LAKE KEMP, WICHITA RIVER, TEXAS

LETTER

FROM

THE SECRETARY OF THE ARMY

TRANSMITTING

A LETTER FROM THE CHIEF OF ENGINEERS, DEPARTMENT OF THE ARMY, DATED AUGUST 28, 1962, SUBMITTING A FAVORABLE REPORT, TOGETHER WITH ACCOMPANYING PAPERS AND ILLUSTRATIONS, ON A REVIEW OF THE REPORTS ON LAKE KEMP, WICHITA RIVER, TEXAS, REQUESTED BY A RESOLUTION OF THE COMMITTEE ON PUBLIC WORKS, UNITED STATES SENATE, ADOPTED ON APRIL 16, 1959

PRESENTED BY MR. MANSFIELD FOR MR. CHAVEZ

SEPTEMBER 24, 1962.—Referred to the Committee on Public Works and ordered to be printed with illustrations

---

U.S. GOVERNMENT PRINTING OFFICE
WASHINGTON : 1962

89691 O

CONTENTS

	Page
Letter of transmittal	v
Comments of the Bureau of the Budget	vi
Comments of the State of Texas	vii
Comments of the Department of the Interior	x
Comments of the Public Health Service	xi
Report of the Chief of Engineers, Department of the Army	1
Report of the Board of Engineers for Rivers and Harbors	3
Report of the District Engineer:	
Syllabus	11
Authority	12
Extent of investigation	12
Prior reports	13
Description	13
a. Watershed	13
b. Stream	14
c. Channel and valley	14
d. Geology and soils	14
Economic development	14
a. Population	14
b. Industrial development	15
c. Agricultural development	15
d. Transportation facilities	15
e. Supplemental data	15
Climatology	15
Runoff and stream flow data	15
Existing Corps of Engineers' projects	16
Improvements by other Federal and non-Federal agencies	16
Improvements desired	17
Structural problems at Lake Kemp	17
a. General	17
b. Dam	17
c. Spillway	22
d. Outlet works	22
Irrigation system	23
Operation problems at Lake Kemp	23
Planning considerations	24
Reconstruction of Lake Kemp	27
Estimates of first cost	30
Estimate of annual cost	30
Estimates of benefits	31
a. Flood control benefits	31
b. Unevaluated flood control benefits	32
c. Conservation	32
d. Recreation	32
e. Fish and wildlife	32
f. Summary of benefits	32
Project justification	32
Federal and non-Federal participation	33
Recommended apportionment of cost among Federal and non-Federal interests	36
a. Federal	36
b. Non-Federal	37
c. Summary	37
Assurances of local cooperation	38
Coordination with other agencies	39
a. General	39
b. Public Health Service	39

Report of the district engineer—Continued Page
c. Bureau of Reclamation 39
d. Fish and Wildlife Service 39
Discussion 39
Conclusions 40
Recommendations 41
Recommendations of the Division Engineer 42

ILLUSTRATIONS ACCOMPANYING REPORT OF THE DISTRICT ENGINEER

Plate 1. Watershed map.

APPENDIXES ACCOMPANYING REPORT OF THE DISTRICT ENGINEER

Page
Appendix:
I. Hydrology (plates not printed) 43
II. Damages, benefits, justification and cost allocation (plates not printed) 67
III. Project plans and cost estimates (only Plate 1 printed) 87
IV. Report by Public Health Service 101
V. Report by Fish and Wildlife Service 123
VI. Report by Bureau of Reclamation 127
VII. Assurances and comments 151
VIII. Digest of hearing record 181

SUPPLEMENTARY DATA ACCOMPANYING REPORT OF THE DISTRICT ENGINEER
(Supplement A not printed)

Supplement A. Supplemental economic data.
Supplement B. Information called by Senate Resolution No. 148, 85th Congress, adopted January 28, 1958 185

LETTER OF TRANSMITTAL

DEPARTMENT OF THE ARMY
WASHINGTON 25, D.C.

IN REPLY REFER TO:

September 21, 1962

Honorable Dennis Chavez
Chairman, Committee on Public Works
United States Senate

Dear Mr. Chairman:

I am transmitting herewith a favorable report dated 28 August 1962, from the Chief of Engineers, Department of the Army, together with accompanying papers and illustrations, on a review of the reports on Lake Kemp, Wichita River, Texas, requested by a resolution of the Committee on Public Works, United States Senate, adopted 16 April 1959.

In accordance with Section 1 of Public Law 534, 78th Congress, and Public Law 85-624, the views of the State of Texas and the Department of the Interior are set forth in the inclosed communications. The views of the Public Health Service are inclosed also.

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 proposed improvements, 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,

Cyrus Vance

Cyrus R. Vance
Secretary of the Army

1 Incl (dup)
Rept w/accompg
papers & illus

COMMENTS OF THE BUREAU OF THE BUDGET

EXECUTIVE OFFICE OF THE PRESIDENT
BUREAU OF THE BUDGET
WASHINGTON 25, D.C.

September 18, 1962

Honorable Cyrus R. Vance
Secretary of the Army
Washington 25, D. C.

Dear Mr. Secretary:

Assistant Secretary Schaub's letter of September 12, 1962, submitted the proposed report of the Chief of Engineers on Lake Kemp, Wichita River, Texas, in response to a resolution of the Committee on Public Works, United States Senate, adopted April 16, 1959.

The Chief of Engineers recommends, subject to certain stated conditions of local cooperation, modification of the privately-owned Lake Kemp structure by replacement of the existing outlet works and spillway, raising the height of the dam three feet, and strengthening the embankment to provide a total of 526,000 acre-feet of storage capacity of which 200,000 acre-feet would be allocated to flood control. The total estimated cost of construction is $8,295,000, of which $1,885,000 is allocated to conservation uses and would be repaid by local interests within 50 years with interest. The project will be operated and maintained by the local interests with reimbursement by the Federal Government for the flood control portion of the costs, now estimated at $45,900 annually. The benefit-cost ratio is stated to be 2.5.

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. However, no commitment can be made at this time as to when any estimate of appropriation would be submitted for construction of the proposed improvements, 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

The Senate of The State of Texas Austin

CULP KRUEGER
STATE SENATOR
DISTRICT NO. 18
EL CAMPO

COUNTIES

AUSTIN
COLORADO
WITT
FAYETTE
LAVACA
MATAGORDA
WASHINGTON
WHARTON

June 28, 1962

Major General William F. Cassidy
Acting Chief of Engineers
U. S. Army Corps of Engineers
Washington 25, D. C.

Dear General Cassidy:

This has further reference to your letter of May 24, 1962, transmitting copy of the proposed report on Lake Kemp, Wichita River, Texas.

At the request of Governor Daniel, the Texas Water Commission reviewed this report and approved its feasibility, as evidenced by the attached copy of a Commission Order. I concur in the findings and conclusions of the Commission.

Sincerely yours,

CULP KRUEGER
Acting Governor

CK:bdk
Enclosure
cc: Honorable Joe D. Carter, Chairman
Texas Water Commission
Capitol Station, Box 2311
Austin, Texas

TEXAS WATER COMMISSION

AN ORDER approving the feasibility of the proposed Federal Project to modify and rehabilitate the existing Lake Kemp Project, as described in the "Survey Report on Lake Kemp, Wichita River, Texas," by the Corps of Engineers, United States Army.

BE IT ORDERED BY THE TEXAS WATER COMMISSION:

Section 1. Statement of Authority. Article 7472e, Vernon's Annotated Civil Statutes, provides that upon receipt of any engineering report submitted by a Federal Agency seeking the Governor's approval of a Federal Project, the Texas Water Commission Agen
shall study and make recommendations to the Governor as to the feasibility of the Federal Project. The Commission shall cause a public hearing to be held to receive the views of persons or groups who might be affected should the Federal Project be initiated and completed.

Section 2. Statement of Jurisdiction. (a) By letter dated May 28, 1962, the Honorable Price Daniel, Governor of Texas, requested the Texas Water Commission to study and make recommendations concerning the proposed Federal Project to modify and rehabilitate the existing Lake Kemp Project in the interest of flood control to operate in conjunction with its irrigation, water supply and other related uses, as described in the report of the Corps of Engineers, United States Army, entitled "Survey Report on Lake Kemp, Wichita River, Texas," dated November 15, 1961, and to enter its order finding said project to be feasible or not feasible. (b) In accordance with Article 7472e, the Commission caused a public hearing after due notice by publication and mail, to be held on June 22, 1962, at 10:00 o'clock A.M., in the offices of the Texas Water Commission, 201 East Fourteenth Street, Austin, Texas, on said project, and at which time all those interested or who may be affected should the project recommended in said report be initiated and completed were requested to come forward and give testimony.

Section 3. After fully considering all the evidence and exhibits presented by persons and groups who may be affected should the project be initiated and completed, including the matters set forth in Section 4 of Article 7472e, the Commission finds that said project is feasible and that the public interest will be served thereby.

Section 4. It is further ordered that a certified copy of this Order be transmitted to the Governor.

Section 5. This Order shall take effect on the 22nd day of June, 1962, the date of its passage, and it is so ordered.

SIGNED IN THE PRESENCE OF THE
TEXAS WATER COMMISSION

/s/ Joe D. Carter
Joe D. Carter, Chairman

ATTEST:

/s/ Ben F. Looney, Jr
Ben F. Looney, Jr., Secretary

I certify that the foregoing order was adopted by the Texas Water Commission at a meeting held on the 22nd day of June, 1962, upon motion of Commissioner Dent, seconded by Commissioner Beckwith, Commissioner Beckwith voting "aye", Commissioner Dent voting "aye", and Chairman Carter voting "aye".

/s/ Ben F. Looney, Jr.
Ben F. Looney, Jr., Secretary

STATE OF TEXAS |
|
COUNTY OF TRAVIS |

I, Ben F. Looney, Jr., Secretary of the Texas Water Commission do hereby certify that the foregoing is a true and correct copy of an order of said Commission, the original of which is filed in the permanent records of said Commission.

Given under my hand and the seal of the Texas Water Commission, this the 26th day of June, A. D., 1962.

Ben F. Looney, Jr.
Ben F. Looney, Jr., Secretary

COMMENTS OF THE DEPARTMENT OF THE INTERIOR

UNITED STATES
DEPARTMENT OF THE INTERIOR
OFFICE OF THE SECRETARY
WASHINGTON 25, D. C.

August 1, 1962

Lt. General Walter K. Wilson, Jr.
Chief of Engineers
Department of the Army
Washington 25, D. C.

Dear General Wilson:

This is in reply to your letter of May 24 transmitting for our comments reports on Lake Kemp, Wichita River, Texas. The recommended construction consists of rehabilitating and modifying the existing non-Federal Lake Kemp project to include storage capacity allocated to flood control, in addition to the present use for irrigation, emergency water supply, and other related uses. The Federal Government will direct flood control operations and reimburse local interests annually for the flood control portion of the annual costs. Local interests would be required to provide free public access in accordance with the principles of Section 4 of the Flood Control Act.

The Fish and Wildlife Service advises that the proposed modification of the Lake Kemp project offers possibilities for enhancing the waterfowl resources of this reservoir. In view of these possibilities, and your recommendation for free public access, it is requested that the Bureau of Sport Fisheries and Wildlife be given an opportunity to work with the Tulsa District Engineer and the Texas Game and Fish Commission in the development of final plans for this project.

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

The opportunity of presenting our comments is appreciated.

Sincerely yours,

Assistant Secretary of the Interior

x

COMMENTS OF THE PUBLIC HEALTH SERVICE

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

PUBLIC HEALTH SERVICE — WASHINGTON 25, D. C.

BUREAU OF STATE SERVICES

July 27, 1962

Refer to:

Major General Walter K. Wilson, Jr.
Chief of Engineers
Department of the Army
Washington 25, D. C.

Dear General Wilson:

This is in reply to General Cassidy's letter of May 24, 1962, requesting comments on the "Survey Report on Lake Kemp, Wichita River, Texas."

The Public Health Service report included as Appendix IV covers municipal and industrial water supply needs related to this project.

As pointed out in that report, organic pollution is not a problem in the watershed. Water stored in Lake Kemp is of poor chemical quality, having high concentrations of chlorides, sulfates, and total dissolved solids. For this reason, water stored in the lake would have practically no value as dilution water for pollution control purposes in the Wichita River. Retention and gradual release of flood waters will provide some quality improvement in the main stem of the Red River, since the waters in Lake Kemp are less mineralized than the waters in the main stem of the Red River.

If natural sources of pollution above Lake Kemp are effectively controlled, the water may become useful for municipal and industrial water supply purposes depending, of course, on the degree to which the mineral discharges are controlled. A re-evaluation of the water use requirement should be made at the time control of natural pollution is achieved.

The opportunity to review the report is appreciated. We stand ready to supply further consultation on your request.

Sincerely yours,

James B. Coulter

James B. Coulter
Acting Chief
Technical Services Branch
Division of Water Supply
and Pollution Control

LAKE KEMP, WICHITA RIVER, 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

28 August 1962

SUBJECT: Lake Kemp, Wichita River, Texas

TO: THE SECRETARY OF THE ARMY

1. I submit for transmission to Congress the report of the Board of Engineers for Rivers and Harbors, accompanied by the reports of the District and Division Engineers on Lake Kemp, Wichita River, Texas, in response to a resolution of the Committee on Public Works of the United States Senate adopted 16 April 1959, with respect to the advisability of modifying and rehabilitating the existing non-Federal Lake Kemp project in the interest of flood control, to operate in conjunction with irrigation, water supply, and other related uses.

2. The District and Division Engineers recommend modification of the Lake Kemp project by replacement of the existing outlet works and spillway with a new combined structure, raising the height of the dam about 3 feet, and strengthening the embankment, to provide 526,000 acre-feet of storage capacity of which 200,000 acre-feet would be allocated to flood control. They estimate the first cost of reconstruction at $8,295,000, and the annual cost of operation, maintenance, and replacements at $79,600. The total annual charges are estimated at $543,500. The estimated average annual benefits are $1,379,000 consisting of $730,000 for flood control and $649,000 for conservation. The benefit-cost ratio is 2.5. The reporting officers apportion $6,410,000 of the first cost to the Federal Government and $1,885,000 to non-Federal interests after crediting them with the replacement costs of the usable portion of the existing dam and present reservoir lands and the cost of all necessary additional lands. Local interests would be required to maintain and operate the modified project and otherwise cooperate. The Federal Government would reimburse local interests annually for their expenditures for operation, maintenance, and major replacements for flood control, and would direct the flood-control operations, all at an estimated annual cost of $45,900.

3. The Board finds that rehabilitation of Lake Kemp dam and the provision of flood control in the reservoir are urgently needed and justified. It recommends reconstruction generally in accordance with the plans of the reporting officers provided that prior to

construction local interests agree to operate and maintain the project in accordance with regulations prescribed by the Secretary of the Army, retain ownership, provide free public access in accordance with the principles of Section 4 of the Flood Control Act of 1944, reimburse the United States for 22.7 percent of the construction cost in equal annual payments, including interest on the unpaid balance, and meet certain other requirements of local cooperation.

4. I concur in the views and recommendations of the Board.

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 25, D.C.

ENGBR

4 May 1962

SUBJECT: Lake Kemp, Wichita River, Texas

TO: Chief of Engineers
Department of the Army

1. Authority and scope.--This report is in response to the following resolution adopted 16 April 1959:

> Resolved by the Committee on Public Works of the United States Senate, That the Board of Engineers for Rivers and Harbors, created under Section 3 of the River and Harbor Act, approved June 13, 1902, be, and is hereby, requested to review the reports on Red River and Tributaries, Texas, Oklahoma, Arkansas, and Louisiana, published as House Document Numbered 488, Eighty-third Congress, Second Session, and other reports, with a view to determining whether the recommendations contained therein should be modified in any way at the present time, with particular reference to the advisability of modifying and rehabilitating the existing non-Federal Lake Kemp project, located on Wichita River, Texas, in the interest of flood control to operate in conjunction with its irrigation, water supply, and other related uses.

The report considers general plans to reconstruct the non-Federal Lake Kemp Dam on Wichita River about 70 miles above Wichita Falls, Texas, by providing a new spillway and outlet works, and raising and strengthening the dam to prevent possible failure. It is favorable to the improvement subject to certain local cooperation including a cash contribution.

2. Description.--Wichita River, formed at mile 154 by the junction of its North and South Forks, is a south bank tributary to Red River at about mile 907. The long narrow basin drains a sub-humid area of 3,483 square miles in north-central Texas. The drainage area above Lake Kemp Dam at mile 126.7 is 2,099 square

miles and that between Lake Kemp and Wichita Falls at the mouth of Holliday Creek is 1,242 square miles. Below Lake Diversion, about mile 106, are three main tributaries--Beaver, Buffalo, and Holliday Creeks--with drainage areas of 629, 101, and 175 square miles, respectively. Holliday Creek, dammed at mile 9.3 to form Lake Wichita, and the Wichita River both flow for about 10 miles through the city of Wichita Falls and cause considerable flood damages. Average annual rainfall ranges from 22 inches in the western part of the basin to 28 inches in the eastern. Evaporation averages 95 inches annually. The mean annual runoff from the basin above Lake Kemp is 185,400 acre-feet, equivalent to a flow of 256 cubic feet per second; however, there have been long periods of low flows and no flow at times. The channel capacity of Wichita River varies from 6,200 to 7,500 cubic feet per second from Lake Kemp to Wichita Falls and averages about 7,400 cubic feet per second below Holliday Creek. The slope of the main stem averages about 1.7 feet per mile below Lake Kemp.

3. Improvements.--There are no existing or authorized flood-control projects in the Wichita basin. Local interests constructed: Lake Kemp, with a present storage capacity of 461,800 acre-feet, in 1923 for irrigation and water supply; Lake Diversion, with a capacity of 40,000 acre-feet, for secondary storage and diversion of flows for irrigation; an irrigation system capable of irrigating about 90,000 acres of land; Lake Wichita in 1901, with a present capacity of 15,000 acre-feet, for irrigation and water supply; and Santa Rosa Lake on Beaver Creek, with a storage capacity of 7,000 acre-feet in 1929, for irrigation, but it is now used for stock watering and industrial water supply.

4. Condition of Lake Kemp Dam.--Lake Kemp Dam is 99 feet high, 7,980 feet long, and has a top width of 25 feet. It was constructed by hydraulic-fill methods with upstream and downstream slopes varying from 1 on 2 near the crown to 1 on 3 near the base. The dam has an impervious clay core and a 1,380-foot-long steel sheet-piling cutoff wall. The earth-fill dam and upstream riprap are in reasonably good condition. The concrete hollow-buttress weir spillway is 590 feet long and 12 feet high. The concrete is of poor quality, cracked, and spalled. The exposed reinforcing steel is badly rusted. The capacity of the spillway is inadequate. The outlet works consist of two 7-foot diameter conduits controlled by electrically operated gates and appurtenances. The gatehouse is tilted from differential settlement which occurred soon after impoundment began. The capacity

of the outlets is 2,800 cubic feet per second at spillway crest level. Some leakage is occurring. Failure of the spillway is considered likely by consulting engineers if subjected to a large flood.

5. Operation of Lake Kemp.--Since 1926, local interests have maintained a conservation pool of about 288,000 acre-feet, about 10 feet below spillway crest, and water has never been wasted over the spillway. About 190,000 acre-feet of conservation storage has satisfied requirements and the remainder is needed for sedimentation. Although 39,500 acres of land are classified as irrigable, the largest acreage irrigated was 33,000 acres in 1928. In 1958, only 10,700 acres were irrigated. About 36 percent of the area is suitable for pasture sod and the rest for general crops which are not limited in yield by the soluble salt content of 1,700 to 2,000 parts per million in Lake Kemp water.

6. Existing recreational development.--Lake Kemp is the largest water area in the region and attracts people from an area within 150-200 miles of the project for boating, fishing, water sports and hunting. The lake and its environs provide excellent duck and goose hunting. Visitor attendance in 1961 is estimated at 275,000. Management and control of the lake are a part of the Water District operation. The lands around the lake are a part of a single ranch which is fenced to prevent straying of cattle. However, entrance to the public is controlled at three locations which permit, for a fee, use of the entire lake and concession services. The dam site is available for unrestricted access. Services provided by the ranch include more than 30 miles of roads servicing the lake shore and the many peninsulas. This road system has been developed and maintained by the ranch, with participation by the county. Development of the lake area consists of the roads, three boat-launching ramps, two small concessions, and grocery stores at two of the three entrance stations. There has been a large development of private housing bordering protected coves where boathouses are permitted. More than 600 units have been placed on the lake shore under a lease from the ranch. The use of the lake is under jurisdiction of the Water District. Rules and regulations are made by the District and enforced by patrolmen employed by the District. Safety rules govern areas reserved for swimming and fishing, the use of the shoreline for boathouses, piers, and buoys, and the safe operation of boats on the lake. A nominal service fee of $1.10 per car, of which 10 cents is Federal tax, is charged at the three controlled entrances--irrespective of length of continuous stay. The entrance fee provides for development

89691 O-62—2

and maintenance of roads and no restrictions are placed upon the access or use of the lake shore and lake by the public, other than the safety regulations promulgated by the Water District.

7. Floods and flood damages.--Storage space in Lake Kemp in excess of conservation needs has furnished flood protection. Without Lake Kemp, three storms would have produced disastrous flooding; flooding at Wichita Falls, about 70 miles downstream, would occur on the average of once a year in minor amounts, each 5 years in moderate amounts, and each 10 years in major amounts. The maximum flood of record occurred in 1899. The largest flood in recent years, May 1941, with a natural peak discharge of 33,500 cubic feet per second and a stage of 31.8 feet at Wichita Falls was reduced to a peak discharge of 12,900 cubic feet per second and a stage of 21.18 feet. It is estimated that, under expected future conditions without Lake Kemp, the average annual flood damages would amount to $1,015,000 of which one-half would be at Wichita Falls.

8. Improvements desired.--Local interests state that the spillway and outlet works at Lake Kemp have deteriorated and are in need of repair or replacement to prevent failure. They request the United States to rehabilitate the structures at Federal expense and direct operation of flood-control storage in Lake Kemp.

9. Improvements proposed.--The District Engineer finds, after consideration of various amounts of flood-control storage in Lake Kemp and several alternative projects, that 200,000 acre-feet of flood-control storage should be provided at Lake Kemp. This amount of storage would prevent about 72 percent of all expected losses from floods having a frequency of not more than once in 50 years. In his opinion, storage in excess of 200,000 acre-feet would not be justified. Runoff from the large area intervening between Lake Kemp and Wichita Falls can produce major floods at Wichita Falls and on lower Wichita River. The District Engineer proposes replacement of the existing outlet works and spillway with a new combined structure, raising the height of the dam 3 feet, and strengthening the embankment to provide a total storage capacity of 526,000 acre-feet of which 200,000 acre-feet would be allocated to flood control.

10. Costs and feasibility.--The District Engineer estimates the first cost of reconstruction at $8,648,000, based on July 1960 prices, including $35,000 for preauthorization studies. He estimates the replacement value of the usable portion of the existing works at $3,961,000, consisting of $2,130,000 for lands and $1,831,000 for embankment. He finds the total value of the reconstructed project to be $12,609,000. The annual charges for the new work and usable existing works are $543,000 based on a 50-year period of analysis and an interest rate of 2.625 percent annually for both the Federal and non-Federal investments. The estimated annual maintenance and operation costs are $79,600 of which $45,900 would be for flood control. He estimates the average annual benefits at $1,379,000, including $730,000 for flood control and $649,000 for irrigation, without evaluating wildlife benefits or recreation benefits which are now, and under his plan would remain, under private control. The benefit-cost ratio is 2.5.

11. Local cooperation.--The District Engineer allocates the total cost of the new work and the usable portion of the existing facilities using the use-of-facilities method and determines that flood control should bear $6,410,000, not including $35,000 for preauthorization studies, and conservation, $6,164,000. He apportions $6,410,000 in first cost to the Federal Government and provides for annual reimbursement to local interests of the flood-control portion of the annual cost of maintenance, operation, and major replacements, estimated at $35,900. Of the $6,164,000 assigned to non-Federal interests for all conservation uses, he credits them with $1,831,000 for providing the usable portions of the existing dam and $2,130,000 for the present reservoir land, and $318,000 for furnishing all necessary additional lands, resulting in a cash contribution of $1,885,000 determined as follows:

Item	Amount
First cost allocated to conservation	$6,164,000
Credits, at replacement values:	
Usable portion of existing embankment	- 1,831,000
Existing reservoir lands	- 2,130,000
New lands	- 318,000
Net non-Federal contribution	$1,885,000
Percent of net construction cost:	
$1,885,000 ÷ $8,295,000 x 100 =	22.7

The District Engineer proposes that local interests continue to maintain and operate the entire project, operate the flood-control features under Federal regulations, make all relocations, hold and save the United States free from damages, provide all lands and rights-of-way, and adopt and enforce regulations to preserve the existing capacity of the channel through Wichita Falls and prevent further encroachment.

12. Recommendations of the reporting officers.--The District Engineer concludes that Lake Kemp facilities urgently need repair or replacement for safe operation, flood control is justified and can be included without detriment to conservation, and Federal participation is warranted. He recommends reconstruction by the United States subject to local cooperation and with the provision that local interests be authorized to repay their share in equal annual payments, including interest on the unpaid balance, over a period of not more than 50 years after construction. The Division Engineer concurs.

13. Public notice.--The Division Engineer issued a public notice stating the recommendations of the reporting officers and affording interested parties an opportunity to present additional information to the Board. Careful consideration has been given to the communications received.

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

14. Views.--The Board of Engineers for Rivers and Harbors agrees that reconstruction of the Lake Kemp facilities is urgently needed. The recommended work providing dependable storage for flood control is economically justified by a substantial margin. Although the methods of project formulation, economic analysis, and cost apportionment employed by the District Engineer differ from normal practice, the Board accepts the results as reasonable for the unique conditions prevailing. Because of possible failure of the existing structure during an extreme flood, authorization and accomplishment of the project should not be further delayed. The Board notes that the degree of protection which would be afforded by the improvement is relatively low compared to the standard project flood. It believes that local interests should adequately inform interests affected that the reservoir modified as proposed will not provide protection against maximum floods. The Board also believes that, insofar as recreational use of the facility is concerned, local interests should provide free public entrance to the modified Lake Kemp reservoir area in accordance

with the principle of access stated in Section 4 of the Flood Control Act of 1944. The Board considers that the provision of access free of charge at three appropriate places around the reservoir would satisfy this requirement.

15. Recommendations.--The Board accordingly recommends the reconstruction of Lake Kemp Dam on the Wichita River, Texas, to provide for the specific allocation of 200,000 acre-feet of the storage to flood control, 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 of $8,295,000 for Federal construction and estimated annual costs to the United States of $10,000 for direction of the operation for flood control and of $35,900 for reimbursing local interests annually for their operation and maintenance expenditures for flood control: Provided, That prior to construction local interests furnish assurances satisfactory to the Secretary of the Army that they will:

a. Retain ownership and operate and maintain the project for a minimum period of 50 years after completion;

b. Maintain the project and operate the flood-control features in accordance with regulations prescribed by the Secretary of the Army;

c. Accomplish without cost to the United States all relocations and alterations of existing buildings, highways, bridges, sewers, and related and special facilities;

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

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

f. Adopt and enforce regulations to preserve the existing capacity of the channel through the city of Wichita Falls and prevent further encroachment;

g. Adequately inform affected interests annually concerning the probability of residual damages after construction of the modifications;

h. Provide free access to the lake in accordance with the principles of Section 4 of the Flood Control Act of 1944; and

i. Contribute 22.7 percent of the cost for the Federal construction, a contribution presently estimated at $1,885,000, in equal annual payments, over a period of not more than 50 years beginning at the completion of construction, including interest on the unpaid balance at the rate prescribed at the time of construction for projects of this type.

FOR THE BOARD:

WILLIAM F. CASSIDY
Major General, USA
Chairman

S Y L L A B U S

The District Engineer finds that Lake Kemp, a non-Federal reservoir completed in 1923, is a potential hazard to the valley because of deterioration of the spillway and outlet works, and that major reconstruction is required to make the facility safe for future operation. He finds that there is a flood problem on the Wichita River and that flood control storage in Lake Kemp would substantially reduce that problem. He finds that reallocation of a portion of the available storage for flood control purposes can be accomplished without detriment to the present conservation uses. He recommends that the reconstruction of Lake Kemp be accomplished by the United States on the condition that local interests make an equitable cash contribution toward the cost of reconstruction, hold and save the United States free from damages due to construction, retain ownership and jurisdiction of the project, maintain it, and operate the flood control storage as directed by the Secretary of the Army.

U. S. ARMY ENGINEER DISTRICT, TULSA
CORPS OF ENGINEERS
TULSA, OKLAHOMA

November 15, 1961

SUBJECT: Lake Kemp, Wichita River, Texas - Survey Report

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

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

1. AUTHORITY

Authority for this study is contained in a resolution of the U. S. Senate Committee on Public Works, adopted April 16, 1959, which reads as follows:

> "Resolved by the Committee on Public Works of the United States Senate, that the Board of Engineers for Rivers and Harbors, created under Section 3 of the River and Harbor Act, approved June 13, 1902, be, and is hereby, requested to review the reports on Red River and Tributaries, Texas, Oklahoma, Arkansas and Louisiana, published as House Document Numbered 488, Eighty-third Congress, Second Session, and other reports, with a view to determining whether the recommendations contained therein should be modified in any way at the present time, with particular reference to the advisability of modifying and rehabilitating the existing non-Federal Lake Kemp project, located on Wichita River, Texas, in the interest of flood control to operate in conjunction with its irrigation, water supply and other related uses."

2. EXTENT OF INVESTIGATION

a. The primary purpose of this investigation is to determine the advisability of Federal participation in making certain modifications to the existing non-Federal Lake Kemp in the interest of flood control. Irrigation, water supply, and the associated purposes of recreation and fish and wildlife are the primary uses of the existing project. The study showed that the facilities provided by the project for these purposes satisfactorily serve the present and anticipated future needs. However, consideration was given to these project purposes to make sure

that the plans involving flood control would maintain or improve the project for recreation and fish and wildlife uses. The addition of hydroelectric power facilities was found to be impractical due to inadequate stream flow, high evaporation rates, and the low power head available in the existing and contemplated reservoirs. The topography of the area does not provide sufficient head for a pumped-storage power plant.

b. Field work included topographic surveys and subsurface explorations at a site considered for a new spillway, obtaining channel and valley sections below the dam, and review of the economic conditions in the flood plain.

c. Data available, prior to the study, included a flood control evaluation made in 1959 by the Corps of Engineers for local interests in conjunction with an application for assistance under the Small Reclamation Projects Act of 1956; a Soil Conservation Service report on sedimentation in Lake Kemp, dated January 1959; a consulting engineer's report (of 1958) on a plan for a new spillway at Lake Kemp; and engineering and technical data supplied by local interests.

d. The Bureau of Reclamation, the U. S. Fish and Wildlife Service, and the Public Health Service furnished specific data related to the investigations.

e. Office studies included an analysis of hydrologic and economic data, structural planning, and the development of estimates of costs and benefits.

f. The District Engineer made a reconnaissance of the area and discussed the problems and proposed solutions with local interests.

3. PRIOR REPORTS

a. House Document No. 378, 74th Congress, published in 1936, is a report on Red River and Tributaries, which considered the development of power at the existing Lake Kemp and Lake Diversion Reservoirs on the Wichita River. The Chief of Engineers made no specific recommendations regarding improvements on Wichita River.

b. House Document No. 488, 83d Congress, 2d Session, published in 1954, is a review report on Red River and Tributaries, which considered the use of storage in Lake Kemp for flood control and the partial reconstruction of the dam and appurtenances to assure its continued effectiveness. Utilization of storage in Lake Kemp primarily for flood control was found to be unjustified at that time.

4. DESCRIPTION

a. Watershed. The Wichita River watershed, located in north central Texas, is approximately 154 miles long and averages about 23

miles in width. It comprises an area of 3,483 square miles, of which 2,099 square miles are upstream from the Lake Kemp project. In the western upland area, the watershed consists of gently rolling prairies with relatively steep broken hilly area near the stream valley. In the eastern portion of the basin, the watershed is a slightly rolling plain with some hilly areas, characterized by rough, broken terrain. Elevations in the basin vary from about 2,300 feet above mean sea level in the western part to about 900 feet above mean sea level at the mouth of the river. The location and extent of the Wichita River watershed and the existing Lake Kemp are shown on plate I.

b. Stream. The Wichita River, on which Lake Kemp is located, is formed by the junction of its North and South Forks, near the Knox-Baylor County line. Both forks have their sources in Dickens County. From its source, the Wichita River flows about 258 miles in a general easterly direction to enter the Red River at mile 907.0. The principal tributaries below Lake Kemp consist of Beaver, Buffalo and Holliday Creeks. Beaver Creek, a left-bank tributary, has its confluence with the Wichita River at mile 89.4 and drains an area of 629 square miles. Buffalo Creek, with a drainage area of 101 square miles, enters the Wichita River at mile 70.5. Holliday Creek flows from the south through Wichita Falls and enters the Wichita River at mile 46.9 and drains an area of 175 square miles.

c. Channel and valley. The channel of the Wichita River is well-defined, and varies in width from about 75 feet below Lake Kemp to about 300 feet near its mouth. The banks are generally stable and vary in height from 10 to 27 feet. The flood plain downstream from Lake Kemp Reservoir varies from 1 to 5 miles in width. The bottom lands lie in flat benches or terraces, and in many places appear to be nearly level, although there is a gentle slope toward the main channel.

d. Geology and soils. The Wichita River watershed lies in the Osage Plains Section of the Central Lowlands Physiographic Province. The predominant geological formations are of Permian Age. Sandstone, shales, limestones, dolomites and gypsum beds are the principal outcropping formations. Soil cover on the uplands is rather thin and supports only a scattered growth of mesquite trees and native prairie grasses. The valleys are fertile and well-suited to the production of crops, especially when irrigated. Where not cultivated, the valley lands support good stands of native grasses, ideal for cattle grazing.

5. ECONOMIC DEVELOPMENT

a. Population. The Wichita River Basin involves parts of 11 counties, which have a total estimated present population of about 185,000 (1960 census data). It is estimated that approximately 131,000 people reside within the Wichita River Basin. Approximately 118,000 of the total population of the basin are concentrated in Wichita County, and the 1960 census shows a population of 101,724 in the city of Wichita Falls. This is the largest city in the basin and is the center

of the industrial and commercial activities for the entire trade area. Other towns wholly or partially in the watershed are Crowell, Electra, Iowa Park, Paducah and Guthrie, in which a large percentage of the remaining population resides. The rural area of the basin is very sparsely populated.

b. Industrial development. The principal industrial development in the basin is located at Wichita Falls. This city is the principal manufacturing, wholesale, distribution and commercial center for a large area in north central Texas and southwestern Oklahoma. The leading industry in the basin is the production and processing of petroleum and petroleum products. Other important industries consist of foundries, factories, grain elevators, bakeries, metal fabrication, production of stone, clay and chemical products, processing of food, and printing and publications.

c. Agricultural development. There are extensive ranching and agricultural developments in the area. Most of the watershed is devoted to production of agricultural products, livestock raising, and production of livestock and dairy products. In the uplands and rolling prairies of the western section, large ranches predominate and the land is used almost entirely for grazing and supports large numbers of cattle and other livestock. In the lower valley or eastern section, the lands are better suited for the growing of crops. Principal crops grown in the flood plain are wheat, cotton, grain sorghum, alfalfa, corn and oats.

d. Transportation facilities. Transportation facilities are provided by modern highways, railroads and airports. Federal and State highways and railroads cross the basin in general east-west and north-south directions, affording access to important markets of the Southwest.

e. Supplemental data. Additional data concerning the economic aspects of the area, including additional information and details on population, industry, resources and trends, are included in supplement A to this report.

6. CLIMATOLOGY

The climate of the Wichita River Basin is temperate and sub-humid, with long summers and short winters. Warm summers, with frequent long periods of hot, dry weather, develop high evaporation rates with respect to surface waters. Winters are relatively mild, with short intermittent periods during which the temperature may drop below zero. The average annual temperature for the basin is about 63 degrees Fahrenheit. A maximum temperature of 113 degrees and a minimum of minus 12 degrees have been recorded in the basin. The normal annual rainfall over the basin averages about 24 inches.

7. RUNOFF AND STREAM FLOW DATA

The relatively low annual rainfall, high evaporation rates, and the character of the topography, soil, and ground cover result in

relatively low annual runoff in the Wichita River Basin. Moderate to intense rainfall is occasionally experienced which can produce rapid runoff. Streamflow records are available for the gaging station at Wichita Falls. Stage records are also available for reservoir storage at Lake Kemp. Estimates based on rainfall records and streamflow data indicate that the mean annual runoff from the basin above Lake Kemp amounts to 185,400 acre-feet, which is equivalent to approximately 256 cubic feet per second (cfs). The Wichita River is known to have had periods of zero flow and prolonged periods of low-flow.

8. EXISTING CORPS OF ENGINEERS' PROJECTS

There are no existing or authorized Corps of Engineers' projects in the Wichita River Basin.

9. IMPROVEMENTS BY OTHER FEDERAL AND NON-FEDERAL AGENCIES

a. The major existing improvements in the basin include Lake Kemp and Lake Diversion on the main stem of the Wichita River, and their related system of irrigation canals; Lake Wichita on Holliday Creek; and Santa Rosa Lake on Beaver Creek. All of these improvements have been constructed by non-Federal interests.

b. Lake Kemp, located at mile 126.7 of the Wichita River, was completed in 1923 by the Wichita County Water Control and Improvement District No. 1, primarily for irrigation and water supply, and is now owned and operated by Wichita County Water Improvement District No. 2 and the City of Wichita Falls. Its present storage capacity is 461,800 acre-feet.

c. Lake Diversion is located on the Wichita River, about 20 miles downstream from Lake Kemp. It has a storage capacity of 40,000 acre-feet. This project was constructed by the Wichita County Water Improvement Districts Nos. 1 and 2 for operation in conjunction with Lake Kemp, and is now owned and operated by Wichita County Water Improvement District No. 2 and the City of Wichita Falls. It is a secondary-storage reservoir with diversion facility, and, except for runoff from the intervening watershed, receives all its water from releases at Lake Kemp. Lake Diversion is operated as a run-of-the-river project.

d. The irrigation system, owned and operated by Wichita County Water Improvement District No. 2 and the City of Wichita Falls, consists of a main canal which leads eastward from Lake Diversion dam and a network of laterals and drainage ditches. The system is capable of making water available to irrigate approximately 90,000 acres of tillable land.

e. Lake Wichita is located at mile 9.3 of Holliday Creek, immediately upstream from the city of Wichita Falls. This reservoir was constructed in 1901 by private interests for irrigation and water supply purposes. The City of Wichita Falls obtained title to the project

in 1920. The lake is now used primarily for recreational purposes, but provides supplemental industrial water during emergencies. Its present estimated storage capacity is 15,000 acre-feet.

f. Santa Rosa Lake is located on Beaver Creek, a tributary entering the Wichita River about 14 miles below Lake Kemp. The reservoir was built in 1929 for irrigation purposes, but at the present time is being used almost exclusively for stock watering and as a source of industrial water for oilfields and refineries located downstream from the dam. It has a storage capacity of approximately 7,000 acre-feet.

