PROJECT PLANNING BR.	A. P. Rains Jr., ENGINEER, CHIEF ENGINEERING DIVISION

PREPARED UNDER THE DIRECTION OF JAMES S. MAXWELL, COLONEL C.E. DISTRICT ENGINEER

DRAWN BY M.H.C.
CHECKED BY M.H.C.
CHECKED BY W.J.G.

TO ACCOMPANY INTERIM REVIEW REPORT ON WHITE OAK BAYOU DATED JANUARY 29, 1964
FILE: H.S.C. 613-2

PLATE 2

47-542 O-65 (Face blank p. 30) No. 2

INTERIM REVIEW OF REPORTS

BUFFALO BAYOU AND TRIBUTARIES, TEXAS

WHITE OAK BAYOU

APPENDIX II

ECONOMIC EVALUATION

INTERIM REVIEW OF REPORTS
BUFFALO BAYOU AND TRIBUTARIES, TEXAS
WHITE OAK BAYOU

APPENDIX II

ECONOMIC EVALUATION

TABLE OF CONTENTS

TABLES

EXHIBITS

INTERIM REVIEW OF REPORTS
BUFFALO BAYOU AND TRIBUTARIES, TEXAS
WHITE OAK BAYOU

APPENDIX II

ECONOMIC EVALUATION

1. General.- This appendix presents the economics of a proposed extension of the Federal flood control project on White Oak Bayou upstream from the presently authorized upper limit at the Burlington-Rock Island Railroad bridge to the mouth of Cole Creek, a distance of about 2.1 miles. The White Oak Bayou project is part of the authorized flood control project for Buffalo Bayou and tributaries, Texas. The economic study is presented in four sections, as follows: (a) extent and character of the flood plain, (b) property values, (c) flood damages, and (d) benefits. The section on extent and character of the flood plain describes the flood plain and the type of improvements within the area. The sections on property values and flood damages contain an estimate of the average annual flood damages that would be sustained by property under conditions of existing and projected future development in the flood plain. The section on benefits contains estimates of the benefits that are expected to accrue to the plan of improvement recommended in this report. The estimates of values, damages, and benefits are based on data obtained from field surveys made in June 1963. Aerial mosaics and quadrangle sheets were used for delineating the flood plain and for compilation of data on property values and flood damages. The area subject to flooding that was investigated in detail is shown in exhibit 1 to appendix III.

EXTENT AND CHARACTER OF THE FLOOD PLAIN

2. Flood plain of White Oak Bayou.- The area subject to flooding, which was investigated in detail, extends from the Burlington-Rock Island Railroad bridge, channel mile 8.5, to the mouth of Cole Creek, channel mile 10.6. The total land subject to flooding within this reach is about 1,200 acres of urban area. The flood plain of the project area ranges in width from about 3,000 to 4,000 feet, and contains about 1,446 dwelling units with an estimated population of about 4,800 in December 1963. It is estimated that, in 1950, the same area had about 23 dwelling units with a population of about 100.

PROPERTY VALUES

3. Property values in the flood plain.- Estimates of property values and damages are presented herein for the area that, under present conditions, would be inundated by the standard project flood. The total value of all physical property within the flood plain of the standard project flood is estimated at about $31,119,000. The flood plain area, because of its advantageous location, has been in demand for residential expansion. Residential units in the flood plain have increased by more than 60 times over the number of units that existed in 1950. About 97 percent of the estimated property value consists of residential property and the remaining 3 percent consists of business property. Other urban properties are churches; sewer, water, gas, and electrical distribution systems; city streets and bridges; parks; and telephone and telegraph facilities.

4. The value of all classes of property are based on the estimated market value determined by field survey and supplemented with information furnished by realtors and investors within the White Oak Bayou flood plain. These values are shown in table A below.

TABLE A

ESTIMATED PROPERTY VALUES WITHIN THE FLOOD PLAIN
OF STANDARD PROJECT FLOOD (December 1963)

Classification of property	Property values
Urban property:	
Residential	$29,887,600
Commercial & industrial	465,000
Churches & schools	300,000
Utilities	101,200
Municipal	365,200
Total	31,119,000

FLOOD DAMAGES

5. Classes of damages.- Damage estimates are based on data obtained through field surveys and physical inspection of all properties in the flood plain of the standard project flood. The flood damage estimates were made after considering a number of factors, such as the type of loss, the kind and value of structure or improvement, depth of inundation and location. Separate estimates were made for the various types of physical

property classified by use as residential, commercial, municipal utilities and for various types of nonphysical losses.

6. Major floods.- The maximum flood of record in the project area occurred during the period 6-8 December 1935. Residential and industrial flood damages for this flood were not extensive because of the relatively sparse development of the flood plain prior to about 1950. Subsequent growth and development within the flood plain has greatly increased the flood damage potential of this area under current conditions of development.

7. Estimated damages from the standard project flood.- The detailed economic survey included an estimate of the damages that would result from an occurrence of the standard project flood in the project area under December 1963 conditions and are estimated at $5,650,000. The principal flood damage would be physical damages to property. Other flood damages would be losses from the general disruption of activities and the necessary rehabilitation in the project area. Damages estimated for interruption to traffic and communications, rescue work, and all other activities normal to flood emergency procedures, were developed from a comparison with data compiled from similar emergencies which have been experienced elsewhere. The estimates of damages from an occurrence of the standard project flood under December 1963 conditions are presented in table B for each property class.

TABLE B

ESTIMATED DAMAGES WITHIN THE FLOOD PLAIN FROM STANDARD PROJECT FLOOD (December 1963)

Item	Damages
Residential	$5,501,000
Commercial and industrial	36,500
Churches and schools	29,500
Municipal property	14,900
Utilities	13,000
Loss of wages	12,800
Interruption to traffic and communication	6,900
Cost of rescue work and policing	12,200
Cost of combating insects and diseases	3,400
Cost of relief and care of flood victims	19,300
Total	5,649,500

8. The estimated damages to property that would be incurred from floods smaller than the standard project flood were derived from stage-damage curves developed from basic field data on the property affected. Damages were also estimated, under existing conditions of development, for floods that would be expected to occur on the watershed with frequencies of once in 100 years and once in 50 years. Damages from the 100-year flood are estimated at $1,840,000, and from the 50-year flood are estimated at $6,800. Damages from the 25- and 10-year floods are nominal, although they are included in the computations of the average annual damages.

9. Average annual damages under existing conditions.- Estimates of average annual damages were computed by correlating the stage-damage relationship with the flood stage-frequency relationship to establish the damage-frequency relationship. The average annual damages are determined from the area under the damage-frequency curve. Examples of these curves are shown as exhibits 1, 2, and 3, respectively, to this appendix. The total average annual damages for existing conditions and state of development are estimated at $90,800.

BENEFITS

10. General.- The benefits that would be derived from improvement of the proposed 2.1 mile reach of White Oak Bayou for flood control, which is under consideration in this study, would accrue from elimination of most of the damages that would result from flood inundation and erosion. The proposed improvements would provide protection to property from all floods up to and including the standard project flood. Benefits from prevention of damages would increase with the additional growth and development within the area protected by the proposed improvements.

11. Benefits from prevention of damages to existing property.- The flood control improvements, designed to contain the standard project flood, will eliminate all but a nominal amount of damages to existing property. Most of the benefits are credited to residential property. The annual benefits creditable to the plan of improvement for the prevention of flood damages to existing properties are estimated at $77,800 based on December 1963 price levels.

