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**Missouri River Basin: Letter from the Secretary of War
Transmitting a Letter from the Chief of Engineers, United States
Army, Dated December 31, 1943, Submitting a Report Together
with Accompanying Papers and Illustrations, on a Review of
Reports on the Missouri River, for Flood Control Along the Main
Stem from Sioux City, Iowa, to the Mouth, Required by a
Resolution of the Committee on Flood Control, House of
Representatives, Adopted on May 13, 1943**

United States Congress

US House of Representatives

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Lewis A. Pick

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MISSOURI RIVER BASIN

LETTER

FROM

THE SECRETARY OF WAR

TRANSMITTING

A LETTER FROM THE CHIEF OF ENGINEERS, UNITED STATES ARMY, DATED DECEMBER 31, 1943, SUBMITTING A REPORT, TOGETHER WITH ACCOMPANYING PAPERS AND ILLUSTRATIONS, ON A REVIEW OF REPORTS ON THE MISSOURI RIVER, FOR FLOOD CONTROL ALONG THE MAIN STEM FROM SIOUX CITY, IOWA, TO THE MOUTH, REQUESTED BY A RESOLUTION OF THE COMMITTEE ON FLOOD CONTROL, HOUSE OF REPRESENTATIVES, ADOPTED ON MAY 13, 1943



MARCH 2, 1944.—Referred to the Committee on Flood Control and ordered to be printed with two illustrations

UNITED STATES
GOVERNMENT PRINTING OFFICE
WASHINGTON : 1944

CONTENTS

	Page
Letter of transmittal.....	v
Letter from the Bureau of the Budget.....	vii
Letter of the Chief of Engineers, United States Army.....	1
Letter containing comments of the Bureau of Reclamation.....	5
Letter requesting the comments of the Bureau of Reclamation.....	9
Letter containing comments of the Federal Power Commission.....	10
Letter requesting the comments of the Federal Power Commission.....	12
Letter containing comments of the Department of Agriculture.....	12
Letter requesting the comments of the Department of Agriculture.....	13
Report of the Board of Engineers for Rivers and Harbors.....	14
Report of the division engineer.....	19
Syllabus.....	19
I. Introduction and general description.....	19
Authority for report.....	19
Arrangement of report.....	20
Scope of report.....	20
General description of the basin.....	20
General description of basin below Sioux City.....	20
Pertinent existing and authorized Federal projects.....	21
II. Flood characteristics.....	22
General.....	22
III. Flood problem.....	23
Agricultural areas subject to floods.....	23
Municipal areas subject to floods.....	23
Floods.....	24
Desires of local interests.....	25
IV. Proposed flood-control plan.....	26
Levee costs.....	27
V. Economic justification and discussion.....	28
VI. Conclusions.....	30
VII. Recommendations.....	31

LIST OF APPENDIXES MADE IN CONNECTION WITH THE REPORT OF THE DIVISION ENGINEER

(Only pl. 16 printed)

Appendix No. 1.—Maps and charts.

Appendix No. 2.—Transcript of public hearings (not printed).

Sheet No.

Title

- | | |
|-----|---|
| | Index sheet. |
| 1. | Flood-protection plan—mile 769.0 to mile 681.5. |
| 2. | Flood-protection plan—mile 686.5 to mile 514.0. |
| 3. | Flood-protection plan—mile 517.0 to mile 406.0. |
| 4. | Flood-protection plan—mile 410.0 to mile 240.0. |
| 5. | Flood-protection plan—mile 246.0 to mile 85.0. |
| 6. | Flood-protection plan—mile 89.0 to mile 0.0. |
| 7. | Flood-protection plan—Sioux City, Iowa. |
| 8. | Flood-protection plan—Omaha-Council Bluffs. |
| 9. | Flood-protection plan—Gasconade Boatyard, Mo. |
| 10. | Profiles: Mile 765.0 to mile 630.0. |
| 11. | Profiles: Mile 630.0 to mile 514.5. |
| 12. | Profiles: Mile 514.5 to mile 385.0. |
| 13. | Profiles: Mile 385.0 to mile 255.0. |
| 14. | Profiles: Mile 255.0 to mile 125.0. |
| 15. | Profiles: Mile 125.0 to mile 0.0. |
| 16. | Comprehensive plan. |

LETTER OF TRANSMITTAL

WAR DEPARTMENT,
Washington, February 28, 1944.

The SPEAKER OF THE HOUSE OF REPRESENTATIVES.

DEAR MR. SPEAKER: I am transmitting herewith a report dated December 31, 1943, from the Chief of Engineers, United States Army, together with accompanying papers and an illustration, on a review of reports on the Missouri River, with a view to flood control along the main stem from Sioux City, Iowa, to its mouth, requested by a resolution of the Committee on Flood Control, House of Representatives, adopted on May 13, 1943.

In view, however, of the large quantities of materials, equipment, and manpower which would be required on the construction of the projects proposed in the report, and since there is no presently indicated necessity for them in the war program, the Department considers that initiation of construction should be deferred until after the war or until essentiality in the war effort has been established.

By letter of February 16, 1944, the Bureau of the Budget advises that there would be no objection to the submission of the report to Congress for its information, but that the authorization of the improvements recommended by the Chief of Engineers would not be in accord with the program of the President, at least at the present. Further advice as to the relationship to the program of the President, of the improvements considered in the report, will be given by the Bureau of the Budget after review and consideration by that Bureau of reports of other Federal agencies and additional material to be submitted by the Chief of Engineers. A copy of the letter of the Bureau of the Budget containing its comments is enclosed.

Respectfully,

HENRY L. STIMSON,
Secretary of War.

LETTER FROM THE BUREAU OF THE BUDGET

EXECUTIVE OFFICE OF THE PRESIDENT,
BUREAU OF THE BUDGET,
Washington, D. C., February 16, 1944.

The Honorable the SECRETARY OF WAR.

MY DEAR MR. SECRETARY: Reference is made to your letter of January 7, 1944, transmitting in accordance with section 4 of Executive Order No. 9384, dated October 4, 1943, the proposed report of the Chief of Engineers on a review of reports on the Missouri River, with a view to flood control along the main stem from Sioux City, Iowa, to its mouth, and requesting advice as to the relationship of the proposed report to the program of the President.

A preliminary review of this proposed report indicates the following to be the situation:

1. A difference of opinion appears to exist between the Corps of Engineers and the Bureau of Reclamation over the use and control of the waters of the Missouri River and its tributaries west of, or entering above, Sioux City, Iowa, although the exact nature of these differences cannot be ascertained until the report of the Bureau of Reclamation for the area is completed and submitted to the Bureau of the Budget, in accordance with section 4 of Executive Order No. 9384. In response to my inquiry of January 18, 1944, a copy of which I sent to you, the Acting Secretary of the Interior, under date of January 22, 1944, advised me that the Bureau of Reclamation is currently completing, after a 5-year study, and will have available on May 1, 1944, a report on the Missouri River Basin directed primarily toward the development of irrigation, hydroelectric power production, and other beneficial uses of water. Also, until that time, I will not have an estimate of those Federal expenditures to be proposed under the plan of the Bureau of Reclamation that will be in addition to the amounts recommended to be authorized under the plan proposed by the Chief of Engineers.

2. It appears that the flood-control plan proposed for the Missouri River by the Chief of Engineers will not be complete without supplementary action by other departments of the Government. In response to my inquiry of January 21, 1944, a copy of which I sent to you, the Acting Secretary of Agriculture, under date of February 4, 1944, advises me that in the opinion of the Department of Agriculture all proposals for multiple-purpose treatment of river basins should include consideration of the contribution that land-use treatment can properly make, and particularly so in river basins presenting as serious erosion and siltation problems as the Missouri. While the Department of Agriculture has not yet developed specific programs of land-use treatment in this area to supplement the plan proposed by the Chief of Engineers, the Department has made a very rough

preliminary and generalized estimate for the Missouri Basin as a whole that indicates Federal expenditures of \$1,000,000 for planning, and approximately \$350,000,000 for undertaking the programs that would be required in addition to the amounts recommended to be authorized under the plan proposed by the Chief of Engineers.

3. The full development of the water resources of the Missouri Basin should include detailed consideration of the possibilities of hydroelectric power development. In response to my inquiry of January 22, 1944, a copy of which I sent to you, the Chairman of the Federal Power Commission, under date of February 14, 1944, advises me that power development will prove an important factor in any program for the Missouri Basin, it being estimated that the full development of the water resources of the Missouri River and its tributaries might ultimately include the installation of as much as 3,000,000 kilowatts at projects either now contemplated or which subsequent investigation may show to be desirable without sacrifice of the other benefits which the river and its tributaries should contribute to the growth and welfare of the region. More than half of this additional power would probably be found in projects constructed in the main stem of the Missouri River. The Chairman also advises, however, that pending a more detailed survey and study of the Missouri River, the Commission cannot estimate the Federal expenditures for such power development that would be in addition to the amounts recommended to be authorized under the plan proposed by the Chief of Engineers. Such detailed survey and study would require from \$200,000 to \$250,000, in addition to the funds now available to the Federal Power Commission.

4. The plan proposed by the Chief of Engineers recommends improvements be authorized at a first cost to the Federal Government of \$481,600,000, in addition to the recommended completion of other presently authorized reservoirs and levees at a first cost to the Federal Government of \$171,000,000, or a total, in all, of \$658,600,000. In combination with the rough estimated outlays by the Department of Agriculture of \$350,000,000, this would bring the total known cost of carrying out the plans to slightly more than \$1,000,000,000. However, no detailed analyses of the tangible benefits that would accrue under the plan proposed by the Chief of Engineers are now available to justify even the proposed additional Federal expenditure of \$481,600,000 that the Chief of Engineers recommends be authorized, although it is stated in his report that the proposed system of levees and reservoirs would provide complete flood protection to fixed and movable property with an estimated value of about \$1,000,000,000.

5. The proposed report of the Chief of Engineers does not make clear what his views are as to the ultimate relationship that should prevail among the plan proposed in this report, the proposed 9-foot channel project for the Missouri River between Sioux City and the mouth, as recommended in House Document No. 214, Seventy-sixth Congress, and now under consideration by the Congress in the pending bill (H. R. 3961) "Authorizing the construction, repair, and preservation of certain public works on rivers and harbors, and for other purposes," and upstream uses of the water resources of the basin.

6. The immediate authorization and construction of this project, because of war necessity, is not apparent. Your proposed letter to the chairman, Committee on Flood Control, House of Representatives,

states that the War Department believes that initiation of construction on the improvements recommended by the Chief of Engineers "should be deferred until after the war, or until essentiality in the war effort has been established."

I have taken the proposed report up with the President and while there would be no objection to your submitting it to the Congress for its information, if you wish to do so at this time, the authorization of the improvements recommended therein by the Chief of Engineers would not be in accord with the program of the President, at least at the present. Further advice as to the relationship to the program of the President of the improvements considered in the proposed report will be given after the review and consideration in this office of—

1. The proposed report of the Bureau of Reclamation to be completed on May 1, 1944.

2. Detailed estimates of additional appropriations to be submitted by the (a) Department of Agriculture, covering the planning of the necessary supplementary land-use treatment programs in the Missouri Basin; (b) Federal Power Commission for studying power development possibilities of the water resources in the area.

3. Special supplementary statements by the Chief of Engineers providing additional details as to his views of (a) the tangible flood-control benefits to be derived in relation to the Federal outlays that are recommended in this proposed report; (b) the ultimate relationship that should prevail among the flood-control plan recommended in this proposed report, the proposed 9-foot channel project for the Missouri River, and upstream uses of the water resources in this basin.

Accordingly, I am forwarding copies of this letter to the Secretaries of Interior and Agriculture and the Chairman of the Federal Power Commission for their information and necessary action. I hope that you will direct the Chief of Engineers to prepare and submit to the Bureau of the Budget at the earliest practicable date, but certainly not later than May 1, 1944, the special supplementary statements that I have referred to above.

I would appreciate your including a copy of this letter in any submission to the Congress that you may decide to make at this time of the proposed report of the Chief of Engineers.

Very truly yours,

HAROLD D. SMITH, *Director.*

LETTER OF THE CHIEF OF ENGINEERS, UNITED STATES ARMY

WAR DEPARTMENT,
OFFICE OF THE CHIEF OF ENGINEERS,
Washington, December 31, 1943.

The CHAIRMAN, COMMITTEE ON FLOOD CONTROL,
House of Representatives, Washington, D. C.

MY DEAR MR. CHAIRMAN: 1. The Committee on Flood Control of the House of Representatives, by resolution adopted on May 13, 1943, requested the Board of Engineers for Rivers and Harbors to review the reports on the Missouri River contained in House Document No. 238, Seventy-third Congress, second session, and House Document No. 821, Seventy-sixth Congress, third session, with a view to determining whether any modification should be made therein at this time with respect to flood control along the main stem of the Missouri River from Sioux City, Iowa, to its mouth. I enclose the report of the Board in response thereto.