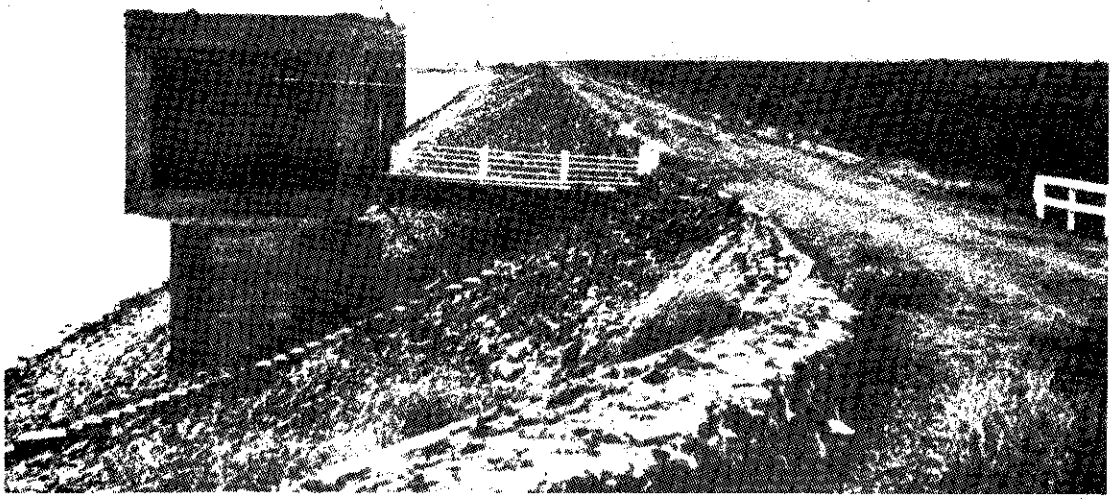
10. IMPROVEMENTS DESIRED

Public hearings were held at Wichita Falls, Texas, on July 7, 1944 and December 15, 1959. A summary digest of the latest hearing is presented in appendix VIII. Attending the hearing were representatives of other Federal agencies, officials of the City of Wichita Falls, officials of Wichita County Water Improvement Districts Nos. 1 and 2, representatives of local newspapers and television and radio stations, and other local interests. These interests presented information on the value of Lake Kemp in preventing floods on the Wichita and Red Rivers. They stated that the spillway and outlet works have deteriorated and are in need of repair or replacement to prevent failure of the structure. Because of the hazard that exists in the possibility of failure of the spillway and outlet works, local interests requested that the Federal Government rehabilitate these facilities at Government expense, and thereafter direct operation of flood control storage in Lake Kemp in conjunction with other flood control projects in the Red River Basin.

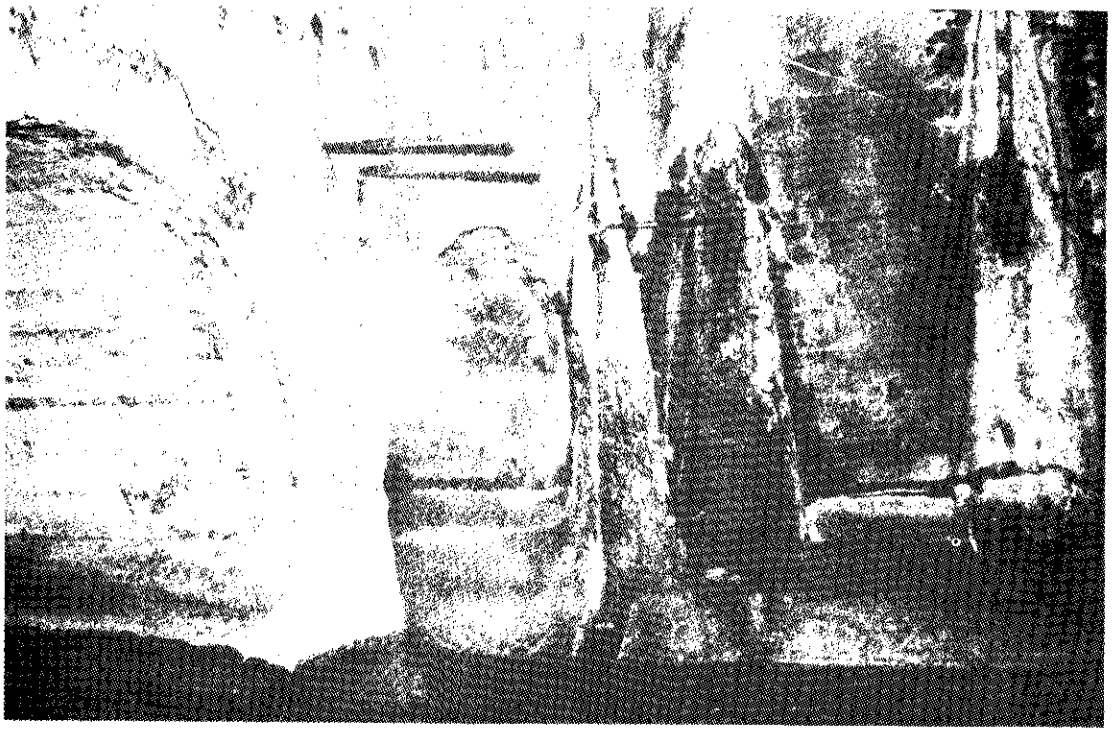
11. STRUCTURAL PROBLEMS AT LAKE KEMP

a. General. The Lake Kemp Dam is located about 40 miles southwest of Wichita Falls, Texas. Access to the site is provided by U. S. Highways 183 and 283. The existing project was constructed by the Wichita County Water Control and Improvement District No. 1 during the period 1921-1923 and is now owned and operated by Wichita County Water Improvement District No. 2 and the City of Wichita Falls. Existing improvements consist of the dam, an uncontrolled spillway and outlet structure. The land surrounding the impoundment is privately-owned, and access to the land and to the water is controlled by the owner. Through a fee entrance charge, recreational use is permitted for fishing, boating, swimming, etc.

b. Dam. The 7,980-foot-long dam was constructed by hydraulic fill methods. It has a maximum height of 99 feet and a top width of 25 feet. The slope of both the upstream and downstream faces of the dam varies from 1-on-2 near the crown to 1-on-3 near the base. The upstream slope of the dam is protected by one and one-half feet of riprap with 8 inches gravel backing which extends from the top of the

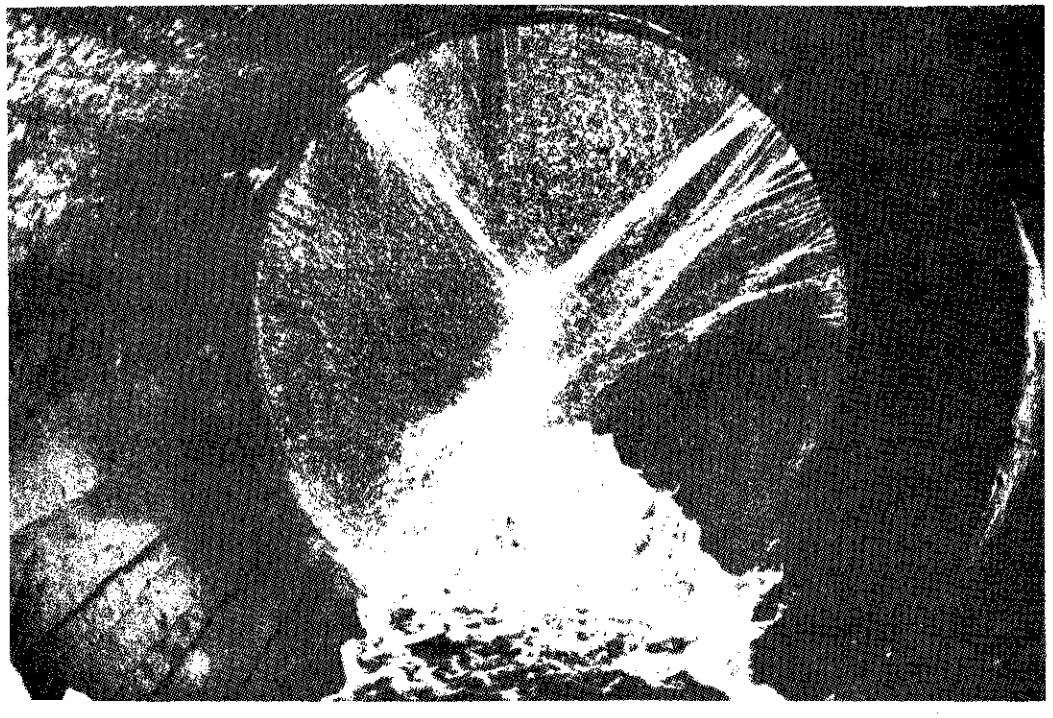


Lake Kemp Dam and Outlet Gate Tower

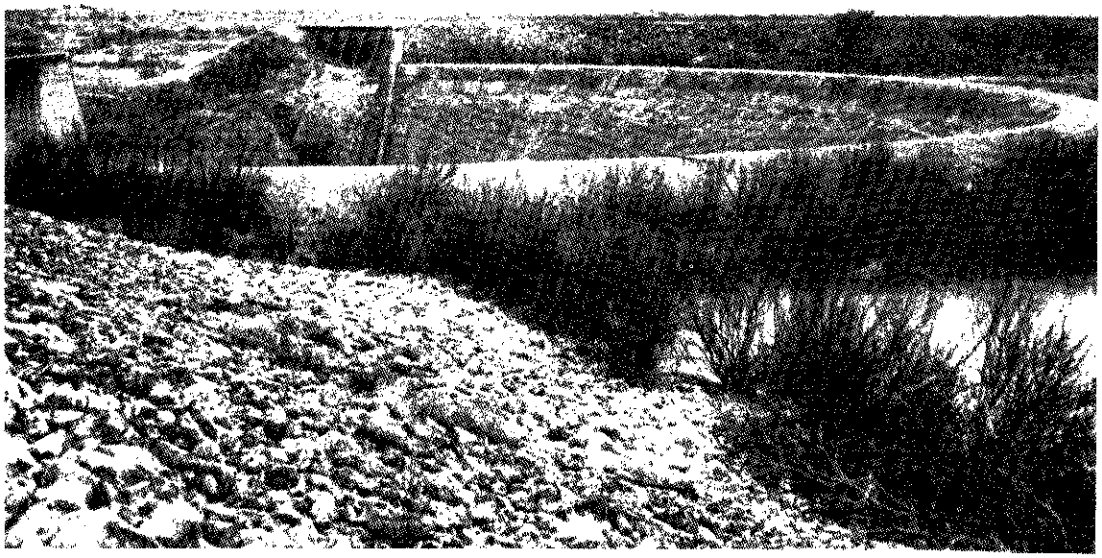


Cracks and Seepage Discolorations Around Outlet Conduits
at Discharge End

Lake Kemp Outlet Conduits
Encrustations and Cracks in Conduit (Note Pencil)

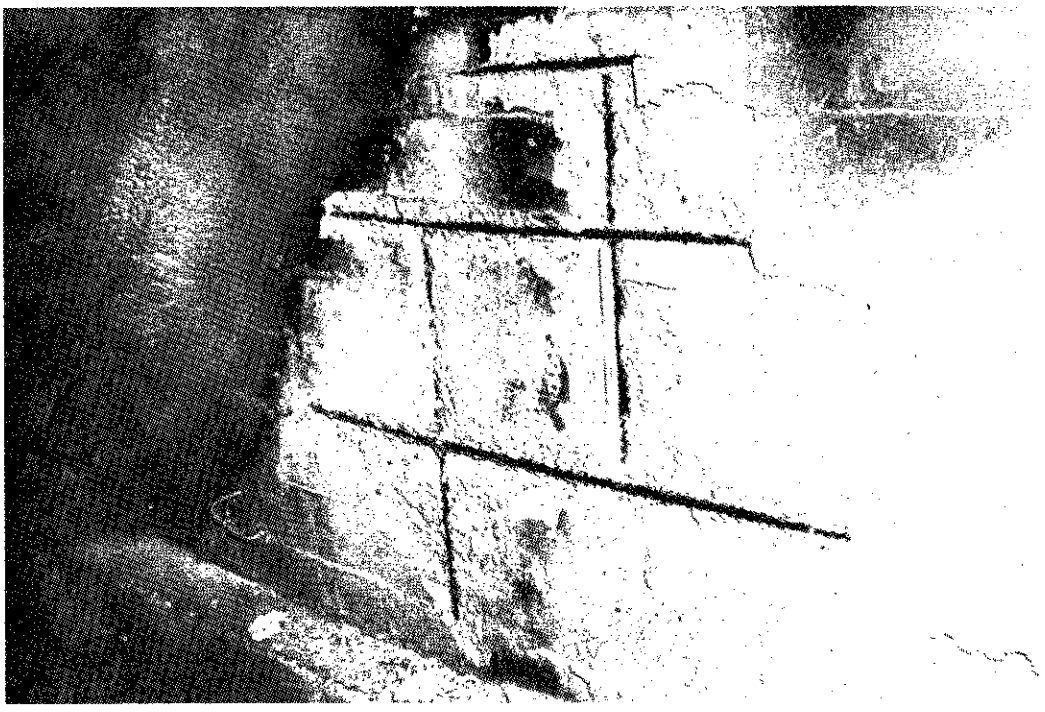


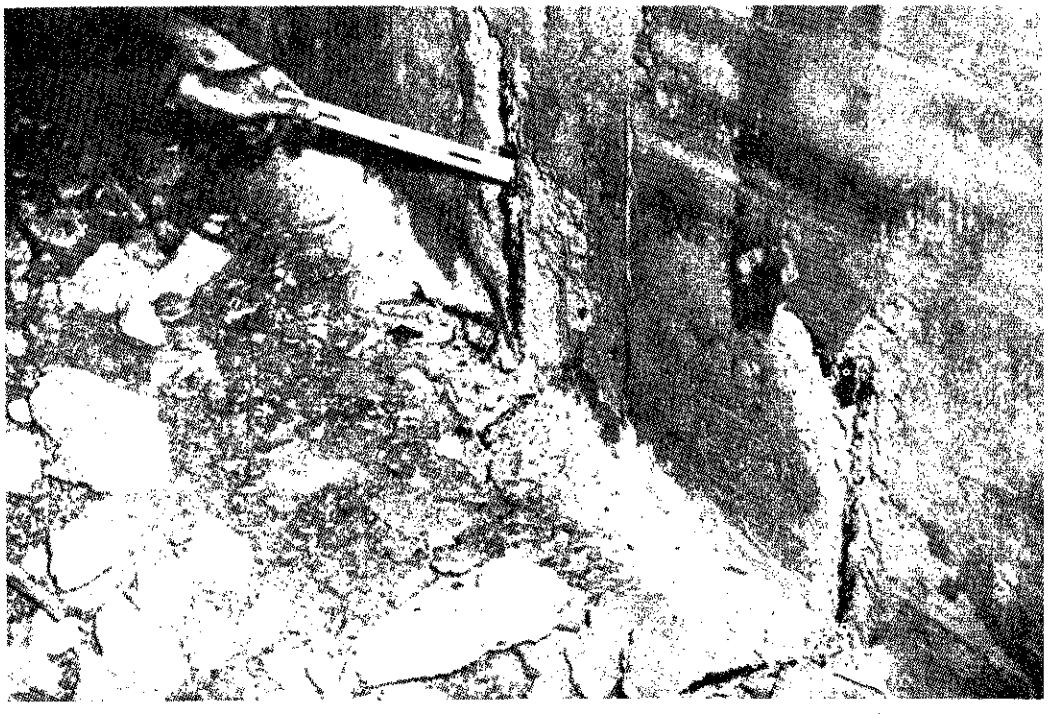
Leakage Around Conduit Gate. Minor Seepage
Noted Around Gate in Other Conduit



Lake Kemp Spillway

Downstream View of Spillway Showing Cracks at Base of Hollow Buttress Weir. (Note Book and Cigarette Package.)





Lake Kemp - Interior Views of Spillway
Spalling, Cracks and Exposure of Reinforcement is Evidenced on
Practically All 69 Buttress Walls. Two Examples Shown.

89691 O–62—3

dam to its base. The dam has an impervious clay core and has a 1,380-foot-long steel sheet piling cutoff wall. A gravel-surfaced service road 20 feet wide is provided along the crown. The earthfill dam and the upstream riprap are in reasonably good condition. It is considered that this portion of the existing project will be serviceable for an extended period of time.

c. Spillway. The existing spillway structure consists of a concrete hollow buttress ogee weir, semi-circular in shape, with a crest length of 590 feet and a height of about 12 feet. The chute and apron portion of the spillway below the base of the weir consists of a thin concrete surface placed on a rock base. The face of the weir has a horizontal crack immediately above its base, which extends the full perimeter of the weir section. The crack is sufficiently wide to admit light into some of the interior compartments of the spillway. The exterior and interior surfaces of the weir were coated with gunite several years ago, which has since scaled in many places. The interior buttress walls have not been treated and the steel reinforcing bars in these walls are rusting. In some cases, about half the cross-sectional area of steel has rusted away. Some of the exposed steel reinforcing bars appear to be buckled. Spalling of the concrete has exposed the steel in many places. Much of the spalled concrete is quite soft and easily crumbled. Some of the buttress walls are cracked, indicating that some settlement has occurred. In addition to its deteriorated condition, the spillway is considered grossly inadequate in capacity to handle floods of the magnitude the watershed is capable of producing. Replacement of the spillway is essential for safe operation of the project in the future.

d. Outlet works. The outlet works, located near the right abutment and encased by the embankment, consists of two 7-foot-diameter conduits, each equipped with electrically operated gates; a concrete approach apron 50 feet wide and 69 feet long, equipped with training walls; a stilling basin 117 feet long and varying in width from about 51 feet to 68 feet, built in 2 sections, each having an end sill, the two end sills being about 20 feet apart; and a gate structure. Four additional conduits, which were used for diversion purposes during construction, have been plugged with steel and concrete bulkheads. The gate house structure is tilted as a result of settlement which occurred soon after impoundment began. The capacity of the two service conduits is 2,800 cfs with pool at spillway crest level, elevation 1153.0. Stains around a crack in a construction joint in the west service conduit indicate that some material from the embankment has leached from the vicinity of the cutoff wall outside the construction joint. While the outlet works is in somewhat better condition than the spillway, it is also deteriorated. Inspection of the outlet conduits shows opening of construction joints and cavitation of concrete. Some leakage of water is occurring. Failure of this structure could cause an excessive amount of water to be discharged into the Wichita River below Lake Kemp, which would produce flooding at Wichita Falls and on extensive rural areas. Failure of the Lake Kemp Dam could possibly lead to failure of the existing downstream Lake Diversion Dam.

12. IRRIGATION SYSTEM

The majority of lands now served with irrigation water from Lake Kemp Reservoir lies within District No. 2. Within the District there are approximately 55,000 acres, including 39,500 acres classed by the District as suitable for irrigation. Of this area, the largest acreage was irrigated in 1928, when 33,000 acres were in crops. In 1958, 10,700 acres were irrigated. The lands are served by a canal system which diverts from the Wichita River at Diversion Lake, some 18 river miles below Lake Kemp. The South Side Canal is 34 miles long and the North Side Canal is 30 miles long. The entire lateral system is 148 miles in length, making a total system owned, operated, and maintained by the District of 212 miles. All water is delivered to the irrigated lands by gravity; there are no pumps or pumping equipment. In general, it can be said that about 36 percent of the area that could be irrigated is best adapted to sod crops, such as Coastal Bermuda grass which requires no cultivation after being established. Large amounts of water required for leaching are beneficial to the grass. The remaining 64 percent of the area is suitable for general farm crops. The coarse and moderately-coarse textured soils could be planted to intensively cultivated crops such as vegetables. Lake Kemp water ordinarily contains a total of 1,700 to 2,000 parts per million total soluble salts. The quality of water actually used for irrigation from Lake Diversion is slightly better than the Lake Kemp water. Where soils are properly drained, the water quality does not materially limit the yields of farm crops. General farm crops such as grain sorghum, forage sorghum, cotton, small grains, and grass have not been limited in yield by water quality except for a few times. Records of State and Federal agencies establish the size of a typical irrigated farm in the District to be about a 200-acre farm, containing 145 irrigated acres and 55 acres of dryland native pasture. District records for the 5 years 1955-1959 show that about 60 percent of the irrigation land is in cultivation, and agricultural leaders in the area believe that the land-use trend is toward a greater use of irrigated pastures. Livestock is a basic enterprise in the area. Agricultural representatives interviewed by the Bureau of Reclamation expressed the opinion that irrigated cropland in the Wichita valley is worth twice the non-irrigated cropland. For this area, the Bureau of Reclamation estimates total net farm income of $517,000. Farm sales, due to irrigation, are estimated at $1.95 million annually. Loss of irrigation would cause a very noticeable effect upon the local economy. Many of the intangible benefits resulting from irrigation would be lost, while others would be greatly reduced by the movement of families away from the area and loss of local income.

13. OPERATION PROBLEMS AT LAKE KEMP

As previously reported, local interests constructed Lake Kemp for the primary purposes of irrigation, water supply, and related uses. All the storage releases from Lake Kemp flow by gravity into Diversion Reservoir. Water diverted from Diversion Reservoir is used mostly for irrigation, but some is used as an emergency municipal water supply

stand-by and for oil well drilling, oil well water-flooding, refineries and other commercial uses. A representative of the Water Improvement District advised that the last 50,000 acre-feet of storage in Lake Kemp is reserved for water supply by the City of Wichita Falls, and that there are no other binding contracts. Since 1926, local interests have maintained a conservation pool of about 288,000 acre-feet at a level 10 feet below spillway crest, and water has never been wasted over the spillway. However, inflow into Lake Kemp in 1941, 1950, 1955 and 1957 reached respective elevations of 1.0, 2.2, 1.1 and 2.8 feet below the spillway crest level. In January 1958, consulting engineers employed by the Wichita County Water Control and Improvement District No. 1 to inspect the spillway at Lake Kemp reported, among other things:

> "that the existing spillway is weakened by age and is inadequate to handle the floods which can be expected to pass through Lake Kemp in the future. Steps should be taken to prevent flood flows from passing over the existing spillway in its weakened state; and considerable additional spillway capacity is needed to provide for the large floods of which the watershed is capable. As matters now stand, a large flood would very likely cause failure of the spillway, with consequent flooding in Wichita Falls and possible damage to Diversion Dam."

Flood damages resulting from possible failure of the existing Lake Kemp spillway have been evaluated as a part of this study. These flood damages would vary in accordance with the flood conditions on the Wichita River at the time of the assumed spillway failure. Should the spillway fail during a period when the Wichita River below the dam was not flooding, failure of the spillway would cause estimated flood damages in the amount of $665,000, of which $119,000 would be crop losses, $436,000 would be losses to rural structures, and $110,000 would be losses to urban structures at Wichita Falls. If the spillway were to fail when the downstream area was experiencing a flood with a frequency of once in 50 years, the added flood losses caused by such failure are estimated at $1,407,000, including $8,000 to crops, $62,000 to rural structures, and $1,337,000 to urban structures at Wichita Falls.

14. PLANNING CONSIDERATIONS

a. From a technical engineering viewpoint, the present structural deficiencies of the spillway and outlet works of Lake Kemp constitute a hazard to the safety and integrity of the structure itself during high impoundment in the reservoir. The present deteriorated condition of the structure creates an "any time" potential catastrophic-type damage to $100,116,000 worth of property and crops, and there always exists a real threat of the possible loss of life for some of the 12,420 persons who normally occupy the areas subject to overflow below Lake Kemp. Even though the spillway at Lake Kemp has not been

operational during the past 35 years, experience in other similar-type areas definitely demonstrates that storms greatly in excess of those experienced can be expected to occur at any time of the year. There seems to be unanimous opinion in the engineering profession that remedial works are a necessity if Lake Kemp is to be continued in its present use for irrigation, water supply, and other asscciated uses. Over the years, there have been recurring expressions and opinions, of both professional technicians and responsible local interests, that continued delay of remedial works increases the risk and likelihood of spillway and outlet works failure. The possible consequences are large, in terms of immediate dollar damage and as measured by the long-run adverse impact to the agricultural economy of the region.

b. Since 1926, local interests have maintained a pool of about 288,000 acre-feet, of which 190,000 acre-feet are for irrigation and emergency water supply uses, and the remainder is needed for sedimentation purposes. This amount of conservation storage has satisfactorily served local interests' past needs and they have requested retention of approximately the same storage for their use in the future. The Bureau of Reclamation has estimated,,on a preliminary basis, that an average of 65,700 acre-feet of water per year would be required to irrigate 18,000 acres of crops and pasture land. As previously reported, the loss of irrigation to this area would cause a very noticeable adverse effect on the local and regional economy. The same amount of conservation storage (190,000 acre-feet) has been used by local interests in the past and is being used at the present time to provide a yield of 70,000 acre-feet of water, and will thus meet the foreseeable needs estimated by the Bureau of Reclamation. It is envisioned that the residual yield of 5,000 acre-feet of water will be used for emergency water supply. The 15,000-acre semi-public lake created by the impoundment of conservation storage can continue to provide day-use recreational opportunities to a four-county-wide region. In consideration of the desires of local interests for the continued dedication of present amount of conservation storage for irrigation and emergency water supply uses, and in view of the contribution that Lake Kemp has made in the past to the going economy of the area (and will and can in the future with appropriate remedial works), it is considered that any remedial reconstruction scheme for Lake Kemp should envision for the future about the same magnitude of conservation storage as now exists (190,000 acre-feet). Studies show the conservation benefits of about $649,000 each year will continue to be realized from the use of conservation storage for irrigation. Studies also show that the cost of a single-purpose reconstructed conservation project is at least $206,000 less each year than the annual benefits.

c. After careful review of engineering findings described herein, the District Engineer is convinced that remedial work to spillway and outlet works must be accomplished before he can favorably consider any recommendations to the Congress regarding the addition of flood control storage space in the Lake Kemp project at Federal expense. In

consideration of adding flood control storage space in a possible reconstructed Lake Kemp, it was recognized that, in the past, storage space in the reservoir not used for conservation has been available for the temporary retention of flood waters. This operation has provided some incidental flood protection on the Wichita River; however, it has not provided inviolate flood control storage, nor have such operational uses been under the supervision of the Secretary of the Army, in consonance with Federal standards. Reliable, positive flood prevention benefits can be obtained only when positive flood control storage is provided in a reconstructed Lake Kemp, or by other alternative equivalent means. On these premises, then, the flood problem along the Wichita River for the next 50 to 100 years is considered to be equivalent to conditions expected to obtain without any existing man-constructed flood control works.

d. According to local information, the maximum flood of record on the Wichita River occurred in 1899. Other major floods are known to have occurred in May 1901, May 1908, April 1915, and June 1915. The floods of May 1941, October 1941 and October 1955 would have produced disastrous flooding if Lake Kemp had been non-existent. It is estimated that, without Lake Kemp, minor flooding would occur at Wichita Falls on an average of once each year, moderate flooding on an average of once every 5 years, and major flooding on an average of once every 10 years. The flood plain area inundated by a repetition of the maximum flood of record between Lake Kemp Dam site and the backwater limits of Red River involves an estimated 34,910 acres, of which 33,240 acres are rural and 1,670 acres are urban lands at Wichita Falls. The estimated present-day (1960) value of property within the area is $100,116,000, of which $348,000 are crops, $10,183,000 are publicly-owned properties, and $89,585,000 are privately-owned properties. It is estimated that under expected future conditions and development on Wichita River downstream from Lake Kemp, but with Lake Kemp considered non-existent, the average annual flood damages would amount to $1,015,000. More than one-half of the losses would be at Wichita Falls.

e. The determination of flood control storage requirements that should be provided in a reconstructed Lake Kemp took into account the estimated volume and peak discharges of historical floods that have occurred; the flood control capacities provided in other projects with similar climatological and hydrological characteristics; the pool elevation probability; what constitutes a reasonable degree of protection; the nature of potential benefits to be expected in the flood plain (particularly the concentration of improvements subject to damage at the city of Wichita Falls, located some 70 miles downstream); and alternative means of providing equivalent flood protection. From these considerations, it was concluded that Lake Kemp offered the most feasible solution to the flood problem of several alternatives considered, and that sufficient storage should be provided in Lake Kemp to control all floods that can be expected to occur at least once in 50 years. The estimated storage requirement to meet this condition is

200,000 acre-feet. Operation of a reconstructed project would provide for releases of not more than bankful capacity at the dam for all floods with a frequency of once in 50 years or less. This reduction in floods will be effective for the entire length of Wichita River, provided there is no runoff entering the stream below the dam. The drainage area between the dam and Wichita Falls (at the mouth of Holliday Creek) is 1,242 square miles. Runoff from this area can produce major floods at Wichita Falls and on lower Wichita River. Studies show that, with a flood control capacity of 200,000 acre-feet, a reconstructed Lake Kemp will prevent about 72 percent of all flood losses expected to be experienced along Wichita River. The provision of more storage to control floods larger than the once-in-50-years flood would not significantly increase the average annual flood losses prevented and would not justify additional costs. Channel improvements, levees, and other local protection projects downstream from Lake Kemp were studied as separate units and in combination with flood control storage in Lake Kemp, but were not found to be economically feasible. However, it was found that significant flood problems also exist on tributary streams, particularly on Holliday Creek and Plum Creek at Wichita Falls. These problems are currently under investigation and are scheduled to be covered in separate reports. The improvements under consideration for these streams would supplement the formulation of plans for modifying Lake Kemp; and, if found to be feasible, would help to solve the serious flood problem at Wichita Falls. Means to control floods caused by runoff originating in the drainage areas from other tributaries below Lake Kemp were considered, but no feasible or practical solutions were developed. The provision of 200,000 acre-feet of flood control storage in Lake Kemp results in a practical and economical solution to the flood problem.

15. RECONSTRUCTION OF LAKE KEMP

a. The plan of improvement provides for the existing spillway and outlet works to be closed off and replaced by a new combined spillway and outlet works. The new structure would be located about midway between the existing spillway and the south end of the dam. It would consist of a concrete gravity-type weir surmounted by gates and with a gated sluice through the base of the weir. The plan provides for raising the embankment 3 feet. Plans and sections of the dam and spillway are shown on plate 2, appendix III.

b. This plan would provide a total storage of 526,000 acre-feet in the reservoir, of which 200,000 acre-feet would be allocated to flood control purposes. It is estimated that 3,800 additional acres of land would be required, and that there are 167 recreational cabins that would require moving in order to avoid potential damages resulting from operation of the project.

c. It is proposed that, upon completion of construction, the project would be operated and maintained by local interests. Flood control operation would be in accordance with Section 7 of the

Flood Control Act approved December 22, 1944, which provides that it shall be the duty of the Secretary of the Army to prescribe regulations for the use of storage allocated to flood control or navigation in all reservoirs constructed wholly or in part with Federal funds. The project would be operated for maximum benefits along the Wichita River. Flood control releases would be made so as not to exceed channel capacity on the Wichita River, insofar as possible.

d. Physical features and engineering data pertinent to the existing project and to the plan of improvement are shown in table 1.

TABLE 1

PHYSICAL FEATURES AND ENGINEERING DATA
LAKE KEMP

Feature	Existing Project	Proposed Modification
Stream	Wichita River	
Miles above mouth	126.7	
Drainage area above dam, sq mi	2,099	
Purposes	Cons	Fld contr & cons
General elevations, ft, msl:		
Top of dam	1167.0	1170.0
Top of flood control pool	-	1156.0
Spillway crest	1153.0	1121.0
Top of conservation pool	(1) 1153.0	1144.0
Reservoir area, acres:		
Top of flood control pool	-	22,440
Spillway crest (existing)	20,630	-
Top of conservation pool	(2) 20,630	15,150
Reservoir storage, acre-feet:		
Flood control	-	200,000
Conservation	-	190,000
Sediment	-	(3) 136,000
Total reservoir storage	461,800	526,000
Dam:		
Type	Earthfill	Earthfill
Crest length (excl spillway)	7,980	7,015
Maximum height of dam, ft	99	102
Spillway:		
Type	Uncontrolled	Controlled
Net crest length, ft	564	400
Type of gates	-	Radial (tainter)
Number and size of gates	-	10 - 40'x35'
Capacity, cfs	(4) 64,000	450,000
Emergency spillway in dam:		
Type	Low section	-
Net length, ft	405	-
Capacity, cfs	(4) 50,000	-
Outlet works:		
Type	Conduits	Sluice
Number and size	2 - 7' dia	1 - 5'8"x7'

(1) Local interests have kept storage space above elev 1143.0 empty, except during flood periods.
(2) Area at normal pool (elev 1143.0): 14,600 acres.
(3) Includes 23,600 acre-feet of sediment in flood control pool.
(4) With a 10-foot head.

16. ESTIMATES OF FIRST COST

a. The estimated first cost for the reconstruction of the Lake Kemp project, based on July 1960 prices, is $8,648,000, including $35,000 preauthorization costs. Table 2 shows, in summary, a feature breakdown of the estimated first cost for reconstruction of Lake Kemp Dam and spillway, and for additional lands and damages.

TABLE 2

ESTIMATED COST

Item	Cost
Lands and damages	$ 318,000
Reservoir	2,300
Dam:	
Embankment	457,000
Outlet works	77,300
Spillway	6,583,000
Preauthorization studies	35,000
Engineering and design	564,700
Supervision and administration	610,700
Total reconstruction cost	$8,648,000

b. In order to make an economic analysis of the over-all project, the value of existing lands and usable structures was added to the estimated reconstruction cost. The estimated value of the portion of the existing project which is incorporated in the proposed plan is $3,961,000. The over-all cost of the project for evaluation purposes then amounts to $12,609,000.

17. ESTIMATE OF ANNUAL COST

The estimated annual cost for Lake Kemp, including reconstruction and existing embankment and lands, is $543,500, as itemized in table 3.

TABLE 3

ESTIMATED ANNUAL CHARGES

Item	Cost
Interest	$336,900
Amortization	127,000
Operation and maintenance	79,600
Total	$543,500

18. ESTIMATES OF BENEFITS

a. Flood control benefits. Flood control benefits expected to accrue to the plan of improvement amount to $730,000 annually. The benefits consist of flood losses that will be prevented during the extended life of the project. Flood routings indicate that, under existing conditions or with improvements considered, Lake Kemp would have minor influence on Red River, but no flood control benefits are claimed on that stream for this study. Flood control benefits are summarized below and are discussed in detail in appendix II.

(1) Flood losses prevented under current conditions. It is estimated that, without reconstructed Lake Kemp, future flood losses on the Wichita River downstream from the project would amount to $792,000 annually. Studies indicate that Lake Kemp, as modified by the proposed plan of improvement, would prevent about $569,000 of these losses.

(2) Flood losses prevented under future conditions. The Wichita Falls metropolitan area has experienced a phenomenal growth in both population and economic development during the last two decades. Studies of this past development and present trends indicate that the area will experience continuing economic growth. The present trend for suburban living has caused a movement to unimproved land and has resulted in more extensive development in and near the flood plain of the Wichita River. It is considered that the flood plain of the Wichita River will continue to develop whether or not the Lake Kemp project is reconstructed. Studies of past development, present trends and projections for the future are presented in supplement A to this report. Based on these studies, it is estimated that average annual flood losses to property expected to be subject to future overflow will be $223,000 more than anticipated under present-day conditions of development. The corresponding additional average annual flood losses expected to be prevented with a reconstructed Lake Kemp total $161,000.

b. Unevaluated flood control benefits:

(1) Intangible benefits. Benefits of intangible nature and not susceptible to evaluation in terms of an average annual monetary value, would be realized. Such benefits would include reduction of delays in transportation and harvesting of crops, reduction of loss of business income, reduction in human suffering and inconvenience resulting from evacuation and reoccupation of flooded areas, and reduction in health hazards due to unsanitary conditions caused by floods.

(2) Other benefits. There would be flood damages in the event of failure of the Lake Kemp Dam, which have not been included in the economic evaluation contained herein. Additional discussion of these benefits is presented in appendix II.

c. Conservation. The storage allocated to conservation will be available for irrigation, emergency water supply, and other purposes, as in the past. It is estimated that irrigation benefits would amount to $649,000. No credit has been taken for benefits that may obtain from storage used for domestic and industrial water supply purposes.

d. Recreation. Existing recreational facilities of Lake Kemp are under private ownership and control. Recreational use would continue to be under non-Federal control. Benefits for recreation have not been evaluated for the purposes of this study.

e. Fish and wildlife. Fish and wildlife benefits were not evaluated. The Fish and Wildlife Service states in their report (appendix V) that the proposed modification of the reservoir should not have any significant effect on fish and wildlife resources, but that possibilities for enhancement of the area for waterfowl do exist, and would be investigated at such time as plans become more firm.

f. Summary of benefits. The evaluated benefits which would accrue to the rehabilitated Lake Kemp are as follows:

Flood control	$ 730,000
Conservation	649,000
Total	$1,379,000

19. PROJECT JUSTIFICATION

The tabulation below shows that the annual benefits for conservation and flood control are in excess of the annual charges, and the benefit-cost ratio for the project is 2.5.

Purpose	Annual Benefits	Annual Charges	Excess Benefits	B/C Ratio
	$	$	$	
Flood control	730,000	282,400	447,600	2.6
Conservation	649,000	261,100	387,900	2.5
Total	1,379,000	543,500	835,500	2.5

20. FEDERAL AND NON-FEDERAL PARTICIPATION

a. Lake Kemp is owned, operated, and maintained by local interests. They have requested that the Federal Government reconstruct the project to make it safe for future operation. The proposed plan for reconstruction of Lake Kemp involves flood control, the directing of flood control operation following completion of the reconstruction, and the retention of the conservation functions of the project as presently utilized by local interests.

b. Several alternative methods of project formulation and cost sharing were considered for the purposes of this study. One plan was essentially the same as the recommended plan discussed herein, except that it was proposed that local interests furnish lands for three public-use areas (plate 1, appendix III) and permit free access by the public. Flood control, conservation, recreation, and fish and wildlife were included as project purposes and the cost allocation was made by the separable costs-remaining benefits method. The value of existing lands and additional lands required for the reconstructed project, including the public-use areas, was included in the cost allocation and economic analysis. The value of the existing embankment was not included. Under this plan, the Federal Government would bear the cost allocated to flood control and local interests would bear the costs allocated to conservation. Because it was estimated that about one-half of the visitors coming to the project for recreation and fish and wildlife would be attracted by the public-use areas, the Federal Government and non-Federal interests would share the costs allocated to those purposes on a 50-50 basis. In the cost apportionment, local interests were given credit for the value of lands utilized by the existing project, the salvage value of existing cabins, and the cost of additional lands needed for the reconstruction and public-use areas. The allocated first costs apportioned in accordance with the above are shown in table 4.

TABLE 4

APPORTIONMENT OF ALLOCATED FIRST COST (1)

Feature	Federal Share	Non-Federal Share	Total
	$	$	$
Flood control	5,082,000	0	5,082,000
Conservation	0	4,230,000	4,230,000
Recreation	845,000	845,000	1,690,000
Fish & wildlife	493,000	492,000	985,000
Total	6,420,000	5,567,000	11,987,000
Lands & salvage value of cabins	0	-2,430,000	-2,430,000
Net cost	6,420,000	3,137,000	9,557,000
Additional lands required for the reconstruction	-	-607,000	-
Share of net construction costs	6,420,000	2,530,000	8,950,000

(1) Excludes preauthorization cost.

The non-Federal share of the net construction cost of $2,530,000 (cash contribution) would amount to 28.3 percent of $8,950,000, the reconstruction cost after deducting the cost of additional lands and the preauthorization costs.

c. In accordance with the plan, local interests would be responsible for the over-all physical operation and maintenance. The Federal Government would reimburse local interests annually for the cost for operation and maintenance of the flood control feature and for 50 percent of the operation and maintenance for recreation and fish and wildlife. Based on the current estimate, the amount payable by the Federal Government to local interests for operation and maintenance would average about $46,700 annually.

d. A cost allocation was also made by the separable costs-remaining benefits method, assuming that no public-use areas would be provided and that access to the lake for recreational purposes would be by paid admission. Under this concept, it was considered that the costs allocated to recreation and fish and wildlife would be entirely a non-Federal responsibility. The cash contribution required of local interests by this plan would be in the neighborhood of $3,400,000.

e. However, to make a realistic allocation of the first cost of rehabilitation of Lake Kemp between the flood control and conservation

functions, it was considered necessary to add to reconstruction cost the value of the project lands and the portion of the embankment utilized in the plan of improvement, a total of $12,609,000. Since the reconstruction of Lake Kemp would not alter the use of the project for recreation and fish and wildlife, these features have not been included as project purposes. Cost allocation has been made by the use of facilities method, since flood control and conservation are the only project purposes and benefits for these features are directly proportioned to their storage. This is consistent with paragraph 71b, Laws and Procedures Governing Conduct of the Civil Works Program, dated April 1959. The results are summarized below:

Item		Over-all Project	Plan of Improvement (New Work)
Reconstruction first cost		$8,648,000	$8,648,000
Value of lands & structures		3,961,000	-
Total		$12,609,000	$8,648,000
Allocation:			
Flood control	(1)	$6,410,000	$6,410,000
Conservation	(2)	$6,164,000	$2,203,000
Preauthorization cost		$ 35,000	$ 35,000

(1) Applicable to plan of improvement.
(2) This amount, reduced by the value of lands and structures ($3,961,000), is applicable to plan of improvement.