12. Benefits from prevention of damages to future growth and development.- About 75 percent of the flood plain of this portion of White Oak Bayou is presently developed. Growth and development in the area is expected to continue at a rate where full development in the remaining 25 percent of the area will be reached by 1973. The average annual equivalent benefits for prevention of damages to the future growth and development, based on an interest rate of 3.0 percent and computation factors set out in EM 1120-2-118, appendix II, are estimated at $22,000.

13. Residual damages.- With the improvements proposed, damages could still be incurred from floods larger than a standard project flood; however, the total damages from such floods would be reduced to some extent by the proposed improvements. The residual damages are shown graphically on exhibit 3 of this appendix. The average annual residual damages for the recommended plan are estimated at $13,000 annually.

14. Summary of benefits.- The estimated average annual benefits that would accrue to the flood control improvements proposed in this report total about $99,800 as shown in table C.

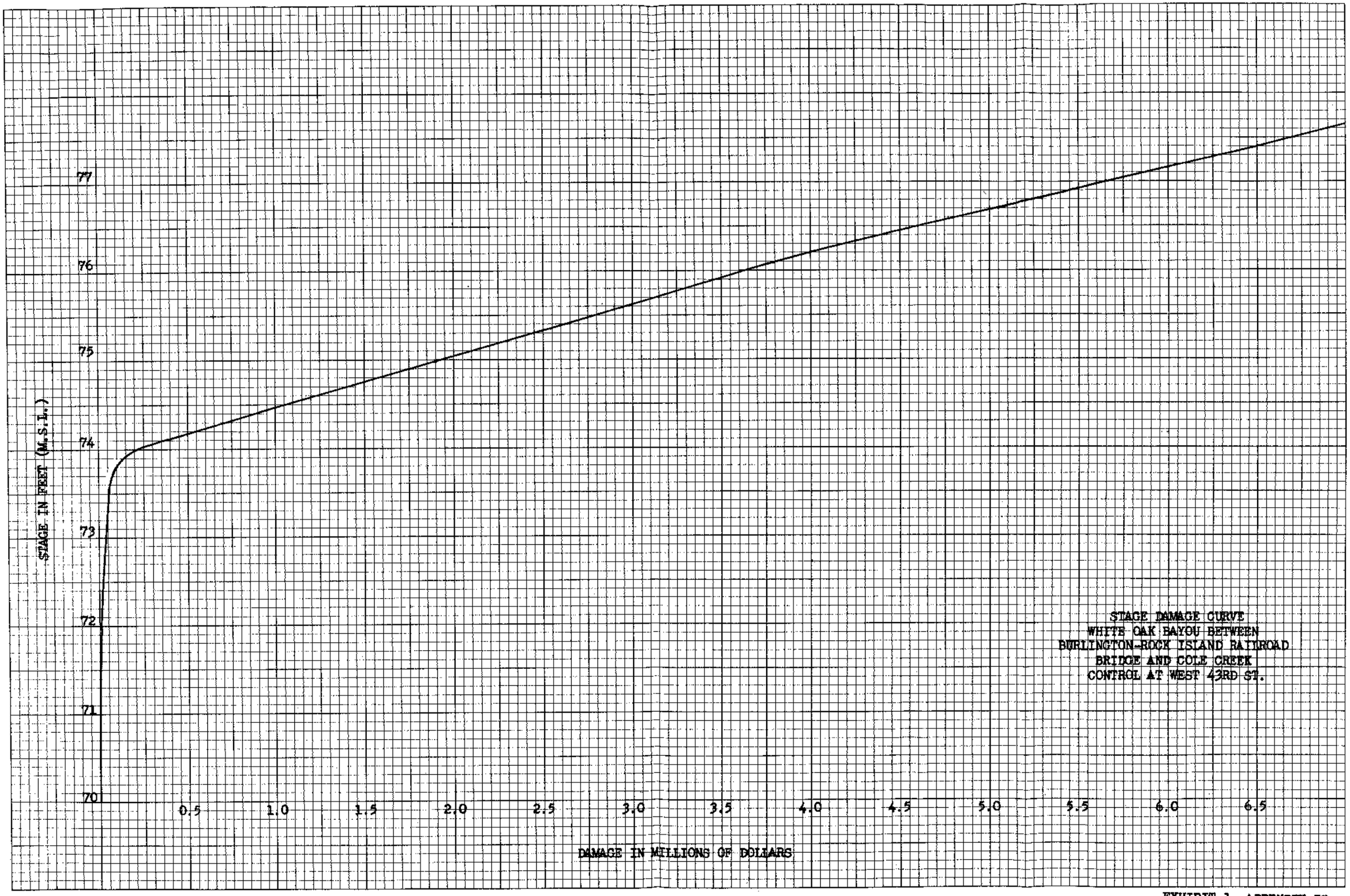
TABLE C

SUMMARY OF AVERAGE ANNUAL BENEFITS

Type	Benefits
Damages prevented to present development	$ 77,800
Damages prevented to future growth and development	22,000 (1)
Total damages	$ 99,800

