

# The Colorado River

"A Natural Menace Becomes a National Resource"

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*Interim Report of the Secretary of  
the Interior*

JULY 1947

DEPARTMENT OF THE INTERIOR

*J. A. Krug, Secretary*

BUREAU OF RECLAMATION

*Michael W. Straus, Commissioner*

# The Colorado River

A NATURAL MENACE BECOMES A NATIONAL RESOURCE

*Interim Report on the Status of the Investigations  
Authorized To Be Made by the Boulder Canyon  
Project Act and the Boulder Canyon Project  
Adjustment Act*

UNITED STATES DEPARTMENT OF THE INTERIOR

J. A. Krug, Secretary

BUREAU OF RECLAMATION

Michael W. Straus, Commissioner

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[In the following text, only those page numbers that are set in *Italics* refer to this House Document; those that are set in *Roman* refer to the Departmental Report, which is entitled THE COLORADO RIVER.]

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# Letters of Transmittal

THE SECRETARY OF THE INTERIOR

WASHINGTON, D. C.

JULY 24, 1947.

HON. JOSEPH W. MARTIN, JR.,  
*Speaker of the House of Representatives.*

MY DEAR MR. SPEAKER: There is enclosed herewith a copy of my interim report dated July 19, 1947, on the status of our investigations of potential water resource developments in the Colorado River Basin in Arizona, California, Colorado, Nevada, New Mexico, Utah, and Wyoming. The report is based on a departmental report dated June 7, 1946, and a report dated March 22, 1946, by the directors of regions III and IV of the Bureau of Reclamation. The studies and investigations on which the interim and underlying inventory reports are based were authorized by section 15 of the Boulder Canyon Project Act (45 Stat. 1057, 1065) and section 2 of the Boulder Canyon Project Adjustment Act (54 Stat. 774).

Pursuant to section 1 of the Flood Control Act of 1944 the departmental report of June 7, 1946, and the regional directors' report of March 22, 1946, were transmitted to the seven affected States and the Secretary of War for comment. These reports were also transmitted to the Federal Power Commission and the Department of Agriculture. The replies of these States and of the Federal agencies are transmitted herewith and are discussed in the interim report.

As stated in the interim report, existing circumstances tend to preclude the formulation of a comprehensive plan of development of the water resources of the Colorado River Basin at this time. Accordingly, although I cannot now recommend authorization of any project, I am transmitting the report to you in order that the Congress may be apprised of this comprehensive inventory of potential water resource developments in the Colorado River Basin and of the present situation regarding water rights in that basin.

On July 19, 1947, the report was submitted to the President. The Bureau of the Budget has advised me that there would be no objection to the submission of the report to the Congress, but that the authorization of any of the projects inventoried in the report should not be considered to be in accord with the program of the President until a determination is made of the rights of the individual States to utilize the waters of the Colorado River system.

I hope that this report will be published as a House or Senate document.

Sincerely yours,

(Signed) J. A. KRUG,  
*Secretary of the Interior.*

EXECUTIVE OFFICE OF THE PRESIDENT

BUREAU OF THE BUDGET

WASHINGTON 25, D. C.

JULY 23, 1947.

The honorable, the SECRETARY OF THE INTERIOR.

MY DEAR MR. SECRETARY: I have received your letter of July 19, 1947, addressed to the President enclosing your proposed interim report to the Congress on the status of the investigation of the Colorado River Basin authorized to be made by section 15 of the Boulder Canyon Project Act and section 1 of the Boulder Canyon Project Adjustment Act. It is noted that your report does not recommend the authorization of any projects at this time, but rather comprises a comprehensive inventory of potential water resource developments in the basin. Acting under authority of the President's directive of July 2, 1946, I am able to advise you that there would be no objection to submission of the proposed interim report to the Congress, but that the authorization of any of the projects inventoried in your report should not be considered to be in accord with the program of the President until a determination is made of the rights of the individual States to utilize the waters of the Colorado River system.