The estimated operation and maintenance costs for the project amount to $79,600. These costs are allocated between flood control and conservation as follows:

Item	Flood Control	Conservation	Total
Ordinary operation & maintenance	$31,000	$29,000	$60,000
Major replacements	4,900	4,700	9,600
Subtotal	$35,900	$33,700	$69,600
Federal direction of flood control operation	10,000	-	10,000
Total	$45,900	$33,700	$79,600

Under this proposal, ownership and operation and maintenance of the reconstructed Lake Kemp would remain a non-Federal responsibility. Federal responsibility would be in the interest of providing flood control storage and to the directing of its operation following completion of the reconstruction. Accordingly, the following basic items of Federal and non-Federal participation are considered the most equitable and are so recommended:

(1) The Federal Government will perform all construction except relocations.

(2) The Federal Government will direct flood control operation after completion of construction.

(3) The Federal Government will reimburse non-Federal interests annually for the cost of operating, maintaining and providing major replacements for the flood control feature of the project.

(4) Non-Federal interests will provide, without cost to the United States, all lands and easements necessary for construction and operation of the project.

(5) Non-Federal interests will perform all relocation of cabins, buildings, utilities, highways, bridges, sewers, and related facilities.

(6) Non-Federal interests will maintain all works, and will operate the flood control features in accordance with regulations prescribed by the Secretary of the Army.

(7) Non-Federal interests will assume that portion of the reconstruction costs allocated to conservation uses.

(8) Non-Federal interests will hold and save the United States free from damages due to the construction works.

(9) Non-Federal interests will adopt and enforce regulations to preserve the existing capacity of the channel through the city of Wichita Falls and prevent further encroachment.

21. RECOMMENDED APPORTIONMENT OF COST AMONG FEDERAL & NON-FEDERAL INTERESTS

a. Federal. Under the recommended method, the cost allocated to flood control ($6,410,000) and the preauthorization costs ($35,000), totaling $6,445,000, would be the responsibility of the Federal Government. It is estimated that the operation and maintenance cost to the Government for Federal direction of flood control operation would be $10,000 annually. Other operation and maintenance costs and major replacement costs allocated to flood control, and thereby a Federal responsibility, are estimated to average $35,900 annually. Local

interests would operate the flood control feature of the project under the direction of the Secretary of the Army and would provide all operation, maintenance and replacements presently estimated at an average of $69,600 annually ($79,600, less $10,000 for direction of flood control operation). On the basis of the current estimate, the amount reimbursable to local interests by the Federal Government for operation, maintenance and major replacements would average $35,900 annually. The Federal Government's share of this cost (reimbursable to local interests) would thus be 51.6 percent of the actual annual operation, maintenance and replacement costs incurred by local interests.

b. Non-Federal. The cost for reconstruction of the project chargeable to local interests for conservation storage is estimated at $2,203,000, of which $318,000 would be for additional lands, leaving a remainder of $1,885,000, equivalent to 22.7 percent of the reconstruction cost after deducting the preauthorization cost and cost of additional lands. Local interests have stated that to pay an amount of this magnitude in a lump sum prior to construction would be out of their reach, and have requested consideration of long-term financing for their share of the reconstruction costs. Accordingly, it is proposed that local interests pay their share in annual payments, including interest on the unpaid balance, over a period of not more than 50 years, beginning at the completion of the reconstruction. These annual payments are presently estimated to be $69,900. Local interests would be responsible for operating, maintaining and providing major replacements at an estimated average annual cost of $69,600. Of this amount, the Federal Government would reimburse local interests annually an amount equivalent to 51.6 percent of their actual cost for operation, maintenance and major replacements, which, on the basis of the current estimate, would average $35,900 annually. The remaining 48.4 percent of the operation, maintenance and major replacement costs (currently estimated to average $33,700 annually) would be financed by local interests.

c. Summary. A summary of Federal and non-Federal costs is shown in table 5.

89691 O-62—4

TABLE 5

SUMMARY OF FEDERAL AND NON-FEDERAL COSTS
(Exclusive of preauthorization costs)

Item	Flood Control	Conservation	Total
First Cost:			
Allocated first cost	$6,410,000	$6,164,000	$12,574,000
Value of usable portion of existing embankment & lands	-	3,961,000	3,961,000
Allocated net reconstruction cost	$6,410,000	$2,203,000	$8,613,000
Initial non-Fed cost (lands)	-	318,000	318,000
Initial Federal cost	$6,410,000	(1)$1,885,000	$8,295,000
Percent of initial Federal cost	77.3	(1)22.7	100.0
Annual Cost:			
Federal operation	$10,000	0	$10,000
Operation, maintenance & major replacements, dollars	(2)$35,900	$33,700	$69,600
percent	(2) (51.6)	(48.4)	(100)
Total	$45,900	$33,700	$79,600

(1) Reimbursable to United States by local interests.
(2) Payable to local interests.

22. ASSURANCES OF LOCAL COOPERATION

Agreement by local interests to the foregoing is contained in a resolution adopted 12 April 1962 by Wichita County Water Improvement District No. 2 and the City of Wichita Falls, Texas.

23. COORDINATION WITH OTHER AGENCIES

a. General. Federal, State and local agencies were consulted during the preparation of this report. Field-level comments of other agencies regarding the plan of improvement are included in appendix VII. Their comments, which were considered in the preparation of the final report, indicated general concurrence with the proposed plan of improvement. Studies and comments by Federal and State agencies prior to field-level review are summarized below.

b. Public Health Service. The Public Health Service prepared a report on needs, quality and value of water in Lake Kemp (appendix IV). They found that there is a need for additional water supply in the Lake Kemp area. It is the opinion of the Public Health Service that the quality of water in Lake Kemp is, at present, unsatisfactory for municipal water supply because of high mineral content, and would have negligible value unless the quality is improved.

c. Bureau of Reclamation. The Bureau of Reclamation furnished a reconnaissance report on requirements for irrigation water and its benefits. This report is included as appendix VI. These studies show that the storage of water for irrigation in Lake Kemp would provide both tangible and intangible benefits, and that loss of irrigation water in the area would cause a very noticeable effect upon the local economy. Irrigation benefits and irrigation water requirements used in this study are based primarily on values furnished by the Bureau of Reclamation.

d. Fish and Wildlife Service. The Fish and Wildlife Service, Bureau of Sport Fisheries and Wildlife, prepared a report of their preliminary studies of Lake Kemp (appendix V). They state that the proposed modification of Lake Kemp should have little effect on fish and wildlife resources, but more detailed studies will be necessary to determine the full impact of the project. They plan to further investigate the project in the event the improvements are authorized for construction.

e. Information on the plan of improvement was furnished the Texas Game and Fish Commission. The studies of the Fish and Wildlife Service were made in cooperation with the Texas Game and Fish Commission.

24. DISCUSSION

a. The non-Federal Lake Kemp, located on the Wichita River approximately 70 miles above the City of Wichita Falls, Texas, was placed in operation in 1923 for conservation purposes. The spillway and outlet works have deteriorated to the extent that the structures are considered to be no longer safe. In the event of failure of the structures, flood damages would be severe and might be of disastrous proportion, particularly at Wichita Falls. Local interests have requested that the Federal Government reconstruct the Lake Kemp project in the interest of flood control and preservation of the present conservation uses.

b. The plan of improvement provides for closing off the existing spillway and outlet works, constructing a new combination spillway and outlet works at another location, and raising the existing earth dam approximately 3 feet with material available from spillway excavation. The plan of improvement, in addition to retaining the conservation storage maintained by local interests in the existing reservoir, would provide a high degree of flood protection to the Wichita River valley downstream from Lake Kemp. Flood control and conservation benefits accruing to the project are more than sufficient to justify the cost of the reconstruction.

c. Since the reconstruction of Lake Kemp would not alter the use of the project for recreation and fish and wildlife, these features have not been included as project purposes. The provision of power is not feasible. Cost allocation has been made by the use of facilities method, since flood control and conservation are the only project purposes and benefits for these features are directly proportioned to their storage.

d. Additional information on the plan of improvement called for by Senate Resolution 148, 85th Congress, adopted January 28, 1958, is contained in supplement B to this report.

25. CONCLUSIONS

a. The existing spillway and outlet structures at Lake Kemp urgently need repair or replacement for safe future operation of the project.

b. Reallocation of available storage in Lake Kemp to include the function of flood control can be accomplished without detriment to its conservation function.

c. Flood control provided in the reconstructed Lake Kemp project, as proposed herein, is justified.

d. The plan of apportionment of cost among Federal and non-Federal interests is equitable and fair, since it assigns the responsibility for flood control to the Federal Government and the responsibility for conservation to non-Federal interests. Further, it gives credit to non-Federal interests for the value of the lands for the existing project, including its value as use for a dam site (usable portion of the existing embankment).

e. Expenditure of Federal funds is warranted for the purpose of establishing flood control provisions in Lake Kemp in conjunction with the plan of reconstruction proposed herein.

26. RECOMMENDATIONS

a. I recommend that the reconstruction of Lake Kemp on the Wichita River, Texas, to provide for a specific allocation of flood control storage therein, be authorized for construction at an estimated initial cost to the Federal Government of $8,295,000, an annual cost of $10,000 for directing flood control operation thereof, and an annual cost of 51.6 percent of the cost of operation, maintenance and major replacement currently estimated to average $35,900, all generally in accordance with the plan of improvement described herein, with such modifications as in the discretion of the Chief of Engineers may be advisable, and on condition that local interests will (1) continue to operate and maintain the entire project; (2) operate the flood control features in accordance with regulations prescribed by the Secretary of the Army; (3) perform without cost to the United States all relocations and alterations of existing buildings, highways, bridges, sewers, and related and special facilities; (4) hold and save the United States free from damages due to construction works; (5) provide without cost to the United States all lands and easements necessary for construction and operation of the project; and (6) adopt and enforce regulations to preserve the existing capacity of the channel through the city of Wichita Falls and prevent further encroachment.

b. I also recommend that local interests be required to reimburse the United States for the cost of reconstruction allocated to the conservation storage in an amount equivalent to 22.7 percent of the reconstruction cost after deducting the preauthorization cost and cost of additional lands, currently estimated at $1,885,000. It is further recommended that local interests be authorized to repay their share in equal annual payments, including interest on the unpaid balance, over a period of not more than 50 years beginning at the completion of construction, currently estimated to be $69,900 annually.

HOWARD W. PENNEY
Colonel, CE
District Engineer

[First endorsement]

SWDGW-4
SUBJECT: Lake Kemp, Wichita River, Texas - Survey Report

United States Army Engineer Division, Southwestern, Dallas, Texas, November 27, 1961

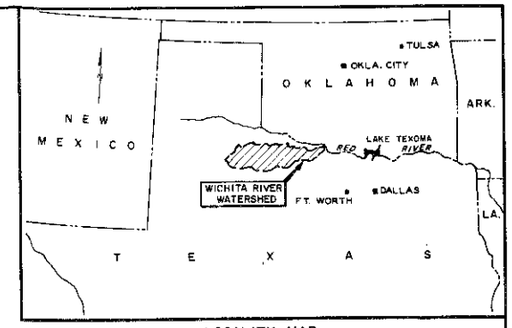
TO: Chief of Engineers, Department of the Army, Washington, D.C.

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

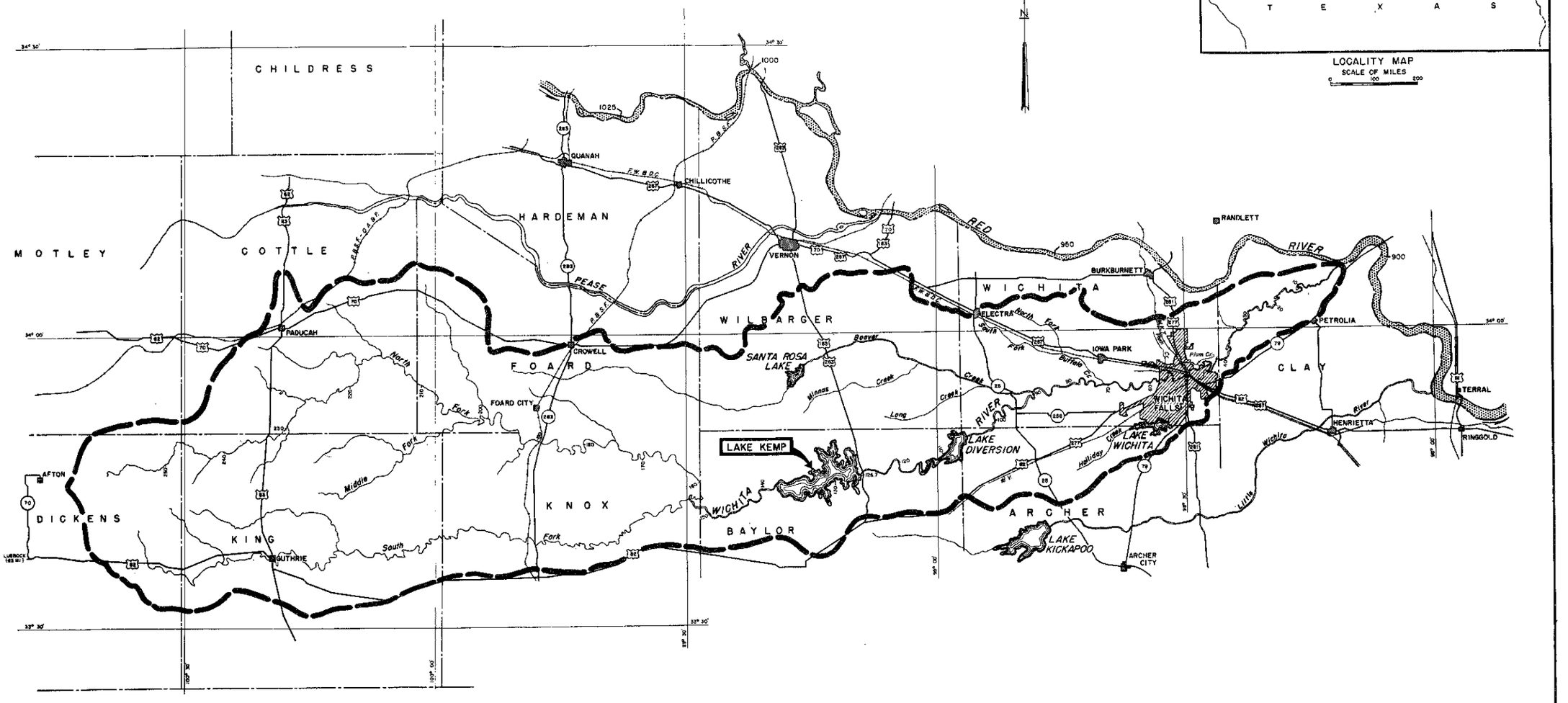
ROBERT J. FLEMING
Major General, USA
Division Engineer

CORPS OF ENGINEERS

U.S. ARMY



LOCALITY MAP
SCALE OF MILES
0 100 200



LAKE KEMP
WICHITA RIVER, TEXAS

WATERSHED MAP

SCALE OF MILES
5 0 5 10

U. S. ARMY ENGINEER DISTRICT, TULSA, CORPS OF ENGINEERS — AUG. 1961

SUBMITTED:	APPROVAL RECOMMENDED:	APPROVED:
CHIEF, PLANNING & REPORTS BRANCH	CHIEF, ENGINEERING DIVISION	COL., CORPS OF ENGINEERS, DISTRICT ENGINEER

DRAWN: K.L.D.
TRACED: K.L.D
CHECKED: J.C.D

TO ACCOMPANY SURVEY REPORT

R-1/102

PLATE I

89691 O-62 (Face p. 42)

SURVEY REPORT
ON
LAKE KEMP
WICHITA RIVER, TEXAS

APPENDIX I

HYDROLOGY

U. S. ARMY ENGINEER DISTRICT, TULSA
CORPS OF ENGINEERS
TULSA, OKLAHOMA

APPENDIX I

HYDROLOGY

TABLE OF CONTENTS

Paragraph	Title	Page
1	PURPOSE	47
2	CLIMATOLOGY	47
	a. Weather	47
	b. Precipitation	47
	c. Temperature	48
	d. Wind	48
	e. Evaporation	48
3	BASIN CHARACTERISTICS	49
4	RUNOFF	49
	a. Stream stage and discharge records	49
	b. Runoff data	49
	c. Estimates of discharge	52
5	STORMS	54
	a. Storms of record	54
	b. Storm occurrences	54
6	FLOODS OF RECORD	55
	a. General	55
	b. Number and magnitude	55
	c. Peak flow	56
	d. Flood of June 1915	58
	e. Flood of May 1908	58
	f. Flood of May 1941	58
	g. Flood of October 1941	58
	h. Flood of October 1955	59
	i. Natural discharge probability	59
7	PROPOSED STORAGE CAPACITIES AND RESERVOIR OPERATIONS	59
	a. Area and capacity curves	59
	b. Flood control capacity requirements	59
	c. Channel improvement	60
	d. Sedimentation	61
	e. Storage capacities	61
	f. Proposed method of flood control operation	61
	g. Effect of reservoir operation on the floods of record	61
	h. Basis for relocations and land acquisition	62

TABLE OF CONTENTS (Contd)

Paragraph	Title	Page
8	DETERMINATION OF SPILLWAY REQUIREMENTS	62
	a. General	62
	b. Initial losses and infiltration rates	62
	c. Unit hydrographs	63
	d. Maximum probable storm	63
	e. Magnitude of the spillway design flood	64
	f. Standard project flood	65
	g. Routing of the spillway design flood	65
	h. Spillway and outlet works	65
	i. Freeboard	65
9	PERTINENT DATA	66

TABLES

Table	Title	Page
1	U. S. Weather Bureau Station Data	47
2	Monthly Distribution of Mean Annual Precipitation	48
3	Estimated Monthly Pan Evaporation at Lake Kemp	49
4	Pertinent Data for Stream Gaging Stations in the Red River Basin	50
5	Annual Runoff Data	51
6	Estimated Monthly and Annual Flows in Acre-Feet Wichita River at Lake Kemp	53
7	Major Storms	54
8	Number and Magnitude of Storms	55
9	Estimated Number and Magnitude of Floods Under Natural Conditions at Lake Kemp Dam Site and Wichita Falls for the Period April 1938 Through September 1958	56
10	Estimated Largest Floods of Record at Wichita Falls Gage	57
11	Flood Control Storage Required to Control Major Floods	60
12	Allocated Reservoir Capacities	61
13	Estimated Number and Magnitude of Floods on Wichita River at Wichita Falls Gage With and Without Lake Kemp Operating - April 1938 Through September 1958	62
14	Initial Losses and Infiltration Rates	63
15	Spillway Design Flood - Lake Kemp	64
16	Comparative Data for Spillway Design Flood -Lake Kemp	65
17	Pertinent Data - Lake Kemp	66

PLATES (not printed)

Plate	Title
1	Locality Map Showing Rainfall and Stream Gaging Stations
2	Stream Profile
3	Discharge Probability (Natural River Conditions) at Dam Site
4	Area and Capacity Curves
5	Six-Hour Unit Hydrograph
6	Comparison of Flood Peak Discharge
7	Spillway Design Flood Operational Hydrographs
8	Spillway Rating Curve
9	Spillway Gate Regulation Curve
10	Sluice Rating Curve

APPENDIX I

HYDROLOGY

1. PURPOSE

This appendix presents data relative to hydrology and related subjects supplementing that contained in the main report.

2. CLIMATOLOGY

a. Weather. - The climate of the Wichita River Basin is temperate and subhumid. The summers are warm and long periods of hot, dry weather frequently occur. The short winters are sometimes severe with sudden drops in temperature. Pertinent data relative to several representative U. S. Weather Bureau Stations in or near the watershed are presented in table 1. The location of these stations is shown on plate 1.

TABLE 1

U. S. WEATHER BUREAU STATION DATA

Station	County	Elevation in Feet (m.s.l.)	Length of Record (years)	Mean Annual Precipitation (inches)
Spur, Texas	Dickens	2,274	44	21.36
Crowell, Texas	Foard	1,470	39	24.00
Vernon, Texas	Wilbarger	1,205	24	26.14
Dundee, Texas	Archer	1,225	34	24.63
Wichita Falls, Texas	Wichita	1,020	60	26.69
Henrietta, Texas	Clay	915	65	27.64
Waurika, Oklahoma	Jefferson	912	46	31.04

b. Precipitation. - The normal annual precipitation over the basin is approximately 24 inches ranging from 22 inches in the western section to 28 inches in the eastern section. The entire area is subject to locally intense rainfall and lies near enough to the Gulf of Mexico to be affected by tropical disturbances. The average annual snowfall is about four inches and usually melts very rapidly. The monthly distribution of normal annual precipitation is shown in table 2.

TABLE 2

MONTHLY DISTRIBUTION OF MEAN ANNUAL PRECIPITATION

Month	Normal Precipitation (inches)	Percent of Normal Annual Precipitation
January	1.00	4.0
February	1.17	4.8
March	1.42	5.9
April	2.27	9.4
May	3.32	13.8
June	2.84	11.8
July	1.93	8.0
August	2.17	9.0
September	2.75	11.4
October	2.85	11.8
November	1.23	5.1
December	1.20	5.0
	24.15	100.0

c. Temperature. - The average temperature is 63 degrees F. A maximum temperature of 113 degrees F. on August 11, 1936 and a minimum temperature of -12 degrees F. on January 4, 1947 have been recorded at Wichita Falls.

d. Wind. - The prevailing wind direction is from a south-southwesterly direction with the greatest wind movement occurring in the spring months. Data from wind recording stations in the general vicinity of the basin indicate that a velocity of 45 miles per hour is the highest wind velocity that can reasonably be expected for a duration of one hour or more.

e. Evaporation. - Data on evaporation rates are available at several stations in and near the basin. Relatively low humidity and moderate wind movements are conducive to comparatively high rates of evaporation. The estimated monthly evaporation rates listed in table 3 are estimated from regional station data and are considered to represent standard U. S. Weather Bureau Class A land-pan evaporation rates at the site.

TABLE 3

ESTIMATED MONTHLY PAN EVAPORATION AT LAKE KEMP

Month	Evaporation (inches)	Month	Evaporation (inches)
January	2.82	July	13.55
February	3.81	August	12.57
March	6.57	September	9.75
April	8.55	October	7.00
May	10.37	November	4.25
June	12.22	December	3.54
		Total Annual	95.00

3. BASIN CHARACTERISTICS

The Wichita River Basin, which has a total drainage area of 3,483 square miles, is located in north central Texas. The drainage basin with rainfall and stream gaging stations is shown on plate 1. The stream rises in Dickens County near Afton, Texas, and flows in an easterly direction through Dickens, King, Knox, Cotter, Foard, Baylor, Archer, Wichita and Clay Counties entering Red River at river mile 907. The Wichita River, above mile 154, consists of the North Fork with 1,868 square miles of drainage area and the South Fork with 670 square miles of drainage area. The drainage area above Lake Kemp Reservoir is 2,099 square miles. The three main tributaries below Lake Kemp Dam are Beaver, Buffalo and Holliday Creeks and their confluences are at approximate river miles 89, 70 and 47 with drainage areas of 629, 101 and 175 square miles, respectively. The channel capacity of Wichita River averages about 7,400 c.f.s. in the vicinity of Wichita Falls below Holliday Creek and 6,200 c.f.s. to 7,500 c.f.s. from Lake Kemp to Holliday Creek. The slope of the main stem averages about 1.7 feet per mile below Lake Kemp and the stream profile is shown on plate 2.

4. RUNOFF

a. Stream stage and discharge records. - The periods of record, maximum and minimum stage and/or flows and other pertinent data for gaging stations on the Wichita River and Little Wichita River, and two gaging stations on the Red River are shown in table 4.

b. Runoff data. - The mean annual runoff in acre-feet and inches, with other data, for the stations in the general vicinity of Lake Kemp are presented in table 5.

TABLE 4

PERTINENT DATA FOR

STREAM GAGING STATIONS IN THE RED RIVER BASIN

Station	Stream	Miles Above Mouth	Drainage Area (sq.mi.)	Elevation of Zero of Gage (m.s.l.)	Flood Stage (feet)	Maximum of Record: Stage (feet)	Maximum of Record: Discharge (c.f.s.)	Maximum of Record: Date	Minimum of Record: Stage (feet)	Minimum of Record: Discharge (c.f.s.)	Minimum of Record: Date	Maximum Flood of Record: Volume (acre-feet)	Maximum Flood of Record: Inclusive Dates	Daily Stages (agency)	Discharge Measurements (agency)	Period of Record (inclusive dates)
Wichita Falls, Texas	Wichita River	55.3	3,140	924.26	20.0	24.00	17,800(1)	10/3/41	3.40(2)	6.0	2/21/39	561,200	4/29 - 7/17/41	U.S.D.A.	(3)	2/10/1900 - 2/ 8/02
														U.S.G.S.	U.S.G.S.	3/ 1/1900 - 1/31/02
														U.S.G.S.	(3)	10/ 1/10 - 12/31/10
														U.S.G.S.	B.W.R.I.C.(4)	1/ 1/11 - 12/31/11(5)
														-	B.W.R.I.C.(4)	1/ 1/12 - 6/30/18(5)(6)
														U.S.G.S.	U.S.G.S.	4/ 1/38 - 9/30/60(7)
Archer City, Texas	Little Wichita River	45.5	481	934.72	24.0	28.0	-	1930	(8)	0	(9)	99,200	9/16 - 10/1/36	U.S.G.S.	U.S.G.S.	5/29/32 - 1/ 6/56
Henrietta, Texas	Little Wichita River	13.8	1,037	831.57	17.0	21.0	-	1908	(8)	0	(9)	247,100	4/23 - 5/30/57	U.S.G.S.	U.S.G.S.	1/31/52 - 9/30/60(7)
Terral, Oklahoma	Red River	872.0	28,723	770.31	22.0	28.12	197,000	6/8/41	9.22(10)	43	3/15/39	4,360,000	4/20 - 7/ 5/57	U.S.G.S.	U.S.G.S.	1/ 1/38 - 9/30/60(7)
Gainesville, Texas	Red River	791.5	30,782	627.91	25.0	24.15(11)	168,000	6/9/41	5.05(12)	48	1/27/40	4,957,000	4/21 - 7/10/57	C.E.	C.E.	5/28/36 - 9/30/60(7)

(1) Maximum discharge known, 50,000 c.f.s., June 8, 1915.
(2) Minimum stage of record, 2.42 feet (22 c.f.s.), March 17, 19, 1957.
(3) Stages only.
(4) Big Wichita River Irrigation Company
(5) Intermittent record.
(6) Unpublished records computed in acre-feet by Big Wichita River Irrigation Company; stages not available.
(7) Continued in operation.
(8) Pool at gage or streambed dry.
(9) At times.
(10) Minimum stage of record, 6.62 feet, October 7, 1957.
(11) Maximum stage of record, 26.53 feet (146,000 c.f.s.), May 21, 1951.
(12) Minimum stage of record, 3.82 feet, September 7, 1936.

TABLE 5

ANNUAL RUNOFF DATA

Station	Stream	Drainage Area (sq mi)	Complete Water Years of Record (1)	Annual Runoff in Acre-Feet			Average Annual Runoff (inches)
				Maximum	Minimum	Mean	
Wichita Falls, Texas	Wichita River	3,140	23	707,600	59,900	236,900	1.41
Archer City, Texas	Little Wichita River	481	23	187,800	3,520	59,880	2.33
Henrietta, Texas	Little Wichita River	1,037	7	308,900	32,430	108,500	1.96
Terral, Oklahoma	Red River	28,723	22	5,154,000	378,800	1,870,000	1.22
Gainesville, Texas	Red River	30,782	24	6,054,000	471,100	2,315,000	1.41

(1) Includes 1960 water year for all gages in operation.

c. Estimates of discharge. - Estimates of monthly flows on Wichita River at Lake Kemp for the period January 1924 through September 1960 have been computed from daily reservoir stage and gate opening records. The estimated monthly and annual flows are shown in table 6.

88691 O-62—5

TABLE 6

Estimated Monthly and Annual Flows in Acre Feet

WICHITA RIVER AT LAKE KEMP

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1924	1,500	0	7,370	14,840	7,280	36,400	2,600	22,610	4,370	15,100	500	0	112,700
1925	700	0	0	49,180	28,600	260	18,100	57,440	70,790	11,930	0	0	237,000
1926	0	9,700	10,320	0	37,550	27,510	3,250	62,120	95,800	97,300	0	14,600	358,200
1927	4,100	3,650	46,320	23,280	31,570	20,000	5,100	0	3,120	1,200	0	8,480	146,800
1928	0	18,400	1,200	6,700	40,050	18,600	7,210	2,500	0	14,430	0	0	109,100
1929	0	0	9,770	620	57,980	2,760	29,550	4,970	80,510	4,500	4,450	0	195,100
1930	7,800	16,300	3,000	11,660	37,940	20,040	800	3,800	0	101,540	0	44,580	247,500
1931	0	47,300	4,200	5,800	3,000	3,700	3,700	0	0	25,100	24,200	7,500	124,500
1932	15,600	22,600	0	5,300	2,200	20,210	62,300	27,500	48,980	1,700	0	41,200	247,600
1933	1,400	1,300	16,500	4,300	38,020	900	4,150	12,380	6,970	3,000	1,080	6,500	96,500
1934	0	1,300	7,800	12,630	16,170	1,700	0	1,600	15,500	0	23,180	0	79,900
1935	1,100	2,350	5,100	1,610	80,000	13,000	1,400	5,080	84,400	7,100	3,000	3,000	207,100
1936	200	1,500	310	4,700	14,330	36,600	8,770	0	146,450	1,500	0	1,200	216,800
1937	400	0	15,300	4,230	500	53,120	2,590	52,150	3,400	25,720	1,500	1,500	160,400
1938	0	47,630	9,600	13,700	63,000	64,530	13,950	0	5,840	0	2,700	0	221,000
1939	5,200	0	13,600	2,420	24,080	41,140	48,730	26,100	0	5,350	4,740	400	171,800
1940	1,000	3,800	0	6,360	14,000	7,000	4,700	34,980	4,480	15,750	20,500	3,300	115,900
1941	4,600	12,900	1,200	31,310	230,950	118,340	10,160	22,450	4,350	110,250	9,610	9,430	567,800
1942	3,860	5,530	3,200	51,800	7,120	1,000	700	760	23,790	25,790	980	6,160	130,700
1943	420	0	1,570	14,100	16,960	18,650	0	0	0	0	0	850	52,600
1944	4,800	9,620	2,420	0	4,600	12,650	1,030	700	0	12,700	6,700	4,090	59,300
1945	6,100	2,190	7,200	4,700	1,710	8,380	40,740	8,820	35,810	9,600	0	0	125,200
1946	1,200	2,640	1,100	0	6,390	4,820	29,060	30,200	68,680	6,120	8,690	22,200	199,800
1947	2,600	0	850	2,020	161,320	20,420	6,000	15,560	0	1,300	3,340	14,900	237,300
1948	0	9,620	3,590	2,440	25,040	40,270	20,030	0	0	5,500	0	0	106,500
1949	3,910	9,200	7,200	2,280	43,220	36,300	18,130	30,610	33,920	17,470	17,100	34,140	253,500
1950	33,800	4,770	0	16,780	50,700	18,570	48,490	117,720	95,970	10,260	0	2,330	399,300
1951	7,200	13,690	1,800	1,800	45,260	14,260	8,400	9,330	13,700	350	2,170	0	118,000
1952	3,470	2,170	1,800	7,640	20,080	0	14,340	4,040	5,360	5,670	4,460	7,580	76,600
1953	5,740	1,620	6,490	6,710	6,800	20,570	11,950	44,680	2,190	89,440	4,100	0	200,300
1954	3,870	40	3,270	16,560	62,700	45,810	0	2,000	1,960	660	2,200	5,440	144,500
1955	1,200	1,200	10,110	2,530	52,710	31,900	2,010	0	36,630	163,800	1,400	0	303,600
1956	0	1,560	0	0	920	0	2,000	1,000	0	7,860	0	1,810	15,100
1957	900	3,600	3,600	89,400	179,040	55,670	5,090	0	200	15,100	28,300	0	380,900
1958	0	0	6,200	1,600	60,300	1,300	15,560	1,300	3,540	2,200	0	670	92,700
1959	260	0	0	9,420	18,750	46,840	24,820	0	11,820	45,220	1,870	3,680	162,700
Mean	3,420	7,110	5,800	11,900	41,460	24,260	13,210	16,730	25,270	23,390	4,910	6,820	185,400

5. STORMS

a. Storms of record. - Storms in the basin are generally of two types: those with a high intensity but covering only limited areas, and general storms which extend over a large portion of the basin. Storms averaging three inches or more over the area above Lake Kemp or over the Wichita River basin during the period January 1935 through December 1959 are shown in table 7.

TABLE 7

MAJOR STORMS

Date of Storm	Average Rainfall (inches)	
	Above Lake Kemp	Over Basin
May 13-18, 1935	3.35	2.75
Sep 14-18, 1936	5.04	5.79
Aug 18-24, 1937	6.90	5.36
Oct 8-13, 1937	3.07	3.55
Feb 14-18, 1938	2.62	3.40
May 2- 5, 1941	3.57	3.42
Oct 1- 4, 1941	3.32	4.07
Sep 18-20, 1942	3.07	2.63
Oct 14-20, 1942	2.91	3.08
Jul 1-15, 1945	3.92	3.77
Sep 21-31, 1945	3.76	4.43
May 5-12, 1947	5.40	4.54
Jun 7-15, 1949	3.91	3.35
May 9-14, 1950	3.25	3.28
Jul 20-27, 1950	2.97	3.05
May 15-18, 1951	3.82	4.25
Oct 21-27, 1953	3.48	3.65
May 9-12, 1954	3.99	4.02
May 22-27, 1954	3.35	3.11
May 16-20, 1955	2.82	3.43
Sep 22-26, 1955	3.05	3.98
Oct 1- 5, 1955	5.50	4.83
Apr 19 thru May 5, 1957	7.57	8.38
Nov 4- 7, 1957	3.21	3.68
Sep 30 thru Oct 5, 1959	4.38	4.72
Dec 14-17, 1959	3.07	3.03

b. Storm occurrences. - The number of occurrences of these storms presented in table 7, grouped according to various amounts of rainfall, are shown in table 8.

TABLE 8

NUMBER AND MAGNITUDE OF STORMS

Rainfall (inches)	Above Lake Kemp: No. of Occurrences	Above Lake Kemp: Accum. No. of Occurrences	Over Basin: No. of Occurrences	Over Basin: Accum. No. of Occurrences
8.38	0	0	1	1
7.57	1	1	0	1
6.90	1	2	0	1
5.79	0	2	1	2
5.00-5.49	3	5	1	3
4.50-4.99	0	5	3	6
4.00-4.49	1	6	4	10
3.50-3.99	6	12	5	15
3.00-3.49	10	22	9	24

6. FLOODS OF RECORD

a. General. - No extreme flooding of lands along the Wichita River below Lake Kemp has been experienced since storage was made available in 1922. According to local information, the maximum known flood occurred in 1899, resulting in only minor damage because of the relatively undeveloped conditions of the valley. Other major floods are known to have occurred in the basin in May 1901, May 1908, April 1915 and June 1915. Discharge records at the Wichita Falls gage show only four floods have occurred since the gage was installed in 1938, and that these peaks do not all coincide with periods of high inflow into Lake Kemp. The maximum daily inflow of 60,000 acre-feet into Lake Kemp occurred on May 3, 1941, but the maximum stage recorded at Wichita Falls occurred during the flood of October 1941 when a peak stage of 24.0 feet or four feet above flood stage was reached.

b. Number and magnitude. - The estimated number of occurrences of floods under natural conditions at Lake Kemp Dam and Wichita Falls gage is shown in table 9.

TABLE 9

ESTIMATED NUMBER AND MAGNITUDE OF FLOODS UNDER NATURAL CONDITIONS AT LAKE KEMP DAM SITE AND WICHITA FALLS FOR THE PERIOD APRIL 1938 THROUGH SEPTEMBER 1958

Feet Above Bankfull	Lake Kemp Dam Site		Wichita Falls	
	Number of Occurrences	Accumulated Number of Occurrences	Number of Occurrence	Accumulated Number of Occurrences
12.00 - 13.99	2	2	0	0
10.00 - 11.99	0	2	1	1
8.00 - 9.99	0	2	0	1
6.00 - 7.99	1	3	1	2
4.00 - 5.99	3	6	1	3
2.00 - 3.99	5	11	8	11
0 - 1.99	49	60	19	30

c. Peak flow. - The date of occurrence, peak discharge, stage and volume for the eight largest floods at Wichita Falls gage with and without Lake Kemp operating, are shown in table 10.

TABLE 10

ESTIMATED LARGEST FLOODS OF RECORD AT WICHITA FALLS GAGE

	With Lake Kemp Operating			Without Lake Kemp Operating			
Crest Date	Stage Height (ft)(1)	Peak Discharge (c.f.s.)	Date of Flow	Stage Height (ft)(1)	Peak Discharge (c.f.s.)	Volume (ac-ft)	Inches
May 5, 1941	21.18	12,900	Apr 30 - May 9	31.80	33,500	259,000	1.55
Oct 5, 1955	20.88	9,510	Oct 1-10	27.17	23,750	254,500	1.52
Oct 3, 1941	24.00	17,800	Oct 1-6	25.65	20,800	144,000	0.86
Jun 4, 1941	22.71	15,500	Jun 1-5	22.71	15,500	91,900	0.55
May 3, 1957	18.27	7,200	Apr 20 - May 9	22.70	15,400	222,200	1.33
Aug 4, 1950	21.42	9,000	Aug 1-7	21.95	14,150	92,900	0.55
May 20, 1957	18.60	7,660	May 17-22	21.70	13,730	110,200	0.66
May 21, 1947	16.39	6,320	May 6-25	21.30	13,100	250,700	1.50

(1) Flood stage is 20.0 feet

d. Flood of June 1915. - The storm of June 4-7, 1915, produced maximum flood of modern times in terms of peak discharge and stage. The maximum recorded rainfall within the basin was 5.75 inches at Wichita Falls. Reported rainfall over the basin averaged 5.56 inches. The peak discharge at Wichita Falls was estimated to have been 50,000 c.f.s. and the volume as 294,000 acre-feet or 1.7 inches of runoff during the period June 1-17.

e. Flood of May 1908. - Although data relative to the May 1908 flood are meager, the flood height and volume are reported to have been about equivalent to the June 1915 flood. The rain which caused the flood occurred during the period May 22-24 and averaged 4.97 inches over the basin. The maximum recorded rainfall was at Wichita Falls where 6.40 inches were measured. Practically all of the rain fell in about 36 hours.

f. Flood of May 1941. - The flood of May 1941 was caused by the storm of May 2-5 and resulted in a peak discharge of 12,900 c.f.s. at the Wichita Falls gage. The estimated peak discharge at the gage would have been 33,500 c.f.s. without Lake Kemp in operation. This would have been the largest discharge for the period of record. The rainfall averaged 3.57 inches above Lake Kemp and 3.42 inches over the entire basin. The total estimated volume past the Wichita Falls gage was 259,000 acre-feet or 1.55 inches of runoff, of which approximately 19,000 acre-feet were runoff from the April 26-30 storm. Lake Kemp had a recorded maximum daily inflow of 60,000 acre-feet with an estimated peak inflow of 34,000 c.f.s. During this flood, Lake Kemp attained an elevation of 1152.0, which is the maximum stage of record since the reservoir has been in operation.

g. Flood of October 1941. - The flood of October 1941 resulted from the storm of October 1-4 and has a peak discharge at Wichita Falls of 17,800 c.f.s. and a peak stage of 24.0 feet. This was the maximum stage of gaged record at Wichita Falls. The storm had its greatest rainfall in the basin between Lake Kemp and Wichita Falls, averaging about 4.95 inches. The area above Lake Kemp had an average rainfall of about 3.32 inches. Average rainfall over the entire basin was 4.07 inches. The greatest measurement of rainfall occurred at Iowa Park, Texas, about nine miles west of Wichita Falls, where 8.54 inches of rain were recorded. The greatest 24-hour recorded rain was also at the Iowa Park Station and amounted to 6.58 inches. Inflow into Lake Kemp approximated 50,000 acre-feet or 0.45 inch for that watershed. There was no release from Lake Kemp and the total flood volume was 94,000 acre-feet, or 1.75 inches for the intervening area between Lake Kemp and Wichita Falls. If Lake Kemp had not been operated, the total volume passing Wichita Falls would have amounted to 144,000 acre-feet, or 0.86 inch of runoff for the entire watershed.

h. Flood of October 1955. - The flood of October 1955 resulted from the storm of October 1-5 and had a peak discharge at Wichita Falls gage of 9,510 c.f.s. and a volume of 99,000 acre-feet from the intervening area below Lake Kemp. The area above Lake Kemp had an average rainfall of 5.50 inches while the area below the dam averaged 3.86 inches. The storm centered in the north central section of the watershed with 9.18 inches reported at Crowell, Texas. Inflow into Lake Kemp totaled 155,500 acre-feet or 1.39 inches for the watershed with a maximum daily inflow of 50,000 acre-feet. The maximum elevation attained by Lake Kemp during this flood was 1151.8.

i. Natural discharge probability. - Computations of natural discharge frequency for various economic reaches along the river below Lake Kemp were made using general procedures presented in EM 1110-2-1450, dated March 1959. Flows of record for the period April 1938 through September 1959 were used at the Wichita Falls gage. Estimated flows based on daily pool elevation and discharge records at Lake Kemp were used for discharge frequency curve at the dam site. These curves were compared with available regional frequency studies and were revised upward to agree with regional frequency data. The revised curves were substantiated by application of historical flood data. The adopted natural discharge frequency curve at Lake Kemp Dam site is shown on plate 3.