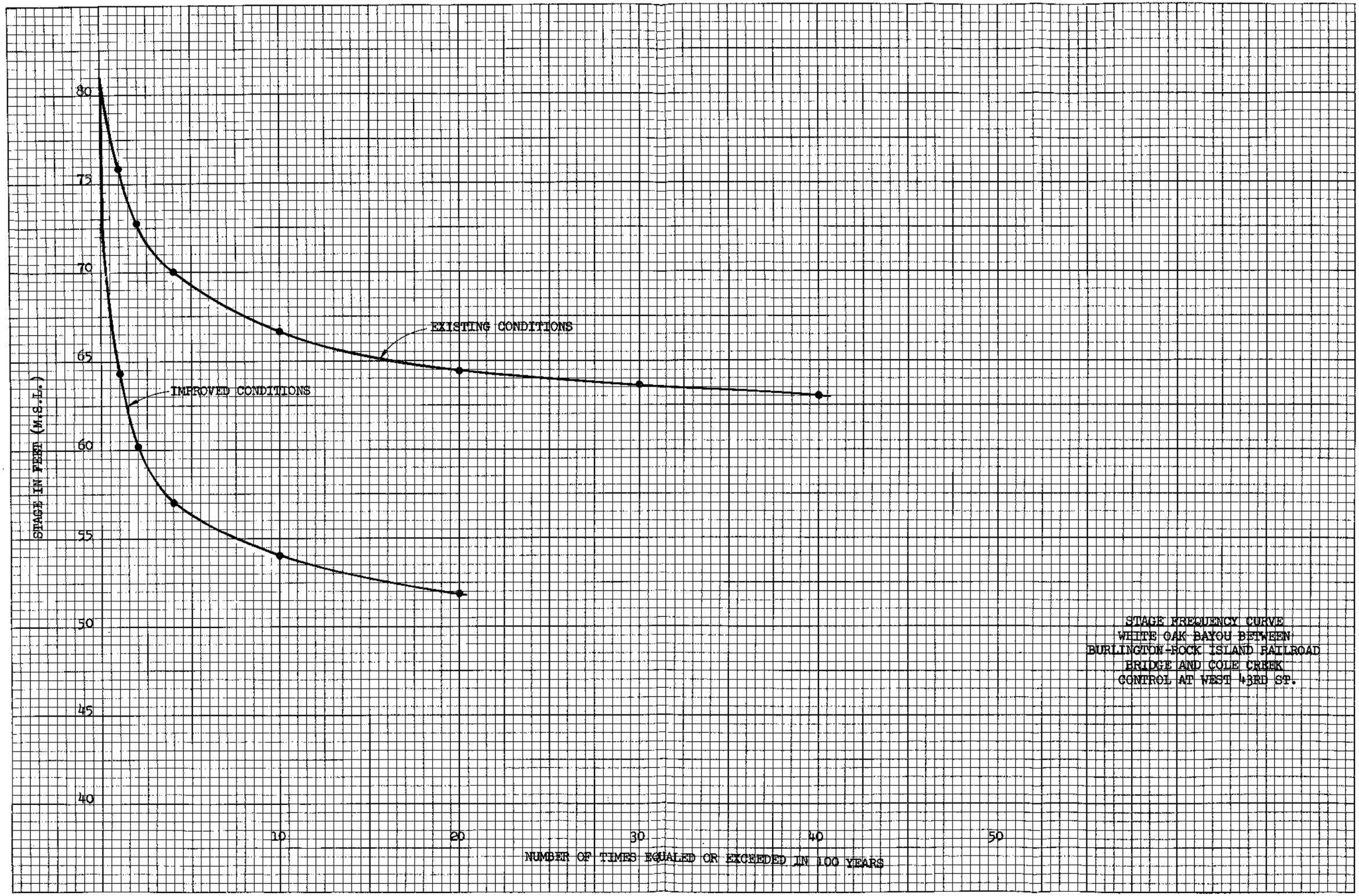
(1) Equivalent average annual value

15. Comparison of benefits and costs.- The estimated annual charges for the plan of improvement are presented in detail in appendix III of this report. The annual charges include the estimated costs for operating and maintaining the recommended extension. The average annual benefits, as estimated in this appendix, are $99,800; the annual charges $82,000; and the benefit-to-cost ratio is 1.2.



STAGE DAMAGE CURVE
WHITE OAK BAYOU BETWEEN
BURLINGTON-ROCK ISLAND RAILROAD
BRIDGE AND COLE CREEK
CONTROL AT WEST 43RD ST.

EXHIBIT 1, APPENDIX II



STAGE FREQUENCY CURVE
WHITE OAK BAYOU BETWEEN
BURLINGTON-ROCK ISLAND RAILROAD
BRIDGE AND COLE CREEK
CONTROL AT WEST 43RD ST.

EXHIBIT 2, APPENDIX II

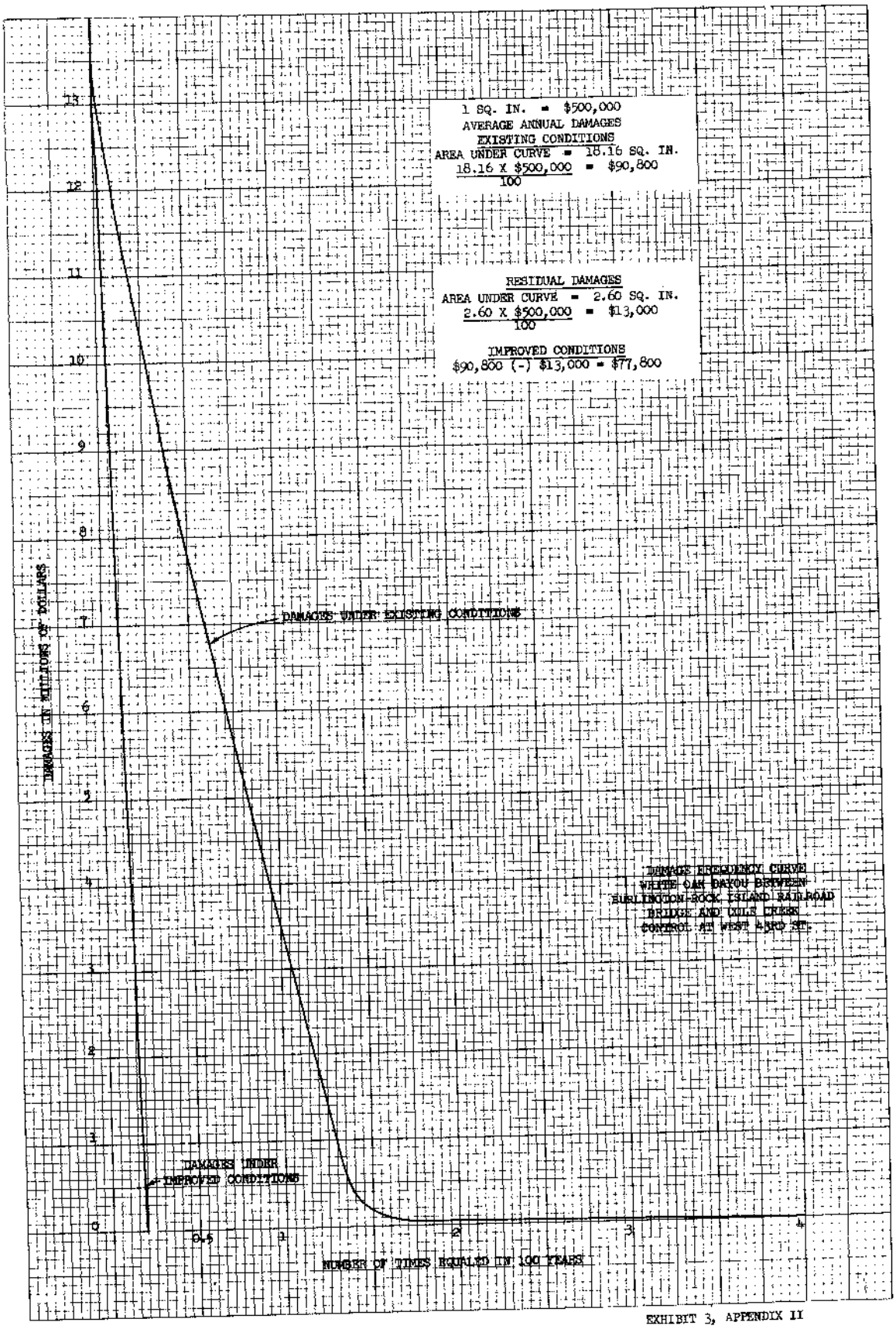


EXHIBIT 3, APPENDIX II

INTERIM REVIEW OF REPORTS ON

BUFFALO BAYOU AND TRIBUTARIES, TEXAS

WHITE OAK BAYOU

APPENDIX III

ENGINEERING AND COST DATA

INTERIM REVIEW OF REPORTS ON
BUFFALO BAYOU AND TRIBUTARIES, TEXAS
WHITE OAK BAYOU

APPENDIX III

ENGINEERING AND COST DATA

TABLE OF CONTENTS

INTERIM REVIEW OF REPORTS ON
BUFFALO BAYOU AND TRIBUTARIES, TEXAS
WHITE OAK BAYOU

APPENDIX III

ENGINEERING AND COST DATA

1. Scope.- This appendix presents information on White Oak Bayou pertinent to the planning of a Federal project to afford protection from flooding between Burlington-Rock Island Railroad bridge and Cole Creek in Houston, Texas. Data presented in this appendix relate particularly to existing and proposed improvements, first costs, annual charges, subsurface conditions, rights-of-way, channel construction, spoil disposal methods and maintenance costs for the proposed flood protection improvements.