Sincerely yours,

(Signed) JAMES E. WEBB,  
*Director.*

THE SECRETARY OF THE INTERIOR

WASHINGTON, D. C.

JULY 19, 1947.

The PRESIDENT,  
*The White House*

(Through the Bureau of the Budget).

MY DEAR MR. PRESIDENT: There are enclosed a report to me dated June 6, 1946, from the Acting Commissioner of Reclamation, and an accompanying report, dated

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 March 22, 1946, by the regional directors of regions III and IV of the Bureau of Reclamation, on the development of the water resources of the Colorado River Basin in Arizona, California, Colorado, Nevada, New Mexico, Utah, and Wyoming.

The Commissioner has obtained the written views of the seven affected States and of the Secretary of War, as required by the Flood Control Act of 1944. Letters of comment have also been obtained from the Federal Power Commission and from the Secretary of Agriculture. Copies of all these letters are transmitted herewith.

As stated in the accompanying letter from the Commissioner of Reclamation to me dated July 17, 1947, which I have approved and adopted, due to existing circumstances a comprehensive plan of development of the water resources of the Colorado River Basin cannot be formulated at this time. Accordingly, although I cannot recommend authorization of any projects at this time, I am sending the accompanying inventory report forward in order that you and the Congress may be apprized of this comprehensive inventory of potential water resource developments in the Colorado River Basin, and of the present situation regarding water rights in the Colorado River Basin.

Unless you have objection, the report and other documents enclosed will be transmitted to the Congress as an interim report on the status of the investigations authorized to be made by section 15 of the Boulder Canyon Project Act (45 Stat. 1057, 1065) and section 1 of the Boulder Canyon Project Adjustment Act (54 Stat. 774).

Sincerely yours,

(Signed) J. A. KRUG,  
*Secretary of the Interior.*

UNITED STATES DEPARTMENT OF THE  
 INTERIOR

BUREAU OF RECLAMATION  
 WASHINGTON, D. C.

JULY 17, 1947.

The SECRETARY OF THE INTERIOR.

SIR: On June 6, 1946, Acting Commissioner William E. Warne transmitted to you a proposed comprehensive report on the development of the water resources of the Colorado River Basin, which Acting Secretary Chapman adopted as the proposed report of the Department on June 7, 1946.

In accordance with the provisions of section 1 of the Flood Control Act of December 22, 1944 (58 Stat. 887), the proposed report was transmitted in June 1946 for review and comment to all of the States of the Colorado River Basin—viz, Arizona, California, Colorado, Nevada, New Mexico, Utah, and Wyoming—and to the

Secretary of War. The report was also transmitted to the Federal Power Commission and the Secretary of Agriculture, for their comments. The affected States and the interested Federal agencies have all submitted comments which are transmitted herewith.

SCOPE AND PURPOSE

The report describes the Colorado River Basin's resources, its present development, and its needs and problems. It presents an inventory of 134 potential projects for water development within the basin and evaluates the over-all benefits and costs of these projects as an indication of what might be expected from full water-resource development. Potentialities for the exportation of water from the Colorado River Basin to adjoining basins also are briefly considered.

With respect to plans for future development, the report is general in character. It states that water-supply limitations will not permit construction of all potential projects described, and also explains that the listing of projects in the report will not preclude the consideration of other projects which additional investigations may show to be desirable. For each of the within-basin projects discussed, it presents estimates of the area of land to be irrigated and the power to be produced, the nature of other expected benefits, and the estimated construction costs. Because many of the projects have not been studied in detail and because of the complex water-right situation, no selection is made of projects for inclusion in the ultimate plan of development, and no initial construction program is proposed. The report does not recommend that the Congress now authorize the construction of any project, but it does recommend that detailed investigations of potential projects be continued and expanded to obtain adequate information through which the basin States can select and recommend projects for successive stages of development.