7. PROPOSED STORAGE CAPACITIES AND RESERVOIR OPERATIONS

a. Area and capacity curves. - The Corps of Engineers made a hydrographic and instrumental survey of Lake Kemp in 1944. The Soil Conservation Service made a similar survey in 1958 and the area-capacity curves based on the study are contained in a preliminary report of Lake Kemp Sedimentation Study dated January 1959. The SCS area-capacity curves were adopted and extrapolated above elevation 1153.0; however, if the project is authorized, more topography should be obtained between elevations 1140.0 and 1153.0 since neither the Corps of Engineers nor the Soil Conservation Service has any detailed data in that range. The area-capacity curves are shown on plate 4.

b. Flood control capacity requirements.

(1) Lake Kemp Reservoir would be operated for maximum benefits below the dam site on the Wichita River and for incidental benefits on the Red River. Storages required to control the standard project flood and five major floods since April 1938 are shown in table 11.

TABLE 11

FLOOD CONTROL STORAGE REQUIRED TO CONTROL MAJOR FLOODS

Flood	Flood Volume Entering Lake Kemp	Flood Control Storage Required (acre-feet)	(inches)
Standard Project Flood	874,400	871,000	7.78
October 1955	155,500	153,300	1.37
May 1941	150,500	145,500	1.30
May 1954	92,000	90,000	.81
May 1947	131,000	83,000	.74
May 1957	72,000	70,000	.63

(2) A flood control capacity of 200,000 acre-feet (1.79 inches) is adopted for Lake Kemp Reservoir. This capacity is based in part on data in table 11, the estimated volumes of historical floods and flood control capacities provided in other Corps of Engineers projects in the general area having similar climatological and hydrological characteristics and on pool elevation probability. The reservoir would control all floods up to and including the once-in-50-year flood. Studies made using only 150,000 acre-feet of flood control storage indicate that frequency of filling would have been increased to once in 10-1/2 years, reducing the flood control benefits much more than savings in structure. Since, Lake Kemp is located 70 miles above the City of Wichita Falls and, as indicated in table 13, floods are produced at Wichita Falls from the intervening area below Lake Kemp, a high degree of flood control is desirable in the reservoir. The 200,000 acre-feet of flood control storage would control all floods of record and would control the once-in-50-year flood; therefore, additional flood control storage would not be practical.

c. Channel improvement. - The channel capacity between Lake Kemp and Wichita Falls varies from 6,200 c.f.s. to 7,500 c.f.s. There is little benefit to be gained by channel improvement in the rural areas since flood losses are relatively minor in the stages immediately above bankfull and reduction which could be attributed to possible channel improvement would be negligible. The drainage area of the Wichita River above the mouth of Holliday Creek is 3,341 square miles of which 2,099 square miles are above Lake Kemp. Based on regional frequency studies and with Lake Kemp in operation, flooding will occur at Wichita Falls every 1-1/2 years. If the channel capacity was doubled, the recurrence interval would be every three years; however, since the flood plain of the Wichita River near Wichita Falls is flat, minor flooding can inundate large areas and larger floods add only to the depth, which indicates that if a channel improvement project is constructed it should include levees and have the capacity to control

large floods. Since the uncontrolled area above Wichita Falls is large and the duration of flooding for most floods is limited to a few days, increased channel capacities could have only a minor effect on flood control storage requirements at Lake Kemp and no channel improvement is recommended in this survey report.

d. Sedimentation. - The Soil Conservation Service Preliminary Report of Lake Kemp Sedimentation Study dated January 1959 estimated that 98,243 acre-feet of sediment had deposited in Lake Kemp Reservoir in a 36-year period. This is at the rate of about 2,729 acre-feet annually, equivalent to about 1.32 acre-feet per square mile per year. This appears to be reasonable and it was used as the basis for adopting 136,000 acre-feet as the required sediment reserve in Lake Kemp for a 50-year period.

e. Storage capacities. - The storage allocations for Lake Kemp Reservoir are shown in table 12.

TABLE 12

ALLOCATED RESERVOIR CAPACITIES

Feature	Storage	
	Acre-feet	Inches
Flood control	200,000	1.79
Conservation	190,000	1.70
Sediment	136,000	1.21
Total	526,000	4.70

f. Proposed method of flood control operation. - Lake Kemp Reservoir would be operated for maximum benefits along the Wichita River. The controlling channel capacity on the Wichita River below Lake Kemp is 6,200 c.f.s. to the confluence of Holliday Creek and 7,400 c.f.s. below Holliday Creek. Reservoir releases would be made in conjunction with Lake Wichita release to maintain channel capacity on the Wichita River insofar as possible. In the event that the volume of predicted inflow is in excess of the flood control storage available in the reservoir, releases will be made in accordance with gate regulation curves which would assure full use of flood control storage.

g. Effect of reservoir operation on the floods of record. - Lake Kemp Reservoir would have controlled all floods of record at the dam site. Studies indicate that Lake Kemp would afford minor flood reduction on the Red River. Lake Kemp would not have reduced the peak discharge of the standard project flood at the dam site or

at the Wichita Falls gage. It is estimated that the floods of 1899, 1908 and 1915 would have been reduced to bankfull at the dam site and reduced in stage by 1.0 foot, 0.9 foot and 4.5 feet, respectively, at Wichita Falls. The effect of the reservoir on floods of record at the Wichita Falls gage is shown in table 13.

TABLE 13

ESTIMATED NUMBER AND MAGNITUDE OF FLOODS ON WICHITA RIVER AT WICHITA FALLS GAGE WITH AND WITHOUT LAKE KEMP OPERATING-APRIL 1938 THROUGH SEPTEMBER 1958

Peak Stage (feet above operating stage)	Natural		Lake Kemp Operating	
	Number of Occurrences	Accumulated Number of Occurrences	Number of Occurrences	Accumulated Number of Occurrences
10.00 to 11.99	1	1	0	0
8.00 to 9.99	0	1	0	0
6.00 to 7.99	1	2	0	0
4.00 to 5.99	1	3	1	1
2.00 to 3.99	8	11	1	2
0 to 1.99	19	30	2	4

h. Basis for relocations and land acquisition. - The elevation of the once-in-50-year pool, plus three feet of freeboard for wave wash and saturation, will serve as a guide for relocations and land acquisition in the flat pool area. The envelope curve of backwater effects of the 50-year flood will serve as a guide for relocations and for flowage easements on land in the upper reaches of the reservoir. Fee title will be acquired on land below the once-in-50-year pool.

8. DETERMINATION OF SPILLWAY REQUIREMENTS

a. General. - In accordance with established procedures, the spillway design floods were submitted to Office, Chief of Engineers, for approval by letter dated 17 March 1960, subject: "Spillway Design Flood, Lake Kemp Reservoir, Wichita River, Texas". The flood was approved by OCE in 4th Indorsement dated 28 July 1960. These data are included in this report as a matter of record.

b. Initial losses and infiltration rates.

(1) Infiltration studies have been made at Wichita Falls for several flood periods, for the area between Lake Kemp and Wichita Falls when Lake Kemp has held all inflow from above the dam. Initial losses and infiltration indices for this area are shown in table 14.

TABLE 14

INITIAL LOSSES AND INFILTRATION RATES

Storm Period	Average Rainfall (inches)	Storm Runoff (inches)	Initial Loss L_1 (inches)	Infiltration Index, Fav (inches)
October 1-4, 1941	4.97	1.75	1.90	0.048
August 1, 1950	3.26	1.12	1.62	0.035
May 17-19, 1951	5.91	0.79	4.36	0.080
May 18-20, 1955	4.10	0.70	2.50	0.060

(2) After a review of the above data, and consideration of soil, vegetal cover and topographic conditions, an initial loss of 2.00 inches and an infiltration rate of 0.05 inch per hour were considered sufficiently conservative and were selected for the maximum probable storm.

c. Unit hydrographs. - A synthetic six-hour unit hydrograph was developed at the dam site. The constant $C_T = 2.13$ was used, based on studies by this office, and a value of $C_p = .8$ was adopted as being near the upper limit of acceptable values, although the studies, based on meager data, indicated a somewhat higher value. The unit hydrograph is shown on plate 5.

d. Maximum probable storm. - The maximum probable storm was derived from charts in U. S. Weather Bureau Hydrometeorological Report No. 33. Extension of the curves in that report to areas larger than 1,000 square miles, and rainfall durations longer than 48 hours were accomplished as shown in the Hydrometeorological Section of U. S. Weather Bureau letter report to Corps of Engineers inclosed with 2d Ind, dated 18 May 1959, to letter from the Tulsa District, dated 10 February 1959, subject: "Spillway Design Storms - Millwood and Broken Bow Reservoirs". A ten percent reduction of the maximum probably precipitation was used for basin shape and maximum storm enveloping effects. The resulting storm was arranged by six-hour periods in accordance with Civil Engineer Bulletin 52-8. The six-hour periods of rainfall loss, rainfall excess, mean ordinates of the adopted unit hydrograph and mean ordinates of the resulting flood, including 300 c.f.s. base flow, are shown on table 15.

TABLE 15

SPILLWAY DESIGN FLOOD - LAKE KEMP

Hour	Rainfall (inches)	Loss (inches)	Rainfall Excess (inches)	Adopted Unit Hydrograph (1,000's c.f.s.)	Maximum Probable Flood (1,000's c.f.s.)
6	0.20	0.20		1.2	0.3
12	0.30	0.30		6.0	0.3
18	0.60	0.60		12.8	0.3
24	0.70	0.70		19.8	0.3
30	0.90	0.40	0.50	25.2	0.9
36	1.90	0.30	1.60	28.8	5.2
42	15.20	0.30	14.90	29.8	34.3
48	1.00	0.30	0.70	27.7	121.2
54	0.80	0.30	0.50	23.3	240.6
60	0.60	0.30	0.30	17.8	363.1
66	0.40	0.30	0.10	12.5	459.7
72	0.30	0.30		8.3	523.8
78				5.2	541.3
84				3.2	505.1
90				1.9	428.8
96				1.1	332.8
102				0.6	238.8
108				0.3	162.3
114				0.2	104.6
120				0.1	65.9
126				0.1	40.2
132					24.0
138					13.9
144					7.9
150					5.4
156					3.2
162					1.4
168					1.2
174					1.1
Total	22.90	4.30	18.60	225.8	4,227.9

e. Magnitude of the spillway design flood. - The envelope curves of maximum experienced peak discharges of record for areas west of the 97th Meridian within the Tulsa District, together with curves derived by Myer and Creager, are shown on plate 6. The peak discharge for the spillway design flood for Lake Kemp is shown thereon. Peak discharges and flood volumes for the spillway design flood and related data are shown in table 16.

TABLE 16

COMPARATIVE DATA FOR SPILLWAY
DESIGN FLOOD - LAKE KEMP

Volume (acre-feet)	Peak Discharge		Myers Rating (percent)	Creagers "c"	Ratio Peak (1)
	Cubic Feet Per Second	c.f.s. per Square Mile			
2,086,000	543,000	258.2	118.3	104.0	4.10

(1) Ratio maximum probable flood to envelope of maximum experienced peak discharges for comparable areas west of the 97th Meridian as shown on plate 6.

f. Standard project flood. - A standard project flood was derived based on 50 percent of the spillway design storm. This flood had a volume of 874,400 acre-feet which is 6.3 times the maximum five-day volume during the period 1938 through 1958. The peak discharge is 233,000 c.f.s. which is 6.8 times the maximum estimated peak during the same period.

g. Routing of the spillway design flood. - The antecedent and spillway design floods were adjusted for conditions of inflow into full pool for routing through the reservoir. The standard project flood was utilized as the antecedent flood with an interval of three days with no rain before start of the spillway design flood. The routing was made by gate regulation curves developed to induce three feet of surcharge above top of flood control pool and with the sluice in operation. The pool elevation at the beginning of the spillway design flood was determined by routing the antecedent flood on an empty pool. The operational hydrographs for the spillway design flood are shown on plate 7.

h. Spillway and outlet works. - The spillway would consist of an ogee weir with crest at elevation 1121.0. Spillway releases would be controlled by ten 40' x 35' tainter gates which would surmount the spillway crest. This spillway would discharge 462,500 c.f.s. at maximum pool elevation 1165.2. Spillway and gate regulation curves are shown on plates 8 and 9. One 5'-8" x 7'-0" sluice with invert at elevation 1090.0 would provide the necessary releases for conservation purposes. The sluice rating curve is shown on plate 10.

i. Freeboard. - Freeboard requirements for Lake Kemp were computed in accordance with the procedures outlined in letter from Southwestern Division, subject: "Conference on Determination of Freeboard Requirements for McGee Bend Dam, Angelina River, Texas", dated 12 October 1958. The maximum wind fetch is 5.7 miles and the weighted or effective fetch is 2.0 miles. The average pool depth is 60 feet. On the basis of an overland wind velocity of 45 miles

per hour, the significant wave would be 3.7 feet and the wind tide 0.? foot, for a total of 3.9 feet. In accordance with current Corps of Engineers policy for earthfill structures, a minimum freeboard of five feet above the maximum water surface would be recommended; however, since the computed wave height is less than four feet a freeboard of 4.8 feet was adopted.

9. PERTINENT DATA

Pertinent data as discussed in the report are shown in table 17.

TABLE 17

PERTINENT DATA - LAKE KEMP

Feature	Present Structure	Proposed Modifications
Location		
Stream	Wichita River	Wichita River
River mile	126.7	126.7
Drainage area, square miles	2,099	2,099
Top of dam, elevation	1167.0	1170.0
Maximum pool, elevation	-	1165.2
Top flood control pool, elevation	-	1156.0
Top conservation pool, elevation	1153.0 (1)	1144.0
Storage, acre-feet		
Flood control	-	200,000
Conservation	461,800 (2)	190,000
Sediment reserve	-	136,000 (3)
Total	461,800	526,000
Area, acres		
Top flood control pool	-	22,440
Top conservation pool	-	15,150
Spillway		
Type	Uncontrolled	Controlled
Length	564'	10-40'x35'gates
Crest, elevation	1153.0	1121.0
Outlet works	2-7' diameter conduits	1-5'8"x7'0"sluice

(1) The conservation pool has been maintained at elevation 1143.0 in order to provide storage for flood control.
(2) Capacity at elevation 1143.0 is 287,900 acre-feet.
(3) Includes 23,600 acre-feet of sediment in the flood control pool.

SURVEY REPORT
ON
LAKE KEMP
WICHITA RIVER, TEXAS

APPENDIX II
DAMAGES, BENEFITS, JUSTIFICATION AND COST ALLOCATION

U. S. ARMY ENGINEER DISTRICT, TULSA
CORPS OF ENGINEERS
TULSA, OKLAHOMA

APPENDIX II

DAMAGES, BENEFITS, JUSTIFICATION AND COST ALLOCATION

TABLE OF CONTENTS

Paragraph	Title	Page
1	PURPOSE	70
2	AREA UNDER CONSIDERATION	70
3	POPULATION	71
4	ECONOMIC DEVELOPMENT	71
5	VALUE OF PROPERTY	72
	a. General	72
	b. Mineral resources	74
6	VALUE OF CROPS	74
7	EXPERIENCED FLOOD LOSSES	75
8	METHOD OF INVESTIGATION	75
9	USE OF EXPERIENCED FLOOD DATA	76
10	AVERAGE ANNUAL LOSS	76
11	FLOOD CONTROL BENEFITS	78
	a. Annual flood losses prevented	78
	b. Future development	78
	c. Increased land utilization	78
	d. Red River benefits	78
	e. Other flood control benefits	78
12	INTANGIBLE BENEFITS	79
13	SUMMARY OF FLOOD CONTROL BENEFITS	79
14	OTHER RESERVOIR BENEFITS	79
	a. Conservation benefits	79
	b. Recreation	80
	c. Fish and wildlife	80
	d. Summary of benefits	80
15	ESTIMATED COST AND ANNUAL CHARGES	80
16	PROJECT JUSTIFICATION	80

TABLE OF CONTENTS (Continued)

Paragraph	Title	Page
17	PROJECT FORMULATION	81
	a. General	81
	b. Flood control	81
	c. Conservation	81
18	MAXIMIZING BENEFITS	81
	a. General	81
	b. Flood control	82
19	RESIDUAL FLOOD LOSSES	83
20	COST ALLOCATION	83
21	FEDERAL-NON-FEDERAL COST SHARING	86
	a. Federal	86
	b. Non-Federal	86

TABLES

Table No.		Page
1	Classification of Land	71
2	Valuation of Property	73
3	Annual Value of Crops	75
4	Average Annual Loss Expectancies	77
5	Summary of Annual Flood Control Benefits	79
6	Cost Allocation Study - Summary of Costs, Annual Charges and Benefits	84
7	Cost Allocation by Use-of-Facilities Method	85

FIGURES

Figure		Page
1	Excess Benefits Over Cost vs. Flood Control Storage	82

PLATES (not printed)

Plate No.	Title
1	Loss-Benefit Curves
2	Flood Plain at Wichita Falls, Texas

89691 O-62—6

DAMAGES, BENEFITS, JUSTIFICATION AND COST ALLOCATION

1. PURPOSE

The purpose of this appendix is to present economic data regarding values, damages and benefits supplemental to that contained in the main report. Damages and benefits presented herein are based on April 1960 price levels and development.

2. AREA UNDER CONSIDERATION

The flood plain considered in this report consists of the overflow area subject to inundation by the 1915 flood on the Wichita River below Lake Kemp Dam, exclusive of the area within Lake Diversion, and with Lake Kemp considered as not in operation. Under this condition, the flooded area will average about three-fifths of a mile in width above Wichita Falls, Texas, and about one mile in width from Wichita Falls to the confluence with Red River. The lands subject to flood damage are comparatively flat and are flanked by gradually sloping hills on each side of the valley. The overflow area involves an estimated 34,910 acres, of which 33,240 are rural lands and 1,670 are urban lands. The classification of lands in this area is contained in table 1.

TABLE 1

CLASSIFICATION OF LAND

Stream and Reach	Urban (acres)	Cultivated (acres)	Open Pasture (acres)	Wooded Pasture (acres)	Total (acres)	Total Urban and Rural (acres)
WICHITA RIVER						
From Lake Kemp Dam to Wichita Falls (1)	-	3,110	3,410	7,570	14,090	14,090
Wichita Falls, Tex	1,670	-	-	-	-	1,670
From Wichita Falls to back-water limits of Red River	-	7,080	5,750	6,320	19,150	19,150
TOTAL	1,670	10,190	9,160	13,890	33,240	34,910

(1) Exclusive of area within Lake Diversion

3. POPULATION

The residential population in the Wichita River flood plain, based on a 1958 survey, is estimated to total 8,640, of which 120 persons are located in rural areas and 8,520 are located in Wichita Falls. There are about 3,780 persons who earn their livelihood in the overflow area, of which 60 reside in the rural area and 3,720 in the urban area. The U. S. Census Bureau lists the 1960 population of the City of Wichita Falls as 101,724, which is an increase of about 50 percent since 1950, when the population was 68,042.

4. ECONOMIC DEVELOPMENT

The flood plain of Wichita River below Lake Kemp Dam to the confluence with Red River is used chiefly for the production of oil and gas, the raising of livestock, and the production of crops. In the rural areas, approximately 31 percent of the flood plain is in crops, with 27 percent in open pasture and the remaining 42 percent in wooded pasture. The principal crops are wheat, alfalfa, cotton, sorghums, oats and corn. A major portion (1,670 acres) of the urban area of the City of Wichita Falls, Texas, is located in the overflow area of the Wichita River. This is a highly industrialized and

residential area. Wichita Falls is served by two major airlines and two railroads. Three U. S. Highways and two State Highways and numerous farm to market roads serve the Wichita River Basin.

5. VALUE OF PROPERTY

a. General. - The total value of all physical property located within the limits of the flood plain, including the values of the agricultural lands, but exclusive of proven and unproven minerals and crops which are discussed elsewhere in this report, is estimated to be $99,768,000, of which $9,450,000 applies to property in the rural area and $90,318,000 to improvements in the urban area. The valuation of each class of property is shown in table 2.

TABLE 2

VALUATION OF PROPERTY

Classification of Property	From Lake Kemp Dam to Wichita Falls	From Wichita Falls to Backwater Limits of Red River	Subtotal - Rural Areas	Wichita Falls, Texas	Total All Property
	$	$	$	$	$
Publicly owned property					
Highways and bridges	1,013,000	762,000	1,775,000	3,558,000	5,333,000
Municipal	-	-	-	1,190,000	1,190,000
Institutional	-	-	-	669,000	669,000
Parks	375,000	-	375,000	320,000	695,000
Utilities and services	-	-	-	2,296,000	2,296,000
Total - Publicly owned property	1,388,000	762,000	2,150,000	8,033,000	10,183,000
Privately owned property					
Railroads and utilities	108,000	164,000	272,000	2,637,000	2,909,000
Institutional	-	-	-	313,000	313,000
Urban residential	-	-	-	15,568,000	15,568,000
Commercial and industrial	-	-	-	63,767,000	63,767,000
Gas and oil lines	41,000	2,683,000	2,724,000	-	2,724,000
Rural supplies, stock and equipment	1,842,000	1,223,000	3,065,000	-	3,065,000
Rural land and improvements	418,000	821,000	1,239,000	-	1,239,000
Total - Privately owned property	2,409,000	4,891,000	7,300,000	82,285,000	89,585,000
GRAND TOTAL	3,797,000	5,653,000	9,450,000	90,318,000	99,768,000

b. Mineral resources. - The principal mineral resources known to exist in the flood plain limits of the Wichita River are natural gas and crude oil. Since the discovery of the K.M.A. oilfield in 1919, operators have been drilling throughout the area. As a result of such widespread activity, other fields have been discovered and developed. Due to this extensive exploration, oilfields have been developed from the vicinity of the Lake Diversion Dam northeasterly to the northern edge of the City of Wichita Falls and are intermittently spaced northeasterly to the Red River. This is primarily old and shallow production. At the present time, there are approximately 650 oil and gas wells in the flood plain with an estimated production of 2,500 barrels of oil daily. The estimated mineral value of $5,250,000 includes the present-day value of mineral rights and the value of recoverable minerals, less the cost of production and depreciation of equipment.

6. VALUE OF CROPS

The principal crops grown in the flood plain area are wheat, cotton, grain sorghum, alfalfa, corn and oats. The annual value of crops, based on April 1960 price levels, is estimated to be $348,000. Further details of crop values are shown in table 3.

TABLE 3

ANNUAL VALUE OF CROPS

Item	Lake Kemp Dam to Wichita Falls		Wichita Falls to Backwater Limits of Red River		Total	
	Acres	Value	Acres	Value	Acres	Value
		$		$		$
Wheat	1,710	55,500	2,870	98,800	4,580	154,300
Cotton	230	11,400	960	47,700	1,190	59,100
Sorghum	560	10,100	1,340	24,300	1,900	34,400
Alfalfa	150	8,600	960	55,400	1,110	64,000
Corn	80	1,500	570	10,700	650	12,200
Oats	380	8,000	380	8,000	760	16,000
Open Pasture	3,410	1,600	5,750	2,900	9,160	4,500
Wooded Pasture	7,570	1,900	6,320	1,600	13,890	3,500
TOTAL	14,090	98,600	19,150	249,400	33,240	348,000

7. EXPERIENCED FLOOD LOSSES

The operation of Lake Kemp since its completion has eliminated or reduced all major floods to moderate or minor magnitude, even in the lower reaches. Major floods, prior to reservoir control, occurred in 1899, 1901, 1908 and 1915. Based on present-day conditions and prices (April 1960) and assuming rainfall originating above Lake Kemp, it is estimated that a repetition of the 1915 flood, without reservoir control at the Lake Kemp site, would cause damages estimated to be $5,255,000, of which $229,000 would be crop losses, $1,106,000 would be rural structural losses, and $3,920,000 would be urban structural losses in Wichita Falls. With Lake Kemp in place and operating, as described in appendix I, approximately $4,449,000 of the above flood losses attributed to the 1915 flood would be prevented. The estimated flood damages that would have been prevented include $112,000 for crops, $837,000 for rural structures, and $3,500,000 for urban structures in Wichita Falls.

8. METHOD OF INVESTIGATION

A survey of damages resulting from the maximum floods of record on Wichita River below the Lake Kemp Dam (excluding the reach within Lake Diversion), was made in the field by representatives of the Tulsa District in 1958 and 1960, using current prices and present-day development. From these data, stage-damage curves for each classification of property and stage-area curves for each reach were constructed. The stage-damage curves indicate the estimated structural damages for any intermediate stage between bankfull and the maximum stage. The stage-area curves indicate the estimated area in

acres that would be overflowed for any intermediate stage between bankfull and the maximum stage. The curves were utilized in estimating the damages to be expected from the various floods of record. Annual crop damages per acre flooded were based on losses weighted to reflect frequency, duration of flooding and season of year. Plate _ shows the various curves used in the loss and benefit analysis for a portion of the area affected by the proposed project.

9. USE OF EXPERIENCED FLOOD DATA

Experienced flood data pertaining to magnitude and frequency were considered to offer the most reasonable basis for the prediction of future flood occurrences. Accordingly, frequency curves were constructed, based on the assumption that past floods occurring over an extended period would be repeated in the future. Use was made of discharge probability curves, determined by using general procedures as outlined in part VI, paragraphs 2 and 3 of "Statistical Methods of Hydrology", dated July 1952, distributed under Civil Works Engineer Bulletin 52-24, for developing the discharge-frequency and duration-frequency curves. Rating (stage-discharge) curves were developed from known and synthetic data with stage as the ordinate and discharge as the abscissa. The frequency curves (for discharge and for duration) were applied to the rating (stage-discharge) curves to develop a stage-frequency and stage-duration relationship. Flood loss expectancies were computed by applying this relationship (with and without the proposed project) against the stage damage and stage-area curves at increments ranging from the no-damage stage to the maximum stage to be expected in the period of 100 years. For simplicity the stage-duration relationship is shown on the stage-area curve with the corresponding crop loss per acre for the various days of duration.

10. AVERAGE ANNUAL LOSS

Recurring losses in the flood-plain areas under consideration were converted to average annual losses by use of damage-frequency curves, with and without the proposed project. The damage-frequency curves for crops were derived by taking a specific stage on the stage-area curves and multiplying the indicated acres flooded by the corresponding annual crop loss per acre (items shown on stage-area curves) with the results correlated with the stage-frequency relationship. Similarly, the damage-frequency curve for structures was obtained by correlation of the stage-damage curve and the stage-frequency relationship. Plate 1 shows the results obtained by these procedures for a portion of the area affected by the Lake Kemp project. Data for crops and structural losses in the remaining reaches were treated in a like manner. The average annual structural and crop damages, natural and modified, were determined by measuring the area under the damage-frequency curves which were plotted with damages as the ordinate and percent-change-of-occurrence as the abscissa. Average annual loss expectancies, with Lake Kemp assumed not in operation, under natural flow conditions are summarized in table 4.

TABLE 4

AVERAGE ANNUAL LOSS EXPECTANCIES
(Lake Kemp assumed not in operation)

Classification of Property	From Lake Kemp to Wichita Falls, Texas	Wichita Falls, Texas	From Wichita Falls to Backwater Limits of Red River	Total
	$	$	$	$
Publicly owned property:				
Highways and bridges	15,200	16,100	12,600	43,900
Municipal	-	3,500	-	3,500
Institutional	-	1,700	-	1,700
Parks	9,700	1,100	-	10,800
Utilities and services	-	6,900	-	6,900
Total - Publicly owned property	24,900	29,300	12,600	66,800
Privately owned property:				
Railroads and utilities	600	18,000	700	19,300
Institutional	-	5,000	-	5,000
Urban residential	-	144,000	-	144,000
Commercial & industrial	-	251,600	-	251,600
Oil and gas lines (1)	137,200	-	11,200	148,400
Rural supplies, stock and equipment	18,600	-	12,200	30,800
Rural land and improvements	40,900	-	28,500	69,400
Crops	18,100	-	38,600	56,700
Total - Privately owned property	215,400	418,600	91,200	725,200
GRAND TOTAL	240,300	447,900	103,800	792,000

(1) Including losses to proven minerals and related equipment.

11. FLOOD CONTROL BENEFITS

a. Annual flood losses prevented. - When Lake Kemp is operated for flood control as discussed in appendix I, it is estimated that about $569,000 of the annual flood losses shown in table 4 would be prevented. The annual flood damages prevented include $37,400 to crops, $200,200 to rural structures and $331,400 to urban structures in Wichita Falls.

b. Future development. - It has been assumed that construction of physical property in the flood plain area will continue to develop without improvement of Lake Kemp Dam. Based on past developments and present trends, as discussed in Supplement A, it is considered reasonable to assume that over a 50-year period, an average increase of 32 percent, 20 percent and 40 percent will accrue to urban structures, rural structures and crop values, respectively. These average percent increases were applied to the flood losses prevented to derive future development flood loss benefits. Based on the above, the total annual future development flood loss prevention benefits are $161,000 of which $106,000 are for urban structures, $40,000 are for rural structures and $15,000 are for crops.

c. Increased land utilization. - No benefits from increased land utilization due to flood protection in the rural and urban areas have been credited to the project, as they are considered to be small.

d. Red River benefits. - The operation of Lake Kemp under existing conditions or with improvements considered herein would have only minor influence on floods occurring on Red River from the mouth of Wichita River to the upper limits of Lake Texoma formed by Denison Dam. Studies of flood routings have indicated that Lake Kemp would afford minor reductions on some of the Red River floods. For this reason, Red River benefits from the operation of Lake Kemp under existing or improved conditions were not evaluated for this study.

e. Other flood control benefits. - Flood damages resulting in the event of failure of the existing Lake Kemp spillway have been considered but are not included in the flood control benefits reported herein. These flood damages would vary in accordance with the flood conditions on the Wichita River at the time of the assumed spillway failure.

(1) Should the spillway fail during a period when the Wichita River below the dam was not flooding, failure of the spillway would cause estimated flood damages in the amount of $665,000, of which $119,000 would be crop losses, $436,000 would be losses to rural structures, and $110,000 would be losses to urban structures.

(2) If the spillway were to fail during a flood with a frequency of once in 50 years, the added flood losses resulting from

such failure are estimated at $1,407,000, including $8,000 to crops, $62,000 to rural structures, and $1,337,000 to urban structures at Wichita Falls.

12. INTANGIBLE BENEFITS

Lake Kemp, when operated for flood control as outlined in this report, would provide other flood control benefits not susceptible to monetary evaluation. These would include benefits from reduction of interruption to motor and rail traffic, wherein the time element is of importance, loss of business income, reduction in human suffering and inconvenience resulting from evacuation and reoccupation of flooded areas, and reduction in health hazards due to unsanitary conditions caused by floods.

13. SUMMARY OF FLOOD CONTROL BENEFITS

Benefits estimated to accrue from operation of Lake Kemp for flood control purposes as discussed herein are summarized in table 5.

TABLE 5

SUMMARY OF ANNUAL FLOOD CONTROL BENEFITS

Item	Amount
	$
Flood losses prevented:	
Crops	37,400
Rural structures	200,200
Urban structures	331,400
Subtotal	569,000
Future development	161,000
Total	730,000

14. OTHER RESERVOIR BENEFITS

a. Conservation benefits. - The reconstructed Lake Kemp will provide the same amount of conservation storage (190,000 acre-feet) as local interests have utilized in the past and are using at present. The present use is primarily for irrigation. It is also available for emergency water supply, although the quality is not good. The Public Health Service, in their report of June 1960, indicated that the quality of water needs to be improved for municipal and industrial use, and estimates that when these conditions are met, water would be worth 7.3 cents per thousand gallons. The Bureau of Reclamation has estimated that an average of 65,700 acre-feet per year would be required to irrigate 18,000 acres of land in the future.

Benefits from this use are estimated to be $649,000 annually. The estimated annual yield from the conservation storage is 70,000 acre-feet, most of which would be needed to supply the irrigation needs. The yield from storage for possible emergency water supply has not been evaluated for the purposes of this study.

b. Recreation. - Lake Kemp is a semipublic lake, providing day-use recreational opportunities for Baylor, Wilbarger, Wichita and Archer Counties, Texas. The land around the lake is privately owned, and an entrance fee is charged for cars visiting the lake for boating and swimming. Provision of recreational facilities and free public access areas are not proposed as a Federal cost, since the project will continue to operate under the present administration and ownership. Benefits for recreation are not claimed herein.

c. Fish and wildlife. - The Fish and Wildlife Service, by draft of June 8, 1960 states in part: "The proposed modification of the reservoir, leaving the conservation pool unchanged, should not have any significant effect on the fish and wildlife resources, but more detailed studies will be necessary to fully ascertain the import of the project. Possibilities for enhancement of the area for waterfowl do exist, and will be investigated by the Bureau of Sport Fisheries and Wildlife and the Texas Game and Fish Commission at such time as the Corps' plans become more firm and pertinent operational data become available". On the basis of the foregoing, no benefits for fish and wildlife have been claimed herein.

d. Summary of benefits. - The total average annual benefits which are utilized in the economic justification of the project are estimated to be $1,379,000 of which $730,000 are flood control benefits and $649,000 are conservation benefits.

15. ESTIMATED COST AND ANNUAL CHARGES

The cost and annual charges used in this report are based on 1960 price levels. In view of the inflated value of land, the interest rate of 2-5/8 percent was considered ample to reflect any net loss that might occur due to use of the land for project purposes. Since the proposed project would not require any future additions, it was concluded that financial and economic costs are the same. The cost for the rehabilitation of the project is estimated to be $8,648,000. The estimated cost and annual charges for the multiple-purpose project, including an allowance for the value of usable lands and embankment, are estimated to be $12,609,000 and $543,500, respectively.

16. PROJECT JUSTIFICATION

The annual flood control benefits of $730,000 or the annual conservation benefits of $649,000 are each sufficient to justify the rehabilitation of Lake Kemp. When the total annual benefits are

compared with the annual charges of the project, including an allowance for usable lands and embankment of the existing project estimated to be $543,500, the benefit-cost ratio is 2.5. The allocated annual cost and benefit-cost ratio for flood control are $282,400 and 2.6, and for conservation, they amount to $261,100 and 2.5.

17. PROJECT FORMULATION

a. General. - This report considers the desirability of rehabilitating the Lake Kemp project for flood control and conservation purposes. Local interests requested that the project include sufficient water conservation storage space to permit optimum economical development of the water resources of the Wichita River Basin. Local interests also requested that the project include flood control storage to provide maximum benefits downstream.

b. Flood control. - In the selection of flood control storage in Lake Kemp, the following factors are pertinent:

(1) About 200,000 acre-feet of storage is required to control the once-in-fifty-years flood.

(2) About 871,000 acre-feet of storage is required to control the standard project flood.

(3) The location of a well-developed urban area some 70 miles below the project emphasizes the need for protection against as large a flood as is reasonable.

c. Conservation. - The conservation storage of 190,000 acre-feet is that storage utilized by local interests in the past and used at present. Due to its quality, no increase in the demand for this water is anticipated in the foreseeable future, and since this storage meets the desires of local interests, the 190,000 acre-feet was selected for the conservation storage.

18. MAXIMIZING BENEFITS

a. General. - The plan of improvement for Lake Kemp was developed with the objective that it would (1) provide project benefits exceeding project costs; (2) provide benefits at least equal to the cost of each separable segment or purpose; (3) provide a practical means of fulfilling existing and prospective needs; (4) be more economical to develop than other alternatives; (5) consider all beneficial and detrimental effects; and (6) insofar as consistent with the above, provide a maximum of benefits over cost. Preliminary economic studies showed that the project would be well justified for flood control alone, conservation alone or for both flood control and conservation. Since only one storage was considered for

conservation purposes, conservation benefits were not maximized. However, the selected storage appears to fulfill the above objectives.

b. Flood control. - Various studies were made in the economic test for optimum flood control storage at Lake Kemp. In one study it was considered that since the existing project has pre-empted the Lake Kemp dam site, an alternate site would be selected for the analysis of an alternate flood control only project. Investigations indicated two other possible sites, one immediately upstream from Lake Kemp, the other between Lake Kemp Dam and Lake Diversion. The upper site was selected for study since the lower site would require a higher and longer embankment to provide the same volume of storage and would impound water against the downstream side of the embankment of Lake Kemp Dam. In this economic test for optimum flood control storage, the annual costs for various amounts of storage at the upstream site (entirely independent of the existing project) were compared with the flood control benefits. The excess benefits over cost, based on this study, are shown in figure 1. The indicated optimum flood control storage is about 200,000 acre-feet. Another study was made of the optimum flood control storage capacity on the basis of incremental cost of various flood control storages incremental to 190,000 acre-feet of conservation storage. This study also indicated that the optimum flood control storage is about 200,000 acre-feet.