2. The Board concurs in the report of the division engineer and recommends modification of the approved general comprehensive plan for flood control and other purposes in the Missouri River Basin to include 12 additional multiple-purpose reservoirs, works to divert water to the Devils Lake and James River Basin regions, and a system of levees and appurtenant works along the Missouri River between Sioux City and the mouth, in general accordance with the plan of the division engineer, as shown on the accompanying map, with such modifications thereof and changes therein as the Secretary of War and Chief of Engineers may find advisable, at an estimated cost to the United States of \$481,600,000 for these additional works, with local cooperation as specified in the Board's report. The Board further recommends that in addition to previous authorizations of funds there be authorized, for appropriation, funds sufficient to provide for initiation and prosecution of the expanded general comprehensive plan in logical steps.

3. The reports of the division engineer and the Board were referred to the Bureau of Reclamation, the Federal Power Commission, and the Department of Agriculture for their comments. Several conferences have also been held both in Washington and in the field between representatives of these agencies and of the Corps of Engineers. The views and comments of the three agencies are contained in full in the letters of reply which accompany this report.

4. The Department of Agriculture states that, although its responsibilities do not embrace the construction of the types of engineering works discussed in the report, the benefits of the proposed program for flood control, irrigation, power, navigation, wildlife, recreation, and other multiple-purpose developments are of great concern to the interests of agriculture in this important area and will have a direct bearing on the use of the rural resources of the basin. Both the droughts of recent years and the disastrous floods of 1943 demonstrate the need for such a comprehensive plan of multiple-purpose regulation and development of the upper Missouri River. The

Department of Agriculture is of the opinion that the proposal of the division engineer and of the Board for progressive step-by-step cooperative development is a constructive approach to the solution of the problems of water use in the Missouri River Basin and it assures its full cooperation in the accomplishment of this plan. That Department believes that it may be of particular assistance through its programs for water-flow retardation and soil-erosion prevention which may serve as valuable supplements to the comprehensive program.

5. The Federal Power Commission is of the opinion that the proposed comprehensive plan should go far toward resolving present conflicts of interest in the use of the water resources of the basin through the construction of additional storage reservoirs. These conflicts now arise because of insufficiency of usable water, under present conditions of basin development, to meet all projected water requirements. The Commission approves the recognition in the report of the importance of cooperation among governmental agencies and local interests in the development of the program and it desires to cooperate further in the working out of details. It considers that the Missouri Basin affords a unique opportunity for such cooperative procedure, which should be directed to assure the maximum benefits possible under the multiple-use concept. The Commission is convinced that power development will prove an important factor in the Missouri Basin program and believes that at least 10,000,000,000 kilowatt-hours of additional hydroelectric energy per year may eventually be developed without sacrifice of other benefits to the region from the use of its water resources. The Commission recommends that current authorizations for flood control be broadened to permit construction for multiple-purpose use and that the plan of the division engineer and the Board for undertaking the development of the Missouri River on a step-by-step basis be authorized, with latitude for such modification as changing conditions show to be desirable.

6. The Bureau of Reclamation believes that the development of a truly comprehensive plan of improvement for the Missouri River Basin can best be accomplished through integration of the studies and investigations of the Corps of Engineers with those of the Bureau, each agency operating in its respective field as determined by existing law. A proportionate share of all the benefits from an integrated basin program should, in the opinion of the Bureau, be applied to each feature of the program in advance of construction, and all reservoirs, including Fort Peck, should be operated to obtain the maximum benefit from all water uses, with preference being given to functions which contribute most to the welfare and livelihood of the greatest number of people. The Bureau recommends adoption of the policy that works of improvement under a comprehensive plan should be constructed, maintained, and operated by the agency with the dominant interest under existing law, after appropriate consultation with other agencies definitely concerned with phases other than that interest. The Bureau considers the plan of improvement proposed in the reports of the division engineer and the Board of Engineers for Rivers and Harbors, adequate for flood control along the lower river, but calls attention to flood problems on the upper tributaries for which a solution is not provided. It is the opinion of the Bureau that reser-

voirs on the Yellowstone River and tributaries should be built primarily for irrigation after coordination with plans now being prepared by the Bureau, and that the door should be left open for possible changes in the number and size of the proposed main-stem reservoirs and in plans for diversions into the Dakotas. If the improvements proposed by the division engineer and the Board are carried out in accordance with the views of the Bureau of Reclamation, that agency sees no reason why these improvements would not fit in a comprehensive plan for the Missouri River Basin.

7. It is evident that all the Federal agencies concerned agree that the maximum feasible multiple-purpose use of water and the broadest economic program of reservoirs for that type of use are the primary principles on which the planned development of the water resources of the Missouri River Valley should be based. It is equally evident that to accomplish this type of development, the details of planning must be worked out in a progressive manner through the correlation and coordinated efforts of all agencies, Federal, State, and local, concerned with these resources. Due allowance must be made for any changed conditions that may arise in the future. However, I do not consider it practicable to make final allocation of proportionate costs in advance of construction.

8. The appropriate distribution of proper benefits over the entire valley is a definite part of the plan proposed in the report of the division engineer and the Board, not only to those projects recommended in the report itself, but also to any others that may legally be proposed by other agencies. That report also contemplates that the uses of presently authorized and existing multiple-purpose reservoirs will be progressively broadened and reapportioned as additional water is stored by the dams proposed in the expanded plan. The adjustment of water use to meet the changing needs of the Missouri Basin as a whole can and will be made as the comprehensive development proceeds step-by-step toward ultimate accomplishment. When completed the basin plan will be operated for maximum multiple-purpose use. Thus preference can be given to the functions which contribute most significantly to the welfare and livelihood of the people of various parts of the basin, and at the same time adequate steps can be taken to meet new economic situations that may arise in the future.

9. The Corps of Engineers recognizes the broad and important interests and responsibilities of the Bureau of Reclamation in the Missouri River Basin and will continue to plan its work in that basin so as to coordinate fully the activities of both agencies. There is no question that reservoirs on the Yellowstone River and its tributaries will furnish an important contribution to water conservation in the upper portion of the Missouri Valley. The two reservoirs proposed in the report of the division engineer and of the Board, augmented by such additional projects as the Bureau may find advisable, should be planned, with modifications if necessary, to provide the maximum feasible storage for conservation purposes. Many of the reservoirs of the proposed system will produce major benefits to conservation and irrigation, notably in the upper basin. Tributary reservoirs should, when advisable from the standpoint of basin-wide development, be constructed, operated, and maintained by the agency with the dominant interest under existing law. It is essential, however, that the main-stem projects be built, operated, and maintained by the Corps

of Engineers, and that the utilization of storage reserved for flood control in all multiple-purpose reservoirs on tributaries be in accordance with regulations prescribed by the Secretary of War, in order to secure necessary unified control of the flood waters of the Missouri River itself, and to coordinate reservoir operation in this basin with that of other basins to obtain the maximum practical results for flood control on the Mississippi River. Conversely, utilization of storage reserved for irrigation in all multiple-purpose reservoirs should be in accordance with regulations prescribed by the Secretary of the Interior.

10. The amount of storage in the main-stem reservoirs and the location and size of these reservoirs is of vital importance to the ultimate development of the entire basin. I am convinced in the light of all information now available that the plan of the division engineer and the Board provides a flexible basis for securing that storage and obtaining the full multiple-purpose use of the waters of the Missouri Valley. The plan contemplates further expansion with a view to solving the flood and other problems in the upper tributary basins. Many of these solutions will doubtless be accomplished through the construction, by appropriate agencies, of additional multiple-purpose reservoirs on those tributaries and headwater streams.

11. The Department recognizes water-flow retardation, soil-erosion prevention, and production of hydroelectric power as important parts of the Missouri Basin program. The generation of power, in multiple-purpose projects now authorized for flood control and in those proposed in the expanded plan of development, is a definite part of the recommended program. Plans for the production, transmission, and sale of hydroelectric power should be worked out with the cooperation of the Federal Power Commission. Installation of power facilities so as to meet the economic needs of the Missouri Basin should be approved from time to time by the Secretary of War upon recommendations by the Federal Power Commission and the Chief of Engineers.

12. The proposed reservoirs will inundate Indian lands at several points. The estimates submitted on the over-all cost of the projects include funds to cover the cost of taking such lands and buildings, including relocation of burial grounds. It is to be understood, therefore, that approval of this plan includes authority for the Indians through their tribal councils, with the approval of the Secretary of the Interior, to convey and relinquish such property to the United States, and authority for the Secretary of War to enter into appropriate agreements with the Secretary of the Interior and the Indian tribes concerned for the payment of the fair value of the property taken, or for the contribution of a sum approximating such value toward locating or constructing or toward relocating or reconstructing buildings, works, facilities, or water projects in the vicinity of the Missouri River or its tributaries.

13. In summary, I believe that the expanded plan of development for the Missouri River Basin as recommended by the division engineer and the Board, establishes a broad framework for comprehensive basin-wide improvements that will derive the maximum benefits from the full multiple-purpose use of the water resources of that basin. That plan is flexible in that it proposes sufficient latitude to permit such modifications thereof and changes therein as may be found advisable, and it should be augmented by appropriate work of other

agencies duly constituted by law to perform such work. Thus there are no problems of water use that cannot be satisfactorily solved with the full cooperation of all water-use agencies as the over-all plan of improvement is placed under construction.

14. This comprehensive plan should be approved now and at least the first phase of development authorized to be prosecuted in the same manner as that prescribed by existing law for similar comprehensive plans for large river basins. Approval at this time will permit details to be worked out through coordination and cooperation with all other agencies concerned and will enable working plans to be prepared so that construction can be initiated expeditiously and prosecuted with efficiency and dispatch throughout the post-war period.

15. I have considered carefully the reports of the division engineer and the Board of Engineers and the statements thereon made by the three afore-mentioned Federal agencies. I concur with the Board of Engineers in approving the plans of the division engineer and I recommend modification of the general comprehensive plan for the Missouri River Basin substantially in accordance with the plans of the division engineer for flood control, irrigation, power development, navigation, and other purposes, with such modifications thereof and changes therein as the Secretary of War and Chief of Engineers may from time to time find advisable, at an estimated cost to the United States of \$481,600,000 for additional works; subject to the conditions that local interests provide without cost to the United States all land, easements, and rights-of-way necessary for construction of levee units and appurtenant works and maintain the levee units and appurtenant works after completion; maintenance includes normally such matters as cutting grass, removal of weeds, local drainage, and minor repairs. It is further recommended that in addition to previous authorizations of funds there be authorized for appropriation, funds sufficient to provide for initiation and prosecution of the expanded general comprehensive plan in logical steps.

Very truly yours,

E. REYBOLD,
Major General, Chief of Engineers.

COMMENTS OF THE BUREAU OF RECLAMATION

DEPARTMENT OF THE INTERIOR,
BUREAU OF RECLAMATION,
Washington, D. C., December 17, 1943.

Maj. Gen. E. REYBOLD,
Chief of Engineers, War Department.

DEAR GENERAL REYBOLD: I have studied carefully the report of the Board of Engineers for Rivers and Harbors, dated August 23, 1943, on the subject of the Missouri River, mouth to Sioux City, Iowa, upon which, in your letter of August 28, 1943, you requested the Bureau of Reclamation to make comments.

A PLAN FOR THE WHOLE BASIN

Primarily, the Bureau of Reclamation desires to emphasize that the plan for the Missouri Basin initially presented to the Congress should be truly comprehensive in adequately providing not only for

the control of floods and the improvement of navigation, but also for full development of irrigation, hydroelectric power production, and all other beneficial uses of water. The criterion for the design of the plan, and of its component parts, should be whether it will secure that management of the waters of the Missouri River which is most beneficial to the residents of the basin.

The report of the Board of Rivers and Harbors, in accordance with the general congressional authorization to the Corps of Engineers, is directed principally toward flood control and navigation improvement. A report on the Missouri River Basin, based on over 5 years of intensive investigations, is currently being prepared by the Bureau of Reclamation for completion this spring. That report, likewise in accordance with the general congressional authorization to the Bureau of Reclamation, is directed primarily toward the development of irrigation, hydroelectric power production, and other beneficial uses of water. I believe that you will agree that a truly comprehensive plan can be developed best through integration of these two approaches.