The scope and purpose of the report appear generally to have been understood, although, in some instances, they have misconstrued by some of the commenting States and Federal agencies. A number of comments are directed to the lack of detail in such items as economic analysis of individual projects, water-supply studies, land classification, ground-water investigations, project-operation studies, power-output characteristics and market, quality of water, and silt control. The report, consistent with its scope and purpose, treats all of these subjects generally and does not purport to consider them in detail. The Department should continue and intensify its studies of all the problems related to the development and full economic utilization of the water resources of the basin, and the report so recommends.

With reference to projects for the exportation of water from the natural drainage basin of the Colorado River

## LETTERS OF TRANSMITTAL

to adjoining territory, Colorado has noted that export-diversion potentialities in that State are discussed less fully than certain parallel potentialities elsewhere in the basin. In preparing the report, the policy adopted was to give little more than mention to export-diversion projects, leaving their further discussion to reports concerning the territory into which the water is imported. An exception to this rule was made in the case of the Salton Sea Valley of California, since that area already makes use of large amounts of Colorado River water. With this exception, any lack of parallel emphasis on potential export projects is unintentional rather than a matter of partiality or prejudice.

### DIVISION OF WATER

Serious consideration was given in the preparation of the report to the possible selection and recommendation of a group of projects for the most beneficial and fullest utilization of the available water supply, that group to comprise a comprehensive plan of development. The utility of such a selection by the Department would have been questionable, however, because of a lack of agreement among the States as to their respective rights to deplete the flow of the river system. The Colorado River compact divides the water between the upper basin and lower basin, but it makes no division among the States within each basin. Your proposed report prompted the appointment of a compact commission, which is now attempting to apportion upper-basin water among the States of the upper basin. Similar action has not yet been taken by the lower-basin States, although congressional resolutions recently have been introduced into the Congress which purport to have the equivalent objective by calling for adjudication of the waters of the lower basin by court action. The Department of the Interior is assisting the Upper Basin Compact Commission in assembling factual information. It is equally ready to assist the States of the lower basin in the determination of their respective rights.

The water-right situation in the Colorado River Basin is highly controversial. The several documents bearing upon the matter—the Colorado River compact, the Boulder Canyon Project Act, the California Self-limitation Act, the various contracts for the delivery of water from Lake Mead, and the Mexican treaty—are, in important particulars, variously interpreted by the States which are parties to them. In the realization that it was not within the scope or authority of the report to attempt to decide such controversial questions, a deliberate effort was made in its preparation to avoid any interpretation of these documents. Colorado has criticized the report for failing to make such interpretations of the contracts and for failing to limit the inventory of potential projects in the lower basin to those which Colorado considers to be within the lower basin's water right.

Many of the comments by the basin States, particularly a number by Arizona, Colorado, and California, appear to be intended not so much to criticize the report as to explain or advance the commenting State's positions with respect to the division of water of the Colorado River system.

### "CONSUMPTIVE USE" VERSUS "STREAM DEPLETION"

The manner in which the report estimates the quantitative use of water by existing and potential projects has been criticized from opposite viewpoints by the basin States. California has stated that the report departs from an important technical concept of the Colorado River compact in that it does not determine "consumptive use" at the place of water use, but instead determines "stream depletion" resulting from the various developments measured at the point where the river crosses the international boundary. Arizona advances the "stream depletion" theory as the proper measure of quantitative use. Colorado takes a similar position, but states that the report does not properly evaluate depletions because it fails to give sufficient weight to losses from the natural stream channels above Lee Ferry.

It is not intended that the report support either of the opposing positions on the question as to how water use shall be measured under the compact. Consistent with the policy of not attempting to interpret the Colorado River compact, and in order to avoid any implied definition of the term "consumptive use," that term was not used in the report. The term "stream depletions" is used to present factual information without any implication that the term is, or is not, synonymous with "consumptive use" as referred to in the compact. Channel losses above Lee Ferry are believed to be relatively small in proportion to the depletions resulting from the existing and potential use of water and, consequently, were not separately estimated. Such an estimate would not have been justified in view of the character of the depletion studies which are necessarily general in nature.