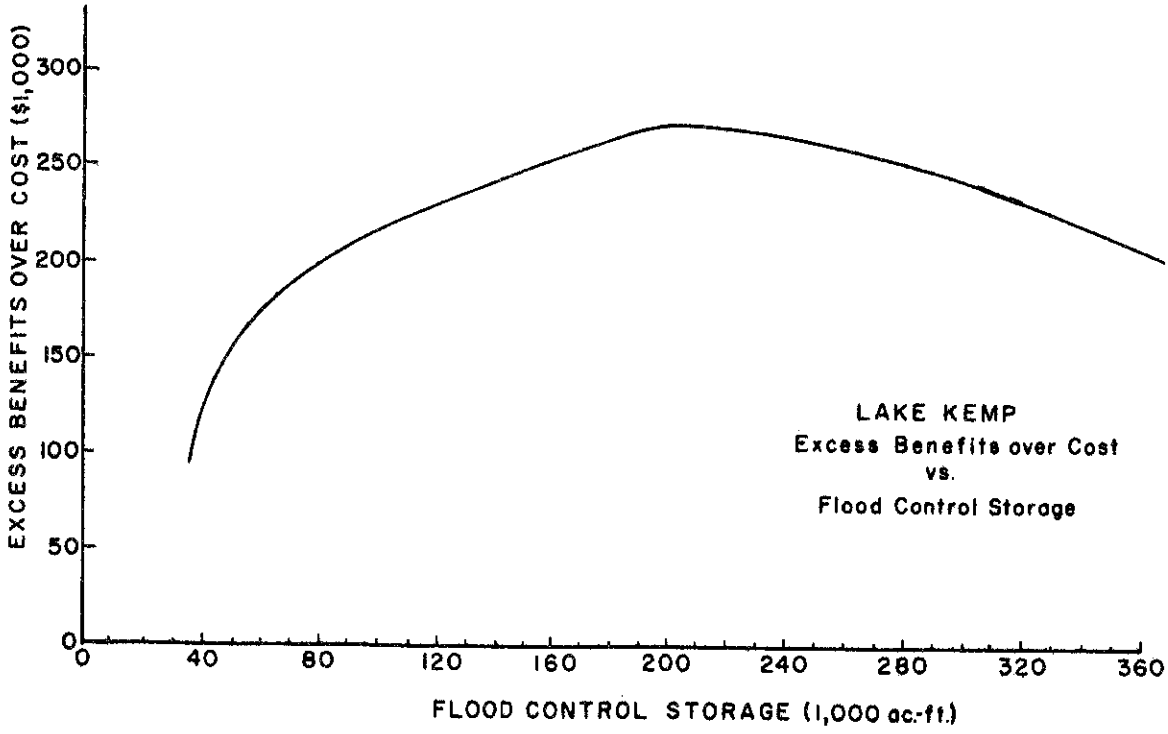


FIGURE 1

19. RESIDUAL FLOOD LOSSES

The plan for reconstruction of Lake Kemp would control all floods up to and including the once-in-50-year flood to bankfull stage at the dam site. However, floods larger than the once-in-50-year flood could occur. Because of this, and because of the large intervening drainage area between Lake Kemp and Wichita Falls, it is probable that flood losses will occur at Wichita Falls after the reconstruction of Lake Kemp is completed. With Lake Kemp in place and operating as described in appendix I, the residual average annual flood losses are estimated to be $223,000 of which $116,500 would be losses to urban property in Wichita Falls. The flood losses for an uncontrolled flood of 100-year frequency is estimated to be $6,934,000 including $232,000 for crops, $1,225,000 for rural structures, and $5,477,000 for urban structures. The approximate area subject to flooding at Wichita Falls by a flood of this magnitude is shown on plate 2 of this appendix. The residual flood losses from this flood as controlled by the reconstructed Lake Kemp is estimated to be $3,908,000, including $185,000 for crops, $947,000 for rural structures and $2,776,000 for urban structures. The above data indicates that while only about 45 percent of the flood losses for a 100-year flood would be prevented by the reconstructed Lake Kemp, an average of about 72 percent of the flood losses expected to result from all floods with a frequency of once in 50 years or less would be prevented.

20. COST ALLOCATION

In accordance with standard procedure, the use-of-facilities method of cost allocation was used for the Lake Kemp project. The cost to be allocated was considered to be the cost of reconstruction ($8,648,000) plus the estimated value of the usable lands and embankment of the existing project ($3,961,000) or a total of $12,609,000. The alternate cost used for a conservation only project consisted of the cost of reconstruction of the present project for conservation purposes only ($7,299,000) plus the estimated value of the usable lands and embankment of the existing project ($3,354,000) or a total of $10,653,000. The alternate cost used for a flood control only project was considered as the cost of a new single purpose project upstream from the existing Lake Kemp and was estimated to be $10,600,000. In the use-of-facilities method of cost allocation, specific costs are assigned to each function and the remaining joint costs of the multiple-purpose project are prorated to each function on the basis of the useful storage in that function at the end of 50 years. The distributed pro rata cost and the specific cost are added together to obtain the total cost allocated to each purpose. A summary of costs, annual charges and benefits are given in table 6 for multiple-purpose and single-purpose projects. Details of the cost allocation are shown in table 7.

TABLE 6

COST ALLOCATION STUDY
SUMMARY OF COSTS, ANNUAL CHARGES AND BENEFITS
(In Thousands of Dollars)

Item	Multiple-Purpose Projects				Single-Purpose Projects	
	Specifics		Joint Use	Total	Flood Control	Conservation
	Flood Control	Conservation				
First cost (1)	11.8	83.2	12,514.0	12,609.0	10,600.0	10,653.0
Period of construction, yrs.	-	-	-	2	2	2
Interest rate, percent	-	-	-	2-5/8	2-5/8	2-5/8
Interest during construction	0.3	2.2	224.5	(2) 227.0	278.0	(3) 192.0
Investment	12.1	85.4	12,738.5	12,836.0	10,878.0	10,845.0
Annual charges:						
Interest on investment	0.3	2.2	334.4	336.9	286.0	284.7
Amortization of investment	0.1	0.8	126.1	127.0	107.3	107.3
Operation and maintenance	11.1	0.6	58.3	70.0	55.5	41.8
Major replacements	0.1	0.2	9.3	9.6	9.2	9.2
Total - Annual Charges	11.6	3.8	528.1	543.5	458.0	443.0
Annual benefits:						
Flood control	730.0	-	-	730.0	730.0	-
Conservation	-	649.0	-	649.0	-	649.0
Total - Annual Benefits	730.0	649.0	-	1,379.0	730.0	649.0
Benefit-cost ratio	-	-	-	2.5	1.6	1.5

(1) Multiple-purpose and conservation-only project includes values for usable portion of existing project.
(2) Interest on first cost ($8,648,000) for reconstruction of Lake Kemp dam and spillway.
(3) Interest on first cost ($7,299,000) for reconstruction of Lake Kemp dam and spillway.

TABLE 7

COST ALLOCATION BY USE-OF-FACILITIES METHOD

	Flood Control	Conservation	Total
1. LIMITS OF ALLOCATION			
a. Benefits	$ 730,000	$ 649,000	$ 1,379,000
b. Alternate cost	458,000	443,000	-
c. Benefits limited by alternate cost	458,000	443,000	901,000
d. Separable cost	100,500	85,500	186,000
2. ALLOCATION OF ANNUAL COST			
a. Storage (acre-feet)(1)	200,000	190,000	390,000
b. Percentage	51.28	48.72	100.0
c. Specific cost	11,600	3,800	15,400
d. Joint cost	270,800	257,300	528,100
e. Total cost	282,400	261,100	543,500
f. Benefit-cost ratio	2.6	2.5	2.5
3. ALLOCATION OF OPERATION AND MAINTENANCE COST			
a. Specific cost	11,100	600	11,700
b. Allocated joint cost	29,900	28,400	58,300
c. Total allocation	41,000	29,000	70,000
4. ALLOCATION OF MAJOR REPLACEMENTS			
a. Specific cost	100	200	300
b. Allocated joint cost	4,800	4,500	9,300
c. Total allocation	4,900	4,700	9,600
5. ALLOCATED INVESTMENT			
a. Annual investment cost	236,500	227,400	463,900
b. Allocated investment	6,544,000	6,292,000	12,836,000
c. Percentage	50.98	49.02	100.0
d. Interest during construction	116,000	111,000	227,000
e. Construction cost	6,428,000	6,181,000	12,609,000
f. Preauthorization cost	18,000	17,000	35,000
g. Net Construction cost	6,410,000	6,164,000	12,574,000

(1) Based on storage available at end of 50 years.

89691 O-62—7

21. FEDERAL-NONFEDERAL COST SHARING

a. Federal. Under the recommended method, the costs allocated to flood control ($6,410,000) and the preauthorization costs ($35,000), totaling $6,445,000, would be the responsibility of the Federal Government. It is estimated that the operation and maintenance cost to the Government for engineering studies and investigations would be $10,000 annually. Other operation and maintenance costs and major replacement costs allocated to flood control and thereby a Federal responsibility are estimated to average $35,900 annually. Local interests would operate the flood control feature of the project under the direction of the Secretary of the Army and would provide all operation, maintenance and replacements presently estimated at an average of $69,600 annually ($79,600 less $10,000 for engineering studies and investigation). The Federal Government's share of this cost (reimbursable to local interests) would be 51.6 percent of the actual annual operation, maintenance and replacement costs incurred by local interests. On the basis of the current estimate, the amount reimbursable to local interests by the Federal Government for operation, maintenance and major replacements would average $35,900 annually.

b. Non-Federal. The cost for reconstruction of the project chargeable to local interests for conservation storage is $2,203,000. Of this amount, $318,000 would be for the purchase of additional lands. The remainder $1,885,000, which amounts to 22.7 percent of the reconstruction cost after deducting the preauthorization cost and cost of additional lands, would be paid by local interests in annual payments with interest over a period of not more than 50 years, beginning at completion of the reconstruction. Local interests would be responsible for operating, maintaining and providing major replacements at an estimated average annual cost of $69,600. The Federal Government would reimburse local interests annually an amount equivalent to 51.6 percent of their actual cost for operation, maintenance, and major replacements, which on the basis of the current estimate would average $35,900 annually. The remaining 48.4 percent of the operation, maintenance and major replacement costs (currently estimated to average $33,700 annually) would be financed by local interests.

SURVEY REPORT
ON
LAKE KEMP
WICHITA RIVER, TEXAS

APPENDIX III

PROJECT PLANS AND COST ESTIMATES

U. S. ARMY ENGINEER DISTRICT, TULSA
CORPS OF ENGINEERS
TULSA, OKLAHOMA

APPENDIX III

PROJECT PLAN AND COST ESTIMATE

TABLE OF CONTENTS

Paragraph	Title	Page
1	PURPOSE	90
2	GENERAL	90
3	DAM	
	a. Existing	90
	b. Proposed	91
	c. General geology and topography	91
	d. Scope of the explorations	91
	e. Geology of the site	91
	f. Soils at the site	91
	g. Aggregates	91
4	SPILLWAY	
	a. Existing	92
	b. Proposed	92
5	OUTLET WORKS	
	a. Existing	93
	b. Proposed	93
6	RELOCATIONS	93
7	REAL ESTATE	94
8	RESERVOIR DEVELOPMENT FOR PUBLIC USE	94
9.	BASIS FOR COST ESTIMATES	
	a. Unit prices	95
	b. Contingencies, engineering and overhead	95
	c. Interest during construction	95
	d. Annual charges	95
10	SUMMARY OF COST ESTIMATES	95
11	DETAILS OF ESTIMATED COSTS	
	a. Reconstruction costs	95
	b. Value of usable portion of existing project	98
12	ESTIMATED ANNUAL CHARGES	98

TABLES

Table	Title	Page
1	Summary of Estimated Reconstruction Costs	95
2	Details of Estimated Reconstruction Costs of Dam and Spillway	96
3	Details of Investment and Annual Costs	99

PLATES (only plate 1 printed)

Plate	Title	
1	Reservoir Area	Follows page 99
2	Dam and Spillway - Plan and Section	
3-5	Geological Logs	

PROJECT PLAN AND COST ESTIMATES

1. PURPOSE

This appendix presents data on the proposed plan for reconstruction of the existing non-Federal Lake Kemp to provide for flood control storage in the project in conjunction with its irrigation, water supply, and other related uses.

2. GENERAL

a. The Lake Kemp Dam is at mile 126.7 of the Wichita River in Baylor County about 40 miles southwest of Wichita Falls, Texas. Access to the site is provided by U. S. Highway 183 and 283. The existing project was constructed by the Wichita Water Improvement District No. 1 during the period 1921-1923 and is now owned and operated by District 2 and the City of Wichita Falls.

b. Existing improvements consist of the dam, an uncontrolled spillway and outlet structure. It is proposed to raise the top of dam three feet, from elevation 1167.0 to elevation 1170.0, to extend the dam across the entrance of the existing uncontrolled spillway, to construct a gated spillway in the embankment about 2,000 feet northwest of the right abutment, and plug the existing outlet works. A reservoir area map is shown on plate 1. Plan and sections of the dam, spillway and outlet works are shown on plate 2.

c. The feasibility of locating the spillway in a saddle near the right abutment was investigated as an alternate to the valley spillway location. Consideration was given to both controlled and uncontrolled structures at this location, however, the cost of these structures together with the cost of outflow channels, remedial work to protect U. S. Highways 183 and 283, and the cost of reconstruction of the present outlet structure would have exceeded the cost of the plan of alteration proposed.

3. DAM

a. Existing. - The dam was constructed during 1921 and 1923 by hydraulic fill methods. It has a maximum height of 99 feet, and a top width of 25 feet, at elevation 1167.0 feet above m.s.l. The upstream face of the dam has a slope of 1 vertical to 2 horizontal from the top of dam to elevation 1152.5 and 1 vertical to 3 horizontal below that point. The side slope of the downstream side of the dam is 1 vertical to 2 horizontal from the top of the dam to elevation 1142.5, 1 vertical to 2-1/8 horizontal to elevation 1117.5 and 1 vertical to 3 horizontal below elevation 1117.5. The upstream slope of the dam is

protected by 1-1/2 feet of riprap with eight inches gravel backing which extends from the top of the dam to its base. The dam has an impervious clay core and has a steel sheet piling cutoff wall extending from station 2+40 to station 15+20. A gravel surfaced service road 20 feet wide is provided along the crown.

b. Proposed. - It is proposed to increase the height of the dam three feet and to utilize material from the section excavated for the installation of the spillway by raising the dam on the downstream side of the embankment and adding a berm on the downstream slope of the embankment. The top of the berm would be at elevation 1130.0 m.s.l., would be 35 feet in width and would have a 1 on 4 side slope. This berm would extend from the right abutment to station 20+00 and is primarily for disposal of required excavation and for reinforcement of the existing dam. Three feet of filter material would be placed between the waste berm and the existing embankment. The embankment across the entrance of the existing spillway would be constructed to conform to the adjacent portions of the dam. A service road 20 feet wide would be provided along the crown.

c. General geology and topography. - Lake Kemp is in the Osage Plains section of the Central Lowland Physiographic Province. Rocks of the Wichita formation of Permian age underlie the entire area.

d. Scope of the explorations. - Explorations comprised three 4-inch core holes drilled in 1960 at the downstream toe of the embankment in the vicinity of the proposed spillway site. Hole number 3 was extended approximately 50 feet in February 1962. The extension was NX size. Logs of these holes are shown on plates 3 through 6. The location of the core holes is shown on plate 2.

e. Geology of the site. - At the spillway site the strata were, in descending order, hard quartz cobble conglomerate, moderately hard to very soft fine-grained sandstone, and soft shale, all members of the Wichita formation. The overburden ranges from 12 to 22 feet in thickness and is mostly sandy clay and sand, with some gravel.

f. Soils at the site. - As shown in the accompanying logs of the exploratory holes, the soils range from fine-grained impervious clays (in CL soil group) to the more granular sands (principally in the SM group). Both types of soils would be suitable for construction of the planned enlargement of the embankment.

g. Aggregates. - The nearest known production of coarse aggregate is a limestone quarry near Chico, Texas, approximately 115 rail miles from Seymour, Texas. The nearest connection with the railroad is at Mabella about six miles from the dam and about 15 miles from Seymour. Other known quarries are near Cisco, Texas, 133 rail miles from Seymour, and at Richards Spur, Oklahoma, 162 rail miles from Seymour. Sand for fine aggregate is produced at Seymour and Wichita Falls, Texas, approximately 20 and 50 miles, respectively, from the dam at Lake Kemp. It is possible that both fine and coarse

aggregates can be obtained from the immediate vicinity of the dam. A thin upper member of the Lueders limestone (Wichita group) and a local sand deposit were used to produce a satisfactory durable concrete for the conduits at the dam. However, the spillway concrete made with local natural gravel does not have a satisfactory services record.

4. SPILLWAY

a. Existing. - The existing spillway structure consists of an ogee weir semicircular in plan and is formed by a curved hollow buttress concrete structure 12 feet in height. The crest of the weir is at elevation 1153.0 and is 564 feet in length. A chute constructed of stone surfaced with concrete extends from the base of the buttress portion to the apron 78 feet below, at elevation 1062.0. In addition, an emergency spillway located between station 70+35 and station 74+40 is provided. This spillway is divided into two sections, 70 feet and 335 feet long with crest elevations at 1160.5 and 1163.0, respectively. Concrete headwalls are provided as abutments for the emergency sections. The face of the weir described above has a horizontal crack immediately above the base of the buttresses and extending along the full perimeter of the weir. This crack is sufficiently wide to admit light into some of the interior compartments. Both exterior and interior surfaces of the weir were coated with gunite several years ago. This material has peeled away from the surface in several places. The reinforcing steel in the buttress walls is rusting and has resulted in spalling, the steel being exposed in many places. Much of the spalled concrete is quite soft and easily crumbled. Some of the buttress walls are cracked, an indication that settlement has occurred. Some of the exposed reinforcing steel appears to be buckled and in some cases as much as one-half of the cross-sectional area has rusted away.

b. Proposed.

(1) Spillway. - It is proposed to construct a gated spillway structure in the present embankment between stations 22+20 and 29+80. The spillway would be a concrete gravity-type ogee weir surmounted by crest gates. The gross length of the spillway would be 472 feet. Spillway discharge would be controlled by 10 - 40' x 35' tainter gates separated by piers, eight feet in width. The crest of the weir would be at elevation 1121.0. The upstream face of the weir would have a batter of 3 on 1. A bridge would be provided across the spillway for the service road.

(2) Stilling basin. - The stilling basin would consist of an apron 472 feet wide and 285 feet long with a vertical end sill. The stilling basin floor would be at elevation 1070.5 and the top of end sill at elevation 1079.5. Top of stilling basin wall would be at elevation 1115.0. Two rows of baffles would be provided in the stilling basin.

(3) Plan of diversion. - Since preservation of the conservation pool is considered a requirement during the construction of the new spillway, an earth cofferdam would be constructed upstream of the proposed spillway location. Material excavated from the new spillway location would be used to construct the cofferdam. When the embankment reaches an elevation above the water surface, approximately 1135, sheet piling would be driven along the center line to provide a cutoff. The embankment then would be raised to elevation 1153, the once-in-10-year pool level. This embankment, in conjunction with the emergency section (near station 70+00) which could be breached in an emergency, would provide adequate protection during construction. The cofferdam would be removed and the approach channel excavated at the appropriate time during the construction of the spillway.

5. OUTLET WORKS

a. Existing. - The outlet works, located near the right abutment and encased by the embankment, consists of two 7-foot diameter conduits each equipped with electrically operated gates; a concrete approach apron, 50 feet wide and 69 feet long, equipped with training walls; a stilling basin, 117 feet long and varying in width from about 51 feet to 68 feet, built in two sections each having an end sill, the two end sills being about 20 feet apart; and a gate structure. Four additional conduits which were used for diversion purposes during construction have been plugged with steel and concrete bulkheads. The gate house structure is tilted as a result of settlement which occurred soon after impoundment began. The capacity of the two service conduits is 2,800 c.f.s. with pool at spillway crest level, elevation 1153.0. Stains around a crack in a construction joint in the west service conduit indicate that some material from the embankment has leached from the vicinity of the cutoff wall outside the construction joint.

b. Proposed. - It is proposed to plug the existing outlet works with concrete and to grout the foundation and fill around the structure to prevent seepage. A sluice 5'8" x 7'0" would be provided through the center pier of the proposed spillway for irrigation and water supply releases.

6. RELOCATIONS

The reconstruction of the dam and spillway and the reallocation of storage space in the reservoir will not require the relocation of any existing roads or utilities.

7. REAL ESTATE

The reconstruction of Lake Kemp would require the acquisition by flowage easement of an additional 3,800 acres of land. This additional land would be required to provide for raising top of flood control pool three feet and to provide three feet of freeboard for wave-wash and saturation. There are 167 recreational cabins located in the affected area that will require removal.

8. RESERVOIR DEVELOPMENT FOR PUBLIC USE

The reservoir area is located on the Wichita River about 50 miles west of the City of Wichita Falls, Texas. The topography is open range land, having few trees and few distinguishing features or change of elevation that would be of scenic interest. The recreational interest is the large lake of 15,150 acres, which is the largest water area in the region. The project is located on privately owned land with access permitted only by fee collected at three toll gates. Small concessions on the lake are operated by the owner, providing rental boats, groceries and other supplies. Privately owned cottages are located on land leased from the Waggoner Ranch with access obtained by annual entrance fees. The control of persons using the lake is part of the ranch operation through control of hunting, use of the shoreline, fire prevention, etc. Public attendance has been estimated as 275,000 in 1961, of which 80 percent is estimated to represent visitation to the cottage development area.

9. BASIS FOR COST ESTIMATES

a. Unit prices. - Unit prices are based on average bid prices for similar projects constructed or under construction in the Tulsa District, adjusted to 1960 price levels.

b. Contingencies, engineering and overhead. - In accordance with EM 1110-2-1303, an allowance of 15 percent for contingencies and construction costs has been used. Engineering and design and supervision and administration for construction are based on percentages taken from curves compiled from experience on similar projects.

c. Interest during construction. - A 2-year construction period was assumed for purposes of determining the total investment. The interest rate was taken as 2-5/8 percent over one-half of the construction period.

d. Annual charges. - The estimate for annual charges is based on a 2-5/8 percent interest rate with the cost of the project amortized over a 50-year period.

10. SUMMARY OF COST ESTIMATES

A summary of the estimated costs of the reconstruction of Lake Kemp Dam and Spillway is shown in table 1.

TABLE 1

SUMMARY OF ESTIMATED RECONSTRUCTION COSTS

No.	Item	Amount
01	Lands and Damages	$ 318,000
03	Reservoir	2,300
04	Dam	7,117,300
29	Preauthorization Studies	35,000
30	Engineering and Design	564,700
31	Supervision and Administration	610,700
	Total Reconstruction Cost	$8,648,000

11. DETAILS OF ESTIMATED COSTS

a. Reconstruction costs. - Details of the estimated cost for the reconstruction of Lake Kemp Dam and Spillway are shown in table 2.

TABLE 2

DETAILS OF ESTIMATED RECONSTRUCTION COSTS OF DAM AND SPILLWAY

No.	Item	Unit	Quantity	Cost	Amount
				$	$
01	Lands and Damages				
	Flowage easement	Acres	3,800	50.00	190,000
	Resettlement	Cottgs	167	500.00	83,500
	Subtotal, lands & damages				273,500
	Administrative cost				4,500
	Subtotal, direct cost				278,000
	Contingencies				40,000
	Total cost of lands and damages				318,000
03	Reservoir and Pool Preparation				
	Erosion control	Job	-	LS	2,000
	Contingencies				300
	Total estimated cost, reservoir				2,300
04	Dam				
.1	Embankment				
	Stripping for embankment	CY	7,600	0.30	2,280
	Excavation, trench - earth	CY	17,900	0.60	10,740
	Excavation, borrow-impervious	CY	34,000	0.30	10,200
	Compacted fill, impervious	CY	29,400	0.12	3,530
	Compacted fill, random	CY	245,000	0.12	29,400
	Filter material	CY	37,000	2.50	92,500
	Riprap	CY	6,200	7.25	44,950
	Bedding material	CY	2,500	8.00	20,000
	Seed and mulch	Acre	2.2	300.00	660
	Foundation preparation	Sq	1,840	1.00	1,840
	Roadway surfacing, gravel	SY	15,420	2.50	38,550
	Guardrail, metal plate	LF	13,880	3.50	48,580
	D. S. berm, dumped waste	CY	147,000	0.05	7,350
	Remove concrete structures	CY	450	4.00	1,800
	Remove existing embankment	CY	117,800	0.30	35,340
	Remove sheet steel piling	SF	24,400	1.00	24,400
	Grout and plug existing outlet works	Job	-	LB	25,000
	Subtotal, direct cost				397,120
	Contingencies				59,880
	Total estimated cost, Embankment				457,000

TABLE 2 (Cont)

No.	Item	Unit	Quantity	Cost	Amount
				$	$
.1	Spillway				
	Clearing work area	Acre	18	100.00	1,800
	Excavation, common	CY	490,000	0.75	367,500
	Excavation, rock	CY	287,200	2.00	574,400
	Excavation, special	CY	5,200	10.00	52,000
	Backfill, compacted	CY	40,500	1.80	72,900
	Concrete, bridge deck & parapet	CY	850	80.00	68,000
	Concrete, sills and baffles	CY	1,850	30.00	55,500
	Concrete, walls and piers	CY	13,260	35.00	464,100
	Concrete, apron slab and key	CY	11,990	28.00	335,720
	Concrete, mass-exterior	CY	9,440	22.00	207,680
	Concrete, mass-interior	CY	76,450	21.00	1,605,450
	Reinforcement steel	Lb	1,774,000	0.15	266,100
	Crest gates	Lb	1,550,000	0.40	620,000
	Crest gate hoists	Lb	415,000	1.00	415,000
	Derrick stone	CY	6,100	9.25	56,430
	Spalls	CY	1,200	7.25	8,700
	Gravel in drains	CY	560	8.00	4,480
	Structural steel	Lb	621,700	0.22	136,770
	Miscellaneous steel and iron	Lb	59,000	0.75	44,250
	Miscellaneous nonferrous metal	Lb	15,100	1.00	15,100
	Water stops	Lb	4,430	2.00	8,860
	Miscellaneous pipe & fittings	Lb	54,300	0.75	40,730
	Drilling and grouting	LF	7,560	6.00	45,360
	Drill and place anchors	LF	4,720	3.00	14,160
	Drill drain holes	LF	3,780	4.00	15,120
	Guardrail	LF	1,510	11.00	16,610
	Handrail pipe	LF	640	7.00	4,480
	Foundation protective treatment	SY	15,500	1.00	15,500
	Electrical system	Job	-	LS	139,300
	Staff gages	Job	-	LS	2,000
	Diversion and care of river	Job	-	LS	110,000
	Subtotal, direct cost				5,784,000
	Contingencies				799,000
	Total estimated cost, Spillway				6,583,000

TABLE 2 (Cont)

No.	Item	Unit	Quantity	Cost	Amount
				$	$
.3	Outlet Works				
	Sluice gates, hydraulic	Lb	56,900	0.75	42,680
	Sluice lining, cast iron	Lb	24,300	0.35	8,510
	Emergency bulkheads and guides	Lb	20,900	0.55	11,500
	Miscellaneous pipe and fittings	Lb	6,000	0.75	4,500
	Subtotal, direct cost				67,190
	Contingencies				10,110
	Total estimated cost, Outlet Works				77,300
29	Preauthorization Studies				35,000
30	Engineering and Design				564,700
31	Supervision and Administration				610,700
	Total Reconstruction Cost				8,648,000

b. Value of usable portion of existing project. The value of the usable portion of the existing project was assumed to be the present-day cost of reproducing the usable portion of the embankment and worth of the project lands. The cost of reproducing the usable portion of the embankment was estimated to be $1,831,000 and the cost of existing project lands was estimated to be $2,130,000. The total value of the usable portion of the project would be $3,961,000.

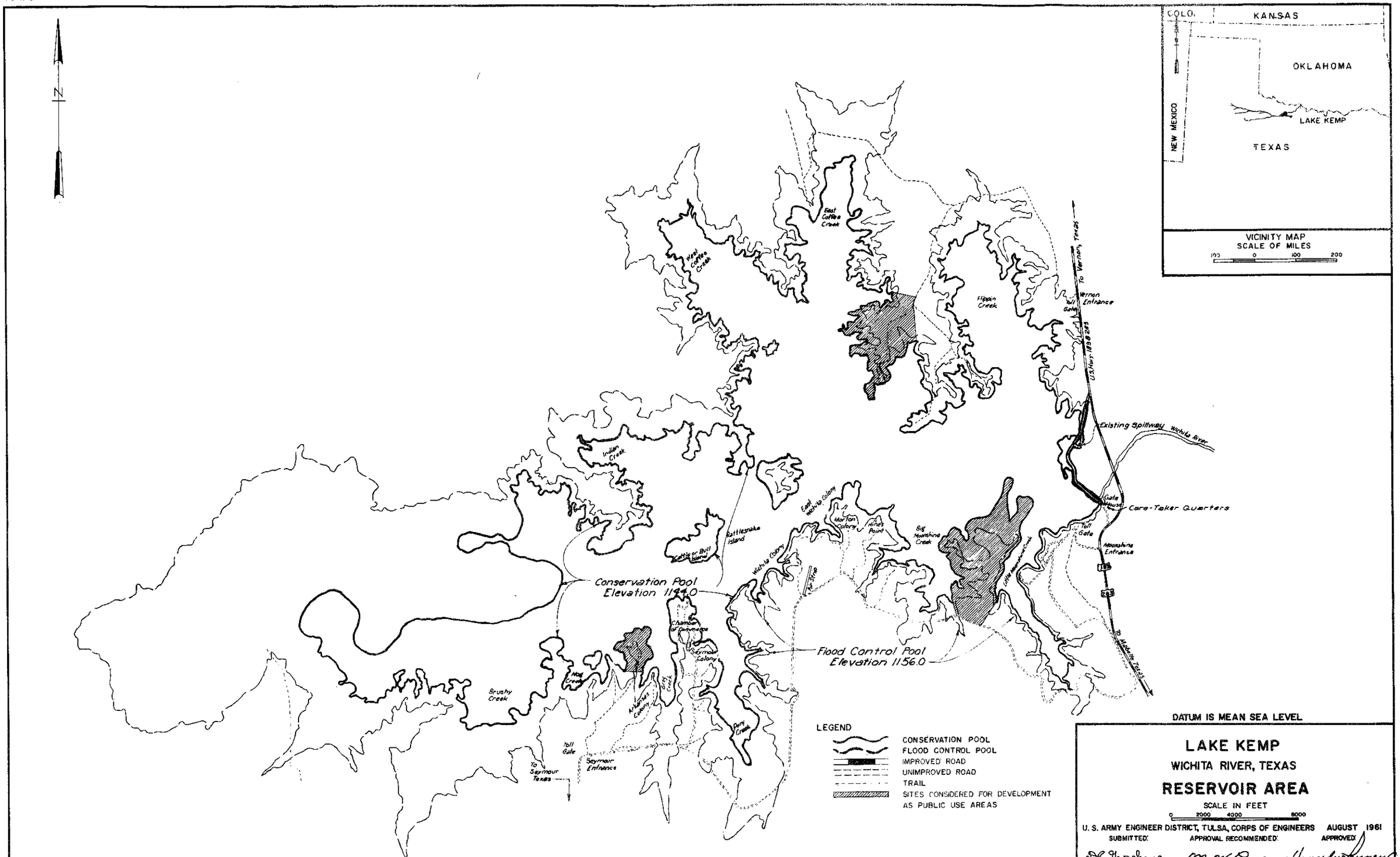
12. ESTIMATED ANNUAL CHARGES

Details of the estimated investment costs and annual charges are shown in table 3.

TABLE 3

DETAILS OF INVESTMENT AND ANNUAL COSTS

Item	Amount
Period of construction & interest rate	2 yrs; 2-5/8 %
Investment:	
First cost, reconstruction	$ 8,648,000
Interest during construction	227,000
Gross cost, reconstruction	$ 8,875,000
Value of usable portion of existing project	3,961,000
Gross investment	$12,836,000
Annual charges:	
Interest	$ 336,900
Amortization	127,000
Operation and maintenance	60,000
Major replacement	9,600
Engineering studies and investigations	10,000
Total	$ 543,500



DATUM IS MEAN SEA LEVEL

LAKE KEMP
WICHITA RIVER, TEXAS
RESERVOIR AREA

SCALE IN FEET
0 2000 4000 8000

U. S. ARMY ENGINEER DISTRICT, TULSA, CORPS OF ENGINEERS AUGUST 1961

SUBMITTED:	APPROVAL RECOMMENDED:	APPROVED:
CHIEF, PLANNING & REPORTS BRANCH	CHIEF, ENGINEERING DIVISION	COL., CORPS OF ENGINEERS DISTRICT ENGINEER

DRAWN: L. E. M.
TRACED: L. E. M.
CHECKED: J. E. T. A. C. W.

TO ACCOMPANY SURVEY REPORT

R-1/103

APPENDIX III PLATE I

89691 O-62 (Face blank p. 100)

SURVEY REPORT
ON
LAKE KEMP
WICHITA RIVER, TEXAS

APPENDIX IV

REPORT BY PUBLIC HEALTH SERVICE

U. S. ARMY ENGINEER DISTRICT, TULSA
CORPS OF ENGINEERS
TULSA, OKLAHOMA

89691 O-62—8

WATER SUPPLY ASPECTS

OF

PROPOSED LAKE KEMP REHABILITATION

WICHITA RIVER

TEXAS

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service, Region VII
Dallas, Texas

In Cooperation with the

DEPARTMENT OF THE ARMY
U. S. Army Engineer District - Tulsa, Oklahoma

JULY 1960

TABLE OF CONTENTS

Page

LIST OF TABLES 104

LIST OF FIGURES 104

INTRODUCTION

Authority and Scope 105

Acknowledgments 105

SUMMARY AND CONCLUSIONS

Summary 105

Conclusions 106

DESCRIPTION OF AREA 107

ECONOMICS AND POPULATION 108

Extractive Industries 108

Manufacturing Industries 110

Trade and Service Industries 110

Government Employment 110

Population 111

Future Growth Prospects 111

PRESENT WATER SUPPLIES

Sources 113

Quality 113

Quantity Used 115

FUTURE WATER SUPPLIES

Quantity Requirements 117

Possible Sources 117

Lake Kemp As a Source 117

Monetary Value of Storage in Lake Kemp 120

BIBLIOGRAPHY 121

LIST OF TABLES

		Page
Table 1.	Value of Mineral Production, Archer, Clay, and Wichita Counties, Texas, 1952-1958 . . .	108
2.	Value of Crops and Livestock Sold, Archer Clay, and Wichita Counties, Texas, 1944, 1949, 1954	109
3.	Water Quality of Lake Kickapoo, Lake Wichita, and Lake Kemp	114
4.	Wichita Falls Water Consumption, 1930-59 . .	116
5.	Quality - Water Leaving Lake Kemp	119

LIST OF FIGURES

		Page
Figure 1.	Water Requirements, Wichita Falls, Texas . . .	118

INTRODUCTION

Authority and Scope

Under provisions of the Memorandum of Agreement between the Department of the Army and the Department of Health, Education, and Welfare, dated November 4, 1958, the Public Health Service provides assistance in implementing the Water Supply Act of 1958 (Title III, Public Law 500, 85th Congress). By letter dated 23 October 1959, the U. S. Corps of Engineers, Tulsa District, requested of Public Health Service a report on the water supply aspects of Lake Kemp, including water quality, needs, and value.

Acknowledgments

The assistance of representatives of the following groups and agencies is gratefully acknowledged:

City of Wichita Falls, Texas

Texas State Department of Health

Texas Board of Water Engineers

Wichita County Health Department

Wichita County Water Control and Improvement District Number One

Wichita Falls Chamber of Commerce

SUMMARY AND CONCLUSIONS

Summary

1. Lake Kemp is formed by an existing non-Federal dam, built in 1923 on the Wichita River, about 40 miles west of Wichita Falls, Texas. It has a limited present use for irrigation and some industrial processes.

2. The Corps of Engineers is making an investigation to determine the advisability of Federal rehabilitation of the project to provide for flood control in addition to conservation aspects. Currently under consideration is the possibility of allocating 190,000 acre-feet of conservation storage which might be used for irrigation, for municipal and industrial water supply, or both.

3. The potential user of M & I water from the project is the city of Wichita Falls. Its population is expected to reach 310,000 by the year 2010. Corresponding water needs will be about 70 mgd, of which an estimated 20 mgd can be met from the existing sources of Lakes Kickapoo and Wichita.

4. It is the opinion of the Public Health Service that the quality of water in the Wichita River at Lake Kemp is, at present, unsatisfactory for municipal supply, because of the high concentration of chlorides and sulfates.

5. Studies are in progress by the Public Health Service in the Red River Basin to determine the location, nature, and extent of sources of contamination. These studies will not be completed until about 1963. However, it has been established that the contamination at Lake Kemp is principally of natural origin and is concentrated in three groups of salt springs, one on each of the three forks of the upper Wichita River. The Public Health Service and the Corps of Engineers are concurrently studying methods for the containment of pollutants from these sources, to make the downstream water quality satisfactory.

6. Estimates of the firm yield from conservation storage at Lake Kemp made by the Corps of Engineers show a potential of 62 mgd from 190,000 acre-feet of conservation storage.

Conclusions

1. If the mineral concentrations can be reduced to acceptable maxima, there will be a definite need for storage in Lake Kemp for M & I water supply. The project is ideally situated to serve the city of Wichita Falls, which will need a supplementary supply within the next ten years, and will require an estimated 50 mgd of additional supply by the year 2010.

2. The benefits from storage in Lake Kemp for municipal and industrial water supply would be about $1,060,000 per year, for a firm yield of 50 mgd. This is based on the cost of developing an alternative supply at the Ringgold site on the Little Wichita River. However, this value pertains only if the quality problem is overcome.

3. Unless the quality of water entering Lake Kemp can be improved, by the control of upstream natural pollution at its source, storage for water supply will have negligible value.

DESCRIPTION OF AREA

Lake Kemp is located in north central Texas, about forty miles west of Wichita Falls. It was formed by a dam built in 1923, currently operated by Wichita County Water Control and Improvement Districts Number One and Number Two. It has limited present use for irrigation and some industrial processes.

The Corps of Engineers is investigating the advisability of Federal rehabilitation of the project, for flood control and conservation purposes. For preliminary planning purposes, the proposed modification includes provision of 190,000 acre-feet of storage in the conservation pool, along with 200,000 acre-feet for flood control and 136,000 acre-feet for sedimentation allowance.

The terrain of the region is generally rolling with elevations ranging between 800 and 1,000 feet. It is part prairie and part timbered with post oak and mesquite. Precipitation averages 27 inches annually, but the evaporation rate is high due to high temperature and wind velocity during the period of greatest rainfall.

The economy of the area exhibits considerable diversity. The primary sources of economic activity are agriculture, mineral extraction, manufacturing, and military employment.

There are several small communities in the area. Wichita Falls with 101,000 is the only large city. All others are less than 6,000 population.

The principal water demand center for Lake Kemp is the city of Wichita Falls, Texas. The population and industrial growth of Wichita Falls and the consequent water demand will depend in large part upon the presence of natural resources, the pattern of industrial development in the area, and the growth of the market. The demographic and economic analysis of the county within which Wichita Falls lies and the two counties immediately adjacent to it will help explain the past growth trends of this city and will also give a good indication of the future growth potential. The three counties in this primary area of influence are Archer, Clay, and Wichita Counties. The first part of this chapter shows the trend of the various segments of the economy and the resultant development in the three-county area and the city of Wichita Falls. The second part of the economic analysis covers growth prospects.

Extractive Industries

Minerals

The extraction of mineral resources is an important activity in the economy of the three-county area. The total value of petroleum, natural gas, and natural gas liquids extracted in the three counties has been averaging $80,000,000 annually for several years. (See Table 1.)

Table 1

Value of Mineral Production 1/
Archer, Clay, and Wichita Counties, Texas
1952-1958
(Figures in millions of dollars)

Counties	1952	1953	1954	1955	1956	1957	1958
Archer	$29	$27	$26	$26	$28	$29	$30
Clay	13	14	16	19	19	18	17
Wichita	33	38	38	32	33	35	35
TOTAL	$75	$79	$80	$77	$80	$82	$82

Production of petroleum will continue for many years. In the oil fields for which data are available, estimated resource reserves are sufficient in the three counties to sustain the present rate of extraction (primary recovery) for eighteen years.[2] Secondary recovery operations will extend this time considerably. Explorations are continuing; during 1957-1958, 2,683 wells were drilled, of which 1,637 were producing wells. In addition to petroleum and gas, there is some extraction of stone, sand, and gravel.

Agriculture

The role of agriculture in the economy of the three-county area has been declining. Not only has the number employed in agriculture been decreasing but the number of farms, the acreage of croplands harvested and the value of crops and livestock sold have also been decreasing. The number of farms has steadily decreased from 3,267 in 1945 to 2,160 in 1954. Although the average size of the farms has increased from approximately 590 acres to 830 acres during this period, thereby appearing to compensate for the decrease in the number of farms, the amount of farm production fell off significantly. The acreage of cropland harvested dropped from 317,000 acres in 1944 to 308,000 in 1949 and continued to drop to 221,000 in 1954. The value of crops and livestock sold increased between 1944 and 1949 but declined 22 per cent between 1949 and 1954. (See Table 2.) The net result has been a decrease in the physical volume of production of approximately 19 per cent between 1949 and 1954. Since 1954 the declining trend in agriculture seems to be continuing. The number in the labor force working on farms was approximately 3,600 in 1955 and 3,500 in 1959.[4]

Table 2

Value of Crops and Livestock Sold[3]
Archer, Clay, and Wichita Counties, Texas
1944, 1949, 1954
(Figures are in thousands of dollars)

Year	Value of Crops Sold	Value of Livestock Sold	Total
1944	3,015	6,167	9,182
1949	5,231	13,217	18,448
1954	4,338	9,982	14,320

Manufacturing Industries

The location of manufacturing firms in the three-county area is confined almost entirely to the city of Wichita Falls. Both in terms of employment and value added by manufacture, Wichita Falls has over 95 per cent of the total manufacturing activity in the three-county area. The manufacturing base of Wichita Falls has had an expanding trend. The number and size of firms engaged in manufacturing, the number of employees, and the value of the output have all increased. The number of firms employing twenty or more workers increased from nine in 1947 to eleven in 1954, then jumped to forty-one in 1958. Between 1947 and 1958 the value added by manufacture increased from $21,648,000 to $28,193,000. 4/

Wichita Falls' industrial base is becoming increasingly diversified. There are firms employing twenty or more persons in the following industrial groups: food and kindred products, apparel and related products, lumber and wood products, printing and publishing industries, chemical and allied products, petroleum and coal products, primary metal industries, fabricated metal products, machinery (except electrical), and transportation equipment.