2. General.- Investigations were made to determine the best method for providing flood protection to the reach of White Oak Bayou between Burlington-Rock Island Railroad bridge and Cole Creek. The characteristics of the topography and the extent of development on the upper watershed preclude the use of a detention reservoir to control floodwater. The extent of recent development on the upper watershed is shown on exhibits 4 and 5 of this appendix. The existing channel in this reach was enlarged and realined by Harris County Flood Control District in 1954 and 1955, and for a time afforded some relief from flooding in the area. Since that time, continued development in the flood plain has increased the rates of runoff and made the improvements inadequate. The existing channel has an estimated within banks capacity of 10,000 cubic feet per second at Burlington-Rock Island Railroad bridge. Rainfall runoff producing a discharge of this magnitude is estimated to have a recurrence interval of once in about twenty years. The authorized Federal flood control project for White Oak Bayou from the mouth to Burlington-Rock Island Railroad bridge provides protection from the standard project storm. The character of the urban development in the 2.1 mile upstream reach is almost identical to that downstream from the bridge and indications are that the flood plain will be almost fully developed within the next few years. It is believed that no lesser degree of protection should be provided in the proposed extension than is afforded by the authorized Federal project immediately downstream. Accordingly, protection from a standard project flood was established as a basic criterion for the improvement plans investigated. A plan for enlargement of the existing earth channel to provide protection from the standard project flood was investigated and within the practicable physical limitations for this type of improvement, was found to produce discharge velocities greater than could be tolerated in the sandy type soils that would be encountered. These velocities would cause erosion and bank failure and maintenance costs would be excessive. Accordingly, the channel design selected for the plan of improvement provides for a partially lined concrete channel, essentially the same as planned for the authorized project downstream. A summary of estimated first costs for the plan of improvement is given in table A.

3. Construction costs, methods and schedules.- The average prevailing construction costs for the area as of December 1963 were used in preparing the detailed estimates of first cost for the project. Excavation of the channel would be accomplished by the use of draglines, power shovels and motorized and towed scrapers. The concrete channel lining would be placed after excavation of all material. Stream flow would be diverted from the construction reaches through a temporary diversion ditch. The construction reaches would then be dewatered allowing excavation and placing of concrete lining to be performed in the dry. After the concrete has properly cured, stream flow would be diverted back into the completed portion of the channel. The ten-foot berm above the concrete and sloping of the natural side slopes to top of bank would then be accomplished. Excavated material would be used in filling low areas adjacent to the channel and for raising channel banks. Erosion control for earth slopes above the concrete lining on this project would be provided by sprigging and overseeding the slopes and berms with bermuda grass. Top soil would be placed on the ten-foot berms to insure establishment and growth of a good turf cover. A sheet pile weir-type velocity control structure as shown on plate 3 would be constructed at the upper end of the recommended extension to prevent erosion at the juncture of the concrete lined and the existing unlined reaches of the stream upstream from the improvement. A 20-foot reach immediately upstream from the velocity control structure would be lined with riprap. Design and construction of the recommended extension would be coordinated with the design and construction of the upper reach of the authorized project from 18th Street to Burlington-Rock Island Railroad bridge. Consequently, the velocity control structure that is now planned at the upper end of the authorized project would not be necessary and would be omitted. The schedule for design and construction of the authorized project and the recommended schedule for design and construction of the improvement recommended in this report, if authorized in FY 1964, are shown on figure 1.

4. Relocations.- A total of six pipelines would have to be altered either by lowering below the improved channel or by lengthening existing aerial crossings over the present channel to prevent obstruction. The cost estimate in this report would be adequate for either method of alteration. A minimum clearance of one foot between design water surface and aerial structures crossing the channel is provided except for the foot bridge approximately 100 feet upstream from West 43rd Street. This bridge, in its present position, would provide a clearance of 0.9 foot. The bridge is comparatively new and the small difference between the actual clearance and the minimum design clearance does not warrant the additional cost of raising the bridge. Accordingly, the cost estimate for altering this bridge was made on the basis of lengthening and not raising the bridge; however, in the detailed design studies, the possibility of removing this bridge completely and servicing the foot traffic by a walkway constructed on West 43rd Street bridge will be investigated. The cost estimate used in this report is believed to be adequate to accomplish either solution. The road bridge at West 43rd Street is a narrow two-lane bridge and would

have to be approximately doubled in length to span the design channel. The existing Pinemont road bridge would have to be replaced to provide sufficient vertical clearance and adequate span width for crossing the design channel. Creekmont Drive road bridge is relatively new and has approximately 3.5 feet clearance above the design water surface. The existing foundation is adequate for the design channel and lengthening requirements.

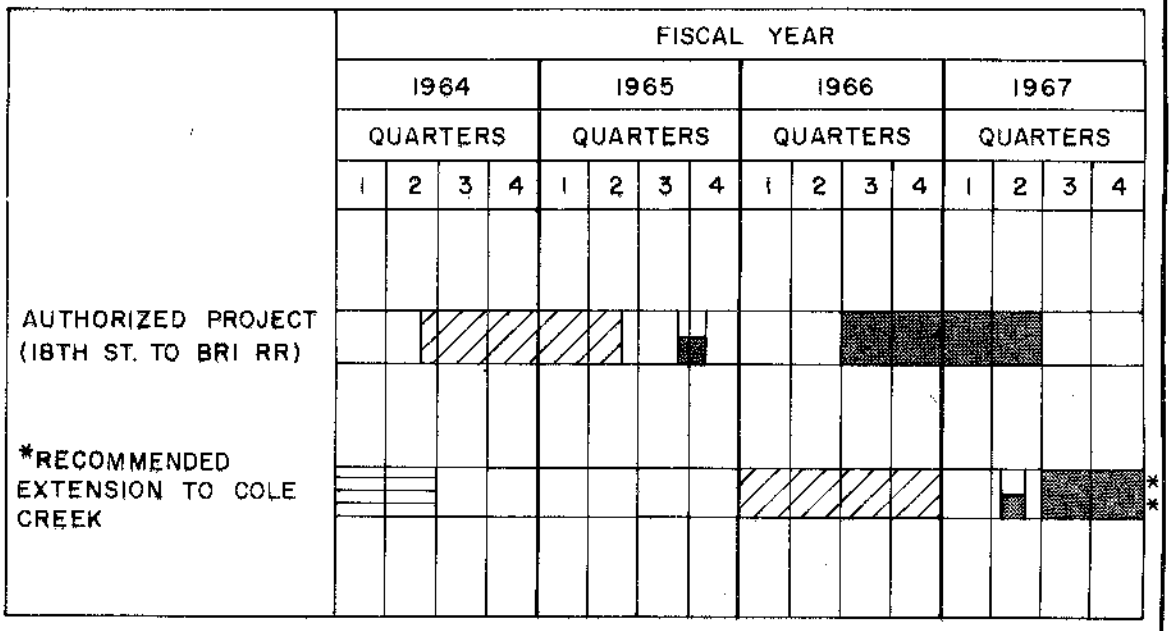
5. Annual charges.- Estimates of interest and amortization of construction costs included in the annual charges are based on 3.0 percent interest on the Federal and non-Federal investments. The estimated construction period for the project is twelve months; accordingly, no interests on investment during construction was included in computing annual charges. Amortization of the investments is computed for a period of 100 years. The annual charges also include estimated costs of $4,000 for operation and maintenance of the proposed improvements. The estimated annual charges for the Federal project are shown in table B.

6. Rights-of-way and spoil easements.- Acquisition of rights-of-way easements on approximately 61 acres of land would be required for channel enlargement. In addition, spoil disposal easements would be required on 36 acres. The average prevailing values for rights-of-way and spoil easement acreages were used in preparing the estimates of first cost.

7. Maintenance and operation.- Maintenance and operation would consist of keeping the subdrainage system cleaned, removal of silted material in concrete lined portion of the channel and maintaining grass cover on earth side slopes. The estimate of annual maintenance of the project is presented in table B.

8. Subsurface investigation.- Five Shelby tube borings averaging thirty-four feet below existing grade were drilled for the purpose of determining soil types and conditions along the bayou. The locations and logs of these borings are shown on exhibit 2 of this appendix.