### URGENCY FOR EARLY DEVELOPMENT AND THE OBSTACLES TO THAT DEVELOPMENT

The Bureau is cognizant of the tremendously expanding requirements for electric power in both the upper and lower basins and their service areas, as pointed out by the Federal Power Commission. It is aware of the serious problems presented by the rising costs of all fuel and the growing scarcity of fuel oil. It is sympathetic with California's recommendation that an immediate and intensive investigation be made by the Bureau of Reclamation, in cooperation with other interested agencies, of possible hydroelectric projects on the Colorado

River upstream from Lake Mead. It cannot agree, however, with California's representation that such projects would be largely nonconsumptive of water, since it is known that the quantity of water lost by evaporation from necessary reservoirs would be substantial.

The Bureau also agrees with the States of Arizona, Colorado, Nevada, New Mexico, Utah, and Wyoming as to their need for new projects for irrigation, power, and other purposes. Inherent in the recommendation made in the report that the States recommend projects for the next stage of development was the hope that a construction program could be agreed upon by the States of the upper and lower basins, respectively, and that a water right for each selected project would be assured by agreement among the States. A majority of the States, acting individually, have recommended the construction of certain projects within their borders, but there is presently no agreement among the States of either the upper or the lower basin as to specific projects.

The projects not presently under construction which the various individual States have suggested for early consideration are contained in table I below. The suggestions or recommendations of the States that early consideration be given the following projects contain numerous and, in some cases, complex qualifications. This table does not attempt to enumerate those qualifications, which are contained in the attached comments of the States.

TABLE I.—*Projects suggested by individual States for early consideration*

State	Project
Arizona.....	First unit of the Gila project, including the reduced Yuma-Mesa division and the Well-ton-Mohawk division thereof.
California.....	Bridge Canyon and central Arizona project. Possible hydroelectric projects upstream from Lake Mead on the Colorado River.
Colorado.....	Paonia project. Pine River extension. La Plata project. Florida project. Silt project. Dolores project. Collbran project. Little Snake development. Mill Creek, Archuleta County. Four Mile and Turkey Creek Lakes, Archuleta County. Dutton Park, Archuleta County. Buckler-Harris Lakes, Archuleta County.
Nevada.....	Bridge Canyon project (as a main-stream power development).
New Mexico.....	Hammond project. Pine River extension. Animas-La Plata project (particularly the first unit, the La Plata River project).

Utah.....	Central Utah (first stage). Vernal. Jensen. Gooseberry. Ouray. Emery County. Hurricane. Santa Clara.
Wyoming.....	Sublette project (including Kendall Reservoir). West Side unit. Daniel unit. Elkhorn unit. Seedskadee unit. Eden project. Lyman project. Little Snake project.

Viewed from both local and national standpoints, there is no doubt as to the urgency for continuing at once the development of the resources of the Colorado River. The principal obstacle to immediate progress is the fact that, although neither the upper nor lower basin is currently using all of the water allocated to it by the Colorado River compact, there is disagreement as to how the unused water shall be distributed among the States of each of the two basins. Until these disagreements are at least partially resolved there is little hope that substantial progress can be made toward meeting the needs of the region and the Nation.

References to the selection of projects for the next stage of river development, made by some of the States in their comments, require explanation. In the process of preparing a report, a preliminary draft dated October 1945, which included a list of projects proposed for the next stage of construction, was distributed to the States for their confidential review and for suggestions as to revisions which should be made before the report was officially submitted to the Secretary, and then to the States and to the War Department. In the revised and official draft dated March 22, 1946, the list of projects proposed for next-stage construction was deleted, primarily because of the water-right situation. A number of Wyoming's comments are dated prior to March 22, 1946, and refer to the earlier unofficial draft and specifically to parts of it that were excluded from the official report.

### BASIN-WIDE CONCEPT

California has commented that "projects should be analyzed and reported upon individually as to their engineering and economic feasibility and findings made relative thereto as required by law." Colorado has made a similar comment. It is agreed that each project must be considered on its own merits, but should be considered also from the standpoint of its effect upon the engineering feasibility and economic justification of an over-all plan for basin development.