During the last several years over one million dollars annually have been invested in capital expenditure for plants and equipment.

Trade and Service Industries

Commercial development has coincided with industrial advancement. The retail, 6/ wholesale, 7/ and service 8/ establishments have shared in the growth of the three-county area, as evidenced by the increase in the number of establishments, employment, and sales. Most of the growth was experienced in the city of Wichita Falls where employment and the number of establishments each increased 35 per cent between 1948-1958. Sales increased 51 per cent from $151,000,000 to $228,500,000.

Government Employment

The U. S. Government is the largest single employer in Wichita Falls. In 1950 approximately 13,500 of a labor force of 36,300, or 37 per cent, were employed by the Federal Government. 9/ The majority of these, 12,500, were military personnel stationed at nearby Shepherd Air Force Base. In May, 1960, the number of military personnel on duty was 15,000. Of these it is estimated that from 6,000 to 7,000 live in Wichita Falls.

Population

The population of the three-county area, exclusive of the city of Wichita Falls, had a declining trend between 1920 and 1950.[97] The decrease from 54,950 in 1920 to 47,147 in 1950 was primarily due to diminution of agricultural production and the decrease of employment directly or indirectly resulting therefrom.

A contrasting trend is indicated in Wichita Falls. Its population has more than doubled from 45,112 in 1940 to 101,000 in 1960. Much of this growth resulted from the establishment of Shepherd Air Force Base in 1941. It is estimated that in 1960 approximately 16,000 Air Force personnel and their dependents live in Wichita Falls. Also contributing to the population increase has been the annexation of adjacent unincorporated areas, the expansion in the industrial base, and the accompanying increase in commercial and service employment.

Future Growth Prospects

The population of the nation is expected to double between 1960 and 2010. This will mean a vast increase in the need for goods and services in the next fifty years. All parts of the nation will continue to contribute to the needs, but the rate of increase in production will not be uniform in all areas. The more favorably a community is endowed with factors which enhance its ability to produce and distribute goods and services, the greater will be its likelihood of growth. An examination of the ability of the study area to meet the increased demands will assist in forecasting the future growth of Wichita Falls. This section will cite the growth expectations in the extractive, manufacturing, and service industries and the resultant population prediction.

The area is endowed with some natural resources for which a considerable increase in demand is anticipated, particularly petroleum and natural gas. Estimated reserves will permit the present high rate of petroleum and natural gas extraction to continue for many years. Increased agricultural activity is also anticipated. Aside from stimulating employment in extractive industries, these reserves will serve to encourage expansion in processing and manufacturing activities. Production is expected to increase in resource-based industries, particularly in food processing, chemicals, and petroleum products. In addition, market-oriented manufacturing firms will be established as population in the market area increases. The most promising are apparel, metal products, and machinery. Likewise, trade and service industries will continue to grow with the area. The economic climate for industrial and commercial growth is favorable. The local as well as the national markets are expanding.

Good transportation facilities are available. Wichita Falls is served by both rail and an excellent highway system. Fuel and power are available at relatively low cost. The area has ample reserves of natural gas. Labor supply likewise is no problem. Labor of all skills will move into this and other areas as opportunities develop. Indications are that Wichita Falls is favorably situated to enjoy a rate of growth commensurate with that of the average for the nation's metropolitan areas. The population projected for Wichita Falls, Texas, in the year 2010 is 310,000.

PRESENT WATER SUPPLIES

Sources

Prior to 1946, Wichita Falls received all of its water from Lake Wichita. This lake, on Holliday Creek adjacent to the city, was purchased by Wichita Falls in 1920. It has a storage capacity of some 15,000 acre-feet and a drainage area of 143 square miles.

In 1946 Lake Kickapoo on the Little Wichita River was placed in service as the principal source of water for Wichita Falls; Lake Wichita remained in service for supplementary use. Kickapoo Reservoir has a drainage area of 275 square miles and a storage capacity of 106,000 acre-feet. 10/

The safe yield, through critical drouth periods, of the Kickapoo storage volume has been variously estimated by different persons. The range of estimated yields, from 15 to 22 mgd, is indicative of the approximate nature of such estimates. The amount by which storage may be reduced by siltation, and the amount of storage to be held in reserve as a factor of safety, are the chief ponderable questions. Officials of Wichita Falls, guided by recommendations of their consulting engineers 11/, consider Lake Kickapoo to have a safe yield of 16 mgd. To this they have added an estimated 4 mgd from Lake Wichita, for a total of 20 mgd.

For the purposes of this study, a combined safe yield from present sources of 20 mgd, as reported by the city and published in the inventory of municipal water facilities 12/, has been adopted.

Quality

Organic pollution is not a serious problem at any of the reservoirs under consideration, as there are no heavy concentrations of population or industry on the watersheds. The quality problem centers on the concentrations of chemical constituents, notably chlorides and sulfates, and on total dissolved solids. Table 3 (from the Lake Wichita Report 10/) shows the comparative chemical quality of waters from Lakes Kickapoo, Wichita, and Kemp.

Table 3

Water Quality of Lake Kickapoo, Lake Wichita, and Lake Kemp
(From Records of Wichita Falls Water Treatment Plant)

Date	Point	Chlorides (ppm)	Total Dissolved Solids (ppm)	Total Hardness (ppm)
5/18/53	Lake Kickapoo	26	288	122
5/17/54	Lake Kickapoo	20	229	112
8/19/54	Lake Kickapoo	19	249	110
11/18/54	Lake Kickapoo	18	203	98
3/30/55	Lake Kickapoo	20	276	118
2/24/56	Lake Kickapoo	17	222	96
5/17/54	Lake Wichita	216	552	182
3/31/55	Lake Wichita	366	941	274
11/18/55	Lake Wichita	164	474	144
2/17/59	Lake Wichita	460	1,020	-
5/25/59	Lake Wichita	580	1,200	-
11/17/54	Lake Kemp	740	1,924	-
3/31/55	Lake Kemp	670	1,733	-
11/18/55	Lake Kemp	488	1,262	-

The Public Health Service drinking water standards 13/ recommend that the concentration of chlorides not exceed 250 parts per million (ppm). A similar maximum concentration is recommended for sulfates. For total dissolved solids, a maximum of 500 ppm is desirable, with up to 1,000 ppm permissible if better quality water is not available.

It will be seen that Lake Kickapoo is satisfactory for water supply by the above standards, but Lakes Wichita and Kemp are not. Water from Lake Wichita (with its present quality) can be used to supplement the supply from Kickapoo, as long as the two supplies are blended before distribution. In such event, it is recommended that the blend contain at least three parts of Lake Kickapoo water for each part of Lake Wichita water.

The principal sources of pollution to Lake Wichita are brine solutions from oil field operations on the watershed. Presently known oil-well operation technology is such that this man-made pollution could be prevented. It is reasonable to expect that the administrative and enforcement details for a pollution abatement program will be worked out by the state agencies concerned with the problem. Therefore, it may be anticipated that Lake Wichita water will be made more acceptable in the future 10/ A different problem exists at Lake Kemp, as will be subsequently discussed.

Quantity Used

Average daily water requirements of Wichita Falls have tripled since the middle of the 1930 decade. Historical use, as shown in Table 4, remained fairly constant during the 1930's, but has increased steadily since that time. An average consumption rate of 13.3 mgd was reached in 1956.

Based on an estimated population of 98,000 in 1956, the average per capita consumption was 136 gallons per day. This includes most of the industrial use in the area. Present water needs of industry are not heavy, and are obtained largely from the city of Wichita Falls.

Table 4

Wichita Falls Water Consumption, 1930-59
(From Records of Wichita Falls Water Treatment Plant)

Year	Average (mgd)	Year	Average (mgd)
1930	4.094	1945	6.467
1931	3.632	1946	6.508
1932	3.157	1947	5.884
1933	3.133	1948	6.388
1934	3.692	1949	7.132
1935	3.145	1950	7.728
1936	3.690	1951	10.633
1937	3.511	1952	12.138
1938	3.712	1953	10.311
1939	4.026	1954	10.699
1940	3.915	1955	10.846
1941	3.978	1956	13.298
1942	5.649	1957	10.596
1943	7.299	1958	11.216
1944	6.216	1959	11.5

FUTURE WATER SUPPLIES

Quantity Requirements

As projected for the Lake Wichita study [10], municipal and industrial water needs for the area are expected to reach approximately 70 mgd by the year 2010. Past usage and projected future requirements are shown graphically on Figure 1. As previously mentioned, present sources in Lakes Kickapoo and Wichita can supply about 20 mgd of this total. New sources will be required to supply the additional 50 mgd.

Possible Sources

Additional supply would logically be obtained from surface water impoundment on the Wichita River, the Little Wichita River, or both. Potential sites exist on the Little Wichita, downstream from the existing Lake Kickapoo, known as the Scotland site and the Ringgold site. Studies of these two sites have been made by the U. S. Bureau of Reclamation, and by Freese and Nichols, consulting engineers.

Each of the above study groups concluded that the Scotland site would be preferred if the quantity needed was not more than 30 mgd; but, if the need was greater, then the Ringgold site would be better in the long run. The Scotland site, although closer to Wichita Falls, is upstream from the Ringgold site, has a smaller intervening drainage area (below Kickapoo), and therefore a lower potential yield.

On the "big" Wichita River, the logical site for impoundment would be the rehabilitated Lake Kemp, which is under study.

Lake Kemp As a Source

Since Wichita Falls is on the Wichita River and Lake Kemp is some 40 miles upstream, the Lake is well located to serve as a water supply source. Transmission costs would be minimal, since water could flow by gravity down the natural channel.

Unfortunately, the water of the Wichita River (including Lake Kemp) is too highly mineralized to be acceptable as a source of municipal supply. This is part of a general problem on the Red River, of which the Wichita is a tributary.

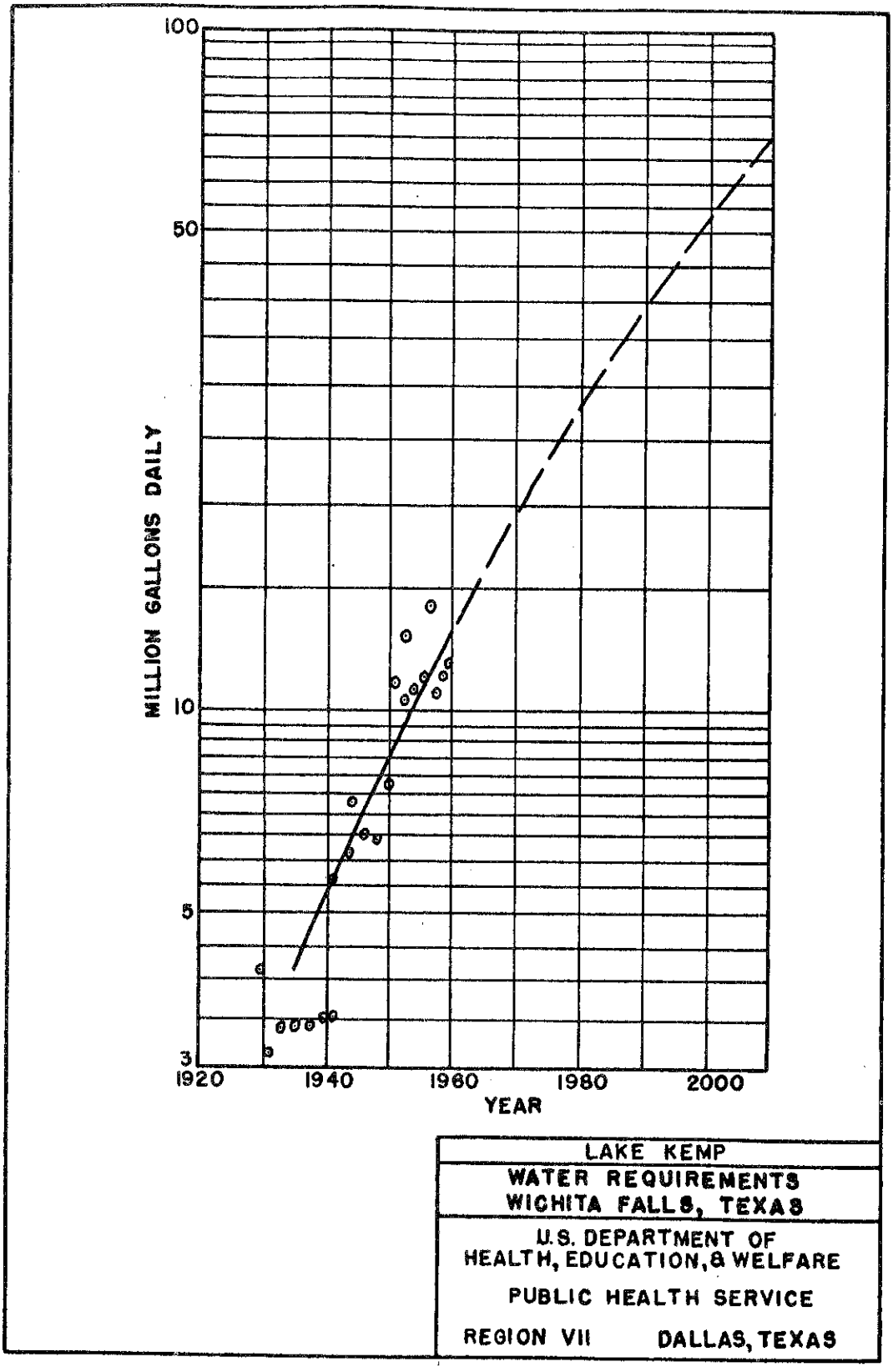

100
50
10
5
3
MILLION GALLONS DAILY
1920
1940
1960
1980
2000
YEAR
LAKE KEMP
WATER REQUIREMENTS
WICHITA FALLS, TEXAS
U.S. DEPARTMENT OF
HEALTH, EDUCATION, & WELFARE
PUBLIC HEALTH SERVICE
REGION VII
DALLAS, TEXAS

FIGURE 1

In February of 1957, the Public Health Service, in cooperation with the Texas State Department of Health, began pilot studies of the water quality problem in the Red River basin. Subsequently, this work has expanded to bring in other agencies, and its scope has been enlarged to include the Arkansas River as well as the Red.

These investigations are still in progress, and it is expected that they will be completed in 1963. Their purpose is to determine the location, nature, and extent, of sources of contamination; and to determine methods by which, with cooperative effort, improvement of water quality may be accomplished.

It has been established that the contamination of Lake Kemp is principally of natural origin; it is concentrated in three groups of salt springs, one on each of the three forks of the upper Wichita River. An indication of the present quality of water from Lake Kemp is given in Table 5. This table summarizes the results of samples collected and analyzed by the Arkansas-Red River Basin study group.

Table 5

Quality - Water Leaving Lake Kemp
(Arkansas-Red River Basin Study Group)

Date	Number of Samples	Average Flow (cfs)	Chlorides		Sulfates	
			Wt'd. Av. (ppm)	Av. Tons per Day	Wt'd. Av. (ppm)	Av. Tons per Day
10-59	3	230	1,020	631	---	---
11-59	2	72	900	174	570	110
12-59	5	55	969	144	538	80
1-60	4	3.1	847	7.1	561	4.7
2-60	4	3.2	821	7.1	520	4.5
3-60	5	44	908	108	538	64

The Corps of Engineers has estimated that a storage volume of 190,000 acre-feet at Lake Kemp would provide a firm yield of about 62 mgd.

Monetary Value of Storage in Lake Kemp

Evaluation of benefits for water supply storage in Lake Kemp is based on comparison with the Ringgold site on the Little Wichita River as an alternative.

The cost of storage at Ringgold, for a yield of 50 mgd would be about 3.2 cents per thousand gallons by interpolation of cost estimates made by the Bureau of Reclamation, adjusted to 1960 construction costs. Adjustment must be made for the difference in transmission cost due to the less favorable location of Ringgold as compared to Lake Kemp.

The major differences in transmission costs are (1) the capital cost of some 26 miles of 54-inch pipeline, and (2) additional energy cost for pumping, to overcome extra frictional resistance equivalent to 151 feet of head plus 90 feet of static lift. The first of these reduces to about 1.14 cents per thousand gallons, and the second to about 1.45 cents, assuming average cost of electric energy at 1.2 cents per kilowatt hour.

The gross value of storage in Lake Kemp is, therefore, on the order of 5.8 cents per thousand gallons of yield of water of acceptable quality. Corresponding annual benefit for a 50-mgd yield is $1,060,000.

Unless and until some method is developed for the containment of pollution from the upstream salt springs, storage of this water will have negligible value for municipal purposes. Certain industries might be able to make selective use of the highly mineralized water for some purposes; but it is believed that strong preference would be shown for development of a source of water whose quality was satisfactory for all ordinary uses.

Summarizing, the benefit from storage in the project for water supply is 7.3 cents per 1,000 gallons if quality is satisfactorily improved, and negligible if it is not. It follows that the justifiable expenditure for storage should not exceed this benefit figure reduced by the cost of quality improvement measures.

BIBLIOGRAPHY

1. U. S. Bureau of Mines, Mineral Yearbook, 1952-1958.

2. Oil and Gas Journal, Review and Forecast Issue, January 25, 1960.

3. U. S. Bureau of Census, Census of Agriculture, Texas, 1950 and 1954.

4. Texas Employment Commission, "Population and Labor Force Estimates of Texas Counties," 1955 and 1959.

5. U. S. Bureau of Census, Census of Manufactures, Texas, 1947, 1954, 1958.

6. U. S. Bureau of Census, Census of Business, Retail Trade, Texas, 1948, 1954, 1958.

7. U. S. Bureau of Census, Census of Business, Wholesale Trade, Texas, 1948, 1954, 1958.

8. U. S. Bureau of Census, Census of Business, Selected Services, Texas, 1948, 1954, 1958.

9. U. S. Bureau of Census, Population Census, Vol. II, Characteristics of the Population, Texas, 1950.

10. U. S. Department of Health, Education, and Welfare, Public Health Service, Lake Wichita Study, Report to U. S. Corps of Engineers, December, 1959.

11. Freese and Nichols, Consulting Engineers, Report on Ringgold Reservoir Water Supply Project, Report to Wichita County Water Control and Improvement District Number One, July, 1958.

12. U. S. Department of Health, Education, and Welfare, Public Health Service, Municipal Water Facilities, December 31, 1956, (and subsequent reports).

13. U. S. Department of Health, Education, and Welfare, Public Health Service, Drinking Water Standards, 1946, U. S. Government Printing Office, Washington, 1960.

SURVEY REPORT
ON
LAKE KEMP
WICHITA RIVER, TEXAS

APPENDIX V

REPORT BY FISH AND WILDLIFE SERVICE

U. S. ARMY ENGINEER DISTRICT, TULSA
CORPS OF ENGINEERS
TULSA, OKLAHOMA

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

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

ADDRESS ONLY THE
REGIONAL DIRECTOR
2-RBS

August 23, 1960

District Engineer
Corps of Engineers, U. S. Army
P. O. Box 61
Tulsa 2, Oklahoma

Dear Sir:

This letter constitutes a preliminary statement of the Bureau of Sport Fisheries and Wildlife on fish and wildlife resources in relation to the proposed Lake Kemp Project, Baylor County, Texas. It has been prepared in accordance with the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.) and has the concurrence of the Texas Game and Fish Commission, as signified by letter from Executive Secretary Howard D. Dodgen, dated August 19, 1960.

Lake Kemp Dam was completed in 1923 on the Wichita River 6.2 miles north of Mabelle, Texas. Lake Kemp was constructed by the Wichita County Water Improvement District No. 1 for the purpose of storing water for irrigation and municipal water supply. The project lies on private land owned by the Waggoner Estates.

It is our understanding that the Corps of Engineers is now investigating the rehabilitation requirements of Lake Kemp and the possibility of incorporating flood control as a project purpose. The most recent information from your office indicates the reservoir is presently operated by local interests to provide some flood control. Elevation of the spillway crest is 1153 1/, and is drawn down to elevation 1144 in anticipation of floods. This latter elevation is being considered by the Corps of Engineers as the top of the conservation pool. The total available storage to spillway crest amounts to 461,700 acre-feet and covers 20,600 acres. At conservation pool level, the acreage is 15,200.

The total storage, with the proposed modification, will be increased to 526,000 acre-feet. Of this storage 200,000 acre-feet will be allocated to flood control and 326,000 will be for conservation and sediment reserve. The flood pool will be increased to 22,500 acres, but the acreage of the conservation pool will remain 15,200.

1/ Elevations are in feet and refer to mean sea level datum.

Fish and wildlife resources of the area are extensive. Some deer and turkey occur near the project area; quail, rabbits, squirrels, doves, and raccoons inhabit the lands surrounding the reservoir. Large numbers of ducks and geese utilize the area during the fall and winter. Lake Kemp also provides some good sport fishing.

Access roads are present along both shores of the downstream half of the reservoir. However, Waggoner Estates charge a fee of $1.10 a day or $10 a season for hunting and fishing in the reservoir area. Despite this, hunting and fishing use is quite heavy. People drive from as far as Amarillo and Dallas, although the majority come from lesser distances.

The proposed modification of the reservoir, leaving the conservation pool unchanged, should not have any significant effect on the fish and wildlife resources, but more detailed studies will be necessary to fully ascertain the impact of the project. Possibilities for enhancement of the area for waterfowl do exist. These possibilities will be investigated by the Bureau of Sport Fisheries and Wildlife and the Texas Game and Fish Commission in the event the Corps of Engineers is authorized to construct the proposed improvements and at such time as plans become more firm and pertinent operational data become available.

Sincerely yours,

John C. Gatlin
Regional Director

Copies (10)

Distribution:

(2) Executive Secretary, Texas Game and Fish Commission, Austin, Texas
(2) Regional Director, Region 3, National Park Service, Santa Fe, New Mexico
(2) Regional Engineer, Region VII, Public Health Service, Department of Health, Education, and Welfare, Dallas, Texas
(2) Field Supervisor, Branch of River Basin Studies, Bureau of Sport Fisheries and Wildlife, Tulsa, Oklahoma

SURVEY REPORT
ON
LAKE KEMP
WICHITA RIVER, TEXAS

APPENDIX VI
REPORT BY BUREAU OF RECLAMATION

U. S. ARMY ENGINEER DISTRICT, TULSA
CORPS OF ENGINEERS
TULSA, OKLAHOMA

RECONNAISSANCE REPORT

ON

BENEFITS OF IRRIGATION

LAKE KEMP

TEXAS

June 1960

BUREAU OF RECLAMATION

REGION 5

Amarillo, Texas

BENEFITS OF IRRIGATION FROM LAKE KEMP, TEXAS

Purpose of Report

This report is in response to a memorandum of understanding dated April 12, 1960, in which the Bureau of Reclamation agreed to furnish the Corps of Engineers a reconnaissance grade evaluation of the benefits of irrigation from water stored in Lake Kemp, Texas.

The water from Lake Kemp has been used for irrigation on the Wichita County Water Control and Improvement Districts Nos. 1 and 2 for about 35 years.

To evaluate the benefits of irrigation in this area, it was assumed that without irrigation, District land would have experienced a development similar to adjacent nonirrigated lands. The benefits of irrigation were assumed to be the difference between the nonirrigated condition and the immediate future condition of the same lands under the existing irrigation. This method of evaluating benefits of irrigation involves the use of farm budgets for the "without" and the "with" irrigation condition on typical farms. Benefits of the irrigation development are obtained by measuring the increase in crop production and other economic activities resulting from irrigation.

Description and Location of Irrigated Area

The lands now served with irrigation water from Lake Kemp Reservoir lie within the Wichita County Water Control and Improvement District Nos. 1 and 2. The majority of irrigation occurs in District No. 2. This District is located between Diversion Dam and the Clay County west line and is almost entirely within Wichita County. The maximum dimensions are approximately 34 miles east and west and 12 miles north and south. Within the District there are approximately 55,000 acres including 39,500 acres classed by the District as capable of being irrigated. Of this area the largest acreage irrigated occurred in 1928 when 33,000 acres were in crops. In 1958 only 10,700 acres were irrigated.

The lands are served by a canal system which diverts from the Wichita River at Diversion Lake some 18 river miles below Lake Kemp. The South Side Canal is 34-miles long and the North Side canal is 30-miles long. The entire lateral system is 148 miles in length, making a total system owned, operated, and maintained by the District of 212 miles. All water is delivered to the irrigated lands by gravity. There are no pumps or pumping equipment.

Physical Orientation

1. Climate.

The climate of this area is subhumid. It is characterized by short, mild winters and long, hot summers. There are two climatic

factors limiting crop production in the Wichita River Valley area. One is high temperatures. The second is a precipitation pattern which limits crop production more by maldistribution than by lack of total rainfall. During the 25-year period, 1935-1959 inclusive, the maximum temperature for each year has never been less than 100 degrees. In 23 years of this period it reached 105 degrees or higher. During this period the temperature extremes recorded at Wichita Falls were 113 degrees above and 12 degrees below zero.

The average annual precipitation at Wichita Falls during the period 1935 to 1959, inclusive, was 26.2 inches, with 19.9 inches or 76 percent occurring during the growing season. This amount of precipitation would be sufficient for most crops grown in the area if it were well distributed. There is however, a wide departure from the average in both the annual and seasonal precipitation. The annual precipitation ranged from a low of 16.38 inches in 1952 to a high of 43.70 inches in 1941, during the 25-year period 1935 to 1959. In this same 25-year period there were 7 months during the growing season when precipitation was recorded as zero or a trace. Two of these months were consecutive. The maximum monthly precipitation was 12.03 inches in May 1957. Two other months had recordings in excess of 11 inches.

High velocity, hot, dry winds, usually from the southwest, often materially reduce yields of some crops and prevent the profitable production of other crops. The growing season is approximately 235 days and provides ample time to mature the crops commonly grown.

2. Soils and Crop Adaptations

The soils of the irrigation area are derived from two general groups of materials: (1) Residual soils formed in place by the weathering of the Red Beds and (2) The alluvial soils derived from recent water-laid unconsolidated sediments. Both groups are Permian in origin.

The soils of the Valley are deficient in the plant nutrients, nitrogen and phosphorus, but have a good supply of potassium for plant growth. Crops generally show striking response to the application of nitrogen and phosphorus in fertilizers.

Since all of the soils in the area, both residual and transported, are derived from Permian formations, they contain considerable amounts of calcium carbonate and calcium sulfate. Due to the presence of these calcium salts, the soils are slightly to moderately alkaline, usually ranging from PH 7.4 to PH 8.3.

The permeability of some of the Valley soils to air and water is rather slow. Hydraulic conductivity rates of water through the moderately fine and fine-textured soils fall in the range of 0.05 to 0.10 inches per hour. Such slow rates of percolation limit the selection of crops to be grown on these soils to grasses that can be inundated for lengthy periods of time. The coarse, moderately coarse and medium-textured soils have permeability rates sufficiently rapid to allow watering and leaching under most of the common cultivated crops.

The soils have been grouped into five general textural classes and are presented in the following table along with their acreages.

GENERAL TEXTURAL CLASSES OF SOILS
IN WICHITA IRRIGATED VALLEY

Textural Classes	Estimated Acreage	Percent of Area
Coarse		
Fine sands and very fine sands	3,400	8.61
Moderately Coarse		
Sandy loams Fine sandy loams	7,306	18.49
Medium		
Very fine sandy loams Loams	14,675	37.15
Moderately Fine		
Silty clay loams Clay loams	11,380	28.81
Fine		
Clays	2,744	6.94
Total	39,505	100.00

(a) Coarse-Textured Soils: This group includes the fine sands and very fine sands and are generally located close to the river, mainly south and southwest of Iowa Park. The soils are suitable for any of the vegetable or field crops generally grown in the area. This soil group is easily cultivated and its moderate rate of water permeability allows it to leach readily.

(b) Moderately Coarse-Textured Soils: The sandy loams and fine sandy loams make up this group. The Yahola very fine sandy loam also is included. Permeabilities range from moderate to slow and leaching is good. Problems in cultivation such as crusting, compaction, and cloddiness are not serious. All of the general field crops and vegetables can be grown on these soils.

(c) Medium-Textured Soils: This group includes all of the very fine sandy loams (except Yahola) and the loams. Permeabilities of this group are slow, but still permit satisfactory leaching.

This group as a whole is a little too tight and crusts too much for some vegetable production but is well adapted to the general field crops, including legumes. This soil group comprises approximately

37 percent of the land capable of being irrigated, and most of the agricultural production in the Valley at the present time is on this soil group.

(d) Moderately-Fine Textured Soils: The silty clay loams and clay loams make up this group which comprises 29 percent of the area. Permeabilities of these soils are very slow, and most irrigators have not used enough water to leach salts. Proper leaching requires that the soils be saturated for such a period of time as would be deterimental to some crops, especially alfalfa. Since it is so difficult to properly water crops on this soil group without drowning and killing the crop, much of this land has been retired from cultivation. Within the past few years, it has been found that Coastal Bermuda grass can be established on these soils and will withstand the intensive irrigation practices that are required to leach the soil profile. The shift from cultivation to sod crops on these soils has been started only recently and is being readily accepted by the farmers. It is expected that the trend will continue and serve as the basis of a livestock economy in the Valley.

(e) Fine-Textured Soils: The clays comprise this group and amount to about 7 percent of the area. The poor physical conditions and very slow permeabilities make them almost impossible to cultivate but they can be managed under a permanent sod such as Coastal Bermuda grass. Little agricultural production is obtained on these soils at the present time.

In general it can be said that about 36 percent of the area that could be irrigated is best adapted to sod crops such as Coastal Bermuda grass which requires no cultivation after being established. Large amounts of water required for leaching are beneficial to the grass. The remaining 64 percent of the area is suitable for general farm crops. The coarse and moderately coarse-textured soils could be planted to intensively cultivated crops such as vegetables.

3. Drainage

Surface drainage of the Valley land is good, excess water being carried off through several small creeks that flow into the Wichita River. Additional surface and internal drainage is provided by the 78 miles of drainage ditches which have been constructed by the Water Improvement District. They are dredged and cleaned frequently. The drainage system is lowering the water table and aiding in the leaching and removal of soluable salt in the ground water which helps to prevent their accumulation in the surface soils.

4. Water Quality

(a) Description: Analyses of Lake Kemp water shows that the highest salinity level reached since 1923 is 3503 parts per million in 1953 during a severe drought when the lake reached a very low level and evaporation concentrated the salts. However, during the seasons of peak use of irrigation, Lake Kemp water ordinarily contains a total of 1700 to 2000 parts per million total soluble salts. The soluble sodium percentage ranges from 39.8 to 68.8 with a mean of approximately 60.0.

Water of the above quality should be used only on soils with good drainage. A sodium hazard will be present when Lake Kemp water is applied to fine textured soils having a high cation-exchange capacity but may be used on coarse-textured soils with good permeability.

The quality of water actually used for irrigation from Lake Diversion is slightly better than the Lake Kemp water. Some surface water is collected into Lake Diversion from the watershed area between Lake Kemp and Lake Diversion. This water has less salt and has the effect of diluting the water released from Lake Kemp.

(b) Water Quality and Crop Adaptations: The quality of the irrigation water is a significant factor in crop production on those farms where improper irrigation practices are used and poor leaching and drainage exists. Frequent light irrigations allow the accumulation of salts in the surface soil. Poor drainage and slow leaching on the finer textured soils prevent the removal of the salts and allow their accumulation in the soil profile. They migrate to the surface as water is removed by transpiration and evaporation.

The water quality does not materially limit the yields of farm crops where soils are properly drained. Salt sensitive crops such as peas and beans are usually affected by the water quality, but general farm crops such as grain sorghum, forage sorghum, cotton, small grains and grass have not been limited in yield by water quality except for the few times when the total water concentration approached 3000 parts per million total soluble salts.

Farmers now are turning to the establishment of Coastal Bermuda grass on the heavier soils and find that it is particularly well adapted to this area. Coastal Bermuda is highlt salt tolerant, can withstand several days of inundation which accomplishes the

89691 O-62—10

leaching process, does not require cultivation after establishment, produces very high yields when fertilized, has no disease or insect problems, and the dense root system loosens the surface soils and increases water penetration and soil permeability.

Agricultural Economy

1. Source of Information

The agricultural data used in this analysis were obtained from publications of the Wichita Valley Experiment Station, Texas A. & M. College, the Agricultural Department of Midwest University in Wichita Falls and by interviews with many farmers in the District and representatives of State, Federal and local agencies familiar with the irrigated area.

2. Agricultural Economy that would exist without irrigation

(a) Size of Farm: Based on the 1950 Agricultural Census and the records of State and Federal agricultural agencies in comparable nonirrigated areas, it was estimated that without the irrigation development, farms would average 320 acres.

(b) Land Use: Data on land use from comparable nonirrigated areas show that cotton, oats for grain and hay, and sudan grass for hay and pasture would be the major crops in the area if there were no irrigation water available. These crops would be used as a feed base for a beef-livestock enterprise. On a typical 320-acre farm there would be about 120 acres of native pasture land and about 200 acres in cultivation. The following tabulation summarizes the land-use pattern that probably would exist in the District if irrigation had not been developed:

Crop	Acres	Percent Cropland	Percent Farm
Cotton	30	15	9
Oats, hay	54	27	17
Oats, grain	46	23	14
Sudan, hay	10	5	3
Sudan, pasture	47	24	15
Native pasture	120		38
Farmstead and idle	13	6	4
Total	320	100	100

(c) Crop yields: Based on the data available and estimates of State and Federal agricultural agencies, the yields of nonirrigated crops that would be produced on lands in District were estimated as follows:

Crop		Unit of Measure	Yield
Cotton	(lint)	lbs.	275
	(seed)	lbs.	467
Oats	(hay)	Tons	1.5
	(grain)	bu.	30
Sudan	(hay)	Tons	0.75
	(pasture)	AUM	3.0
Native pasture		AUM	2.0

(d) Livestock: Beef cattle production is the predominant livestock enterprise in this area. Since the representative nonirrigated farm would contain 120 acres of native pasture and 47 acres of sudan grass pasture, it is believed that a cow herd of 55 grade beef cows would be maintained. The calves would be sold as feeders in the fall at approximately 500 lb. weight.

A farm flock of 50 hens kept principally for home consumption of eggs and meat would be typical.

(e) Land Values: Representatives of the Federal and State agencies were asked for their estimates of long term land values. In most instances they estimated the cultivated land to be worth $100 an acre and native pasture land at something less.

For irrigation benefits determination it was assumed that without irrigation the cultivated land is worth $100 an acre and the pasture farmstead and idle land $75 an acre.

3. Agricultural Economy with irrigation

(a) Size of Farm: Records of all State and Federal agencies with the agriculture of the area were reviewed to establish the size of a typical irrigated farm in the District.

A 200-acre farm containing 145 irrigated acres and 55 acres of dryland native pasture was adopted as the representative farm with irrigation.

(b) Land Use: District records for the past five years, 1955-59, have been used as a base on which to develop a land-use pattern. The trend in cotton acreage has been downward. However, as it is the most valuable cash crop, the acreage is not expected to decline further. About 15 percent of the cropland will be planted to cotton in the District.

Agricultural leaders in the area believe that the land-use trend is toward a greater use of irrigated pastures.

In addition to the seeded tame pastures, which are used for both winter and summer grazing, the acreage planted to Coastal Bermuda grass is rapidly expanding. Coastal Bermuda grass is a perennial that responds to commercial fertilizer and irrigation, has a high carrying capacity for pasture, and can be used for hay. Based on the present trend, it is expected that this crop will occupy about 20 percent of the irrigated cropland. Other pasture crops will occupy about 15 percent of the irrigated land. Oats fit into a pasture-livestock economy by serving as a nurse crop for new pasture seedings, furnishes winter pasture, and produces a crop of grain. It is assumed that 15 percent of the irrigated land will be in this crop.

Approximately 14 percent of the cropland is expected to be in alfalfa and 15 percent in sorghum grown on the more open soils.

Land use on a typical irrigated farm area is presented in the following table:

Crop	Acres	Percent Cropland	Percent Farm
Cotton	21	15	11
Grain sorghum	14	10	7
Sorghum silage	8	5	4
Oats	22	15	11
Alfalfa	20	14	10
Rotation pasture	22	15	11
Coastal Bermuda	29	20	14
Native pasture	55		28
Farmstead and idle	9	6	4
Total	200	100	100

(c) Crop yields: Local U. S. Department of Agriculture agencies, State agencies and individuals, were asked for their estimates of crop yields with irrigation.

Based on available records and estimates of the various agencies the following crop yields were selected for the irrigated lands:

Crop	Unit	Yield
Cotton (lint)	lbs.	500
(seed)	lbs.	850
Grain Sorghum	lbs.	2500
Sorghum silage	Ton	13
Oats	Bu.	55
Alfalfa	Ton	3
Rotation pasture	AUM	12
Coastal Bermuda	AUM	9
Coastal Bermuda	Ton	1

(d) Livestock: Livestock is a basic enterprise in the area and will be used on either irrigated or non-irrigated land.

(e) Land Values: Agricultural representatives interviewed expressed the opinion that irrigated cropland in the Wichita Valley is worth twice the nonirrigated cropland. Therefore, for farm budget and irrigation benefit analyses a value of $200 an acre has been placed on the irrigated cropland, including irrigated pasture.

4. Farm Budget Standards for Determining Irrigation Benefits

Criteria and standards used in the farm budget analysis of the nonirrigated and irrigated condition are described as follows:

(a) Index of Prices and Costs: Prices received and paid by farmers are long-term projected prices used by the Bureau of Reclamation in all economic analysis work in the area. Prices received by farmers are indexed to a 250 price level and prices paid by farmers are indexed to a 265 price level, with 1910-14=100 as the base in both instances. Prices and costs at this level reflect approximately 94 percent parity ratio. The projections represent the level of prices that may be expected to prevail over an extended period of years under assumptions of relatively high employment, continued population and economic growth, and a stable general price level.

(b) Premium for Irrigated Cotton: It is believed that a minimum of 2 cents per pound premium is paid for irrigated cotton due to greater length of staple. During the years 1955 and 1956, farmers in the Washita River Basin and Red River Basin who irrigated their cotton received 5 to 7 cents premium.

A comparison of the average State price for cotton in Oklahoma for the years 1954 through 1956 and the price received for cotton produced on the W. C. Austin Project indicates a premium in normal years of 3 cents per pound.

It is believed that for the purpose of measuring irrigation benefits, 2 cents is a conservative premium to place on irrigated over nonirrigated cotton. For the "without" irrigation budget the projected price of cotton at the "250" price base is 24.5 cents per pound of lint. For the "with" irrigation budget the price is conservatively estimated to be 26.5 cents per pound of lint.

(c) Investment: Farm machinery and buildings are inventoried at new cost under the projected price base.

(c) Labor Requirements: Labor requirements for crops and livestock are those used by the Bureau of Reclamation for the area. Seasonal indices are used to allow for proper seasonal distribution.

(e) Interest: As an annual capital cost, 4 percent of the average farm investment is used as a farm expense.

(f) Insurance: Fire insurance is estimated to cost $7 per thousand for all farm buildings with an insurable value of 50 percent of the new cost.

(g) Taxes: An analysis of Wichita County assessment records indicates that farm land is assessed at 11 percent of actual value. It is assumed that all other farm property is assessed at this same ratio. The tax rate used is the average 1959 tax levy for the two school districts in which the Water Improvement District lies.

(h) Depreciation and Maintenance on Improvements: Annual depreciation is based on a 5 percent sinking fund factor, varying with the life of the building. Maintenance is computed at 2 percent of the new cost on all items including irrigation structures.