9. Subsurface material consist of sandy clays, silts, silty sands and sands. About the top 10 feet of soil along the channel banks is a hard to very stiff sandy clay. A dense fine sand to silty sand is found below this sandy clay and beneath the channel. The materials can be readily excavated by land equipment.



*SUBJECT TO AUTHORIZATION DURING FY 1964
**COMPLETE END OF FY 1968

LEGEND

- SURVEY REPORT
- DESIGN MEMORANDUM
- PLANNING
- CONSTRUCTION

FIGURE 1

RECOMMENDED SCHEDULE FOR CONSTRUCTION OF AUTHORIZED PROJECT AND EXTENSION TO COLE CREEK

INTERIM REVIEW OF REPORTS ON
BUFFALO BAYOU AND TRIBUTARIES, TEXAS
WHITE OAK BAYOU

TABLE A

ESTIMATE OF FIRST COST
BURLINGTON-ROCK ISLAND RR BRIDGE TO COLE CREEK

PLAN OF IMPROVEMENT
(December 1963 prices)

Item	Estimated cost
Federal first costs	
01.0 Lands and damages	$ 1,000
09.0 Channels	1,616,000
30.0 Engineering and design	81,000
31.0 Supervision and administration	102,000
Total Federal first cost	1,800,000
Non-Federal first costs	
Lands and damages	380,000
Relocations	290,000
Total non-Federal first cost	670,000
Total first cost	2,470,000

INTERIM REVIEW OF REPORTS ON
BUFFALO BAYOU AND TRIBUTARIES, TEXAS
WHITE OAK BAYOU

TABLE B

ESTIMATE OF ANNUAL CHARGES
BURLINGTON-ROCK ISLAND RR BRIDGE TO COLE CREEK

PLAN OF IMPROVEMENT

(Construction period - 12 months)
(Interest rate - 3.0%)
(Amortization period - 100 years)

Federal annual charges

Interest on Federal investment	$54,000
Amortization of Federal investment	3,000
Maintenance and operation	0
Total Federal annual charges	57,000

Non-Federal annual charges

Interest on non-Federal investment	20,000
Amortization of non-Federal investment	1,000
Maintenance and operation	4,000
Total non-Federal annual charges	25,000
Total annual charges	82,000

Note: Based on December 1963 prices.

INTERIM REVIEW OF REPORTS ON
BUFFALO BAYOU AND TRIBUTARIES, TEXAS
WHITE OAK BAYOU

TABLE C

DETAILED ESTIMATE OF FIRST COST
BURLINGTON-ROCK ISLAND RR BRIDGE TO COLE CREEK

PLAN OF IMPROVEMENT

(December 1963 prices)

Item	Unit	Quantity	Unit Cost	Quantity	Cost
1. Federal first cost					
(01.0) Lands and damages-Fed title review (total)	Each		$ 50.00	20	$ 1,000
(09.0) Channels					
(a) Clearing and grubbing	Acre		150.00	20	3,000
(b) Care of water	L.F.		5.00	11,100	55,500
(c) Excavation, unclassified	C.Y.		0.30	500,900	150,270
(d) Concrete lining	C.Y.		20.00	20,380	407,600
(e) Portland cement	Bbl.		5.00	28,020	140,100
(f) Reinforcing steel	Lbs.		0.13	1,630,400	211,900
(g) Sand filter blanket	S.Y.		2.00	114,400	228,800
(h) Subdrain, 6" conc. pipe	L.F.		2.50	24,640	61,600
(i) Subdrain cleanouts	Each		95.00	222	21,090
(j) Concrete stairs	Each		275.00	10	2,750
(k) Steel sheet piling cutoff wall	S.F.		4.00	4,000	16,000
(l) 12" rip rap	C.Y.		12.00	120	1,440
(m) Maintenance ramp	Each		3,000.00	3	9,000
(n) Sprigging & overseeding	Acre		350.00	25	8,750
(o) Seeding	Acre		150.00	12	1,800
(p) Topsoil	Acre		1,000.00	4.6	4,600
(q) Remove & dispose of existing structures	L.S.		-	-	3,000
(r) Drainage structures					
(1) 24" inlet Sta.456+45	Each		150.00	1	150
(2) 8' chute Sta.462+70(LB)	Each		700.00	1	700
(3) 15' open drain Sta.462+70 (RB)	Each		4,200.00	1	4,200
(4) 15' open drain Sta.462+90 (RB)	Each		4,200.00	1	4,200
(5) 24" inlet Sta.474+20(LB)	Each		150.00	1	150

TABLE C (Cont'd)

Item	Unit	Unit Cost	Quantity	Cost
(6) 25' lined ditch Sta.475+40 (RB)	L.F.	$ 75.00	100	$ 7,500
(7) 10' chute Sta.478+25(LB)	Each	850.00	1	850
(8) 15' open drain Sta.482+70	Each	4,200.00	1	4,200
(9) Remove 24" CMP and install 30" RCP (72') Sta.489+65(LB)	L.S.	-	-	1,000
(10) 24" inlet Sta.493+90(RB)	Each	150.00	1	150
(11) 8' chute Sta.497+00(LB)	Each	700.00	1	700
(12) 10' open drain Sta.501+40(RB)	Each	3,000.00	1	3,000
(13) 30" inlet Sta.506+80(LB)	Each	170.00	1	170
(14) 10' open drain Sta.507+70(RB)	Each	3,000.00	1	3,000
(15) 4' chute Sta.509+70(RB)	Each	300.00	1	300
(16) 4' chute Sta.509+70(LB)	Each	300.00	1	300
(17) 4' chute Sta.510+20(RB)	Each	300.00	1	300
(18) 72" inlet Sta.510+20(LB)	Each	250.00	1	250
(19) 10' open drain Sta.513+20(RB)	Each	3,000.00	1	3,000
(20) 8' chute Sta.516+70(LB)	Each	700.00	1	700
(21) 10' chute Sta.517+70(RB)	Each	850.00	1	850
(22) 10' chute Sta.521+10(LB)	Each	850.00	1	850
(23) 10' chute Sta.526+85(RB)	Each	850.00	1	850
(24) 10' open drain Sta.529+90(LB)	Each	3,000.00	1	3,000
(25) 20' chute Sta. 534+30(RB)	Each	1,600.00	1	1,600
(26) 8' chute Sta.538+55(LB)	Each	700.00	1	700
(27) 8' chute Sta.539+35(RB)	Each	700.00	1	700
(28) 8' chute Sta.542+50(LB)	Each	700.00	1	700
(29) 10' open drain Sta.543+15(RB)	Each	3,000.00	1	3,000
(30) 30" inlet Sta.547+60(RB)	Each	170.00	1	170
(31) 30" inlet Sta.547+60(LB)	Each	170.00	1	170
(32) 30" inlet Sta.548+20(RB)	Each	170.00	1	170
(33) 30" inlet Sta.548+20(LB)	Each	170.00	1	170
(34) 24" RCP	L.F.	10.00	147	1,470
(35) 30" RCP	L.F.	12.00	182	2,180
Subtotal drainage structures				51,400
(s) Less credit for omitting velocity control structure on authorized project				(-31,000)
Subtotal, channels				1,347,600
Contingencies 20%(-)				268,400
Total, channels				1,616,000
(30.0) Engineering and design				81,000
(31.0) Supervision and administration				102,000
Total Federal first cost				1,800,000

TABLE C (Cont'd)