GOVERNING PRINCIPLES

The development of such a comprehensive plan involves adjustment of many factors of flood control, navigation, irrigation, hydroelectric power production, and numerous other functions of water conservation and management. These adjustments in a unified program can be accomplished satisfactorily only if certain principles are recognized as fundamental in the control and utilization of the waters of the Missouri River. Likewise certain principles of administration are indicated to assure effective, coordinated, and economical planning and execution of the program. I am taking this occasion to express the views of the Bureau of Reclamation on these matters, since they are the basis of my specific comments on the plan that you have presented. I also recommend that these principles be incorporated into whatever authorizing legislation may be enacted by the Congress. If these principles govern, and if the specific comments I make later in this letter are satisfied, then there remains no reason why the work proposed by the report of the Board of Rivers and Harbors, as thus modified, would not fit the comprehensive plan for the basin. There would then be no necessity for delaying the first phase of construction for further integration with later reports. Projects of the Bureau of Reclamation, as authorized by Congress, likewise would be integral with the comprehensive plan. The principles are enunciated below:

1. It is recognized that a sound program for the river subbasins of the Missouri comprehends a wide variety of functions, including but not limited to flood control, navigation, irrigation, restoration of surface and ground water levels, hydroelectric production, pollution abatement, fish and wildlife preservation and recreation. In many, if not all, portions of the entire Missouri watershed some, many, or all of these functions are closely interrelated. In practice, programs for the component subbasins will be developed in several stages each of which should include provision for suitable features necessary for the interrelated functions such as flood control, navigation, irrigation, power production, etc., that are then present.

2. In conformity with that principle, justification procedure should provide for applying the sum of all of the benefits deriving from such an integrated basin program to all of the features included in it. The final allocation of proportionate costs among the various multiple benefits that will accrue from any one feature or group of features should, therefore, be made jointly and reported to the Congress in concert by the Corps of Engineers, the Bureau of Reclamation, and the

Federal Power Commission. These allocations should be reported in advance of the start of construction of any group of related features.

3. In planning the control and utilization of the waters of the Missouri Basin, the widest range of multiple benefits should be sought in each feature or group of features. All reservoirs included in the comprehensive plan, including Fort Peck, should be operated to obtain the maximum benefits in common for flood control, navigation, irrigation, power generation, and other water-conservation activities, including, but not limited to, utilization for fish and wildlife preservation, recreation, pollution abatement, maintenance of surface and ground water levels, silt control, and domestic and industrial purposes. To the extent, however, that several functions of water control and utilization are conflicting, preference should be given to functions which contribute most significantly to the welfare and livelihood of the largest number of people. It is, for example, the view of the Bureau of Reclamation, that the waters of the Missouri River and its tributaries west of or entering above Sioux City are more useful to more people if utilized for domestic, agricultural, and industrial purposes than for navigation-improvement purposes. To the extent that these uses are competitive, domestic, agricultural, and industrial uses should have preference.

4. The Corps of Engineers should construct, operate, and maintain any feature in which flood control and navigation are dominant considerations, and the Bureau of Reclamation should construct, operate, and maintain any feature in which the functions of irrigation, restoration of surface and ground water levels, and power are dominant. To the extent that irrigation, restoration of surface and ground water levels and power are involved in the construction, operation, and maintenance of features in which flood control and navigation are dominant, the Corps of Engineers would advise and consult with the Bureau of Reclamation in the construction, operation, and maintenance of such features; and to the extent that flood control and navigation are involved in features in which irrigation, restoration of surface and ground water levels, and power are dominant, the Bureau of Reclamation would consult and advise with the Corps of Engineers in the construction, operation, and maintenance of such features.

5. The main-stem reservoirs below Fort Peck dam as described in the report of the Board of Rivers and Harbors and as finally authorized, because of their peculiarly close relationship with flood control and navigation below Sioux City, should be constructed, operated, and maintained by the Corps of Engineers. The corps should, however, consult with the Bureau of Reclamation in advance of designing or constructing the necessary dams in order that the plan, purposefully rendered flexible in the report of the Board of Rivers and Harbors, will be adjusted to the needs of irrigation and power as they are developed by the Bureau of Reclamation in North Dakota and South Dakota and, if and when appropriate, other States of the arid and semiarid zone.

RECLAMATION'S INTEREST

For the purpose of indicating the extent of the interests of the Bureau of Reclamation in the Missouri River Basin, you may find illuminating data developed by our studies. At the present time there are 4,185,000 acres of land irrigated in the entire basin, of which 555,000 are in Federal projects. The irrigation works serving this land represent investments totaling approximately \$200,000,000 of which \$61,753,000 are in Federal projects. At present there are 1,342 water-storage reservoirs in the basin, including 11 that principally serve for power generation. Exclusive of the Fort Peck reservoir, which has a capacity of 19,412,000 acre-feet, these reservoirs have a combined capacity of 8,116,000 acre-feet of water. At present there are hydroelectric plants in the basin of a total installed capacity of 461,383 kilowatts, of which about 100,000 kilowatts are in Federal power plants.

Our studies indicate that an additional 4,400,000 acres of land in the basin can be irrigated, 2,300,000 acres from the main stream and the remainder from its tributaries, through the construction of some

90 additional reservoirs and related irrigation works. These studies indicate also that an additional 952,000 kilowatts of hydroelectric power can be developed through utilizing head created at some of the new reservoirs.

In 1940, the value of all crops produced in the 7 arid and semiarid States of the basin was \$444,192,000. Our studies indicate that through full irrigation development of the basin additional crops with a value of \$100,500,000 per annum can be produced. The significance of this to the 4,699,781 people who live in the States that are arid and semiarid, at least in part, in the Missouri River Basin, is not found entirely in the fact that the annual increase would be nearly equal to one-fourth of their entire agricultural income in 1940. The increase in stability that would be provided would be the major consideration. The effects of droughts, which in the past decade caused a net loss of 302,314 in the population of the basin, would be materially ameliorated when such droughts reoccur, as they will in the future. Our estimates are that more than 350,000 persons would find stable farm homes on the newly irrigated land alone. It is obviously important, when these facts are considered, that the irrigation possibilities be realized.

Much of the water that will be used in some parts of the basin in the irrigation of lands must be lifted by pumps to the canals. The hydroelectric power that is possible of development must be closely integrated in the irrigation plan or many possibilities never can be realized. The potential power, of course, will open important commercial and industrial avenues that will lead the whole area to new developments, which, in their degree, also will contribute to new prosperity and added stability.

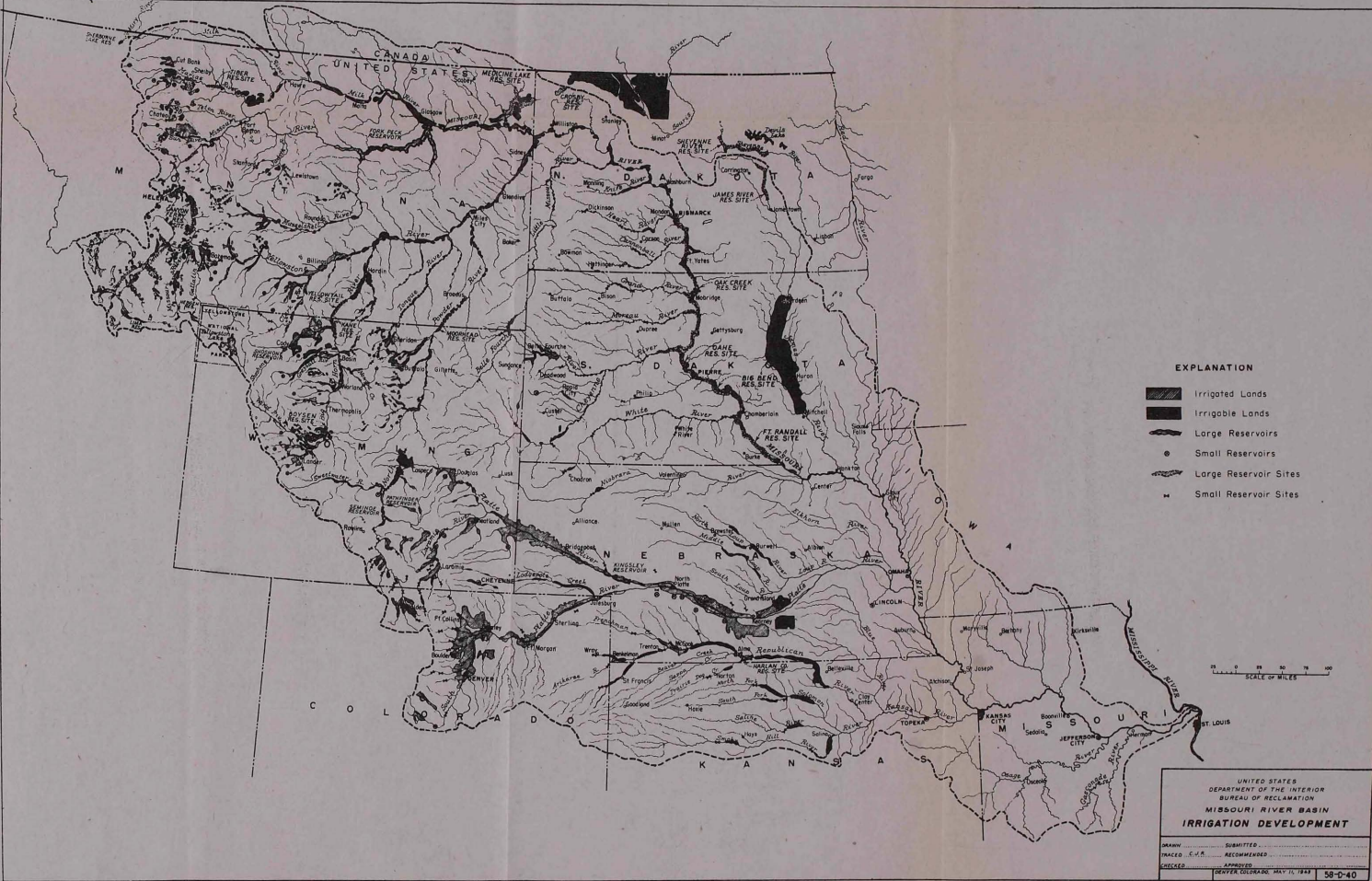
Directly associated, also, with the irrigation development will be the restoration of surface and ground-water levels through diversion of water from the main stream and spreading it through canals. The problem of restoring Devils Lake will thus be met, and ways will be opened to attack the problem of restoration of the ground water in the North Dakota sandstone strata that is the source of supply of most of the domestic wells in several States. Diverted water will assist also in ameliorating pollution problems at nearly a score of cities in North Dakota, South Dakota, and Minnesota.

The Bureau of Reclamation has developed an inventory of irrigation projects that is more nearly complete than exhibit C of your report of September 30, 1933, House Document No. 238, Seventy-third Congress, second session. For the information of the corps and those who may be interested in the plans for the Missouri Basin that we are developing, I am attaching our map of proposed Missouri River Basin developments. This map is not complete as to irrigation projects of less than 1,000 acres in area. The reservoirs shown to be under consideration by this map, in a number of instances, will be useful for the production of power in addition to irrigation, and in many instances they will have appreciable, if not major, flood-control contributions to make.

SPECIFIC COMMENTS

In the light of the discussion that has preceded, I offer the following comment on the report of the Board of Rivers and Harbors that you have submitted:

A. The authorized and proposed reservoirs would provide adequate flood control, I agree, on the Republican, Kansas, Osage, and Gasconade Rivers and on



- EXPLANATION**
-  Irrigated Lands
 -  Irri-gable Lands
 -  Large Reservoirs
 -  Small Reservoirs
 -  Large Reservoir Sites
 -  Small Reservoir Sites

0 10 20 30 40 50 60 70 80 90 100
SCALE OF MILES

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
MISSOURI RIVER BASIN
IRRIGATION DEVELOPMENT

DRAWN	SUBMITTED
MAILED	RECORDED
INDEXED	APPROVED
NEWYORK, COLORADO, MAY 11, 1943	

Cherry Creek through the city of Denver. Construction of the separate projects in these basins should be undertaken by the agency which has the dominant interest, as determined by the policy suggested in subparagraph numbered 4 of this letter.

B. The Boysen and Lower Canyon reservoirs that are proposed, on the other hand, I believe will not provide relief from the damaging ice-jam floods along the Yellowstone River. Since they control too little run-off to be very effective in reducing flood peaks below Sioux City, I question that their construction should be authorized with that purpose only in mind. They should not be authorized for construction and subsequent use for flood-control and navigation purposes below Sioux City in advance of a coordinated study and report on the Yellowstone and its tributaries in which this Bureau participates. The interests of irrigation in Wyoming and Montana are likely to be intimately affected by these two reservoirs, which should be constructed, if and when authorized, by the Bureau of Reclamation.

C. If the plan as now authorized were to be modified as proposed by the report of the Board of Rivers and Harbors and completed, there would remain throughout the upper part of the basin, at least, flood-damaged and flood-menaced areas for which no relief would have been authorized.