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### NONREIMBURSABLE COST ALLOCATIONS

It is apparent from a study of the report that many projects, particularly on the main stem of the Colorado River and its principal tributaries, will result in benefits to the Nation which can properly be made nonreimbursable by the water and power users. Construction costs allocable to silt control, recreation, salinity control, the administration of the Mexican treaty, and similar purposes should be nonreimbursable.

### CONCLUSIONS

My conclusions are:

(1) That a comprehensive plan of development for the Colorado River Basin cannot be formulated at this time;

(2) That further development of the water resources of the Colorado River Basin, particularly large-scale development, is seriously handicapped, if not barred, by lack of a determination of the rights of the individual States to utilize the waters of the Colorado River system. The water supplies for projects to accomplish such development might be assured as a result of compact among the States of the separate basins, appropriate court or congressional action, or otherwise;

(3) That the States of the upper Colorado River Basin and States of the lower Colorado River Basin should be encouraged to proceed expeditiously to determine their respective rights to the waters of the Colorado River consistent with the Colorado River compact;

(4) That construction costs allocated to silt control, recreation, salinity control, the administration of the Mexican treaty, and similar purposes, should be nonreimbursable.

### RECOMMENDATIONS

I recommend:

(1) That you adopt this as your interim report on the status of the investigations authorized to be made by section 15 of the Boulder Canyon Project Act (45 Stat. 1057) and section 1 of the Boulder Canyon Project Adjustment Act (54 Stat. 744);

(2) That you transmit this report, together with the accompanying comments of the States and Federal agencies, your proposed report dated June 7, 1946, and the accompanying basic inventory report of the regional directors to the President, and then to the Congress, in order that they may be apprised of the contents of this comprehensive inventory of potential water resource developments in the Colorado River Basin and of the present situation regarding water rights in the Colorado River Basin, which situation precludes my recommending any projects for construction at this time.

Sincerely yours,

(Signed) MICHAEL W. STRAUS,  
*Commissioner.*

Approved and adopted July 19, 1947.

(Signed) J. A. KRUG,  
*Secretary of the Interior.*

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The Bureau also agrees with the States of Arizona, Colorado, Nevada, New Mexico, Utah, and Wyoming as to their need for new projects for irrigation, power, and other purposes. Inherent in the recommendation made in the report that the States recommend projects for the next stage of development was the hope that a construction program could be agreed upon by the States of the upper and lower basins, respectively, and that a water right for each selected project would be assured by agreement among the States. A majority of the States, acting individually, have recommended the construction of certain projects within their borders, but there is presently no agreement among the States of either the upper or the lower basin as to specific projects.

The projects not presently under construction which the various individual States have suggested for early consideration are contained in table I below. The suggestions or recommendations of the States that early consideration be given the following projects contain numerous and, in some cases, complex qualifications. This table does not attempt to enumerate those qualifications, which are contained in the attached comments of the States.

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Utah . . . . .	Central Utah (first stage). Vernal. Jensen. Gooseberry. Ouray. Emery County. Hurricane. Santa Clara.
Wyoming . . . . .	Sublette project (including Kendall Reservoir). West Side unit. Daniel unit. Elkhorn unit. Seeds-kadee unit. Eden project. Lyman project. Little Snake project.

Viewed from both local and national standpoints, there is no doubt as to the urgency for continuing at once the development of the resources of the Colorado River. The principal obstacle to immediate progress is the fact that, although neither the upper nor lower basin is currently using all of the water allocated to it by the Colorado River compact, there is disagreement as to how the unused water shall be distributed among the States of each of the two basins. Until these disagreements are at least partially resolved there is little hope that substantial progress can be made toward meeting the needs of the region and the Nation.