Item	Unit Quantity	Unit Cost	Quantity	Cost
2. Non-Federal first cost				
Lands and damages				
(a) Rights-of-way				
(1) Burlington-Rock Island RR bridge to West 43rd St.	Acre	$5,000.00	32.2	$161,000
(2) West 43rd St. to Pinemont	Acre	6,000.00	20.8	124,800
(3) Pinemont to Cole Creek	Acre	3,000.00	7.7	23,100
(b) Spoil disposal easement				
(1) Burlington-Rock Island RR bridge to West 43rd St.	Acre	500.00	20.0	10,000
(2) West 43rd St. to Pinemont	Acre	600.00	12.0	7,200
(3) Pinemont to Cole Creek	Acre	300.00	4.0	1,200
(c) Legal and administrative costs	Tracts	150.00	20.0	3,000
Subtotal, lands and damages				330,300
Contingencies, 15%+				49,700
Total lands and damages				380,000
Relocations				
(a) Pipelines, 8" & 14" sanitary sewer siphon, Sta. 459+20	L.S.	-	-	5,000
(b) Pipelines, 12" & 24" w/manholes, Sta. 501+00	L.S.	-	-	6,000
(c) Southwestern Bell T&T - 9 conduit duct Sta. 510+00	L.S.	-	-	45,000
(d) Pipeline, 12" water, Sta. 510+20	L.F.	20.00	85	1,700
(e) Pipeline, 6" water, Sta. 510+35	L.F.	10.00	85	850
(f) Demolition of W. 43rd St. bridge	L.S.	-	-	3,550
(g) Less salvage value of W. 43rd St. bridge	L.S.	-	-	(-250)
(h) W. 43rd St. bridge, Sta. 510+25	L.F.	343.00	190	65,170
(i) Foot bridge, Sta. 511+20	L.F.	60.00	70	4,200
(j) Demolition of Pinemont bridge	L.S.	-	-	4,720
(k) Less salvage value of Pinemont bridge	L.S.	-	-	(-470)
(l) Pinemont bridge, Sta. 549+00	L.F.	343.00	190	65,170
(m) Creekmont St. bridge, Sta. 533+20	L.F.	360.00	86	30,960
(n) Administrative costs	-	-	-	10,000
Subtotal, relocations				241,600
Contingencies, 20%+				48,400
Total relocations				290,000
Total non-Federal first cost				670,000
Total first cost				2,470,000

INTERIM REVIEW OF REPORTS ON
BUFFALO BAYOU AND TRIBUTARIES, TEXAS
WHITE OAK BAYOU

TABLE D

PERTINENT DATA
BURLINGTON-ROCK ISLAND RR BRIDGE TO COLE CREEK
PLAN OF IMPROVEMENT

Location

Stream	White Oak Bayou
Channel-mile limits	8.5 to 10.6

Type of channel -	50' concrete lined
Side slopes -	1:2 lined portion
	1:2.5 unlined portion
Channel excavation-	500,900 cubic yards

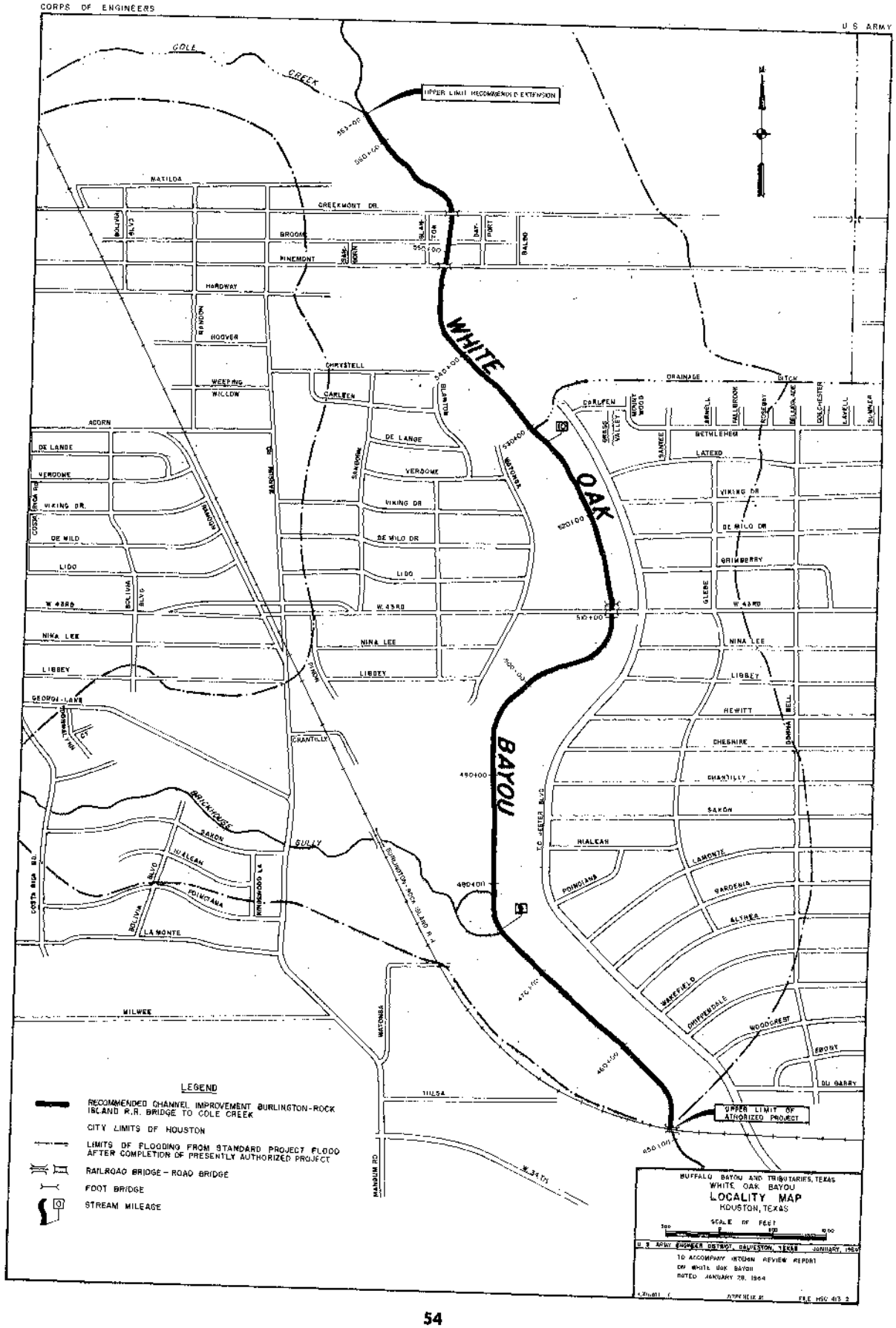
Bridge crossings

Location	Station	Necessary alteration
W. 43rd St.	510+25	New bridge
Foot bridge	511+20	Extend 80'
Pinemont	549+00	New bridge
Creekmont Dr.	553+20	Extend 86'

TABLE D (Cont'd)