D. I am in hearty agreement with the proposal that modification of the plans for the reservoirs proposed in the report of the Board of Rivers and Harbors be an expressly reserved privilege. Our studies indicate that the corps may want to adjust its plans for the location and size of some of these reservoirs when the full facts are developed. The Bureau of Reclamation contemplates the recommendation of construction of a number of reservoirs upstream from the main-stem reservoirs that have been included in the report of the Board of Rivers and Harbors. Numbers of these will have flood-control functions, and they may have far-reaching effects on the storage capacity needed on the Missouri River in North Dakota and South Dakota. Full consideration of these matters may considerably alter the reservoirs as initially suggested. For example, through elimination of one of the main-stem reservoirs, if that should be found to be warranted, and the substitution of several reservoirs on tributaries to provide commensurate flood-control storage, it probably would be possible for the Bureau of Reclamation to make marked irrigation contributions that are not contemplated in the report as it was submitted for comment. Also, our studies indicate that diversions of water from the Fort Peck Reservoir and the Oahe site for use in North Dakota and South Dakota may be preferable to the proposal in the report that a diversion be made at Garrison Dam. Precisely the same ends would be served, many of them perhaps in higher degree and more profitably for everyone. I should not like to see the door closed now against consideration of any alternate means of replenishing Devils Lake, diverting water into the James and Sheyenne Rivers, and providing for irrigation east of the Missouri River.

Thank you for providing me this opportunity to review the report and to make comments upon it. I hope these views may assist in the completion of the best plan that it is possible now to devise, and in the integration of our work into a truly comprehensive plan for the Missouri River Basin as a whole.

Sincerely yours,

H. W. BASHORE, *Commissioner.*

WAR DEPARTMENT,
OFFICE OF THE CHIEF OF ENGINEERS,
Washington, August 28, 1943.

Mr. H. W. BASHORE,
Commissioner, Bureau of Reclamation,
Washington, D. C.

DEAR MR. BASHORE: In accordance with our agreement with reference to multiple-purpose projects, I am enclosing herewith a folder containing copies of the reports of the division engineer and of the Board of Engineers for Rivers and Harbors on the Department's authorized survey on Missouri River, Sioux City, Iowa, to

the mouth, with the request that you furnish me with your comment thereon as soon as practicable.

Very truly yours,

E. REYBOLD,
Major General, Chief of Engineers.

COMMENTS OF THE FEDERAL POWER COMMISSION

FEDERAL POWER COMMISSION,
Washington, December 14, 1943.

Maj. Gen. E. REYBOLD,
*Chief of Engineers, War Department,
Washington, D. C.*

DEAR GENERAL REYBOLD: Reference is made to your letter of August 28, 1943, transmitting copies of the reports of the division engineer and of the Board of Engineers for Rivers and Harbors on the War Department's authorized survey of the Missouri River, Sioux City, Iowa, to the mouth, and requesting comments of this Commission thereon.

The reports of your Department were made in response to the resolution adopted May 13, 1943, by the Committee on Flood Control, House of Representatives, requesting the Board of Engineers for Rivers and Harbors to review the report on the Missouri River contained in House Document No. 238, Seventy-third Congress, second session, and House Document No. 821, Seventy-sixth Congress, third session, with a view to determining whether any modification should be made therein at this time with respect to flood control along the main stem of the Missouri River from Sioux City, Iowa, to its mouth.

The Board of Engineers for Rivers and Harbors, after review and consideration of the report of your division engineer, recommends modification of the approved general comprehensive plan for flood control and other purposes in the Missouri River Basin. The revised plan would include 12 additional multiple-purpose reservoirs, works to divert water to the Devils Lake and James River Basin regions, and a system of levees and similar improvements along the Missouri River between Sioux City and the mouth, in general accordance with the plan of the division engineer, as shown on the map accompanying his report, with such modifications thereof and changes therein as the Secretary of War and the Chief of Engineers may find advisable. The cost to the United States of these additional works is estimated at \$481,600,000.

The Commission's staff has reviewed the reports and recommendations in the light of various studies made in connection with problems of the Missouri River Basin. While there has been no opportunity for detailed study of the projects presently suggested for inclusion in the comprehensive plan, the staff indicates that it is in general accord with the recommendations as providing a broad basis for improvement of the basin. The staff properly points out that the details must, of necessity, be worked out step by step and the authorizing legislation should, therefore, permit wide latitude in the selection and modification of projects.

The proposed comprehensive plan should go far toward resolving present conflicts of interest in the use of the water resources of the basin. These conflicts arise because of insufficiency of usable water,

under present conditions of basin development, to meet all projected water requirements. Construction of additional storage reservoirs on the main stream and tributaries will provide additional water for the various uses by retaining and conserving the flood flows which now pass down the river to the Mississippi and the Gulf.

In this connection, we note with approval the recognition in the report of the importance of cooperation with other governmental agencies and local interests in the development of the program. This basin would appear to afford a unique opportunity for such cooperative procedure including the Bureau of Reclamation, the Land Use Coordinator of the Department of Agriculture, and this Commission, all of which have statutory responsibilities in connection with the ultimate use of its resources. Such cooperation should be directed to assuring the maximum benefits possible under the multiple-use concept. Water is limited and proposed improvements must be carefully evaluated in advance in terms of land as well as water problems, to produce the greatest combined social and economic benefits to the region.

On the basis of a preliminary review of previous surveys, the Commission's staff is convinced that power development will prove an important factor in the Missouri Basin program. It appears that at least 10,000,000,000 kilowatt-hours of additional hydroelectric energy per year may eventually be developed in connection with the storage dams without sacrifice of the other benefits which the river and its tributaries should contribute to the growth and welfare of the region.

The Commission has already furnished your Department with a power-market study for the Fort Randall-Gavins Point projects. We are now working on the preparation of a power-market report for the other main stream multiple-purpose projects proposed to be authorized in the report of the division engineer and of the Board. The Commission will be pleased to have its staff continue to work with your Department in the necessary further studies required for the development of the water resources of this basin.

With a view to assuring the full use of the power possibilities, the Commission recommends that the authorization for improvements in the basin be broadened to permit the War Department to construct on a multiple-purpose basis reservoir projects previously authorized for flood control only. In other words, the War Department should have the authority, as funds become available, to modify the design of presently authorized single-purpose projects to permit their construction initially to serve power and other purposes in addition to flood control if further study should show much modification to be desirable. Specific reference is made, for example, to the projects in the Osage River Basin which may fall in this category.

The Commission appreciates the opportunity to comment on the reports of your Department on a comprehensive plan for the Missouri River Basin. We concur in the recommendation of our staff that the plan, for undertaking the development on a step-by-step basis with latitude for such modifications as to detail as changing conditions demonstrate to be desirable, be authorized. Comment with respect to particular projects and their best use must necessarily be reserved until such time as our cooperation in connection with further studies and definite project plans is called for.

Sincerely yours,

LELAND OLDS, *Chairman.*

WAR DEPARTMENT,
OFFICE OF THE CHIEF OF ENGINEERS,
Washington, August 28, 1943.

HON. LELAND OLDS,
Chairman, Federal Power Commission,
Washington, D. C.

MY DEAR MR. OLDS: In accordance with our usual practice with respect to cooperation in the investigation of multiple-purpose projects, I am transmitting herewith a folder containing copies of the reports of the division engineer and of the Board of Engineers for Rivers and Harbors on the Department's authorized survey of the Missouri River, Sioux City, Iowa, to the mouth. It will be appreciated if you will furnish me with your comments thereon at the earliest practicable date in order that the report of the Department may be completed and submitted to Congress.

Very truly yours,

E. REYBOLD,
Major General, Chief of Engineers.

COMMENTS OF THE DEPARTMENT OF AGRICULTURE

DEPARTMENT OF AGRICULTURE,
Washington, November 23, 1943.

Maj. Gen. THOMAS M. ROBINS,
Acting Chief of Engineers, War Department,
Washington, D. C.

DEAR GENERAL ROBINS: The opportunity afforded by your request of November 10 for comment on the proposed report of August 23, on the Missouri River from the mouth to Sioux City, Iowa, is much appreciated.

Although responsibilities of this Department do not embrace the construction of the types of flood control, irrigation, power, and other major engineering works discussed in the report, the program envisaged is of great concern to the interests of agriculture and rural people in this large and important agricultural area. The damage done by floods on the Missouri and its tributaries is largely agricultural in character; the benefits from power, navigation, irrigation, wildlife, recreation, and other multiple-purpose developments will accrue in no small measure to farm people and rural interests, and will have a direct bearing on the use of the rural resources of the basin. In particular, the potentialities of providing irrigation where economically feasible to farming areas of low or uncertain rainfall are large. Both the droughts of recent years and the disastrous floods of 1943 demonstrate the need for such a comprehensive plan of multiple-purpose regulation and development of the upper Missouri River.

It is our understanding that the plan proposed is not necessarily final, but a framework around which the ultimate basin-wide plan can progressively be developed, with full recognition given to the best utilization of the waters of the main stream and its tributaries in accordance with the multiple-purpose principle.

It is further understood that the extensive program contemplated would necessarily be carried out step by step, with the details formulated progressively in cooperation with other Federal agencies and local interests which take into account future trends, precipitation, and agricultural and industrial developments. It is noted also that because of the many interests involved and the uncertainty as to the manner in which this important section of the United States will develop in the future, the Board considers it impractical at this time to make a detailed monetary estimate of the benefits that will accrue; undoubtedly, therefore, as the program proceeds, opportunity will be afforded for the detailed consideration of costs and benefits of specific elements not now practicable of analysis. In conformity with the progressive, step-by-step, cooperative development of the program, the plan permits changes and modifications by the Secretary of War and the Chief of Engineers.

This approach appears a constructive one toward the solution of a difficult problem.

We wish to assure you of the cooperation of this Department in the progressive working out of this plan. The Department may be of particular assistance through its programs for water-flow retardation and soil-erosion prevention which may serve as valuable supplements, particularly since siltation is a serious problem in portions of the basin.

Sincerely,

E. H. WIECKING,
Land Use Coordinator.

WAR DEPARTMENT,
OFFICE OF THE CHIEF OF ENGINEERS,
Washington, November 10, 1943.

Mr. E. H. WIECKING,
*Land Use Coordinator, Department of Agriculture,
Washington, D. C.*

MY DEAR MR. WIECKING: Reference is made to the Department's letter of September 16, 1943, to Mr. Carleton P. Barnes, with which there were enclosed two copies of the reports of the division engineer and of the Board of Engineers for Rivers and Harbors on the Department's authorized survey of the Missouri River, Sioux City, Iowa, to the mouth. Reference is also made to subsequent telephone conversations between representatives of your office and of this office regarding that investigation. It would be greatly appreciated if, in accordance with our usual practice with respect to cooperation in investigations of multiple-purpose projects, you will furnish me with your comments thereon for use in preparation of report of the Chief of Engineers.

Very truly yours,

THOMAS M. ROBINS,
Major General, Acting Chief of Engineers.

REPORT OF THE BOARD OF ENGINEERS FOR RIVERS AND HARBORS

WAR DEPARTMENT,
THE BOARD OF ENGINEERS FOR RIVERS AND HARBORS,
Washington, August 23, 1943.

Subject: Missouri River, mouth to Sioux City, Iowa.

To: The Chief of Engineers, United States Army.

1. This report is in response to the following resolution adopted May 13, 1943:

Resolved, by the Committee on Flood Control, House of Representatives, 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 report on the Missouri River contained in House Document No. 238, Seventy-third Congress, second session, and House Document No. 821, Seventy-sixth Congress, third session, with a view to determining whether any modification should be made therein at this time with respect to flood control along the main stem of the Missouri River from Sioux City, Iowa, to its mouth.

2. The Missouri River has its source in southwestern Montana, flows generally east and south for 2,460 miles through or along seven States, and empties into the Mississippi River 17 miles above St. Louis, Mo. It drains 529,350 square miles consisting largely of plains but including also easterly slopes of the Rocky Mountains and other rugged areas. About 60 percent of the watershed is upstream from Sioux City, Iowa, 760 miles above the river mouth. The principal tributaries below Sioux City are the Platte and Kansas Rivers from the west and the Grand, Osage, and Gasconade Rivers in Missouri. The average annual precipitation ranges from 26 inches at Sioux City to 40 inches at the river mouth. The soils are very fertile and agriculture is the predominant land use. Sioux City, the Kansas City, at mile 377, and the intervening cities of Omaha, Nebr., and Council Bluffs, Iowa, on opposite sides of the Missouri River at mile 632, contain many major industries and important railroad facilities. During drought periods the regions in the vicinity of Devils Lake and James River in the Dakotas become so short of water that the entire population both human and animal is subject to great hardships. The problem of a possible diversion of water from the upper Missouri River to those areas has been under consideration for a long period.