References to the selection of projects for the next stage of river development, made by some of the States in their comments, require explanation. In the process of preparing a report, a preliminary draft dated October 1945, which included a list of projects proposed for the next stage of construction, was distributed to the States for their confidential review and for suggestions as to revisions which should be made before the report was officially submitted to the Secretary, and then to the States and to the War Department. In the revised and official draft dated March 22, 1946, the list of projects proposed for next-stage construction was deleted, primarily because of the water-right situation. A number of Wyoming's comments are dated prior to March 22, 1946, and refer to the earlier unofficial draft and specifically to parts of it that were excluded from the official report.

### BASIN-WIDE CONCEPT

California has commented that "projects should be analyzed and reported upon individually as to their engineering and economic feasibility and findings made relative thereto as required by law." Colorado has made a similar comment. It is agreed that each project must be considered on its own merits, but should be considered also from the standpoint of its effect upon the engineering feasibility and economic justification of an over-all plan for basin development.

## LETTERS OF TRANSMITTAL

5

### NONREIMBURSABLE COST ALLOCATIONS

It is apparent from a study of the report that many projects, particularly on the main stem of the Colorado River and its principal tributaries, will result in benefits to the Nation which can properly be made nonreimbursable by the water and power users. Construction costs allocable to silt control, recreation, salinity control, the administration of the Mexican treaty, and similar purposes should be nonreimbursable.

### CONCLUSIONS

My conclusions are:

(1) That a comprehensive plan of development for the Colorado River Basin cannot be formulated at this time;

(2) That further development of the water resources of the Colorado River Basin, particularly large-scale development, is seriously handicapped, if not barred, by lack of a determination of the rights of the individual States to utilize the waters of the Colorado River system. The water supplies for projects to accomplish such development might be assured as a result of compact among the States of the separate basins, appropriate court or congressional action, or otherwise;

(3) That the States of the upper Colorado River Basin and States of the lower Colorado River Basin should be encouraged to proceed expeditiously to determine their respective rights to the waters of the Colorado River consistent with the Colorado River compact;

(4) That construction costs allocated to silt control, recreation, salinity control, the administration of the Mexican treaty, and similar purposes, should be nonreimbursable.

### RECOMMENDATIONS

I recommend:

(1) That you adopt this as your interim report on the status of the investigations authorized to be made by section 15 of the Boulder Canyon Project Act (45 Stat. 1057) and section 1 of the Boulder Canyon Project Adjustment Act (54 Stat. 744);

(2) That you transmit this report, together with the accompanying comments of the States and Federal agencies, your proposed report dated June 7, 1946, and the accompanying basic inventory report of the regional directors to the President, and then to the Congress, in order that they may be apprised of the contents of this comprehensive inventory of potential water resource developments in the Colorado River Basin and of the present situation regarding water rights in the Colorado River Basin, which situation precludes my recommending any projects for construction at this time.

Sincerely yours,

(Signed) MICHAEL W. STRAUS,  
*Commissioner.*

Approved and adopted July 19, 1947.

(Signed) J. A. KRUG,  
*Secretary of the Interior.*

# Comments of States and Federal Agencies

## DIGEST OF COMMENTS

The following is a digest of significant comments of the Colorado River Basin States and Federal agencies on the Colorado River report. The comments are grouped under the same headings as those appearing in the Commissioner's report of July 1947.

### (1) *The Scope and Purpose of the Report*

#### *Arizona*

"We view the report as an inventory of possible projects within the basin and as such we consider it most helpful.

"We understand that there are listed alternative projects so that in many instances if one project listed is constructed, such construction may ultimately eliminate another listed project, and we take it as a general proposition that, as to many of the projects listed, further investigations and detailed reports will be necessary before the Bureau of Reclamation is in a position to recommend authorization for construction of such projects" (Arizona comments, p. 15).

#### *California*

"The report represents essentially a catalog of potential projects with a general description thereof \* \* \*" (California comments, p. 52).

"Factors and data which govern the engineering and financial feasibility of the proposed projects are lacking in the report.

"The report does not furnish the necessary data or information for a determination by the affected States of their respective rights to the use of the water of the Colorado River and its tributaries or for a basis for selection of projects by the individual States or for authorization by the Congress of any project" (California comments, p. 52).