Utility crossings

	Station	Type of crossing	Necessary alteration
42" storm sewer corr. iron	454+20	Underground	Remove headwall and 18' of pipe
8" and 14" sanitary sewer	459+20	Underground	Alter siphon
60" storm sewer corr. iron	465+35	Underground	Remove headwall and 20' of pipe
54" storm sewer corr. iron	489+55	Underground	Remove headwall and 18' of pipe
24" storm sewer corr. iron	496+60	Underground	Remove 20' of pipe
18" storm sewer corr. iron	499+70	Underground	Remove 20' of pipe
12" and 24" sanitary sewer	501+00	Underground	Siphon alteration with manholes
24" storm sewer corr. iron	508+40	Underground	Remove 24' of pipe
(9) - telephone cable ducts	510+00	Underground	Lower
12" and 6" water line	510+20 & 510+36	Floor of the bridge	Extend 85'
72" storm sewer corr. iron	510+60	Underground	Remove headwall and 23' of pipe
24" concrete pipe	511+90	Underground	Remove 25' of pipe
30" concrete pipe	513+30	Underground	Remove 21' of pipe
18" storm sewer corr. iron	519+45	Underground	Remove 18' of pipe
18" storm sewer corr. iron	520+85	Underground	Remove 16' of pipe
18" storm sewer corr. iron	526+70R	Underground	Remove 18' of pipe
18" storm sewer corr. iron	526+70L	Underground	Remove 21' of pipe
18" storm sewer corr. iron	534+85	Underground	Remove 23' of pipe
30" concrete pipe	546+80L	Underground	Remove headwalls and 70' of pipe
30" concrete pipe	546+80R	Underground	Remove headwall and 35' of pipe
30" concrete pipe	547+70R	Underground	Remove headwall and 35' of pipe
30" concrete pipe	547+70L	Underground	Remove headwall and 70' of pipe
(2) 18" concrete pipes	551+80R & L	Underground	Remove 14' of pipe. Build chute
(2) 18" concrete pipes	552+50R & L	Underground	Remove 14' of pipe. Build chute


CORPS OF ENGINEERS
U.S. ARMY
COLE CREEK
UPPER LIMIT RECOMMENDED EXTENSION
WHITE OAK BAYOU
BRUCKHOUSE GULLY
BURLINGTON-ROCK ISLAND R.R.
UPPER LIMIT OF ATHORIZED PROJECT
MATILDA
GREENMONT DR.
BROOME
PINEMONT
HARDWAY
HOOVER
WEEPING WILLOW
CHRYSTELL
CARLEEN
ADORN
DE LANDE
VERDOME
VIKING DR.
DE WILD
LIDO
W. 43RD
NINA LEE
LIBBEY
GEORGE LANE
CHANTILLY
SAXON
HIALEAN
POINCIANA
LA MONTE
MILWEE
DRAINAGE DITCH
BETHLEHEM
LATEXO
GRIMBERRY
REWITT
CHESHIRE
LAMONTE
GARDENIA
ALTHEA
WAKEFIELD
DRIFFENDALE
WOODCREST
FRONT
DU BARRY
W. 34TH
LEGEND
RECOMMENDED CHANNEL IMPROVEMENT BURLINGTON-ROCK ISLAND R.R. BRIDGE TO COLE CREEK
CITY LIMITS OF HOUSTON
LIMITS OF FLOODING FROM STANDARD PROJECT FLOOD AFTER COMPLETION OF PRESENTLY AUTHORIZED PROJECT
RAILROAD BRIDGE - ROAD BRIDGE
FOOT BRIDGE
STREAM MILEAGE
BUFFALO BAYOU AND TRIBUTARIES, TEXAS
WHITE OAK BAYOU
LOCALITY MAP
HOUSTON, TEXAS
SCALE OF FEET
U. S. ARMY ENGINEER DISTRICT, GALVESTON, TEXAS JANUARY, 1964
TO ACCOMPANY INTERIM REVIEW REPORT ON WHITE OAK BAYOU DATED JANUARY 28, 1964
APPENDIX B
FILE NO. 413.2

INTERIM REVIEW OF REPORTS ON

BUFFALO BAYOU AND TRIBUTARIES, TEXAS

WHITE OAK BAYOU

APPENDIX IV

COMMENTS BY OTHER AGENCIES

INTERIM REVIEW OF REPORTS ON
BUFFALO BAYOU AND TRIBUTARIES, TEXAS
WHITE OAK BAYOU

APPENDIX IV

COMMENTS BY OTHER AGENCIES

TABLE OF CONTENTS

INTERIM REVIEW OF REPORTS ON
BUFFALO BAYOU AND TRIBUTARIES, TEXAS
WHITE OAK BAYOU

APPENDIX IV

COMMENTS BY OTHER AGENCIES

INTRODUCTION

In accordance with the Interagency Agreement on Coordination of Water and Related Land Resources Activities approved by the President on May 26, 1954, draft copies of the Main Report and appendixes were sent to other Federal agencies at field level for review. Letters from these agencies containing their comments and replies where appropriate are presented in this appendix.

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
BUREAU OF SPORT FISHERIES AND WILDLIFE
P. O. BOX 1306
ALBUQUERQUE, NEW MEXICO

ADDRESS ONLY THE
REGIONAL DIRECTOR

SOUTHWEST REGION
(REGION 2)
ARIZONA
COLORADO
KANSAS
NEW MEXICO
OKLAHOMA
TEXAS
UTAH
WYOMING

June 20, 1962

District Engineer
Corps of Engineers, U. S. Army
P. O. Box 1229
Galveston, Texas

Dear Sir:

This letter constitutes our Bureau's report on the Corps of Engineers' proposed improvements to White Oak Bayou, Buffalo Bayou and Tributaries Project, Texas, authorized under the House Public Works Committee Resolution dated April 20, 1948. Our report, prepared in accordance with the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.), has been coordinated with the Bureau of Commercial Fisheries. The Texas Game and Fish Commission has concurred in the views expressed herein by letter dated May 14, 1962, signed by Mr. Eugene A. Walker, Director of Program Planning.

The proposed work is designed to provide flood protection for the City of Houston, Texas. It is our understanding that the plan of improvement includes the straightening and concrete lining of White Oak Bayou from the Chicago Rock Island and Pacific Railroad bridge near West 34th Street upstream to the mouth of Coles Creek.

White Oak Bayou rises in northwestern Harris County and flows in a narrow channel and in a southeasterly direction through the northern section of the City of Houston to confluence with Buffalo Bayou about 5.7 miles downstream from the Houston Ship Channel turning basin. The bayou in the project area traverses a heavily wooded residential area of metropolitan Houston.

The bayou is intermittent, and its fish habitat has been nearly eliminated by pollution. Songbirds and small mammals such as opossums, raccoons, and squirrels are common in the project area. Hunting is not permitted.

In our report dated October 31, 1960, concerning similar work proposed for a reach of White Oak Bayou downstream from the Chicago Rock Island and Pacific Railroad bridge, we stated that the work would have no effect on the fish and wildlife resources of

EXHIBIT 1
APPENDIX IV

the area. Similarly, the work proposed for White Oak Bayou upstream from the railroad bridge will not affect significantly the fish and wildlife and will offer no opportunities for improvement of these resources.

We appreciate the opportunity extended to us to comment on the proposed work.

Sincerely yours,

John C. Gatlin
Regional Director

Copies (10)

Distribution:

(2) Executive Secretary, Texas Game and Fish Commission, Austin, Texas
(2) Regional Director, Region 4, Texas Game and Fish Commission, Houston, Texas
(1) Chairman, Southwest Field Committee, U. S. Department of the Interior, Muskogee, Oklahoma
(2) Regional Director, Region 4, Bureau of Mines, Bartlesville, Oklahoma
(2) Regional Director, Region 2, Bureau of Commercial Fisheries, St. Petersburg Beach, Florida
(2) Director, Biological Laboratory, Bureau of Commercial Fisheries, Galveston, Texas
(2) Field Supervisor, Branch of River Basin Studies, Bureau of Sport Fisheries and Wildlife, Fort Worth, Texas

GAME AND FISH COMMISSION

AUSTIN, TEXAS

July 3, 1962

District Engineer
U.S. Army Engineer District
Corps of Engineers
606 Santa Fe Building
Galveston, Texas

Gentlemen:

Reference is made to Mr. Kenneth Heagy's letter of June 22, 1962 requesting comments from the Texas Game and Fish Commission concerning the effects on wildlife and fish as the result of proposed improvements to White Oak Bayou from Fort Worth and Denver (Burlington) Railroad bridge to Cole Creek in Houston, Texas.