3. Congress has authorized improvement of the Missouri River for navigation to secure a minimum low water depth of 6 feet between the mouth and Sioux City by means of bank revetment, construction of permeable dikes to contract the low water channel and stabilize the waterway, and by dredging. Although this work has not been completed, commercial use is made of the river and the construction accomplished has removed the threat of bank erosion and the occurrence of cut-offs which were formerly very destructive of bordering properties and crops. Primarily to improve the low water flows for navigation, the United States has constructed Fort Peck Reservoir, with storage capacity of 19,500,000 acre-feet, on the Missouri River in Montana. Recently a power plant with 35,000 kilowatt capacity to generate power for irrigation pumpage and other purposes has been placed in operation at Fort Peck Dam. By storing flood waters this reservoir also produces large flood-control benefits.

4. Two types of severe general floods, known as March and June floods from the months in which they usually occur, are characteristic

of the Missouri River. The March floods result from melting snow in the plains area above Sioux City and the break-up of river ice. These floods are usually accompanied by only a small amount of precipitation. June floods result from snow thaws in the headwater mountains accompanied by heavier rainfall. In addition flash floods of local origin cause heavy damages nearly every year. Severe floods between Sioux City and the mouth occurred in 1844, 1881, 1903, 1908, 1909, 1915, 1927, 1935, 1942, and 1943. Flood flows from the Missouri River contribute substantially to flood stages and damages along the Mississippi River. Between Sioux City and the mouth of the Missouri about 1,800,000 acres of land, largely cultivated and highly productive, are subject to inundation at extreme river states. Important areas in Sioux City, Omaha, Council Bluffs, and the Kansas Citys, and parts or all of over 50 smaller municipalities, are included in the flood plain. In March, May, and June of 1943 very severe floods occurred which overtopped or caused failure of nearly all the levees on the Missouri River below Sioux City. The division engineer estimates the damages of these three floods along the main stem below Sioux City at \$35,000,000. Under general provisions of the Flood Control Act of 1941 and the act for emergency flood control work approved July 12, 1943, the Department spent \$800,000 for rescue and emergency work and is now assisting local interests in restoring their levees to afford the original degree of protection which is estimated to cost \$1,800,000.

5. Improvements constructed by local interests to secure relief from floods along the Missouri River between Sioux City and the mouth consist of levees and drainage works at many localities. These improvements, which are reported to have cost \$20,000,000, generally afford only minor protection to the areas included. By the Flood Control Act approved June 22, 1936, Congress authorized the construction of levees and walls to afford protection from floods at the Kansas Citys in accordance with plans approved by the Chief of Engineers on recommendation of the Board of Engineers for Rivers and Harbors and as amended by further surveys and studies. This work has been partially completed. In a survey report of June 27, 1942, submitted to the Chief of Engineers, the division engineer recommends modification of the plan to include a cut-off near the Kansas Citys and various changes in the protective works. He estimates the total cost of the works under his modified plan at \$15,200,000. The Flood Control Act of August 18, 1941, authorized bank erosion prevention works in the vicinity of Sioux City and levees for protection between Sioux City and Kansas City and authorized \$1,000,000 for initiation of construction. These levees would afford protection from a flood similar to that of 1938. No construction has yet been undertaken. By the Flood Control Act of June 28, 1938, Congress approved a general comprehensive plan for flood control and other purposes in the Missouri River Basin and, for its initiation and partial accomplishment, authorized \$9,000,000 for reservoirs to be selected and approved by the Chief of Engineers. The Flood Control Act of August 18, 1941, authorized the appropriation of \$7,000,000 additional for prosecution of the plan, including the Harlan County Reservoir on Republican River and such other supplemental flood control works on the Republican River as the Secretary of War

and Chief of Engineers may find advisable. Construction of reservoirs under this plan has not been commenced except for Kanopolis Reservoir in the Kansas River Basin. Work on this partially completed reservoir has been deferred to conserve critical materials and labor during the war. A plan for reservoir storage of flood waters on Cherry Creek, Colo., an extreme headwater of Platte River, now estimated to cost \$11,000,000, was also approved by the Flood Control Act of 1941 and \$3,000,000 authorized for partial accomplishment. The estimated total cost of the reservoirs and the protection works for the Kansas City is \$171,000,000.

6. Local interests desire the undertaking of such works as may be found appropriate for securing relief from floods for the farm lands, cities, and smaller urban communities along the Missouri River between Sioux City and the mouth. In view of the magnitude of the problem and the number of separate interests involved, they believe that this should be accomplished as a Federal project. Had the levees authorized by the act of 1941 for the section between Sioux City and Kansas City been constructed, they would not have afforded protection during the flood period of the current year. In view thereof, local interests urge a reconsideration of flood protection measures for the entire 760 miles of river and the formulation and execution of a coordinated comprehensive plan of adequate works.

7. The division engineer finds that a proper solution of the flood problems along the main stem of the Missouri River requires the formulation of a comprehensive plan for works to supplement those heretofore approved. He presents such a plan which provides for the construction of 12 additional multiple-purpose reservoirs, 5 on the Missouri River with dams located above Sioux City between Yankton, S. Dak., and Garrison, N. Dak., 2 in the Yellowstone River Basin, and 5 on tributaries of the Republican River; such works as required to convey a feasible amount of water from the proposed Garrison Reservoir on the upper Missouri River across the Divide to the Devils Lake area and to the headwaters of James River; and levees along both banks of the Missouri River between Sioux City and the mouth to protect all areas practicable, with flood walls as necessary in congested areas including pumping plants and drainage outlets. With the reservoirs the levees are planned to afford protection against floods equal to the largest of record. The division engineer estimates the Federal cost at \$410,000,000 for reservoirs and related works and \$71,600,000 for levees and their appurtenances; and the cost to local interests at \$8,400,000 for levee rights-of-way and relocations; making a total cost of \$490,000,000. By these proposed improvements, not only would large flood damages be prevented along the Missouri River and its tributaries and the Mississippi River, but also floodwaters would be retained for their best uses for all purposes including irrigation, navigation, power, domestic and sanitary purposes, wildlife, and recreation. Considering the large benefits of tangible nature and such intangibles as the saving of human lives, the alleviation of suffering, stabilization of the economic life of the valley, and encouragement of industrial and civic developments, the division engineer concludes that the plan is thoroughly justified. He proposes it as a progressive improvement to be undertaken by steps as conditions warrant and the availability of funds permits.

8. The division engineer recommends: (a) That the general comprehensive plan for flood control and other purposes in the Missouri River Basin approved by the act of June 28, 1938, as modified by subsequent acts, be expanded to include the plans presented herein and as expanded be approved for prosecution by the War Department under the direction of the Secretary of War and supervision of the Chief of Engineers with such modifications thereof and changes therein as in the discretion of the Secretary of War and the Chief of Engineers may become advisable; (b) that all reservoirs constructed under the approved plan shall be constructed, operated, and maintained by the War Department under the direction of the Secretary of War and the supervision of the Chief of Engineers; (c) that no money appropriated for the prosecution of the works herein recommended shall be expended on the construction of any levee until States, levee districts, or local interests have furnished without cost to the United States all lands, easements, and rights-of-way for levees and have agreed that they will maintain the levees after their completion; (d) that in addition to previous authorizations for the Missouri River Basin there be authorized to be appropriated a sum adequate to provide for the initiation and prosecution of the expanded general comprehensive plan in a logical step-by-step manner.

IEWS AND RECOMMENDATIONS OF THE BOARD OF ENGINEERS FOR
RIVERS AND HARBORS

9. Flood control and the conservation of water resources are urgently needed in the Missouri River Basin. The water that now produces floods should be stored and put to beneficial use in the interest of navigation, power development, irrigation, and other useful purposes. To accomplish this, the division engineer has presented a comprehensive plan for improvement which in the opinion of the Board is sound and adequate. Such an extensive program would necessarily be carried out step by step with the details formulated progressively in cooperation with other Federal agencies and local interests so as to take into account future trends in precipitation and agricultural and industrial developments.

10. The division engineer has largely confined his discussion of benefits of the plan to the Missouri River Basin, which embraces approximately one-sixth of the total area of the United States. During the current year, floods along the main stem of the Missouri River caused an estimated damage of \$35,000,000 for the section below Sioux City alone, or an amount nearly one-half as large as the estimated cost of the proposed levees. Considerably higher stages have been experienced in the past whose recurrence under present conditions would cause damages many times greater than those caused by the 1943 flood. Recurrence of these and the occurrence of still larger floods are to be anticipated unless preventive measures are undertaken. From this the Board concludes that the flood problem is a serious one and that large expenditures to remedy it are justified. The Board concurs with the division engineer that by retention for the various uses enumerated, the surplus waters which cause these floods can be made to return very large benefits. The plan presented to serve these multiple purposes would provide the flood-plain lands included below Sioux City with complete protection from all floods of past magnitude.

11. In addition the plan would effect important reductions in flood stages along the Mississippi River below the mouth of the Missouri.

Thus, the proposed Missouri River Basin reservoirs, operated in coordination with the authorized reservoirs in the Ohio, Arkansas, and other basins would become an important and beneficial part of the flood-control system of the lower Mississippi River. Use of the stored water for multiple purposes would also improve low-water flows in the Mississippi River thereby saving considerable dredging costs for the 9-foot navigation channel. Improvement of the low water flow would assist in providing a 12-foot depth in the Mississippi River, study of which has been requested by the Committee on Rivers and Harbors of the House of Representatives.

12. Because of the many interests involved and uncertainty as to the manner in which this important section of the United States may develop in the future, the Board considers it impracticable at this time to make a detailed monetary estimate of the benefits which will accrue from the comprehensive plan. Considering the potentialities of the Missouri River Basin, the Board expects a continued expansion of its economic activities and considers the proposed plan as an advisable aid in that connection. It is certain that the benefits from the work will be very great and widespread. After thorough consideration the Board concludes that the United States will profit by undertaking the improvements as recommended by the division engineer on a step-by-step basis.

13. Accordingly, the Board recommends modification of the approved general comprehensive plan for flood control and other purposes in the Missouri River Basin to include 12 additional multiple-purpose reservoirs, works to divert water to the Devils Lake and James River Basin regions, and a system of levees and similar improvements along the Missouri River between Sioux City and the mouth, in general accordance with the plan of the division engineer as shown on the accompanying map with such modifications thereof and changes therein as the Secretary of War and Chief of Engineers may find advisable, at an estimated cost to the United States of \$481,600,000 for these additional works, the improvements to be constructed and, except for the levees and appurtenances, operated and maintained by the War Department under the direction of the Secretary of War and supervision of the Chief of Engineers; subject to the condition that no expenditures shall be made for the construction of any levee unit and appurtenant works recommended herein until local interests (a) provide without cost to the United States, all land, easements, and rights-of-way necessary for construction of said levee unit and appurtenant works; and (b) agree to hold and save the United States free from damages due to the construction of the levees and appurtenant works; and (c) agree to maintain and operate the levees and appurtenant works after completion, such maintenance to include cutting grass, removal of weeds, local drainage, and minor repairs. The Board further recommends that in addition to previous authorizations of funds there be authorized for appropriation, funds sufficient to provide for initiation and prosecution of the expanded general comprehensive plan in logical steps.

For the Board:

JOHN J. KINGMAN,
Brigadier General, United States Army,
Senior Member.

REVIEW OF REPORTS ON THE MISSOURI RIVER BASIN

SYLLABUS

Approximately 1,800,000 acres of land along the Missouri River between Sioux City and the mouth are subject to destructive floods. This area is predominately agricultural; however, portions of Sioux City, Iowa; Council Bluffs, Iowa; Omaha, Nebr.; the Kansas Citys in Kansas and Missouri, and many smaller municipalities are also subject to flooding in some degree.

Several major floods have occurred during the past 100 years. These include the floods of 1844, 1881, 1903, and three severe floods so far during 1943. The damages caused so far during 1943 are estimated to be about \$35,000,000.

Between Sioux City and the mouth, the river is being improved for navigation. Prior to the construction of river-improvement works, the river meandered from bluff to bluff, and caused serious damage to farm property by bank erosion and channel cut-offs. The river-improvement works have now stabilized the banks and provided a fixed channel in the flood plain, thus eliminating the previous hazards due to bank erosion and cut-offs. However, the flood hazard remains.

In an attempt to provide flood protection for their lands, local interests have constructed levees and drainage works throughout the reach from Sioux City to the mouth. It is estimated that the total amount expended on these works to date is in excess of \$20,000,000. However, the levees are generally inadequate to protect against any except the minor floods, and have not been constructed in accordance with any unified, correlated plan.