(i) Depreciation and Repair on Machinery and Equipment: Depreciation is computed by using the 5 percent sinking fund method for the life of the equipment. Repairs are computed at 2 1/2 percent of the new cost.

Depreciation and repair on the tractor will vary with the number of hours operated annually. Likewise depreciation and repair on the auto and truck varies with the number of miles driven annually.

(j) Utilities: Electricity and telephone are the two major utility expense items. They cover costs incidental to farm operation and are computed on a 265 price base.

(k) Seed and Fertilizer: Seeding rates and fertilizer applications for the "without" and "with" condition budgets are based on current farming practices in the area as indicated by a survey of Federal and State agricultural agency representatives and farmers.

(l) Hourly Labor Rates and Custom Rates: Hourly labor rates for all types of farm labor at 74 cents an hour and all custom labor charges are projected long-term rates applicable to the area.

Tractor-hour operating costs are based on hours of operation for all crops, plus 5 percent of the total hours for all crops as a measure of tractor hour requirements for livestock. Tractor-hour requirements for each crop were used in arriving at the total for all crops.

(m) Farm Privileges: Farm privileges include the estimated rental value of the farm dwelling and the value of garden and livestock products used by the farm family. An amount equal to 1 percent of the farm investment is assumed for accumulation of equity. This is, in effect, a capital expense and is deducted from income in order to arrive at a net farm income.

(n) Area Used for Analysis: The trend of irrigated acres under Lake Kemp has been down and the low point was reached in 1958 when 10,700 acres were irrigated. The 20-year average (1938-57) irrigated area is 20,000 acres. It is estimated that there will be an average of 18,000 acres irrigated in the future years. Irrigation benefits were computed for this area of irrigated land.

In addition to the irrigated land, there is normally about 55 acres of native pasture per farm a total of 6,828 acres for the Districts. The total area of comparison with and without irrigation is 24,828 acres described as follows:

	"Without" Irrigation (Acres)	"With" Irrigation (Acres)
Irrigated land	0	18,000
Dryland	24,828	6,828
Total	24,828	24,828

5. Summary of Farm Budgets

The results of the farm budget analysis of the with the without irrigation condition are shown in the following tabulation:

	"Without" Irrigation	"With" Irrigation	Difference
Number of farms	77.59	124.14	46.55
Farm Products Sold	$702,189	$2,650,513	$1,948,324
Farm perquisites	76,659	122,650	45,991
Gross farm income	778,848	2,773,163	1,994,315
Production expense	548,639	2,256,244	1,707,605
Equity allowance	54,037	98,309	44,272
Net income after equity	176,172	418,610	242,438

Irrigation Benefits

Benefits derived from irrigation are classed as tangible and intangible. The tangible benefits, on which a monetary value can be placed, include three types; direct, indirect, and public. Since the District is presently irrigated, benefits evaluated in this analysis are now being realized. However, if the area loses its irrigation, a similar loss in irrigation benefits could be anticipated. A discussion of these benefits and their estimated values are presented below.

1. Direct Irrigation Benefits

Direct irrigation benefits are the increases in net farm income resulting from the application of irrigation water. The increases in net farm income are derived from differences in the District totals for representative farm budgets with and without irrigation. For this area the total net farm income without irrigation amounts to $230,000 compared to a total net farm income of $517,000 with irrigation. The difference is $287,000, and this amount is the total annual direct irrigation benefit.

2. Indirect Irrigation Benefits

Indirect irrigation benefits are increases in net income of persons other than water users. This is a result of the increased flow of agricultural products from the District due to irrigation. The amount of increased income is estimated by the use of factors representing the ratio of a share of profits in later processing to the increased value of farm sales. Increased farm sales, due to irrigation, are estimated at $1,948,000 annually. The total annual indirect irrigation benefit from these increased sales amounts to $348,000.

3. Public Irrigation Benefits

Public irrigation benefits are judgment estimates of the value of achieving national objectives other than those included in direct and indirect irrigation benefits. For this area the only public benefit is that derived from economic growth. Intensified use of water promotes economic growth by stimulating other investments, and adds elements of balance and stability to an area. As regional development is not susceptible to evaluation by actual market prices, a public benefit

is arbitrarily computed at 5 percent of the direct irrigation benefits. The annual public benefit from economic growth, therefore, amounts to $14,000.

4. Intangible Irrigation Benefits

Development of irrigation in the District has resulted in more farms for this area with a higher net income per farm. This increase in population and income to a local area has been followed by improved community facilities of a cultural and spiritual nature such as schools, churches, and libraries. A higher tax base has also resulted, permitting the enlargement and improvement of public service facilities such as hospitals, parks, and public roads. Irrigation also contributes toward more complete utilization of the land resource, a need that is becoming increasingly important as our population grows and our demand for food increases.

Loss of irrigation to this area would cause a very noticeable effect upon the local economy. Many of the intangible benefits, resulting from irrigation would be lost while others would deteriorate or be seriously hampered by the movement of families away from the area and by the loss of local income.

5. Summary of Irrigation Benefits

Total tangible irrigation benefits for the Wichita County Water Improvement and Control Districts amount to $649,000 annually, or $36.00 per irrigated acre. These benefits are summarized as follows:

	Total	Per acre
Direct benefits	$ 287,000	$15.94
Indirect benefits	348,000	19.33
Public benefits	14,000	0.78
Total benefits	$ 649,000	$36.05
(Rounded)		$36.00

RECONAISSANCE ESTIMATE

OF

DIVERSION REQUIREMENTS AT DIVERSION LAKE FOR

IRRIGATION - LAKE KEMP, TEXAS

Consumptive Use of Irrigation Water

Consumptive use requirements for crops supplied from Lake Kemp were computed by the Blaney-Criddle method. Mean monthly temperature in degrees fahrenheit at the Wichita Falls weather station was used to compute the monthly consumptive use factor. Consumptive use coefficients for each crop were applied to the computed consumptive use factor to determine the consumptive use requirement (inches) for each crop. Consumptive use coefficients used and consumptive use requirements computed for each crop are shown in Table 1.

Monthly precipitation data at Wichita Falls weather station were used to determine effective precipitation for the project area. Plate 1 shows the relationship used to determine effective precipitation from total monthly recorded precipitation.

An operation study was made for each crop, for the period 1926-1959, to determine its irrigation requirement. Moisture storage in the soil was limited for the various crops to that shown in Table 1.

The estimated land use pattern for the irrigated area is shown in Table 1 as percent of irrigable area. These percentages were applied to the computed irrigation requirement for the various crops and totaled to obtain the irrigation requirement for the project. The average annual irrigation requirement was computed to be 1.06 feet for the period 1926-1959.

Leaching Requirements.

In order to prevent excessive salt build up in the soil by the application of relatively poor quality irrigation water, an estimate was made to determine the amount of water needed for leaching. The estimated average concentration of total dissolved solids of irrigation water is 1700 ppm which is equivalent to 2.31 tons of salt per acre foot of water.

Leaching requirements were estimated by the following formula:

$$C_{iw} \quad (D_{iw} + X) = 12\ X$$

Where:

C_{iw} = concentration of total dissolved solids of the irrigation water in tons per acre foot.

D_{iw} = irrigation requirement in feet.

X = leaching requirement in feet

12 = the allowable average concentration of dissolved solids in the root zone soil solution in tons per acre foot.

then,

$$2.31\ (1.06 + X) = 12\ X$$

$X = 0.25$ feet per year leaching requirement.

Farm Waste

It is estimated that farm waste will be about 30 percent of farm delivery. Thus farm delivery = $\frac{\text{Irrigation requirement + leaching}}{0.70}$

Canal and Lateral Losses

The South Side Canal is 34 miles in length, the North Side Canal 30 miles long, and 148 miles of laterals, making a total of 212 miles of canals and laterals. It is estimated that canal and lateral losses will be 40 percent of diversions, thus the diversion requirement at Lake Diversion = $\frac{\text{farm delivery}}{0.60}$

Average annual requirements

For the period 1926-1959, the average annual requirements for the project are as follows:

Consumptive use requirement	2.54 feet
Effective precipitation	1.48 feet
Irrigation requirement	1.06 feet
Leaching requirement	0.25 feet
Total requirement	1.31 feet
Farm waste	0.56 feet
Farm delivery	1.87 feet
Canal and lateral losses	1.26 feet
Diversion requirement at Lake Diversion	3.13 feet

Extent of Irrigation

Consultation with officials of the Wichita County Water Improvement Districts resulted in an estimated 18,000 acres as being a realistic average size of project for the future. Plate 2 shows the acres irrigated for the period 1925-1959. This plot shows a wide range of acres irrigated, varying from a maximum of 33,820 acres in 1928 to a minimum of 10,670 acres in 1958. Since the history of the irrigated area has shown such a wide fluctuation in acres irrigated from year to year, it appears logical to estimate water supply for more than 18,000 acres, thus allowing for a prolonged period in which the area irrigated may well exceed the 18,000 acre estimated future average. Twenty-one thousand (21,000) acres was chosen as the basis of computing irrigation diversion requirements at Lake Diversion.

Irrigation Diversion Requirements

Based on 21,000 acres, the diversion requirement is shown in Table 2 by months for the period 1926-1959. The average for the period is 65,700 acre-feet per year.

It should be pointed out that this estimate is based on irrigation operation only. We know, however, that other uses depend on releases the year around, and should be integrated with irrigation operations to portray a more realistic diversion requirement.

TABLE 1.

PERTINENT DATA - LAKE KEMP IRRIGATION

Crop	Consumptive Use Coefficient	Annual Consumptive Use Requirement (inches)	Soil Moisture Storage Limit (inches)	Percent of Irrigable Area
Cotton	0.70	26.40	5	15
Grain Sorghum	0.70	20.59	5	10
Sorghum Silage	0.70	20.59	5	5
Oats	0.75	13.96	5	15
Alfalfa	0.85	42.66	10	14
Tame Pasture	0.80	40.17	5	15
Coastal Bermuda	0.85	42.66	10	20
Waste*	0.25	12.55	5	6

*Waste land is on farm roads, ditches, fences, farmstead, etc. This is irrigable land and a water charge is paid on it.

Basin Wichita

Project Lake Kemp

Detail Diversion Requirement at Lake Diversion For 21,000 Acres

Table 2

Sheet # 1 of 2

Date 6-22-60

Comp. by SPW

Checked by

Units: 1000's Acre-feet

Year	Month	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935
	January	0	0	0	0	0	0	0	0	0	0
	February	0	0	0	0	0	0	0	0	0	0
	March	0	0	0	0	0	0	0	0	0	0
	April	0	0	0	0	0	0	0	0	0	0
	May	2.5	1.1	4.2	4.2	7.8	.6	2.5	0	3.5	.4
	June	5.9	5.1	5.9	13.7	8.0	12.0	6.7	17.0	14.1	5.7
	July	8.4	11.3	7.3	15.0	22.3	18.9	15.1	23.1	25.6	15.3
	August	10.5	17.4	11.6	15.9	17.8	21.0	11.6	9.5	14.1	19.5
	September	9.0	6.9	16.2	6.9	13.6	15.1	9.5	14.1	6.9	10.5
	October	7.4	5.9	7.3	7.4	.4	1.1	9.7	12.6	9.9	3.2
	November	3.1	0	.4	.4	0	0	3.1	.4	0	0
	December	0	0	0	0	0	0	0	0	0	0
Totals		46.8	47.7	52.9	64.5	69.9	68.7	58.2	76.7	73.9	54.6
		1936	1937	1938	1939	1940	1941	1942	1943	1944	1945
	January	0	0	0	0	0	0	0	0	0	0
	February	0	0	0	0	0	0	0	0	0	0
	March	0	0	0	0	0	0	0	0	0	0
	April	5.2	4.6	0	0	4.8	0	0	0	0	0
	May	5.3	12.6	.4	7.1	7.8	0	9.0	4.8	1.0	1.0
	June	16.2	13.0	2.5	14.3	9.0	0	10.5	8.0	10.1	2.5
	July	24.2	23.7	13.0	23.1	16.2	12.6	23.5	23.5	20.0	16.0
	August	23.1	10.5	19.5	11.5	10.5	14.1	17.9	22.5	14.1	13.7
	September	3.1	15.3	15.4	16.4	10.9	6.9	6.9	15.3	7.3	3.8
	October	7.4	1.1	12.6	5.7	7.4	.4	.9	12.6	2.1	8.4
	November	3.1	0	0	0	0	2.1	0	2.1	0	2.5
	December	0	0	0	0	0	0	0	0	0	0
Totals		87.6	80.8	63.4	78.3	66.6	36.1	68.7	88.8	54.6	47.9

Basin Wichita — Table 2 (concluded)

Project Lake Kemp

Detail Diversion Requirement at Lake Diversion For 21,000 Acres

Sheet # 2 of 2

Date 6-22-60

Comp. by SPW

Checked by [illegible]

Units: 1000's Acre-Feet

Year	Month	1946	1947	1948	1949	1950	1951	1952	1953	1954	1955
	January	0	0	0	0	0	0	0	0	0	0
	February	0	0	0	0	0	0	0	0	0	0
	March	0	0	0	0	0	0	0	0	0	0
	April	0	0	0	0	0	0	.8	0	0	0
	May	1.9	0	0	0	3.1	1.5	5.9	7.3	3.5	.8
	June	13.0	1.0	6.1	11.8	8.2	8.0	15.3	10.5	8.4	6.1
	July	18.9	20.4	17.4	21.0	7.4	12.6	17.9	20.0	22.5	15.3
	August	18.5	23.1	17.4	16.2	6.9	21.0	22.0	12.8	23.1	16.4
	September	5.9	14.1	16.4	7.6	5.3	13.6	16.4	16.2	16.2	3.8
	October	9.4	10.1	8.0	3.1	12.6	8.4	13.7	1.0	10.1	6.9
	November	0	0	2.5	2.7	3.1	2.7	0	0	2.3	3.2
	December	0	0	0	0	0	0	0	0	0	0
Totals		67.6	68.7	67.8	59.4	46.6	67.8	92.0	67.8	86.1	52.5

Year	Month	1956	1957	1958	1959			1926-1959 Average			
	January	0	0	0	0			0			
	February	0	0	0	0			0			
	March	0	0	0	0			0			
	April	8.0	0	0	7.3			.9			
	May	4.6	0	0	7.4			3.3			
	June	13.0	1.1	6.9	6.3			8.7			
	July	23.5	20.4	14.1	9.9			17.6			
	August	13.2	23.1	21.4	15.1			16.5			
	September	16.4	11.5	15.4	12.6			11.1			
	October	2.1	2.3	10.5	.6			6.5			
	November	1.1	0	2.1	.6			1.1			
	December	0	0	0	0			0			
Totals		81.9	58.4	70.4	59.8			65.7			

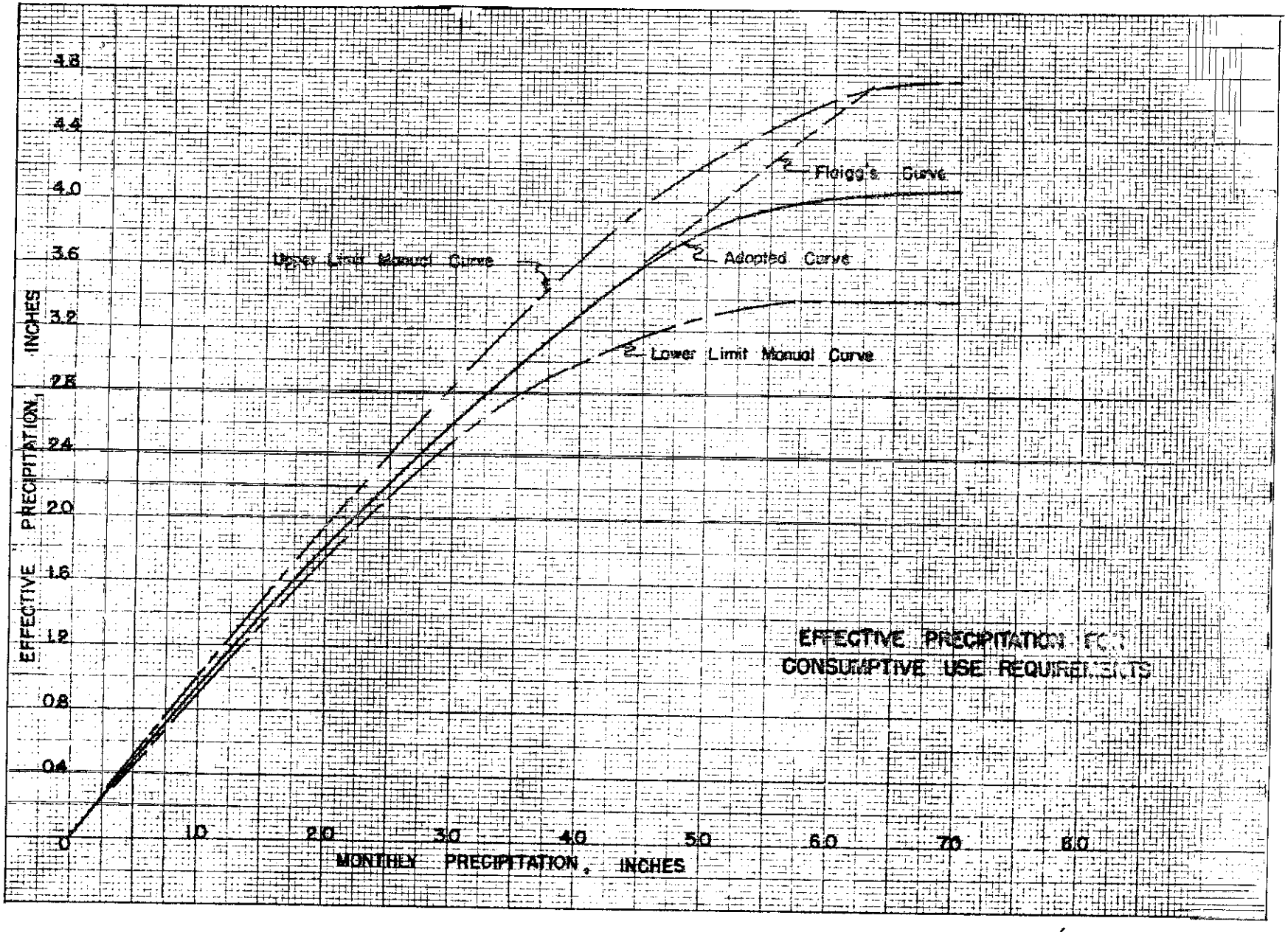
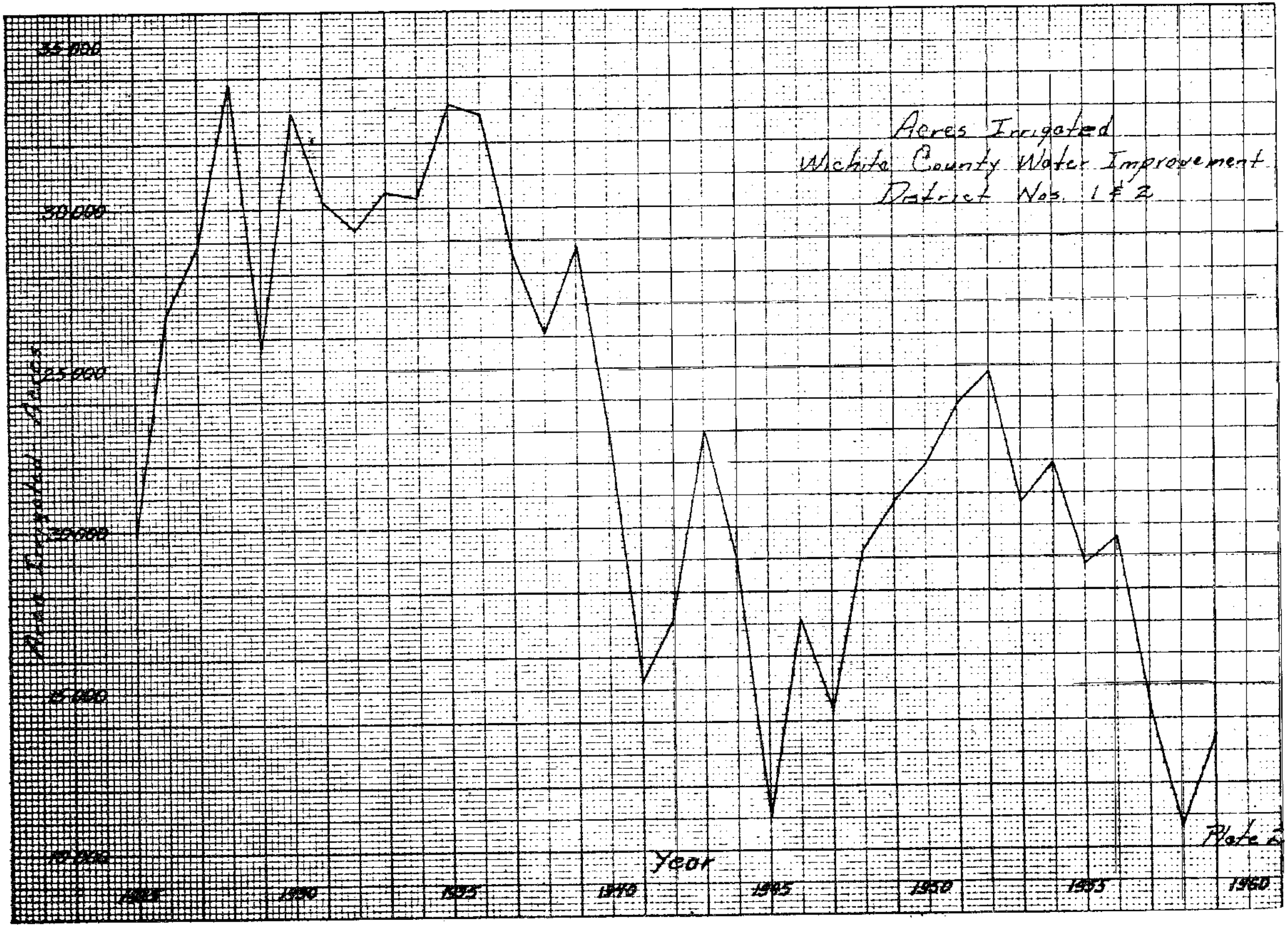

Flaigg's Curve
Adopted Curve
Upper Limit Manual Curve
Lower Limit Manual Curve
EFFECTIVE PRECIPITATION, INCHES
MONTHLY PRECIPITATION, INCHES
EFFECTIVE PRECIPITATION FOR
CONSUMPTIVE USE REQUIREMENTS
0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
0.4
0.8
1.2
1.6
2.0
2.4
2.8
3.2
3.6
4.0
4.4
4.8

Plate 1

89691 O-62—11


Acres Irrigated
Wichita County Water Improvement
District Nos. 1 & 2
35,000
30,000
25,000
20,000
15,000
10,000
Year
1930
1935
1940
1945
1950
1955
1960
Plate 2

SURVEY REPORT
ON
LAKE KEMP
WICHITA RIVER, TEXAS

APPENDIX VII

ASSURANCES AND COMMENTS

U. S. ARMY ENGINEER DISTRICT, TULSA
CORPS OF ENGINEERS
TULSA, OKLAHOMA

APPENDIX VII

ASSURANCES AND COMMENTS

TABLE OF CONTENTS

Item	Page
Assurances	
Resolution, City of Wichita Falls, Texas, and Wichita County Water Improvement District No. 2	153
Comments	
Summary of field-level review comments	156
Letter, Soil Conservation Service, dated October 17, 1961	158
Letter, Soil Conservation Service, dated October 19, 1961	159
Letter, Soil Conservation Service, dated October 31, 1961	162
Letter, Bureau of Mines, dated October 25, 1961	163
Letter, Bureau of Reclamation, dated October 27, 1961	165
Letter, Bureau of Reclamation, dated October 20, 1961	166
Letter, National Park Service, dated October 9, 1961	167
Letter, Federal Power Commission, dated October 18, 1961	168
Letter, Bureau of Public Roads, dated October 17, 1961	170
Letter, Bureau of Public Roads, dated October 13, 1961	171
Letter, Coast and Geodetic Survey, dated October 10, 1961	172
Letter, Public Health Service, dated October 11, 1961	173
Letter, Texas Board of Water Engineers, dated November 3, 1961	174
Letter, Southwestern Power Administration, dated November 8, 1961	178
Letter, Fish & Wildlife Service, dated November 8, 1961	179

RESOLUTION NO. 489

WHEREAS, the Corps of Engineers, under authority of resolution adopted 16 April 1959 by the Committee on Public Works of the United States Senate, has been directed to make an investigation of the advisability of modifying and rehabilitating the existing non-Federal Lake Kemp project, located on Wichita River, Texas, in the interest of flood control, to operate in conjunction with its irrigation, water supply, and other related uses; and,

WHEREAS, it is proposed by the Corps of Engineers that the modification and rehabilitation of the Lake Kemp project be accomplished by the Federal Government; and,

WHEREAS, it is proposed by the Corps of Engineers that, after modification and rehabilitation of the Lake Kemp project, local interests retain jurisdiction of the project and of all project lands; and,

WHEREAS, it is proposed by the Corps of Engineers that, after modification and rehabilitation of the Lake Kemp project, local interests operate and maintain the project, including operation and maintenance required for flood control operation; and,

WHEREAS, it is proposed by the Corps of Engineers that, after modification and rehabilitation of the Lake Kemp project, operation of the project for flood control will be in accordance with Section 7 of the Flood Control Act approved December 22, 1944, which provides that it shall be the duty of the Secretary of the Army to prescribe regulations for the use of storage allocated to flood control in all reservoirs constructed wholly or in part with Federal funds; and,

WHEREAS, it is further proposed by the Corps of Engineers, that, after modification and rehabilitation of the Lake Kemp project, that the United States, subject to appropriations, reimburse local interests annually for that portion of the operation, maintenance and major replacement costs allocated to the flood control function of the project; and,

WHEREAS, the Corps of Engineers has requested assurances of local participation; and,

WHEREAS, it is understood that such assurances do not commit the Federal Government to construction of the proposed improvements; and,

WHEREAS, the City of Wichita Falls and the Wichita County Water Improvement District No. 2, Wichita Falls, Texas, approve of the plan of improvement as proposed by the Corps of Engineers and are fully cognizant of the requirements of local cooperation:

NOW, THEREFORE, BE IT RESOLVED by the Board of Aldermen of the City of Wichita Falls and the Directors of the Wichita County Water Improvement District No. 2:

THAT the Corps of Engineers is hereby advised that the City of Wichita Falls and the Water Improvement District concur with the general plan for reconstruction of Lake Kemp, and are willing and able to

(a) Provide without cost to the United States all lands, easements and rights-of-way necessary for construction and operation of the project;

(b) Remove, without cost to the United States, all cabins from lands required for flood control operation, and perform all relocations and/or alterations of existing buildings, highways, bridges, sewers, related and special facilities, and local betterments;

(c) Hold and save the United States free from damages due to the construction and operation of the project;

(d) Maintain and operate all works after completion, and operate the flood control feature in accordance with regulations prescribed by the Secretary of the Army;

(e) Adopt and enforce regulations to preserve the existing capacity of the channel through the City of Wichita Falls and prevent further encroachment; and

(f) Reimburse the United States for the reconstruction costs allocated to conservation purposes, amounting to about 23 percent of the net reconstruction cost (exclusive of cost of additional lands), in not more than 50 equal annual payments with interest, beginning at the time construction is complete.

ADOPTED by the City of Wichita Falls and the Wichita County Water Improvement District No. 2, Wichita Falls, Texas, this 12th day of April, 1962.

CITY OF WICHITA FALLS

By _____
Mayor

ATTEST:

_____
City Clerk

WICHITA COUNTY WATER IMPROVEMENT DISTRICT NO. 2

By _____
President

ATTEST:

_____
Secretary

SUMMARY OF
FIELD-LEVEL REVIEW COMMENTS

The draft of this report was submitted to other agencies on October 3, 1961, for field-level review. Copies of all letters of comment received from other agencies are included in this appendix. The views of some of the agencies are, in effect, expressions of appreciation for the opportunity to review the report draft, or expressions of general accord with the plan of improvement proposed. Pertinent comments presented by certain reviewing agencies are summarized below.

U. S. Department of Agriculture. The Temple, Texas, office of the Soil Conservation Service, in a letter dated October 19, 1961, presents several comments concerning the plan of improvement and data contained in the report. Their major concern appeared to be the evaluation of irrigation benefits, storage provided for irrigation, and the potential irrigation acreage upon which benefits were computed.

U. S. Department of the Interior:

Bureau of Mines. The Bureau of Mines, Region IV, Bartlesville, Oklahoma, in a letter dated October 25, 1961, concludes that their office study indicates that the proposed modification will have no adverse effects on mineral industries in the area, and that the flood control and conservation storages provided are expected to be beneficial to the petroleum industry.

Bureau of Reclamation. The Bureau of Reclamation, Region 5, Amarillo, Texas, in a letter dated October 27, 1961, suggested a small correction to the report and requested final copies for the Amarillo, Texas, and Oklahoma City, Oklahoma, offices.

Southwestern Power Administration. In a letter dated November 8, 1961 from the Southwestern Power Administration, it is stated that the interest of the Administration will not be affected by the proposed modification of Lake Kemp, unless the consumptive use of water is increased; in which event, a proportionate reduction in generation of hydroelectric power at the downstream Denison project would result.

Fish and Wildlife Service. The Fish and Wildlife Service, in letter of November 8, 1961, suggests that "in the absence of a detailed report from the Bureau of Sport Fisheries and Wildlife, and the Texas Game and Fish Commission the project authorization directs the District Engineer to take such reasonable action as is recommended by the Bureau of Sport Fisheries and Wildlife and the Texas Game and Fish Commission for mitigation of fish and wildlife losses caused by the project and to make such feasible modifications in the project design and operation to enhance fish and wildlife resources as the Secretary of the Interior may direct."

Federal Power Commission. In a letter dated October 18, 1961, the Fort Worth, Texas, office states that conservation releases could be effectively utilized for power purposes; however, due to inadequate stream flow, high evaporation rates, and the low head, installation of power facilities cannot be economically justified. They agree with the statement in the report that the area topography does not provide sufficient head for an economically feasible pumped storage development.

U. S. Department of Commerce. The Bureau of Roads, Austin, Texas, in a letter dated October 13, 1961, concludes that unless the proposed modification is altered to require relocation of existing roads or utilities, they will not require a copy of the final report. The Fort Worth, Texas, regional office, in a letter dated October 17, 1961, states that they have no additional comments to those made by the Division Engineer (Austin, Texas, office).

Department of Health, Education and Welfare. The Dallas, Texas, office of the Public Health Service, in a letter dated October 11, 1961, states that the proposed modifications should have no significant effects on water supply or pollution control aspects.

Texas Board of Water Engineers. Views and comments of this Board were presented in a letter dated November 3, 1961. The need for reconstruction of the Lake Kemp dam and spillway, and for flood protection in the valley below the dam, were recognized. Comments were included concerning the allocation of cost between purposes, and the cost to local interests for the proposed modification. Current research by agencies in the State of Texas on the demineralization of water is noted.

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

P. O. Box 1898
Fort Worth, Texas
October 17, 1961

The District Engineer
U. S. Army Engineer District, Tulsa
Corps of Engineers
616 South Boston
Tulsa 2, Oklahoma

Dear Sir:

In accordance with your request of October 3, 1961 Serial No. 115 of Survey Report on Lake Kemp, Wichita River, Texas is herewith being returned to you.

Comments from the Fort Worth Engineering and Watershed Planning Unit of the Soil Conservation Service have been sent to H. N. Smith, State Conservationist, Temple, Texas. It is expected that he will consolidate all comments and furnish them to you.

Sincerely yours,

Howard Matson, Head
Engineering and Watershed
Planning Unit

Attachment (1)

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

P. O. Box 417
Temple, Texas
October 19, 1961

Colonel Howard W. Penney
District Engineer
U. S. Corps of Engineers
616 South Boston
Tulsa 2, Oklahoma

Dear Colonel Penney:

Your proposed survey report on Lake Kemp, Wichita River, Texas, has been reviewed by technicians of the Soil Conservation Service. The following comments and suggestions are offered for your consideration:

1. The report proposes Federal participation in the reconstruction of a dam constructed and operated by local interests for irrigation and water supply storage. It is stated that the reservoir storage capacity has been managed in such a manner that the project has also provided effective flood control. The flood control management has been so effective that no flood damage has been experienced downstream from the project since the dam was constructed. However, project facilities have apparently deteriorated to such an extent that unless remedial measures are installed, flood damages amounting to $730,000 annually can be expected in the future.

2. The report proposes reconstruction of a part of the facilities to add flood storage capacity and to assure more positive flood control on a Federal and local cost-sharing basis. Projected irrigation benefits to the extent of $649,000 annually also will help to provide economic justification for the reconstruction project.

3. Most of the projected benefits apparently are being realized with the existing project. The agricultural portion of these benefits has a major effect on the agricultural economy of the area. From an agricultural viewpoint these benefits should be safeguarded. The reconstruction of deteriorated facilities undoubtedly will provide assurance that the facilities will function satisfactorily.

4. We do not find any data in the report on the additional area which will be required for additional storage capacity for flood control.

5. It is gratifying to note that the sedimentation survey made on Lake Kemp by the Soil Conservation Service in 1958 was used as a basis for calculating present capacity, and also for estimating the sediment pool required for the 50-year life of the project. We believe, however, that the inclusion of the present surface area at spillway elevation, 20,627 acres, would strengthen the factual data included in the report.

6. We note a discrepancy in the estimates of population growth for the City of Wichita Falls in the year 2010. On page 9, Appendix IV, the Department of HEW gives a projected 2010 population of the city at 310,000. In Supplement "A" Plate 7, the 2010 population estimate for Wichita Falls is about 207,000.

7. It is the opinion of the Soil Conservation Service that the decline in lands irrigated annually has been due to two primary factors: (1) the high salinity of the Lake Kemp water supply, and (2) the encroachment of urban areas, particularly Wichita Falls. We find no evidence in the report that either of these primary factors will be altered. In fact all evidence in the report indicates that these factors will be continued in the future. Therefore, it seems logical to expect a further decline in lands irrigated in the future rather than an increase as predicted in the report. However, benefits are sufficiently high to insure economic feasibility even on a reduced irrigation acreage in the future.

8. It is suggested that a part of the irrigation storage of 190,000 acre-feet could be allocated to flood control thereby reducing project costs. It appears possible that it might not be necessary to raise the dam three feet as proposed in the report.

9. Paragraph 12, Syllabus and Paragraph 5b(1) Supplement A, indicates irrigation as follows:

1928 - 33,000 acres
1954 - 13,471 acres
1958 - 10,700 acres

In view of this apparent decline in irrigation in the project area, the allocation of 190,000 acre-feet of storage with a firm annual yield of 65,700 acre-feet for the irrigation of 18,000 acres appears inconsistent. Also, a conservation benefit of $649,000 based on irrigation of the 18,000 acres may be unrealistic for the same reason. (See 14b., syllabus). Also, in this connection, the continued use of irrigation water containing 1,700 to 2,000 PPM total soluble salts for a 50-100 year period with a projected crop yield increase of 100 percent over the period may be questionable. Paragraph 17c, Supplement A states, "There are adequate supplies of water, but quality must be improved before supplemental irrigation can sustain increasing crop yields." We are unable to determine, from the report, when such improvement in quality of water is expected. A more realistic appraisal of needs for irrigation storage might permit an allocation of a part of the above mentioned 190,000 acre-feet to flood control with a significant saving in project costs.

10. Paragraph 17c and d, Supplement A deals with the use of the recent USDA publication "A 50-Year Look Ahead to U. S. Agriculture" in projecting and computing flood losses to crops. The estimated 100-percent increase in flood losses to crops and the adjusted 40 percent for the 50-year evaluation period may be questionable in view of the above mentioned water quality factor and secondly since the report referred to is a projection of crop yields on a national basis and may not be directly applicable to the project area.

Thank you for the opportunity to review the Lake Kemp report. I hope these comments will be helpful in preparing the final survey report. The continued cooperation of your district in coordination of planning activities for the development of land and water resources is appreciated. If we can assist you in any way, please let me know. We are returning the review draft of the report, as requested.

Very truly yours,

H. N. Smith
State Conservationist

Enclosure (1)

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
Agricultural Office Building, 15th and Quebec
Tulsa 12, Oklahoma
October 31, 1961

District Engineer
U. S. Army Corps of Engineers
616 South Boston
Tulsa 2, Oklahoma

Dear Sir:

According to our information, you have been furnished a letter of comments dated October 19, 1961, from Mr. H. N. Smith, State Conservationist, Texas, covering the field level review of draft report on Lake Kemp, Wichita River, Texas, by the Soil Conservation Service.

The above mentioned letter constitutes the field level review comments of the Department of Agriculture. Thank you for the opportunity of reviewing this report. With your permission, we are retaining copy no. 114 for our files.

Yours very truly,

Byron T. Waldrip

Byron T. Waldrip
Assistant River Basin Representative

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF MINES
REGION IV

OFFICE OF
REGIONAL DIRECTOR

ROOM 206 FEDERAL BUILDING
BARTLESVILLE, OKLAHOMA

October 25, 1961

Colonel Howard W. Penney
District Engineer
U. S. Army Engineer District, Tulsa
P. O. Box 61
Tulsa 2, Oklahoma

File: SWP WR, Lake Kemp,
Wichita River, Texas

Dear Colonel Penney:

Thank you for sending the Bureau of Mines a copy of "Survey Report on Lake Kemp, Wichita River, Texas", dated October 2, 1961, for our field level review.

The report shows that the proposed plan of improvement for Lake Kemp is (1) to raise the earth embankment dam by 3 feet and extend it across the entrance of the existing uncontrolled spillway; (2) replace the damaged existing uncontrolled spillway with a new gated spillway of concrete at another location in the embankment; (3) increase the total storage capacity from 461,800 acre-feet to 526,000 acre feet (it now provides only irrigation and municipal and industrial water supply and sediment storage), which will provide for an initial flood-control storage and a decrease in the conservation pool; and (4) lower the conservation pool by 9 feet, although the present operator has kept this 10 feet lower than the existing authorization.

It is noted that the proposed Lake Kemp dam will not alter much of the area submerged by the conservation pool because the conservation pool will be only 1 foot higher than the level now maintained. However, the proposed flood-control elevation will be an additional 12 feet above the new conservation pool elevation. Appendix III, Plate I indicates that only a few unimproved roads, trails, and cottages would be under water at high flooding intervals.

Lake Kemp lies fully within Baylor County. The Bureau of Mines reported the County mineral production preliminary value in 1960 to be $9,023,400, consisting of only petroleum and natural gas. However, none of this production of petroleum and natural gas is located in or adjacent to Lake Kemp. There is no other known mineral production

in the project area. Downstream from the dam there are known structural limestone deposits that extend northeastward into southeastern Wilbarger County. Below the dam, there are also two known low-grade copper prospects and one inactive copper mine. None of these limestone or copper deposits are now in production or would be adversely affected by this project.

It is noted that the value of mineral production shown in many places in the report for the year of 1958 is a preliminary figure. These are shown in Supplement A, page 5 and Supplement "A", Exhibit 1, pages 1 through 21. We have available the final figures for the years 1958 and 1959 and preliminary mineral production value for the year 1960. Should you desire any of these figures for the counties in the watershed, we would be happy to furnish them. It is also noted that an apparent typographical error exists in Appendix VIII, page 1. This indicates the date of the public hearing in Wichita Falls, Texas as December 15, 1960, whereas other text material (paragraph 10 of page 6) shows this to be December 15, 1959.

An office study of Bureau of Mines records indicates that the proposed modification will have no adverse effects on mineral industries in the area. Flood control attributed to the construction is expected to be beneficial downstream to present production of petroleum; water supply will be beneficial to secondary recovery of petroleum. The Regional Office of the Bureau of Mines has no objection to the proposed project. No field examination was made of the project. As per your request, copy serial No. 125 is returned herewith.