The proposed improvements will have no appreciable detrimental or beneficial effects on fish and wildlife.

Sincerely yours,

Eugene A. Walker

Eugene A. Walker
Director, Program Planning

EAW:ep

EXHIBIT 2
APPENDIX IV

DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE
REGIONAL OFFICE

PUBLIC HEALTH SERVICE Tenth Floor - 1114 Commerce Street
Dallas 2, Texas

January 7, 1964

District Engineer
U. S. Army Engineer District, Galveston
Corps of Engineers
606 Santa Fe Building
P. O. Box 1229
Galveston, Texas

Attention: Mr. T. W. Elam, Chief
Engineering Division

In accordance with your request dated December 27, 1963, we have reviewed the advance copy of the interim report on White Oak Bayou, Texas.

This report contains a study of flooding problems to determine the feasibility of constructing additional flood control improvements for the White Oak Bayou Watershed from the present terminus of an authorized Federal improvement project to Cole Creek. The works of improvement would include approximately 2.1 miles of channel modifications and improvement.

Reduction of flooding in the built-up business and redential areas will be beneficial to the generalpublic health environment. A separate vector evaluation report of this project will be provided later by our Communicable Disease Center in Atlanta, Georgia.

Thank you for the opportunity to review this report.

Sincerely yours,

Jerome H. Svore

JEROME H. SVORE
Regional Program Director
Water Supply&Pollution Control

Enclosure:
Interim Report, White Oak
Bayou, Texas

EXHIBIT 3
APPENDIX IV

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
P. O. Box 648
Temple, Texas 76502

January 10, 1964

Colonel James S. Maxwell
District Engineer
U. S. Corps of Engineers, U. S. Army
606 Santa Fe Building
P. O. Box 1229
Galveston, Texas

Dear Colonel Maxwell:

Thank you for the opportunity to review an advance copy of the Interim Report on White Oak Bayou, Texas.

The report presents results of an investigation of the flood problems along 2.1 miles of White Oak Bayou, immediately upstream from the upper limit of the authorized Federal flood control improvement project for White Oak Bayou, in Houston, Texas.

It is recommended in the report that the authorized project for Buffalo Bayou and Tributaries, Texas, be modified to extend the limit of the White Oak portion of the project upstream about 2.1 miles from the Burlington-Rock Island Railroad bridge to the mouth of Cole Creek. Improvements recommended include enlargement and partial concrete lining of the channel. The estimated first cost to the United States for the new work is $1,800,000. The recommendation is subject to certain provisions of local cooperation.

The area subject to flooding from White Oak Bayou between Burlington-Rock Island Railroad bridge and Cole Creek consists of about 1,200 acres, practically all of which is in the city limits of Houston. Development within the flood plain includes commercial and residential properties, streets and bridges, utilities and parks. The report states "Based on expected growth of the area, it is estimated that the entire flood plain would be substantially developed during the life of the project." In view of the present land use in the watershed showing the predominance of urban development, and the virtual absence of agriculture, we have no specific comments on the report.

Review of the report on White Oak Bayou, Texas, indicates that modification of the authorized project to extend the limit of the White Oak portion of the project upstream about 2.1 miles will have no detrimental effect on any projects, existing or anticipated under programs administered by the Soil Conservation Service.

The advance copy of the interim report on White Oak Bayou, Texas, used in our review is enclosed. If we can assist you in any way, please let me know.

Very truly yours,

H. N. Smith

H. N. Smith
State Conservationist

Attachment

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF MINES

OFFICE OF
[redacted]
AREA DIRECTOR

[redacted]
AREA IV
MINERAL RESOURCE OFFICE

ROOM 206 FEDERAL BUILDING
BARTLESVILLE, OKLAHOMA

January 13, 1964

Mr. T. W. Elam, Chief
Engineering Division
Corps of Engineers
U.S. Army Engineer District
P.O. Box 1229
Galveston, Texas

Your Reference: SWGGW-2c

Dear Mr. Elam:

Thank you for sending us a copy of the interim report on White Oak Bayou, Houston, Texas, for field level review.

The plan of improvement provides for enlargement and partial concrete lining of the channel of White Oak Bayou from Burlington-Rock Island Railroad bridge to Cole Creek, a distance of 2.1 miles. The ratio of estimated average annual benefits ($117,000) to average annual costs ($82,000) is 1.4 to 1.0.

A review of available office data indicates that the proposed project would have no adverse effect on mineral resources in the area; therefore, the Area IV Mineral Resource Office has no objection to the proposed channel enlargement.

Sincerely yours,

Joseph C. Arundale
Acting Area Director

EXHIBIT 5
APPENDIX IV

BILL ELLIOTT, COUNTY JUDGE
COUNTY OF HARRIS
STATE OF TEXAS
HOUSTON 2, TEXAS

January 9, 1964

Colonel James S. Maxwell
District Engineer
Corps of Engineers, U.S. Army
P.O. Box 1229
Galveston, Texas

Dear Colonel Maxwell:

Receipt is acknowledged of your letter dated December 26, 1963, transmitting an advance copy of an Interim Report on Buffalo Bayou and Tributaries, Texas, with specific reference to the improvement of White Oak Bayou from the Burlington-Rock Island Railroad to Cole Creek, a distance of approximately 2.1 stream miles.

Please be advised that the Flood Control District will provide the items of local cooperation as described in Paragraph 46 of this report and will be in position to provide the necessary rights-of-way at a very early date.

I wish to express my sincere appreciation for your very fine cooperation with the District in preparing this report and recommending an extension to Cole Creek of the present White Oak Bayou Project from the present terminus, the Burlington-Rock Island Railroad. The report with enclosures is approved so far as this office is concerned and is returned herewith as requested.

I would greatly appreciate it if you would furnish the Flood Control District six copies of the approved report.

Very truly yours,

Bill Elliott

BILL ELLIOTT
County Judge, Acting for the
Flood Control District

Enc.

cc: Flood Control District

EXHIBIT 6
APPENDIX IV

INTERIM REVIEW OF REPORTS ON
BUFFALO BAYOU AND TRIBUTARIES, TEXAS
WHITE OAK BAYOU

INFORMATION CALLED FOR BY
SENATE RESOLUTION 148, 85TH CONGRESS
ADOPTED JANUARY 28, 1958

1. Authority.- The following information is furnished in response to Senate Resolution 148, 85th Congress, adopted January 28, 1958.

2. Requests by local interests.- At a public hearing held in Houston, Texas, on September 8, 1961, Harris County Flood Control District requested the construction of local flood protection improvements that would protect the 2.1 miles above Burlington-Rock Island Railroad bridge in the Houston area against flooding from White Oak Bayou. It was also requested that a comprehensive investigation be made of the White Oak Bayou watershed.

3. Improvements considered.- A plan of channel improvement that would afford protection from a standard project flood in the 2.1 mile reach of White Oak Bayou above Burlington-Rock Island Railroad bridge was found justified and is recommended for authorization and construction. This is essentially the improvement desired by local interests and affords comparable protection to the presently authorized Federal project immediately downstream. A comprehensive investigation of the remainder of the White Oak Bayou watershed is scheduled in the comprehensive study of the entire Buffalo Bayou watershed, which is now in progress. Economic analyses for the plan investigated were made only on a basis of a 100-year project life.

4. The improvements proposed under the recommended plan of improvement have been discussed with the local interests that would be responsible for providing the cooperation required for the improvements if and when adopted. They have expressed satisfaction with the recommended plan of improvement.