Local interests are anxious to secure a much greater degree of protection than they now have, but consider that the problem is of such magnitude that the burden must be assumed by the Federal Government. There is no question but that the additional flood protection is needed and justified. Although a considerable increase in the amount of protection now afforded can be provided by levees, it is impracticable to provide complete protection against all past floods by levees alone. However, complete protection against all past floods can and should be provided by a system of levees supplemented by reservoirs.

The plan proposed herein would provide for a series of levees and appurtenant works along both sides of the Missouri River from Sioux City to the mouth, supplemented by the presently authorized reservoirs in Nebraska, Kansas, and Missouri, and additional multiple-purpose reservoirs. The estimated cost of the levee project is \$80,000,000 and of the additional multiple-purpose reservoirs is \$410,000,000.

It is recommended that the general comprehensive plan for flood control and other purposes in the Missouri River Basin be expanded to include the plan as proposed in this report.

WAR DEPARTMENT,
OFFICE OF THE DIVISION ENGINEER,
MISSOURI RIVER DIVISION,
Omaha, Nebr., August 10, 1943.

Subject: Report on review of the reports on the Missouri River Basin.
To: The Chief of Engineers, United States Army, Washington, D. C.

I. INTRODUCTION AND GENERAL DESCRIPTION

1. *Authority for report.*—This report is submitted in compliance with the following resolution of the Committee on Flood Control, House of Representatives, adopted May 13, 1943.

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 the Missouri River contained in House Document No. 238, Seventy-third Congress, second session, and House Document 821, Seventy-sixth Congress, third session, with a view to determining whether any modification should be made therein at this time with respect to flood control along the main stem of the Missouri River from Sioux City, Iowa, to its mouth.

2. *Arrangement of report.*—The report contains the following parts:

MAIN BODY OF REPORT

- I. Introduction and general description.
- II. Flood characteristics.
- III. Flood problem.
- IV. Proposed flood-control plan.
- V. Economic justification and discussion.
- VI. Conclusions.
- VII. Recommendations.

APPENDIXES

- I. Maps and charts.¹
- II. Transcript of public hearings.²

3. *Scope of report.*—In the preparation of this report, the "308" report on the Missouri River, House Document 238, Seventy-third Congress, and the report on the Missouri River from Sioux City, Iowa, to Kansas City, Mo., House Document 821, Seventy-sixth Congress, were reviewed. In addition, the following were also utilized: Other reports prepared by this Department, reports of other agencies, flood-damage investigations, hydrographic surveys, studies of aerial photographs of the alluvial valley, special field investigations and compilation of known survey data and other information available in the Department.

4. Public hearings to determine the views and suggestions of local interests were held at Washington, Mo., on June 8, 1943; at Onawa, Iowa, on June 9, 1943; at Nebraska City, Nebr., on June 10, 1943. Data for this report were prepared by the Kansas City and Omaha districts and correlated by the Missouri River division.

5. *General description of the basin.*—The Missouri River is formed by the confluence of the Gallatin, Madison, and Jefferson Rivers at Three Forks, Mont., and flows generally east and south about 2,460 miles to its confluence with the Mississippi River about 17 miles above St. Louis. The drainage area of the basin is 529,350 square miles, including 9,715 square miles in the Dominion of Canada. That portion of the drainage area located within the United States includes all of the State of Nebraska and portions of the States of Montana, Wyoming, North Dakota, South Dakota, Minnesota, Colorado, Iowa, Kansas, and Missouri.

6. Most of the area within the Missouri River Basin is gently rolling or plains country. The Ozark Mountains in Missouri, the Black Hills in South Dakota, and the Rocky Mountains which form the western boundary of the basin are the principal mountainous areas in the basin. In the reaches of the Missouri River above Fort Benton, the river generally flows through narrow valleys and canyons with banks composed of rock and gravel. Between Fort Benton and Sioux City, Iowa, the Missouri River flows through a valley from 1 to 10 miles in width, with easily eroded banks and an unstable channel.

7. *General description of basin below Sioux City.*—The drainage area of the Missouri River above Sioux City is 314,617 square miles, and below Sioux City it is 214,733 square miles. Between Sioux City, Iowa, and the mouth, the principal tributaries are the Platte and Kansas Rivers, whose principal drainage areas are, respectively, in Nebraska and Kansas, and the Grand, Osage, and Gasconade Rivers, whose principal drainage areas are in Missouri.

¹ Only pl. 16 is printed.

² Not printed.

8. Below Sioux City the bluffs along the valley are steeply rolling to nearly vertical and rise from 150 to 300 feet above the valley floor. The valley width varies from $1\frac{1}{2}$ to 17 miles. The average width of the valley is about 5 miles. The valley-floor elevations vary from approximately 420 feet mean sea level at the mouth to approximately 1,100 feet mean sea level at Sioux City.

9. The average rainfall for the area between Sioux City, Iowa, and the mouth varies from about 26 inches at Sioux City to about 40 inches near the mouth. The regimen of the Missouri River is characterized by wide variations between maximum and minimum discharges. In the reach of the river between Sioux City, Iowa, and the mouth, records of river stages are available since 1872. However, except for the period 1879 to 1891, discharge measurements have been obtained at stations along this reach of the river only since about 1928.

10. The area along the Missouri River between Sioux City, Iowa, and the mouth is predominately agricultural. Dairying and truck gardening are carried on extensively near the large municipalities. In the larger municipalities there is considerable industrial development. The area has well-developed railroad and highway facilities. There is an existing 6-foot navigation project from Sioux City, Iowa, to the mouth. Commercial navigation has been carried on below Kansas City, Mo., for many years and to Omaha, Nebr., for several years prior to the war. Several commercial towboats formerly operating on the Missouri River have recently been withdrawn for use on the Mississippi and other inland waterways to assist in relieving the critical transportation problems in the East. However, when towing equipment is available water-borne transportation will be available to the entire area under investigation.

11. *Pertinent existing and authorized Federal projects.*—The existing navigation project between Sioux City, Iowa, and the mouth resulted from authorization contained in acts of Congress dated July 25, 1912; August 8, 1917; March 3, 1925; and January 21, 1927. The existing project provides for securing a navigable channel with a minimum low-water depth of 6 feet, by means of bank revetment, permeable dikes to contract and stabilize the waterway, removal of snags, and occasional dredging. The project is about 97 percent complete between Kansas City, Mo., and the mouth, and about 90 percent complete between Sioux City, Iowa, and Kansas City, Mo. Further new construction has been deferred in order to conserve critical materials and manpower for the war effort. The navigation works, although not completed, have already stabilized the banks of the river, eliminated the constant shifting of the channel, and greatly reduced bank erosion.

12. The Fort Peck Dam in Montana was authorized by the River and Harbor Act of August 30, 1935. The Fort Peck Dam, with a gross reservoir capacity of about 19,500,000 acre-feet, was constructed primarily for assuring adequate navigation depths downstream. The dam was essentially completed in 1939. The reservoir is operated to store excess water during the high-water season for later release to augment the flow during low-water periods. A hydroelectric power plant at the Fort Peck Dam was authorized by the act of Congress of May 18, 1938. On June 30, 1943, one 35,000 kilowatt unit was placed in operation. Operation of the project not only provides water for navigation and the generation of power for irrigation and

other purposes, but produces large flood-control benefits by storing excess flows during high-water periods.

13. Under the Flood Control Act of June 28, 1938, the general comprehensive plan for flood control and other purposes in the Missouri River Basin as set forth in Flood Control Committee Document No. 1, Seventy-fifth Congress, first session, was approved, and \$9,000,000 authorized for reservoirs for the initiation and partial accomplishment of the plan. Construction work has been started on one reservoir project only, the Kanopolis Dam on the Smoky Hill River in central Kansas, at an estimated total cost of \$9,000,000. Completion of the construction work on this dam has been deferred in order to conserve critical materials and manpower.

14. Under the Flood Control Act of August 18, 1941, there was authorized to be appropriated in addition to previous authorizations, \$7,000,000 for the prosecution of the comprehensive plan approved in the act of June 28, 1938, including the Harlan County Reservoir on the Republican River in Nebraska and such other supplemental work on the Republican River as the Secretary of War and the Chief of Engineers may find advisable. The plan presented in this report provides for necessary and desirable dams on tributaries of the Republican River as well as the Harlan County Dam on the main stem of that river as authorized in the Flood Control Act of 1941.

15. A system of levees along the Missouri River between Sioux City, Iowa, and Kansas City, Mo., and a bank-erosion project just above Sioux City were authorized by the Flood Control Act of 1941, substantially in accordance with the plans presented in House Document 821, Seventy-sixth Congress, third session. The plan included in House Document 821 would provide protection against discharges similar to those which occurred during the 1938 flood.

16. A project for protection of the Kansas Citys of Kansas and Missouri was authorized for construction in the Flood Control Act of 1936, "in accordance with plans approved by the Chief of Engineers on recommendation of the Board of Engineers for Rivers and Harbors and as amended by further surveys and studies now in progress * * *." Construction of some of the units of this project was started but has since been deferred in order to conserve critical materials and manpower for the war effort. Further studies have been made and a survey report dated June 27, 1942, has been submitted to the Chief of Engineers. The report of June 27, 1942, proposes modification of the plan used as a basis for the authorization in the Flood Control Act of 1936 to include a cut-off at Liberty Bend, near the Kansas Citys, and various changes in alignment and height of the protective works. The plans presented in the report of June 27, 1942, were discussed at the hearings of the Flood Control Committee in June 1943.

II. FLOOD CHARACTERISTICS

17. *General.*—The Missouri River between Sioux City, Iowa, and the mouth is subject to two general periods of high water each year. The first is often referred to as the March rise. It is caused by the rapid melting of snow in the Plains areas in Montana, Wyoming, and the Dakotas and the break-up and melting of the ice in the main stem and its tributaries. This melting of snow and ice occurs in a

relatively short period of time and turns into flowing water the moisture that has been held back throughout the winter months in the form of snow and ice. This high-water period is usually accompanied by a relatively small amount of precipitation. It is characterized by relatively sharp peaks, although the volume of water during this high-water period is considerable. Due to the fact that this rise is ordinarily accompanied by very little precipitation, the crest flattens as it continues downstream, and floods from this rise are usually most severe in the upper part of the river. An example of a March rise flood is the one that occurred during the spring of 1943. This rise produced stages higher than any since the 1881 flood from Pierre, S. Dak., to Rulo, Nebr.

18. The second general period of high water is often referred to as the June rise. This high-water period occurs subsequent to the March rise and is produced by the combined run-off from two sources: (1) the melting of snow from the mountains in the headwaters regions, which persists for a comparatively long period of time (2 or 3 months), and (2) run-off from rainfall occurring in the basin. Floods from this rise are ordinarily most severe in the lower part of the basin where the rainfall is normally the greatest. The run-off from excessive snow melt from the headwaters regions, combined with run-off from heavy rainfall in the basin, produces floods of major proportions. Examples of this type of flood are those which occurred in 1844 and 1903.

19. The Missouri River Valley is also subject to flash floods which occur at various times during the year. Many of these flash floods reach major proportions for considerable distances along the river and usually occur as a result of heavy run-off from local tributaries or from local ice jams. Practically every year there is some flooding along the Missouri River from Sioux City to the mouth as a result of flash floods.

III. FLOOD PROBLEM

20. *Agricultural areas subject to floods.*—Between Sioux City, Iowa, and the mouth there are about 1,800,000 acres of land subject to flooding at extreme stages. Most of this area is under cultivation at the present time and includes some of the most fertile and productive land in the world. The principal crops grown are corn, wheat, barley, rye, oats, alfalfa, and garden produce. Although the land is highly productive, floods on the Missouri River have always constituted a serious hazard to farming. Previous to the construction of river improvement works, the land was not only subject to floods but to damage by bank erosion and cut-offs. The threat from bank erosion and cut-offs has now been removed by the river stabilization works, but the flood hazard still remains.

21. *Municipal areas subject to floods.*—The principal cities subject to flooding are the Kansas Citys in Kansas and Missouri; Council Bluffs, Iowa; Omaha, Nebr.; and Sioux City, Iowa.

(a) The Kansas Citys, with a total population of over a half million people, include in the bottom lands subject to floods the stock-yards which are the second largest in the world, many manufacturing and industrial establishments, important rail lines and highways, two airports, and the entire municipality of North Kansas City, Mo.

(b) At Council Bluffs, Iowa, a city of more than 40,000 population, over half the city would be inundated in a major flood, including important railroads, manufacturing and industrial establishments.

(c) At Omaha, Nebr., a city of over 200,000 population, the municipal airport is located within the flood plain, also important manufacturing and industrial plants, and the entire village of Carter Lake, Iowa, which includes about 1,250 families.

(d) At Sioux City, Iowa, a city of over 80,000 population, a portion of the business district is subject to flooding, and also a large part of the stockyards, railroad facilities, and some manufacturing and industrial establishments.