"The necessary analyses and data for an evaluation of the electric power estimated to be produced at the several power plants of the potential projects are not presented in the report" (California comments, p. 52).

"More complete and detailed information is required on the quality of water in the various reaches of the Colorado River and its tributaries and the effect of the contemplated future development on such quality, par-

ticularly in the lower reaches of the river as it may be an important element in the administration of the Mexican treaty and of the Colorado River compact.

"Little consideration is given to proposed transmountain or export projects in the upper basin which, if constructed, would play an important role in an ultimate comprehensive plan of development and utilization of the water resources of the Colorado River system" (California comments, p. 52).

"Detailed water-supply and water-utilization studies, which are not presented in the report under review, should be made for each project and for the entire comprehensive plan in order to determine the feasibility of the development from a water-supply standpoint.

"The report should contain estimates of water supply on the basis of the critical periods of subnormal flow, which are controlling, as well as on the long-term average basis" (California comments, p. 52).

"\* \* \* the proposed report of the Secretary of the Interior is only a preliminary progress report and does not constitute a basis for the authorization of any new project therein mentioned \* \* \*" (California comments, pp. 52-53).

#### *Colorado*

"The report is a good inventory of development potentialities, as known at the present time, and it contains much valuable engineering data and factual information. It must be recognized that as a complete list of all construction potentialities or possibilities of using Colorado River water, the report is far from complete" (Colorado comments, p. 56).

"The report is unsound in that it fails to give consideration to the desirability and feasibility of individual projects and thus fails to furnish any true and usable guide for a development program.

"The report is unsound in that it attempts to present a comprehensive development plan, but ignores the elementary fact that the desired orderly development will result from the construction from time to time of individual projects which upon full and complete investigation prove to be feasible, justified, and needed, and which will be desired by local beneficiaries after their repayment obligations are known" (Colorado comments, p. 56).

*Nevada*

"In my opinion, the report is a splendid piece of work. Everyone who is interested should realize that it does not set up any projects, but is merely an inventory of all possible projects, regardless of their respective merits" (Nevada letter from State engineer).

*New Mexico*

"It [the report] is an excellent summation and presentation of the factual data as they are known today. As far as this State's projects are concerned, however, these data are entirely too meager to be used as the basis for planning a specific development program or determine the full potentialities of the water supply" (New Mexico comments, p. 71).

*Utah*

"Assembling, as it does, into one document a complete summary of the present and potential developments of water resources in the entire Colorado River Basin, it provides a basis for over-all analyses of the basin's problems and no doubt will prove invaluable as a guide and stimulus to further development of this great western resource, the Colorado River" (Utah comments, p. 79).

*Wyoming*

No comment.

*War Department*

"The report is entirely factual and does not recommend the authorization of any project or group of projects for construction at this time" (letter from Secretary of War, p. 89).

"Although the report is submitted pursuant to section 9 of the Reclamation Project Act of 1939 and pursuant to section 15 of the Boulder Canyon Project Act, the report does not contain the usual finding of feasibility. It is, therefore, assumed that the report on the Colorado River, in effect, is an inventory of all physically feasible projects involving water conservation, power production, flood control and other related features in the entire Colorado River Basin in the States of Wyoming, Utah, Colorado, New Mexico, Nevada, Arizona, and California investigated by the Bureau and the various cooperating agencies over a period of many years" (letter from Secretary of War, p. 90).

"The data presented in the report of the Acting Commissioner of Reclamation is believed to be a valuable compendium of potentialities for water conservation and utilization in the Colorado River Basin and will assist materially in the formulation of an ultimate comprehensive and coordinated plan of development of the water resources available to the seven Colorado River Basin States" (letter from Secretary of War, p. 90).

*Department of Agriculture*

"The report contains a wealth of engineering data, which should serve well the purpose of facilitating numerous actions necessary before the formulation of a comprehensive water-development plan for the basin can be effectively undertaken. However, from the agricultural standpoint, we feel that the report in its present form lacks data equally essential to sound decisions. The report recognizes that there are more potential projects than water supplies to support them. Therefore, the most beneficial use of both land and water should be of paramount concern. But the report lacks data on the capabilities and relative productivity of the lands involved, especially in respect to the best use of water on the better lands.