Yours very truly,

Robert S. Sanford
Acting Regional Director
Region IV

Enclosure

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

REGIONAL OFFICE, REGION 5
P. O. BOX 1609
AMARILLO, TEXAS

IN REPLY
REFER TO: 5-730

October 27, 1961

Airmail

Col. Howard W. Penney, District Engineer
U. S. Army Engineer District, Tulsa
Corps of Engineers
616 South Boston
Tulsa 2, Oklahoma

Dear Colonel Penney:

We appreciate the opportunity for this office and our Oklahoma City Development Office to review your proposed report on Lake Kemp, Wichita River, Texas, transmitted by your October 3, 1961, letter.

We note that appended to the report is the reconnaissance report on benefits of irrigation furnished by this office and dated June 1960. Comparison of this report with the statement included on page 8 of your report indicates that the fourth line from the bottom of paragraph 12 should be revised as follows: Delete "$26 million" and insert in lieu thereof "$1.95 million."

In accordance with your request, we are returning, under separate cover, the copy of the report furnished this office. Please furnish copies of your final report to this office and our Oklahoma City office.

Sincerely yours,

Acting Regional Director

Separate Enclosure No. 106011

89691 O-62—12

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
OKLAHOMA CITY DEVELOPMENT OFFICE
P. O. BOX 495
OKLAHOMA CITY, OKLAHOMA

IN REPLY
REFER TO:

October 20, 1961

Colonel Howard W. Penney
Corps of Engineers, Tulsa
P. O. Box 61
Tulsa, Oklahoma

Dear Colonel Penney:

In accordance with your letter of October 3, 1961, we are returning Copy No. 128 of your Survey Report on Lake Kemp, Wichita River, Texas.

The consolidated comments of the Bureau of Reclamation will be furnished by the Regional Office.

Very truly yours,

M. G. Barclay
Area Engineer

Enclosure

UNITED STATES
DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE
Region Three
Santa Fe, New Mexico

IN REPLY REFER TO:

L 7423

October 9, 1961

Howard W. Penney, Colonel, CE
District Engineer
U. S. Army Engineer District, Tulsa
Corps of Engineers
616 South Boston
Tulsa 2, Oklahoma

Dear Colonel Penney:

Thank you for the opportunity of reviewing the draft of your proposed report on Lake Kemp, Wichita River, Texas. Our review discloses that we have no comments to make.

The draft copy No. 126 is being returned herewith as you request.

Sincerely yours,

J. M. Carpenter
Acting Regional Director

Enclosure

FEDERAL POWER COMMISSION
REGIONAL OFFICE
1606 WEST VICKERY BOULEVARD - SUITE 112
FORT WORTH 4, TEXAS

100 NORTH UNIVERSITY DRIVE
FORT WORTH 7, TEXAS

October 18, 1961

The District Engineer
U. S. Army Engineer District, Tulsa
P. O. Box 61
Tulsa 2, Oklahoma

Dear Sir:

We have reviewed, with particular attention to the power potentialities, your proposed Survey Report on Lake Kemp, Wichita River, Texas as transmitted by your letter of October 3, 1961. It is noted that the report proposes federal participation in the reconstruction of this non-federal project for flood control and conservation purposes. Local interests would continue to maintain and operate the reconstructed project but it is proposed that operation of the 200,000 acre-feet of flood control storage would be under direction of the Secretary of the Army.

On page 2 of the report it is stated that the addition of hydroelectric power facilities was found to be impractical, since the stream yield is already dedicated to going conservation uses, primarily for irrigation of land that constitutes a large segment of the agricultural economy of the region. Examination of the indicated points and pattern of use for the conservation storage releases indicates that these releases could be effectively utilized for power purposes. However - due to inadequate stream flow, the high evaporation rate, and the low head - installation of power facilities cannot be economically justified. We therefore conclude that facilities for generation of power should not be provided at the Lake Kemp project. We concur in the report statement that the area topography does not provide sufficient head for an economically feasible pumped storage development.

In regard to the effect of the reservoir on the historical inflow to the existing Denison project on the Red River, it is estimated that each acre-foot of flow consumed as a result of Lake Kemp operations and otherwise available for use in power generation at Denison would occasion a loss of 75 kwh at that project. On the other hand, the

regulation afforded by the flood control storage in Lake Kemp reservoir may have a compensating effect to the extent that such regulation may result in generation of power at Denison with flood waters which would otherwise be wasted.

It is to be noted that these comments are submitted at field level and are not to be construed as opinions of the Federal Power Commission. We appreciate the opportunity to review the report which is returned herewith in accordance with your request.

Sincerely yours,

Edgar S. Coffman
Regional Engineer

Enclosure No. 103411:
As stated above

REGION SIX
ARKANSAS
LOUISIANA
OKLAHOMA
TEXAS

U.S. DEPARTMENT OF COMMERCE
BUREAU OF PUBLIC ROADS
P. O. BOX 12037
FORT WORTH 16, TEXAS

October 17, 1961

IN REPLY REFER TO:
06-00.4

Colonel Howard W. Penney
District Engineer
Corps of Engineer District, Tulsa
616 South Boston
Tulsa 2, Oklahoma

Dear Colonel Penney:

Reference is made to your letter (your File No. SWP WR) dated 3 October 1961, together with your draft copy (Serial No. 118) of your Survey Report on Lake Kemp Wichita River, Texas, dated 2 October 1961.

Your letter requested our "field level review and comment" on this proposed report.

A similar letter of the same date, together with report Serial No. 119 was addressed to our Texas Division Engineer at Austin, Texas.

Our Division Engineer, Mr. Coy, has reviewed the report and his comments are incorporated in his attached letter dated October 13, 1961. The Regional office has no additional comments to add to those made by our Division Engineer.

In accordance with your request we are returning the review draft copies Serial No. 118 and Serial No. 119.

We appreciate the opportunity you have afforded the Division and Regional offices to review and comment on your proposed draft copy.

Sincerely yours,

C. T. Nitteberg
Regional Bridge Engineer

Enclosures 3

cc:
Mr. L. S. Coy, Austin, Texas
Mr. S. E. Ridge, Washington, D. C.

REGION SIX
ARKANSAS
LOUISIANA
OKLAHOMA
TEXAS

06-41

U.S. DEPARTMENT OF COMMERCE
BUREAU OF PUBLIC ROADS
Austin, Texas

October 13, 1961

IN REPLY REFER TO:

Colonel Howard W. Penney
District Engineer
Corps of Engineers
616 South Boston
Tulsa 2, Oklahoma

Dear Colonel Penney:

The draft copy (Serial No. 119) of the Survey Report on Lake Kemp, Wichita River, Texas dated October 2, 1961 is returned herewith as requested in your letter dated October 3, 1961.

We have reviewed the report and it is noted that the recommended project will not require the relocation of any existing roads or utilities (page 4 of Appendix III). Unless there is a change in the project requirements in regards to road relocations, it will not be necessary to furnish this office with a copy of the final completed report.

We appreciate the opportunity to review the proposed report on this project.

Sincerely yours,

L. S. Coy
Division Engineer

By W. P. Privette

W. P. Privette
Assistant Division Engineer

Enclosure

U. S. DEPARTMENT OF COMMERCE
COAST AND GEODETIC SURVEY
FORT WORTH DISTRICT OFFICE
P. O. BOX 2195
FORT WORTH 1, TEXAS

October 10, 1961

The District Engineer
U. S. Army Engineer District, Tulsa
Corps of Engineers
616 South Boston
Tulsa 2, Oklahoma

Dear Sir:

The Fort Worth District Office of the Coast and Geodetic Survey does not have any comment to offer on the enclosed report.

Very truly yours,

William C. Russell

William C. Russell
CAPT, C&GS
District Officer

Enclosure:
Lake Kemp Surv Repr
No. 117

DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE
REGIONAL OFFICE

PUBLIC HEALTH SERVICE

Tenth Floor - 1114 Commerce Street
Dallas 2, Texas

October 11, 1961

Colonel Howard W. Penney
District Engineer
U. S. Army Engineer District, Tulsa
Corps of Engineers
616 South Boston
Tulsa 2, Oklahoma

Attention: SWP WR

Dear Colonel Penney:

The survey report on Lake Kemp, Wichita River, Texas has been reviewed. The report considers reconstruction of Lake Kemp to provide flood water storage and repair or replacement of the existing spillway structure.

The proposed modifications should have no significant effects on water supply or pollution control aspects.

We appreciate the opportunity to review this report. The review copies (Nos. 120, 121, 122) are being returned as requested.

Sincerely,

E. C. WARKENTIN
Associate Director for
Environmental Health Services

cc: Texas State Dept. of Health
Mr. Svore
Mr. Haywood

BOARD OF WATER ENGINEERS

DURWOOD MANFORD, CHAIRMAN
R. M. DIXON
O. F. DENT

BEN F. LOONEY, JR.
SECRETARY

P. O. BOX 2311
CAPITOL STATION
AUSTIN 11, TEXAS

513 STATE OFFICE BUILDING
201 EAST 14TH STREET

IN REPLY REFER TO

(DIVISION)

November 3, 1961

Colonel Howard W. Penney
U. S. Army Engineer District, Tulsa
P.O. Box 61
Tulsa 2, Oklahoma

Dear Colonel Penney:

In response to the request contained in your letter of October 3, 1961, the Board of Water Engineers has reviewed the Corps of Engineers' Survey Report dated October 2, 1961, on Lake Kemp, Wichita River, Texas, and offers the following field-level comments thereon.

SUMMARY

The Board of Water Engineers concurs in the need for additional flood control facilities at Lake Kemp, for the protection of lives and property within the flood-plain downstream including a great part of the City of Wichita Falls, and also the need for reconstructing the outlet and spillway works of the existing Lake Kemp.

The proposed modification of the Lake Kemp Dam is a flood control project. It is the view of this Board that the allocation of initial costs to be borne by local interests for this type of project should be limited to the costs of the rights-of-way, estimated at $318,000 and to the operation and maintenance costs.

The report proposes the reconstruction of Lake Kemp Dam to provide for flood control storage and to make the facility safe for future operations. It proposes to close off the present spillway and outlet works, construct new combined spillway and outlet works, and raise the embankment three feet.

The report shows reconstruction to provide flood control storage to appear to have economic justification. The present owners of the project would retain ownership and jurisdiction, maintain the project, operate the flood control storage as directed by the Secretary of the Army, and make equitable cash contributions toward cost of the reconstruction.

The report shows the present structure to be a potential hazard to the valley and an urban area of Wichita Falls, Texas, because of deterioration of the spillway and outlet works and that major reconstruction is required to make the reservoir safe for future operations. The report shows that the present deteriorated condition of the structure creates a potential catastrophic-type damage to $100,116,000 worth of property and crops and a real threat of the possible loss of life of some of the 12,420 persons who normally occupy the area subject to overflow below Lake Kemp.

This office concurs in the need for flood control for this area and also the need for reconstructing the outlet and spillway works of Lake Kemp. In considering flood control storage in Lake Kemp, however, this agency is gratified to know that alternate methods of achieving flood control have been given consideration. The report points out on page 12 and on page 14 of Appendix I that channel improvement and levees on the Wichita River below Lake Kemp were investigated; and, on page 8 of Supplement B, it is stated that an upstream project for flood control only was also considered but that these features were not found to be economically feasible; however, no relative cost was mentioned in the report. On page 14 of Appendix I, there is apparently a typographical error where it is stated that 200,000 acre-feet of flood control storage would not be practical.

The proposed operation of Lake Kemp outlined in the report differs slightly from the operation of the reservoir since storage began in October, 1922, and the dam's completion in August 1923. Wichita County Water Improvement District No. 1 was issued a permit on March 22, 1921, for an appropriation for irrigation and municipal water supply from the reservoir. A contract was entered into April 4, 1923, between Wichita County Water Improvement District No. 1 and Wichita County Water Improvement District No. 2 for joint ownership and operation between the two districts. Subsequently the allocation of costs between the two districts was determined with District No. 2's share being 33.89 percent and District No. 1's share being 66.11 percent. The contract further provided that 50,000 acre-feet of storage be reserved in the reservoir for municipal use only for the City of Wichita Falls and storage in excess of this amount be used for water supply and irrigation of lands in District No. 1 and irrigation of lands in District No. 2. The owners of the reservoir have operated it so that, except during flood time, the lake level was maintained approximately at or below 10 feet lower than the spillway level and the remaining upper storage capacity was reserved for regulating flood flow. The reservoir has not filled from the time of its construction until the present time.

Permit No. 504, issued to Wichita County Water Improvement District No. 1, was for an appropriation of 1,000,000 acre-feet per annum, or so much thereof as may be necessary, when beneficially used, for irrigation, power purposes, and municipal water supply. The permit included a main reservoir (later named Lake Kemp) of 444,168 acre-feet. As noted above the reservoir has not been operated to full capacity. The 1958 sediment

survey indicates the original reservoir capacity to be about 560,000 acre-feet. At an appropriate time the permit should be amended to correct the data on the original capacity and provide for the modifications suggested in the plan.

The owners of the reservoir have reported concern and anxiety over the condition of the emergency spillway, stating that the reservoir would be endangered if the reservoir filled and flow should be experienced over the spillway. Also, a copy of a joint resolution by the Wichita County Water Improvement District Nos. 1 and 2 dated January 12, 1961, stating the owners approval of the proposed plan was furnished to this agency on January 23, 1961. This resolution is essentially the same as the copies contained in the Corps' report at the end of Appendix VII.

This agency's staff has reviewed the preliminary report on Lake Kemp Sedimentation Study by the Soil Conservation Service and concurs with the Corps of Engineers that this is the best information available on the present amount of sediment deposited in Lake Kemp and also concurs with the 136,000 acre-feet estimated for sediment reserve in the reservoir for a 50-year period.

In comparing the benefits and estimated cost of the project, it is noted that the computed benefits of the conservation storage feature is 47 percent of the total annual benefit; whereas, the allocated cost for the conservation storage feature is 49 percent of the total cost, being higher than the proportional benefit.

The estimated cost of the rehabilitation of Lake Kemp project is shown to be $8,295,000 (excluding land cost of $318,000 and pre-authorization expenditures of $35,000) of which, the Federal Government would provide $7,403,000 and local interests $892,000. Local interests are to furnish land rights-of-way, estimated at $318,000, and to operate and maintain the project. The local interests share of the cost of the project is shown to be 10.75 percent which falls within the limits set out in their resolution dated January 12, 1961, as furnished to the Board.

A further comparison is made of the different methods in the cost allocation of conservation storage to the local interests involved. The method adopted was the use-of-facilities method where the cost to the local interests were higher than two of the other methods shown. By this method, the cost amounted to $6,180,000 as the local interests share of the project. By comparison, the incremental-cost method was lowest, which amounted to $1,907,200 and priority-of-use method was next lowest, which amounted to $2,032,000. The report does not make clear the reason for adopting the higher cost.

The proposed project is a modification of an existing water conservation project to add flood control storage. It is the view of this Board that the allocation of initial costs to be borne by local interests for this type of project should be limited to the costs of the rights-of-

way, estimated at $318,000, and to the operation and maintenance costs.

This agency concurs with the report by the Public Health Service that the chemical quality of water at Lake Kemp, at present, is unsatisfactory for municipal supply, because of the high concentration of chlorides and sulfates. However, this agency would like to point out for future consideration the possibility of future demineralization of the water, making Lake Kemp water suitable for municipal and industrial uses. Two programs in the State are underway which might cause this to come about. One of these is work of the Red River Authority which relates to the control of disposal of salt water produced in oil and gas operations, and another is the cooperative experimental project on demineralization of brackish water being carried on jointly by the Board of Water Engineers, University of Dallas, and the Texas Electric Service Company. These programs, and programs carried on by other agencies and private research groups, may result in this water being made suitable for municipal use.

A public hearing will be held by the Board of Water Engineers on the report when it is officially submitted by the Corps of Engineers to the Governor for his comments as required under the Flood Control Act of 1944 and under Article 7472e (Vernon's Civil Statutes).

Under separate cover, one of the copies of the Survey Reports is being returned. The other copy is being retained for reference in case there is correspondence between our offices, or questions raised. If it is desired that the retained copy be returned, it will be returned when the final report is released.

This agency will appreciate being advised of any modifications of the report.

Very truly yours,

TEXAS BOARD OF WATER ENGINEERS

Durwood Manford

Durwood Manford
Chairman

UNITED STATES
DEPARTMENT OF THE INTERIOR
SOUTHWESTERN POWER ADMINISTRATION
POST OFFICE DRAWER 1619
TULSA 1, OKLAHOMA

IN REPLY REFER TO:

November 8, 1961

Your reference:
SWP WR

District Engineer
U. S. Army Engineer District, Tulsa
P. O. Box 61
Tulsa 2, Oklahoma

Dear Sir:

Thank you for the opportunity to review, at field level, your proposed survey report on Lake Kemp, Wichita River, Texas.

The modification and rehabilitation of the existing Lake Kemp Project in the interest of flood control will not affect the interests of this Administration, unless provisions are made for increasing the consumptive uses of water from that project in conjunction with its reconstruction. Should the consumptive use from this reservoir be increased there will be a proportionate reduction in generation of hydroelectric power at the downstream Denison Project.

Sincerely yours,

Douglas G. Wright
Administrator

Enclosure:
Lake Kemp Survey Report
No. 129

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

November 8, 1961

AIRMAIL

District Engineer
Corps of Engineers, U. S. Army
P. O. Box 61
Tulsa, Oklahoma

Dear Sir:

Reference is made to your letter of October 3, 1961, transmitting a copy of your proposed Survey Report on Lake Kemp, Wichita River, Texas, for review and comment.

We note that you have included our letter report of August 23, 1960, as Appendix V of your report and commend you on the manner in which you have made provision for further consideration of fish and wildlife following authorization of the project.

We regret that adequate detailed project information was not available for our use in time to prepare a detailed report fully coordinated with the Texas Game and Fish Commission including our recommendations for protection and development of fish and wildlife resources in the area. Had it been feasible for such recommendations to be included in the report, they could receive Congressional consideration during project authorization.

We, therefore, suggest that your report include language somewhat as follows:

> In the absence of a detailed report from the Bureau of Sport Fisheries and Wildlife, and the Texas Game and Fish Commission the project authorization directs the District Engineer to take such reasonable action as is recommended by the Bureau of Sport Fisheries and Wildlife and the Texas Game and Fish Commission for mitigation of fish and wildlife losses caused by the project and to make such feasible modifications in the project design and operation to enhance fish and wildlife resources as the Secretary of the Interior may direct.

It is recognized that hunting and fishing on the project area is privately controlled. Public hunting and fishing, however, is per-

mitted on a basis of a reasonable entrance fee. These facts would be fully recognized in any recommendations made for fish and wildlife enhancement.

We appreciate the opportunity of reviewing your report and trust that adequate provision will be made to provide for postauthorization development of the fish and wildlife resources. We are returning Copy 123 of your report under separate cover. Field Supervisor Romero will, no doubt, wish to retain Copy No. 124 for reference until the final draft is ready for release, at which time proposed changes may be forwarded to him for insertion, or the report exchanged for a new one.

Sincerely yours,

Carey H. Bennett, Chief
Division of Technical Services

Separate cover:
Survey Report on Lake Kemp, Wichita River, Texas, Serial No. 123

cc:
Executive Secretary, Texas Game and Fish Commission, Austin, Texas
Field Supervisor, Branch of River Basin Studies, Bureau of Sport Fisheries and Wildlife, Tulsa, Oklahoma

SURVEY REPORT
ON
LAKE KEMP
WICHITA RIVER, TEXAS

APPENDIX VIII

DIGEST OF HEARING RECORD

U. S. ARMY ENGINEER DISTRICT, TULSA
CORPS OF ENGINEERS
TULSA, OKLAHOMA

89691 O-62—13

APPENDIX VIII

DIGEST OF HEARING RECORD

PUBLIC HEARING HELD AT WICHITA FALLS, TEXAS
DECEMBER 15, 1959

1. Approximately 82 persons including representatives of Federal and State agencies, local government, news interests, private industry development associations, educational institutions, and numerous private interests were in attendance at a hearing, which was conducted by Colonel Howard W. Penney, District Engineer, Tulsa District.

2. Presentations made at the hearing concerned the advisability of modifying and rehabilitating the existing non-Federal Lake Kemp project, located on Wichita River, Texas, in the interest of flood control, irrigation, water supply and other related uses.

3. The City of Wichita Falls, the Wichita County Water Control and Improvement District Nos. 1 and 2, various civic organizations, private industry and numerous individuals expressed the desire for a new spillway to be built in order that the existing spillway could be abandoned. It was stated that since the construction of Lake Kemp Dam in 1922 a great amount of flood protection has been given the valley below. It was also stated that if a flood in the magnitude of the one of 1915 would recur, Wichita Falls, without the protection of Lake Kemp and Lake Diversion would suffer more than four million dollars damage. In April 1957, Mr. W. J. Turnbull of the Waterways Experiment Station, Vicksburg, Mississippi, made an inspection of the spillway and in his report stated that no water had ever passed over the spillway crest and in its deteriorated condition it was not possible to predict the behavior of the spillway should it be overtopped. He recommended a more detailed study of the spillway be made. In January 1958 Freese and Nichols, consulting engineers, submitted a report of their investigations of the spillway. They found that the present spillway was in a weakened condition and also inadequate to handle the maximum floods to be expected. They recommended that the present spillway be blocked off by constructing a levee between it and the lake and a new spillway be constructed elsewhere. Persons attending the Public Hearing believed the rehabilitation of Lake Kemp is justified because a failure of the existing spillway could cause a failure of the Lake Diversion Dam and the resulting flood would have a disastrous effect on the City of Wichita Falls.

4. Local interests stated that they would buy such land as may be necessary for a new spillway, provide additional easement for

a flood control pool, if necessary, and enter into a contractual arrangement with the Government relative to the operation of the flood control pool.

5. There were no specific requests for consideration of purposes other than flood control, irrigation and water conservation.

6. A total of 31 written statements were presented at the hearing. These statements are included as exhibits in the Transcript of Public Hearing. Ten of the exhibits which contain the basic data presented at the hearing are listed below. All of the remaining 21 statements were in support of the proposed plan.

Exhibit No. 7 - Statement of Oral Jones, President, Board of Directors, Wichita County Water Improvement District No. 1, states the Lake Kemp and Lake Diversion have kept Wichita Falls from having devastating flood condition since their construction.

Exhibit No. 8 - Brief on the value of Lake Kemp and the Diversion Reservoir in controlling floods along the Wichita River Valley and Red River Basin, contains a description of the Wichita River Basin, the present structures and controls, the flood protection they have given, and excerpts from the report of Mr. W. J. Turnbull of the Waterways Experiment Station, Vicksburg,Mississippi, on the condition of the existing spillway.

Exhibit No. 9 - Statement of C. E. Birk, President, Board of Directors, Wichita County Water Improvement District No. 2, states that since the construction of Lake Kemp and Diversion Reservoir, very little crop land has been flooded in the Wichita River Valley. It also states that local interests would:

a. Buy such land as may be necessary for a new spillway.

b. Provide additional easement for flood control pool, if necessary.

c. Enter into a contractual arrangement with the Government relative to the operation of the flood control pool.

Exhibit No. 10 - Brief, "Lake Kemp Spillway Investigation" January 1958, Freese and Nichols, consulting engineers, recommends that the present spillway be abandoned and a new spillway constructed.

Exhibit No. 13 - Statement of C. M. Crowell, Director, Wichita County Water Control and Improvement District No. 1, estimates the amount of flood control benefits that Lake Kemp and Diversion Reservoir give.

Exhibit No. 14 - "A Study of Flood Control in Lake Kemp, Wichita River, Texas", prepared for local interests at the request of the Bureau of Reclamation by U. S. Army Engineer District, Tulsa, February 1959, presents information on flood control aspects of Lake Kemp after the proposed improvements have been made.

Exhibit No. 17 - Statement of Commissioners Court, Wichita County, Report of Possible Wichita River Flood Damage to Roads, Bridges and Other Property of the County of Wichita, /s/ Temple Driver, County Judge states that a failure to the Lake Kemp dam or spillway would cause an estimated loss of $725,000 to county property.

Exhibit No. 20 - Statement of L. B. Dean, District Engineer, Texas Highway Department, states that a failure to the Lake Kemp dam or spillway would possibly destroy bridges and their approaches with a replacement value of $1,415,000.

Exhibit No. 25 - Statement of Lester E. Brooks, Superintendent, Texas Agricultural Experiment Station, Iowa Park, Texas, explains the importance of irrigation to the Wichita River Valley below Lake Kemp.

Exhibit No. 28 - Statement of Marvin L. McCullough, President, North Texas Oil and Gas Association, explains that uncontrolled floods on Wichita River would cause severe damage and curtailed operation to oil fields, refineries, storage farms and pipelines in the river valley.

SURVEY REPORT
ON
LAKE KEMP
WICHITA RIVER, TEXAS

SUPPLEMENT B

INFORMATION CALLED FOR BY
SENATE RESOLUTION NO. 148, 85TH CONGRESS,
ADOPTED JANUARY 28, 1958

U. S. ARMY ENGINEER DISTRICT, TULSA
CORPS OF ENGINEERS
TULSA, OKLAHOMA

TABLE OF CONTENTS

Paragraph	Title	Page
1	PROJECT DESCRIPTION AND ECONOMIC LIFE	188
	a. General	188
	b. Lake Kemp Dam and Reservoir	188
	c. Economic life	190
2	PROJECT COSTS	190
3	BENEFIT-COST RATIOS	190
4	INTANGIBLE PROJECT EFFECTS	191
5	PHYSICAL FEASIBILITY AND COST OF PROVIDING FOR NEEDS	191
6	ALLOCATION OF COST	192
7	EXTENT OF INTEREST IN PROJECT	195
8	REPAYMENT SCHEDULE	195
9	EFFECT OF PROJECT ON STATE AND LOCAL GOVERNMENTS	196
10	ALTERNATE PLANS	196

TABLES

Table	Title	Page
1	Physical Features and Engineering Data Lake Kemp	189
2	Comparison of Annual Charges and Benefits Based on 50-Year and 100-Year Periods of Analysis	190
3	First Cost, Annual Charges and Benefits Allocated by Use-of-Facilities Method.	193
4	First Cost, Annual Charges and Benefits Allocated by Separable Cost-Remaining Benefits Method	193
5	First Cost, Annual Charges and Benefits Allocated by Priority of Use Method	194

TABLES

Table	Title	Page
6	First Cost, Annual Charges and Benefits Allocated by Incremental Cost Method	194
7	First Costs and Annual Charges for Single-Purpose Projects, 50-Year and 100-Year Periods of Analysis	195

LAKE KEMP
WICHITA RIVER, TEXAS

Information Called For By
Senate Resolution 148, 85th Congress
Adopted January 28, 1958

1. PROJECT DESCRIPTION AND ECONOMIC LIFE

a. General. The plan of improvement for Lake Kemp consists of raising the existing dam, constructing a new spillway and outlet works, extending the embankment across the entrance of the present spillway and plugging the present outlet works. The plan of improvement includes storage for flood control, water supply and irrigation. No alternate plans were studied in detail.

b. Lake Kemp Dam and Reservoir. The dam is located 126.7 miles above the mouth of the Wichita River, a tributary of the Red River, and about 40 miles southwest of Wichita Falls, Texas. The existing structure consists of an earth embankment, an uncontrolled spillway and outlet works. It is proposed to raise the top of dam three feet and extend it across the entrance of the existing uncontrolled spillway. A new gated spillway would be constructed in the embankment. Flow over the spillway would be controlled by 10 - 40' x 35' tainter gates. Low flow and water supply releases would be made through a 5'-8" x 7'-0" sluice. The total capacity of the proposed reservoir would be 526,000 acre-feet of which 200,000 acre-feet are for flood control, 190,000 acre-feet are for conservation and 136,000 acre-feet are for sediment reserve. Pertinent data are shown in table 1.

TABLE 1

PHYSICAL FEATURES AND ENGINEERING DATA
LAKE KEMP

Feature	Existing Project	Proposed Modification
Stream	Wichita River	Wichita River
Miles above mouth	126.7	126.7
Drainage area, sq mi above dam	2099	2099
Purposes	Cons	F C & Cons
General elevations, ft, msl:		
Top of dam	1167.0	1170.0
Top of flood control pool	-	1156.0
Spillway crest	1153.0	1121.0
Top of conservation pool	(1) 1153.0	1144.0
Reservoir area, acres:		
Top of flood control pool	-	22,400
Spillway crest (existing)	20,630	-
Top of conservation pool	(2) 20,630	15,150
Reservoir storage, ac ft:		
Flood control	-	200,000
Conservation	-	190,000
Sediment	-	(3) 136,000
Total	461,800	526,000
Dam:		
Type	Earthfill	Earthfill
Crest length (excluding spillway)	7,980	7,015
Maximum height of dam, ft	99	102
Spillway:		
Type	Uncontrolled	Controlled
Net crest length, ft	564	400
Type of gates	-	Radial (Tainter)
Number & size of gates	-	10 - 40' x 35'
Capacity, cfs	(4) 64,000	450,000
Emergency spillway:		
Type	Low section in dam	-
Net length, ft	405	-
Capacity, cfs	50,000	-
Outlet works:		
Type	Conduits	Sluice
Number & size	2 - 7' diameter	1 - 5'-8" x 7'

(1) Local interests have kept the storage space above elevation 1143.0 empty except during flood periods.
(2) Area at normal pool (elevation 1143.0) 14,600 acres.
(3) Includes 23,600 acre-feet of sediment in flood control pool.
(4) With a 10-foot head.

c. Economic life. The sediment storage pool is designed to be filled in 50 years, so that at the end of that time the storage of sediment would be encroaching on the conservation and flood control pools. Since the 50 years sedimentation is about 26 percent of the capacity of the reservoir, the economic life of the project is in excess of 50 years.

2. PROJECT COSTS

a. Estimates of first costs are based on average bid prices for similar work in the same general area, adjusted to 1960 price levels. All estimates include allowances for contingencies and costs for engineering and overhead. The investment includes the project first cost plus interest during construction for one-half of the construction period.

b. Annual charges given in the report are based on annual interest rates of 2-5/8 percent for Federal costs, with amortization of the project costs distributed over 50- and 100-year periods. Allowance for maintenance and operation and major replacement costs is based on past experience for similar projects.

c. Table 2 shows a comparison of the annual charges and benefits for the recommended project, based on 50- and 100-year periods of analysis.

3. BENEFIT-COST RATIOS

The benefit-cost ratio calculated by using tangible benefits and costs for 50-year and 100-year periods is shown in table 2.

TABLE 2

COMPARISON OF ANNUAL CHARGES AND BENEFITS
BASED ON 50-YEAR AND 100-YEAR PERIODS OF ANALYSIS

Item	50-Year	100-Year
Project first cost (1)	$12,609,000	$12,609,000
Annual charges	543,500	443,800
Annual benefits	1,379,000	1,379,000
Benefit-cost ratio	2.5	3.1

(1) Includes $3,961,000 for value of usable portion of existing project and $8,648,000 for the reconstruction.

4. INTANGIBLE PROJECT EFFECTS

Intangible benefits are those benefits which are difficult to evaluate, or for which no satisfactory method of evaluation has been established. The construction of the proposed plan of improvement would relieve the anxiety of the flood-plain residents downstream from the reservoir by eliminating the danger of a spillway failure, by reducing the dangers accompanying floods, and the threat of epidemics which follow. Other intangible benefits include: elimination of pollution of wells and other water supplies; elimination of interruption of normal transportation services which often cause appreciable loss from delayed shipment of livestock, perishable fruits and vegetables, and seasonable merchandise wherein the time element is of importance; and reduction of interruptions to the normal social processes in the valley.

5. PHYSICAL FEASIBILITY AND COST OF PROVIDING FOR NEEDS

a. When Lake Kemp was constructed, no specific storage was allocated to flood control. The water level has been kept below the spillway to permit temporary storage of floodwaters but this method of operation does not constitute inviolate flood control storage. Consulting engineers hired by local interests stated that the spillway had deteriorated to the extent that it was considered unsafe to permit discharge of floodwaters without damaging results. Inspection shows that concrete in the spillway is now crumbling, that reinforcement steel is exposed and rusted, and that the spillway structure is settled and cracked. In addition, the spillway size is inadequate under present-day standards. The outlet works are also deteriorated and are in need of repair or replacement. A specific allocation of flood control storage is needed in Lake Kemp to provide positive flood protection. Reconstruction of the spillway and outlet works is necessary to provide this storage and to preserve the conservation purposes of the reservoir.

b. The Public Health Service, in a report on water supply, finds that water in Lake Kemp is, at present, unsatisfactory for municipal water supply because of high concentrations of chlorides and sulfates. However, the report states that if the mineral concentrations can be reduced to acceptable maximum, there would be a definite need for storage for water supply in the reservoir. Information furnished by the Bureau of Reclamation indicates that there are approximately 55,000 acres of land in the area capable of being irrigated. Information furnished by the Wichita County Water Improvement District indicates that in the year 1959 an estimated 24,122 acre-feet of water were used to irrigate about 13,470 acres of land. Future power needs in the region will be supplied from thermal units. The lands surrounding Lake Kemp are privately owned and there is no free access to the lake. Accordingly, it is proposed that the Federal Government provide no additional recreational development for the project.

6. ALLOCATION OF COST

Cost allocations for Lake Kemp based on the use-of-facilities, separable costs-remaining benefits, priority of use, and incremental cost methods, are presented in tables 3, 4, 5 and 6. Table 7 presents first costs and annual charges for single-purpose projects.

TABLE 3

FIRST COST, ANNUAL CHARGES AND BENEFITS
ALLOCATED BY USE-OF-FACILITIES METHOD
(Thousands of Dollars)

Item	50-Year Period of Analysis: Flood Control	50-Year Period of Analysis: Conservation	50-Year Period of Analysis: Total	100-Year Period of Analysis: Flood Control	100-Year Period of Analysis: Conservation	100-Year Period of Analysis: Total
First cost (1)	6,428.0	6,181.0	12,609.0	6,429.0	6,180.0	12,609 0
Investment	6,544.0	6,292.0	12,836.0	6,545.0	6,291.0	12,836.0
Annual charges:						
Interest & amortization	236.5	227.4	463.9	185.7	178.5	364.2
Operation and maintenance	41.0	29.0	70.0	41.0	29.0	70.0
Major replacements	4.9	4.7	9.6	4.9	4.7	9.6
Total annual charges	282.4	261.1	543.5	231.6	212.2	443.8
Annual benefits	730.0	649.0	1,379.0	730.0	649.0	1,379.0
Benefit-cost ratio	2.6	2.5	2.5	3.2	3.1	3.1

(1) Includes $3,961,000 for value of usable portion of existing project and $8,648,000 for reconstruction.

TABLE 4

FIRST COST, ANNUAL CHARGES AND BENEFITS
ALLOCATED BY SEPARABLE COST-REMAINING BENEFITS METHOD
(Thousands of Dollars)

Item	50-Year Period of Analysis: Flood Control	50-Year Period of Analysis: Conservation	50-Year Period of Analysis: Total	100-Year Period of Analysis: Flood Control	100-Year Period of Analysis: Conservation	100-Year Period of Analysis: Total
First cost (1)	6,322.8	6,286.2	12,609.0	6,325.8	6,283.2	12,609.0
Investment	6,436.0	6,400.0	12,836.0	6,439.0	6,397.0	12,836.0
Annual charges.						
Interest & amortization	232.6	231.3	463.9	182.7	181.5	364.2
Operation & maintenance	41.9	28.1	70.0	41.9	28.1	70.0
Major replacements	4.8	4.8	9.6	4.8	4.8	9.6
Total annual charges	279.3	264.2	543.5	229.4	214.4	443.8
Annual benefits	730.0	649.0	1,379.0	730.0	649.0	1,379.0
Benefit-cost ratio	2.6	2.5	2.5	3.2	3.0	3.1

(1) Includes $3,961,000 for value of usable portion of existing project and $8,648,000 for the reconstruction.

TABLE 5

FIRST COST, ANNUAL CHARGES AND BENEFITS
ALLOCATED BY PRIORITY OF USE METHOD
(Thousands of Dollars)

Item	50-Year Period of Analysis			100-Year Period of Analysis		
	Flood Control	Conservation	Total	Flood Control	Conservation	Total
First Cost (1)	10,589.8	2,019.2	12,609.0	10,576.8	2,032.2	12,609.0
Investment	10,780.0	2,056.0	12,836.0	10,767.0	2,069.0	12,836.0
Annual charges:						
Interest & amortization	389.6	74.3	463.9	305.5	58.7	364.2
Operation & maintenance	60.4	9.6	70.0	60.3	9.7	70.0
Major replacements	8.0	1.6	9.6	8.0	1.6	9.6
Total annual charges	458.0	85.5	543.5	373.8	70.0	443.8
Annual benefits	730.0	649.0	1,379.0	730.0	649.0	1,379.0
Benefit-cost ratio	1.6	7.6	2.5	2.0	9.3	3.1

(1) Includes $3,961,000 for value of usable portion of existing project and $8,648,000 for reconstruction.

TABLE 6

FIRST COST, ANNUAL CHARGES AND BENEFITS
ALLOCATED BY INCREMENTAL COST METHOD
(Thousands of Dollars)

Item	50-Year Period of Analysis			100-Year Period of Analysis		
	Flood Control	Conservation	Total	Flood Control	Conservation	Total
First cost (1)	10,690.8	1,918.2	12,609.0	10,701.8	1,907.2	12,609.0
Investment	10,883.0	1,953.0	12,836.0	10,894.0	1,942.0	12,836.0
Annual charges:						
Interest & amortization	393.3	70.6	463.9	309.1	55.1	364.2
Operation & maintenance	55.5	14.5	70.0	55.5	14.5	70.0
Major replacements	9.2	0.4	9.6	9.2	0.4	9.6
Total annual charges	458.0	85.5	543.5	373.8	70.0	443.8
Annual benefits	730.0	649.0	1,379.0	730.0	649.0	1,379.0
Benefit-cost ratio	1.6	7.6	2.5	2.0	9.3	3.1

(1) Includes $3,961,000 for value of usable portion of existing project and $8,648,000 for reconstruction.

TABLE 7

FIRST COSTS AND ANNUAL CHARGES FOR SINGLE-PURPOSE PROJECTS
50-YEAR AND 100-YEAR PERIODS OF ANALYSIS
(Thousands of Dollars)

Item	Flood Control	Conservation
First cost (1)	10,600.0	10,653.0
Annual charges, 50-year period:		
Interest & amortization (2)	393.3	392.0
Operation & maintenance	55.5	41.8
Major replacements	9.2	9.2
Total annual charges	458.0	443.0
Annual charges, 100-year period:		
Interest & amortization (2)	309.1	307.8
Operation & maintenance	55.5	41.8
Major replacements	9.2	9.2
Total annual charges	373.8	358.8

(1) Flood control cost for new project upstream from Lake Kemp. Conservation cost for rehabilitation of Lake Kemp including $3,354,000 for value of usable portion of existing project.
(2) Based on 2-5/8 percent interest rate.

7. EXTENT OF INTEREST IN PROJECT

Testimony at a public hearing held at Wichita Falls, Texas, December 15, 1959, indicated that local interests desired a new spillway to be constructed so the existing spillway could be abandoned. Local interests stated that they would buy such land as may be necessary for a new spillway, provide additional easement for a flood control pool if necessary, and enter into a contractual agreement with the Federal Government relative to operation of the flood control pool. There were no specific requests for consideration of purposes other than flood control, irrigation and conservation.

8. REPAYMENT SCHEDULE

In accordance with arrangements with local interests they would retain ownership of the project and would be responsible for maintenance and operation after construction. They would furnish the additional lands required for the construction work. They would also reimburse the

United States for 22.7 percent of the reconstruction cost, after deducting the preauthorization cost and cost of additional lands, which on basis of the current estimate would amount to $1,885,000. This reimbursement would be made in not more than 50 annual payments with interest. On the basis of the current estimate, these payments would amount to $69,900 annually.

9. EFFECT OF PROJECT ON STATE & LOCAL GOVERNMENTS

The proposed plan of improvement should not result in any increased cost in State and local government services.

10. ALTERNATE PLANS

The feasibility of locating the spillway in a saddle near the right abutment was investigated as an alternate to the valley spillway location. Consideration was given to both controlled and uncontrolled structures at this location; however, the cost of these structures, together with the cost of outflow channels, remedial work to protect U. S. Highways 183 and 283, and the cost of rehabilitating the present outlet structure, would have exceeded the cost of the plan of alteration proposed.