In addition to these cities, there are over 50 smaller municipalities which are wholly or partially vulnerable to floods along the main stem of the Missouri River.

22. *Floods.*—In the upper part of the river the highest flood of record was caused by the March rise of 1881. Practically the entire area from bluff to bluff was inundated from Sioux City, Iowa, to St. Joseph, Mo., and the river was above flood stage all the way to the mouth. In addition to the damage caused by the water itself, there was a great deal of damage done by the cutting and crushing action of huge cakes of ice as they were swept downstream. When reservoirs are constructed upstream from Sioux City, this type of damage will be largely eliminated. The flood of 1881 caused millions of dollars of damage.

23. In the lower part of the river the highest flood of record was caused by the June rise of 1844. This flood also produced stages in the upper part of the river approaching those of the 1881 flood. Reliable records of the damage caused by this flood are not available. The next highest flood of record in the lower part of the river was caused by the June rise of 1903. This flood paralyzed commerce, industry, and communications for weeks and caused millions of dollars of damage at the Kansas City alone. It flooded the entire bottoms area on which is now located hundreds of industrial and manufacturing plants and the airports. The total direct damage during this flood between Sioux City and the mouth was over \$10,000,000.

24. In addition to the floods of 1844, 1881, and 1903, there have been many other severe floods between Sioux City and the mouth, such as those which occurred during 1908, 1909, 1915, 1927, 1935, 1942, and 1943. In fact, there is flooding of some consequence practically every year on the Missouri River between Sioux City and the mouth.

25. Individual farmers, groups of farmers, levee districts, and drainage districts have constructed levees at many locations between Sioux City and the mouth in an attempt to safeguard their lands and property. Accurate figures are not available as to the total amount expended by local interests on levees and drainage works in their efforts to provide flood protection, but it is estimated that these expenditures have exceeded \$20,000,000. The levees have been successful in protecting against some of the minor floods, but have not been adequate to withstand the more severe floods.

26. The March rise of 1943 produced a major flood in the upper part of the river under investigation. The resulting stages were higher than any experienced since 1881. Levees were breached all the way from Sioux City to Kansas City. Then in May, as a result of heavy rainfall, a major flood occurred in the lower part of the river.

Stages below the mouth of the Osage River were, in general, higher than those of the 1903 flood. This flood breached or overtopped most of the levees between Jefferson City, Mo., and the mouth. Following this flood and as a result of additional heavy rainfall, another severe flood occurred in June which extended all the way from Nebraska City to the mouth, with stages from Waverly, Mo., to Glasgow, Mo., approximating those of the 1903 flood. This flood caused the breaching or overtopping of practically all of the levees between Kansas City and Jefferson City which had not previously failed.

27. The floods of 1943 have caused damages so far of about \$35,000,000 along the main stem of the Missouri River between Sioux City and the mouth. About 1,000,000 acres of land have been inundated, of which about 200,000 acres were flooded for the second time. On about 600,000 acres the flooding prevented the production of the normal crop, and on about 300,000 acres it may require from 1 to 3 years before the land can be placed into full normal crop production. Highways and railroads in the river valley suffered heavily. Practically every agricultural levee between Sioux City and the mouth was either overtopped, breached, or otherwise seriously damaged. Many of these levees had been previously damaged by the high water of 1942, and repaired either by the local interests or by the Federal Government under the provisions of section 5 of the 1941 Flood Control Act. The amount expended under provisions of section 5 of the 1941 Flood Control Act amounted to approximately \$300,000. All this effort and expense was nullified by the 1943 floods. In addition, the Engineer Department expended over \$800,000 for rescue and emergency work during the 1943 floods.

28. Under the provisions of section 5 of the 1941 Flood Control Act and Public Law 138, Seventy-eighth Congress, approved July 12, 1943, the Department is now assisting local interests in the restoration of their damaged levees. The estimated cost of restoring the levees damaged during the 1943 floods to their original degree of protection is approximately \$1,800,000.

29. *Desires of local interests.*—For years the desire for adequate flood protection has been voiced by local interests in their contacts with the Engineer Department. In 1939, following an organized effort on the part of local interests between Sioux City and Kansas City, an investigation was authorized by resolution of the Committee on Commerce, United States Senate, to determine whether any modification should be made in the report on the Missouri River contained in House Document 238, Seventy-third Congress, second session, with respect to flood control along the main stem of the Missouri River from Sioux City, Iowa, to Kansas City, Mo. As a result of this investigation, Congress authorized a system of levees between Sioux City and Kansas City which would provide protection against a flood similar to that of 1938. However, no money was ever appropriated to construct works authorized under this authorization.

30. Discouraged by the apparent futility of restoring and repairing existing private levees, only to have them breached or overtopped time and again, and realizing that the 1943 floods would have breached or overtopped the levees authorized in the 1941 act had they been constructed, local interests have asked for a restudy of the problem. This resulted in the congressional resolution authorizing the present report.

31. Local interests are definitely of the opinion that more adequate protection than is provided by existing works is necessary. They also are convinced this must be accomplished through some unified and well-coordinated plan, and that the problem is of such magnitude that the burden must be assumed by the Federal Government. This general attitude is reflected in the discussions in the public hearings held in connection with this report (see appendix II),² by numerous resolutions adopted by local organizations and by the many recent contracts with local interests in connection with repair of levees under provisions of section 5 of the 1941 Flood Control Act.

IV. PROPOSED FLOOD CONTROL PLAN

32. The plan of flood control proposed herein consists of a series of levees and appurtenant works along both sides of the river from Sioux City, Iowa, to the mouth of the Missouri River, supplemented by the presently authorized reservoirs in Nebraska, Kansas, and Missouri, and additional multiple-purpose reservoirs, including reservoirs above Sioux City. This plan would provide flood protection for agricultural lands along both sides of the river and protection for the cities of Sioux City, Iowa; Council Bluffs, Iowa; Omaha, Nebr.; and the Kansas Citys, Kans. and Mo. A plan for the protection of the Kansas Citys is described in a survey report prepared by the district engineer, Kansas City, dated June 27, 1942, and no change in that plan is proposed herein. The general alignment of the proposed levees is shown on sheets 1 to 9 and the proposed profile of the design flood is shown on sheets 10 to 15, appendix I.¹

33. In determining the degree of protection which should be provided by the levees, the following factors were considered:

(a) The effect on future flood discharges of the operation of the system of authorized reservoirs in the lower part of the basin.

(b) The effect on future flood discharges of the operation of multiple-purpose reservoirs upstream from Sioux City.

(c) The height to which it is practicable to construct earth levees along the Missouri River without danger of destruction by foundation failure or by development of sand boils.

(d) The amount of set-back of the levees which would be required to provide adequate floodway capacity.

34. Flood discharges are usually greatest in the lower part of the river, which area normally receives the greatest amount of rainfall. Also the valley in the lower end is considerably narrower than in the upper part. Consequently, the relative degree of protection which can be economically provided by levees alone is considerably less in the lower part of the river than in the upper river. This emphasizes the need for completion of the reservoirs now authorized for the lower part of the river.

35. Complete protection against all floods of record by levees alone is impracticable. However, the levees proposed herein, supplemented by the presently authorized reservoirs in the lower part of the basin and the additional multiple-purpose reservoirs would provide protection between Sioux City, Iowa, and the mouth against all past floods of record.

¹ Only pl. 16 is printed.

² Not printed.

36. The proposed levees for protecting agricultural areas would be of earth fill, with a 10-foot crown width, and side slopes of 1 on 3 on the river side and 1 on 5 on the land side, with a 2-foot freeboard above the design flood after settlement. Drainage structures would be placed through the levees as required to drain interior run-off. Where required, by foundation conditions or other special reasons, rolled fill levees would be constructed. Proposed floodway widths between levees would vary from a minimum of 3,000 feet from Sioux City, Iowa, to Kansas City, Mo., and 5,000 feet from Kansas City, Mo., to the mouth.

37. At places where there is a concentration of population and property values, such as at Sioux City, Iowa; Omaha, Nebr.; Council Bluffs, Iowa; and Gasconade Boatyard in Missouri, the levees would be rolled fill with 10-foot crown width and side slopes of 1 on 3 on the river side and 1 on 4 on the land side, with a 3-foot freeboard above the design flood. Where space is not available for levees, concrete flood walls would be constructed. Drainage structures would be provided through the levees and where necessary pumping plants would be provided to care for drainage during flood periods. Floodway widths at municipal and special areas would be determined by economic considerations.

38. The plan for control of bank erosion above Sioux City, Iowa, presented in House Document 821, Seventy-sixth Congress, third session, was reconsidered; however, no change in that previously recommended is considered necessary at this time. The plan for the protection of the Kansas Citys as contained in the report referred to in paragraph 32 was also reviewed and no change in the plans proposed therein is considered necessary.

39. *Levee costs.*—The estimated cost of the levees and appurtenant works as proposed herein is as follows:³

Portion of project	Federal		Non-Federal	Total, first cost
	Construction	Bridge raising	Rights-of-way and relocations	
Agricultural.....	\$65,000,000	\$750,000	\$8,250,000	\$74,000,000
Municipal.....	5,400,000	450,000	150,000	6,000,000
Total.....	70,400,000	1,200,000	8,400,000	80,000,000
		71,600,000		

40. The design flood profile and location of the proposed levees as submitted with this report are sufficiently accurate for the purpose of estimating costs; however, before construction is initiated, final design flood profiles and the exact locations of the levees should be correlated with the latest data available on the comprehensive plan of development.

41. Although protection against all past floods of record cannot be accomplished by levees alone, complete protection can and should be provided by completing the reservoirs authorized in the lower part of the basin and by constructing additional reservoirs including reservoirs above Sioux City. In order to provide for the maximum utilization of the waters of the basin, the reservoirs proposed above Sioux City

³ Exclusive of the costs for protection at the Kansas Citys, which costs are shown in table 2, par. 48.

should be multiple-purpose projects. Studies of multiple-purpose projects above Sioux City show that the following should be included as a part of the comprehensive plan of development for the Missouri River Basin:

Project	Location	Approximate gross storage capacity	Approximate total construction cost
		<i>Acre-feet</i>	
Garrison ¹	Near Garrison, N. Dak.....	17,000,000	\$130,000,000
Oak Creek.....	Near Mobridge, S. Dak.....	6,000,000	60,000,000
Oahe.....	Near Pierre, S. Dak.....	6,000,000	50,000,000
Fort Randall.....	Near Wheeler, S. Dak.....	6,000,000	75,000,000
Gavins Point.....	Near Yankton, S. Dak.....	200,000	15,000,000
Lower Canyon.....	Near Livingston, Mont.....	2,250,000	35,000,000
Boysen.....	Near Thermopolis, Wyo.....	3,500,000	20,000,000
Total.....	40,950,000	385,000,000

¹ Includes diversion into the Dakotas.

42. In connection with the proposed Garrison Reservoir, a practical solution to a situation which has long existed in the States of North and South Dakota and which periodically causes much trouble is possible. During excessively dry years the regions in the vicinity of Devils Lake and the James River Basin become so short of water that animals are subjected to great suffering and the people to severe hardship. Droughts almost, if not entirely, destroy animal and plant life in these areas. The best over-all use of the multiple-purpose reservoirs would permit a feasible diversion of water from the Missouri River into the Dakotas for domestic use and other purposes. First there must be conserved and stored in the Missouri Basin enough water to provide this diversion. The plan proposed herein provides for such storage in the reservoirs listed in the preceding paragraph. By the time that water is available, there should also be completed pumping facilities and conduits needed to provide the Devils Lake and James River regions at least as much water as they now have during seasons of normal rainfall. Later this flow of water can be increased to provide much additional irrigation. The plan herein contemplates that there shall be started improvements to provide a diversion of water from the Missouri River into the Dakotas and that this diversion should be progressively increased and improved as time and conditions warrant such improvements. The location of the facilities for the first phase of this improvement is indicated on the map accompanying this report.

V. ECONOMIC JUSTIFICATION AND DISCUSSION

43. The damage caused by the 1943 floods alone on the Missouri River between Sioux City and the mouth is estimated to be about \$35,000,000, or almost one-half of the cost of the proposed levee project.

44. The total value of the area subject to floods along the Missouri River between Sioux City and the mouth, including all fixed and movable property, has been estimated to be about \$1,000,000,000.

45. The comprehensive plan proposed herein would provide not only complete protection for this area against all past floods on the Missouri River, but would effect important reductions in flood stages on the lower Mississippi River. In addition to providing flood-control

benefits on the Missouri and Mississippi Rivers, the comprehensive plan would also provide for the most efficient utilization of the waters of the Missouri River Basin for all purposes, including irrigation, navigation, power, domestic and sanitary purposes, wildlife, and recreation.

46. Furthermore, the plan would provide many intangible benefits including:

(1) The saving of lives.

(2) The alleviation of human suffering.

(3) A general stabilization of the economic life of the valley and of interstate commerce.

(4) The encouragement of industrial and civic developments.

47. The plan is unquestionably justified.

48. Although the construction of the comprehensive plan is justified and should be ultimately accomplished in its entirety, it is recognized that it would not be feasible to initiate the construction of all of the units at one time. Instead, the development should proceed in an orderly, step-by-step manner as circumstances and availability of funds permit. Units selected for the first phase of development should be those which would provide the greatest benefits from progressive step-by-step construction. This general scheme of progressive development has been successfully carried out on the Nile River and other rivers. On the Nile the Aswan Dam was originally a relatively low structure but has since been raised three times as the needs of the region warranted. Similarly, on the Mississippi River the plan for flood control has been modified several times to provide for an increased degree of flood protection. Table 1 shows projects to be authorized and included in the comprehensive plan. Table 2 shows projects already authorized.

TABLE 1.—*Projects to be authorized*

Project	Total cost	First phase	Second phase	Third phase	Fourth phase
Missouri River levees: ¹					
Sioux City, Iowa, to Platte River	\$14,500,000	}	}	}	}
Platte River to Rulo, Nebr.	8,000,000				
Rulo, Nebr., to Kansas City, Mo.	15,000,000				
Kansas City, Mo., to Jefferson City, Mo.	22,500,000				
Jefferson City, Mo., to mouth	14,000,000				
Sioux City, Iowa	600,000				
Omaha, Nebr.	3,800,000				
Council Bluffs, Iowa	1,600,000				
Garrison Reservoir	130,000,000				
Oak Creek Reservoir	60,000,000				
Oahe Reservoir	50,000,000				
Fort Randall Reservoir	75,000,000				
Gavins Point Reservoir	15,000,000				
Medicine Creek Reservoir	2,400,000				
Hale Reservoir	7,200,000				
Red Willow Reservoir	2,100,000				
Enders Reservoir	6,700,000				
Beecher Island Reservoir	6,600,000				
Boysen Reservoir	20,000,000				
Lower Canyon Reservoir	35,000,000				
Total	490,000,000				

¹ Costs shown for projects between Sioux City and Kansas City are the total estimated costs of constructing these units in accordance with the expanded plan as recommended in this report and thus supersede the estimated costs of the project from Sioux City, Iowa, to Kansas City, Mo., as authorized in the 1941 Flood Control Act at a Federal cost of \$5,050,000. However, the estimates for the expanded projects do not include the costs of the erosion project above Sioux City authorized in the 1941 Flood Control Act at an estimated cost of \$875,000.

* TABLE 2.—*Projects now authorized*¹

Project	Total cost	First phase	Second phase	Third phase	Fourth phase
Kanopolis Reservoir.....	² \$9,000,000	}	\$42,700,000	\$41,500,000	\$30,800,000
Harlan County Reservoir.....	³ 20,000,000				
Osceola Reservoir.....	28,500,000				
Tuttle Creek Reservoir.....	28,000,000				
Chillicothe Reservoir.....	28,500,000				
Arlington Reservoir.....	7,300,000				
South Grand Reservoir.....	10,400,000				
Pomme de Terre Reservoir.....	6,200,000				
Richland Reservoir.....	6,900,000				
Cherry Creek Reservoir.....	⁴ 8,200,000				
The Kansas Citys, Mo. and Kans.....	⁵ 18,000,000				
Total.....	171,000,000				

¹ \$29,000,000 have been authorized to date to be appropriated for prosecution of projects listed in table 2.

² Partially constructed. Funds needed to complete estimated to be \$3,000,000.

³ Current estimate (including storage for irrigation), \$31,000,000.

⁴ Current estimate for Cherry Creek project, \$11,000,000.

⁵ Partially constructed. Federal cost to June 1, 1942, \$2,543,527. Estimated additional costs to complete (from Survey report dated June 27, 1942) are: Federal cost, \$13,000,000; non-Federal, \$2,200,000; total, \$15,200,000.

NOTE.—For location of projects, see map accompanying this report.

49. In connection with the development of the multiple-purpose projects, those shown for the Missouri River will provide for the maximum practicable storage of water of the main stem. The water to be impounded in these, as well as the other multiple-purpose structures shown in tables 1 and 2, will be utilized to produce the maximum practicable development of irrigation, navigation, power, and other multiple purposes. However, sufficient storage will be provided in each reservoir to provide for the needs of local flood protection downstream from the reservoir as well as for the needs of the general comprehensive plan for flood control for the Missouri River Basin. To provide for the maximum utilization of the waters stored in multiple-purpose reservoirs, a plan would be worked out for each structure in collaboration with the various water-use agencies involved. The amount of water to be made available to the Bureau of Reclamation for irrigation would be arrived at after close collaboration with that agency. The development of power potentialities would be determined in cooperation with the Federal Power Commission. Water use for other purposes would be arrived at in a similar manner.

VI. CONCLUSIONS

50. It is concluded that the existing approved plan of improvement for the Missouri Basin should be expanded substantially as indicated herein to include in addition to the plan authorized under existing law, the following:

(a) A series of levees and appurtenant works along both sides of the Missouri River from the vicinity of Sioux City, Iowa, to the vicinity of the mouth of the Missouri River.

(b) The following multiple-purpose reservoirs: Five on the main stem of the Missouri River, five on the tributaries of the upper Republican River, one on the Big Horn River, and one on the Yellowstone River.

(c) A diversion from the vicinity of Garrison Dam into the Dakotas extending to the Devils Lake and the James River Basin regions together with the pumping stations, conduits, and other facilities necessary to supply water during drought seasons for the Devils Lake and James River regions.

VII. RECOMMENDATIONS

51. It is recommended:

(a) That the general comprehensive plan for flood control and other purposes in the Missouri River Basin approved by the act of June 28, 1938, as modified by subsequent acts, be expanded to include the plans presented herein and as expanded be approved for prosecution by the War Department under the direction of the Secretary of War and supervision of the Chief of Engineers with such modifications thereof and changes therein as in the discretion of the Secretary of War and the Chief of Engineers may become advisable.

(b) That all reservoirs constructed under the approved plan shall be constructed, operated, and maintained by the War Department under the direction of the Secretary of War and the supervision of the Chief of Engineers.

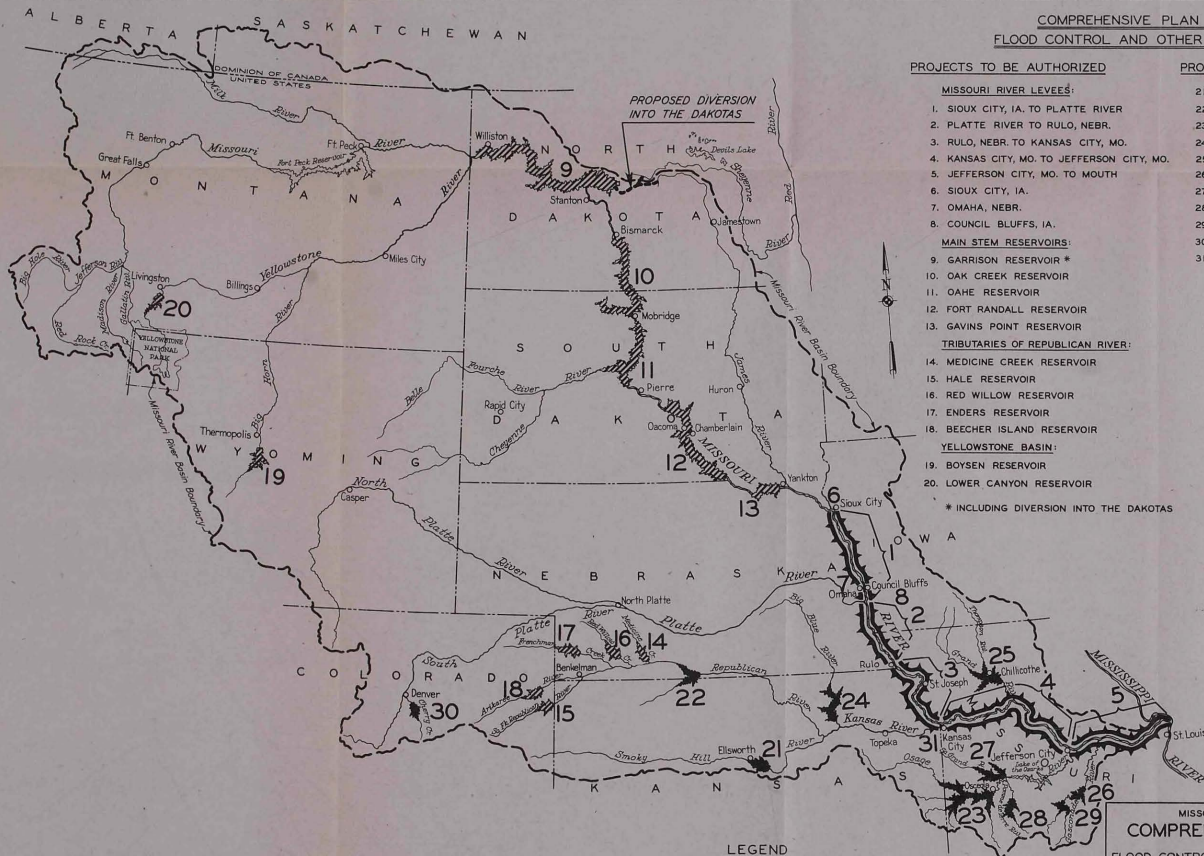
(c) That no money appropriated for the prosecution of the works herein recommended shall be expended on the construction of any levee until States, levee districts, or local interests have furnished without cost to the United States all lands, easements, and rights-of-way for levees and have agreed that they will maintain the levees after their completion; maintenance includes normally such matters as cutting grass, removal of weeds, local drainage, and minor repairs.

(d) That in addition to previous authorizations for the Missouri River Basin there be authorized to be appropriated a sum adequate to provide for the initiation and prosecution of the expanded general comprehensive plan in a logical step-by-step manner.

LEWIS A. PICK,
Colonel, Corps of Engineers, Division Engineer.



COMPREHENSIVE PLAN FOR
FLOOD CONTROL AND OTHER PURPOSES



PROJECTS TO BE AUTHORIZED

MISSOURI RIVER LEVEES:

1. SIOUX CITY, IA, TO PLATTE RIVER
2. PLATTE RIVER TO RULO, NEBR.
3. RULO, NEBR. TO KANSAS CITY, MO.
4. KANSAS CITY, MO. TO JEFFERSON CITY, MO.
5. JEFFERSON CITY, MO. TO MOUTH
6. SIOUX CITY, IA.
7. OMAHA, NEBR.
8. COUNCIL BLUFFS, IA.

MAIN STEM RESERVOIRS:

9. GARRISON RESERVOIR *
10. OAK CREEK RESERVOIR
11. OAH RESERVOIR
12. FORT RANDALL RESERVOIR
13. GAVINS POINT RESERVOIR

TRIBUTARIES OF REPUBLICAN RIVER:

14. MEDICINE CREEK RESERVOIR
15. HALE RESERVOIR
16. RED WILLOW RESERVOIR
17. ENDERS RESERVOIR
18. BEECHER ISLAND RESERVOIR

YELLOWSTONE BASIN:

19. BOYSEN RESERVOIR
20. LOWER CANYON RESERVOIR

* INCLUDING DIVERSION INTO THE DAKOTAS

PROJECTS NOW AUTHORIZED

21. KANOPOLIS RESERVOIR
22. HARLAN COUNTY RESERVOIR
23. OSCEOLA RESERVOIR
24. TUTTLE CREEK RESERVOIR
25. CHILLICOTHE RESERVOIR
26. ARLINGTON RESERVOIR
27. SOUTH GRAND RESERVOIR
28. POMME DE TERRE RESERVOIR
29. RICHLAND RESERVOIR
30. CHERRY CREEK RESERVOIR
31. THE KANSAS CITIES, MO. AND KANS. FLOOD CONTROL

LEGEND

- AUTHORIZED RESERVOIRS
- RESERVOIRS TO BE AUTHORIZED
- LEVEES TO BE AUTHORIZED

MISSOURI RIVER BASIN
COMPREHENSIVE PLAN
FOR
FLOOD CONTROL AND OTHER PURPOSES

In 1 Sheet Scale: see graphic

U.S. ENGINEER OFFICE OMAHA, NEBR.
MISSOURI RIVER DIVISION AUGUST 1943
Approved by *[Signature]*
Checked by *[Signature]*
Drawn by *[Signature]* Title No. 1
W.D.B. W.D.B. C.A.C. dated August 10, 1943 MS 43-2