"More consideration, we believe, should also be given to needed ground-water controls; the whole problem of diversions from the Colorado must be considered in respect to use, depletion and recharge of the several related ground-water basins. Another factor passed over lightly is the question of the amounts of water which must be used to keep alkali accumulations to safe level for crop production.

"The Colorado River Basin is one of the most critical watersheds in the Nation, beset with problems of deterioration of land and water resources through erosion, flood damage, and sedimentation. We believe that the importance of proper watershed management merits more elaboration than was accorded this subject in the report. Certainly a truly comprehensive plan for the Colorado, as it is developed, must include a well developed plan and program for use and management of the watershed lands, which are largely in public ownership, as well as of the stream itself" (pars. 6, 7, and 10 of letter from Secretary of Agriculture).

*Federal Power Commission*

"The report does not contain recommendations for construction of projects or recommendations concerning the finding of feasibility of any plan or projects. It is the Commission's understanding that the report presents an inventory of the major potential projects to serve as a guide in the selection of projects to be included in a comprehensive construction plan, and that it is not intended that the listing of specific projects in the report will preclude the consideration of others which further investigations may show to be desirable" (par. 2 of letter from Federal Power Commission).

*(2) Division of Water**Arizona*

"I note the suggestion that the States should now agree upon allocations of specific quantities of water to

the respective States. I agree that it is now possible and desirable that allocations be made by subcompact to the respective States in the upper basin where no allocation as between them as yet been made by compact, contract, or otherwise \* \* \*. Arizona is participating in such negotiations \* \* \*.

“The apportionment among the States of the lower basin of the water apportioned to the lower basin by the Colorado River compact has been effected by the Colorado River compact, the Boulder Canyon Project Act, the California Limitation Act, the Mexican treaty, the contract between the United States and the State of Arizona, the contract between the United States and the State of Nevada, and the contracts between the United States and the agencies of the State of California” (Arizona comments, p. 15).

*California*

“\* \* \* it is recommended that negotiations be initiated forthwith among the States of the lower basin, acting through their respective Governors, for the purpose of determining the rights of each of the States of the lower basin to the use of the waters of the Colorado River system, in accordance with the Colorado River compact, the Boulder Canyon Project Act, and relevant statutes, decisions, and instruments” (California comments, p. 53).

*Colorado*

“By failing to interpret and construe the contracts between the Secretary of the Interior and the States and water users of the lower basin for the delivery of water from Lake Mead, the report engenders further interstate controversy in that—

“(a) It endeavors to impose upon the States the burden of interpreting, construing, and applying these contracts \* \* \*” (Colorado comments, pp. 55-56).

“Neither basin is concerned with the apportionment between States of the share allocated to the other basin, and neither basin should be restricted or delayed in its development by the failure of the other basin States to divide the water apportioned to that basin by the Colorado River compact. Colorado recognizes the desirability of an allocation of water to the individual States comprising the upper basin. While it is true that compact negotiations are in progress among the States of the upper basin and that the construction of additional major projects should await allocation of water to the States, there are projects which will assuredly use water falling well within the equitable share of the State where located and which should not be made to wait any final allocation of water” (Colorado comments, p. 56).

*Nevada*

No comment.

*New Mexico*

No comment.

*Utah*

“\* \* \* the report does not recommend a specific plan of development, but leaves to the respective States within the Colorado River Basin the selection of projects to be recommended for construction. The process of selection is complicated by the fact that as yet no division has been made among the respective States of the upper and lower Colorado River Basins of the water allocated to each basin by the Colorado River compact \* \* \*” (Utah comments, p. 79).

*Wyoming*

“A resolution pertaining to the Bureau report was passed as follows:

“That the group go on record as favoring the United States Bureau of Reclamation report wherein it pertains to the initial development program.

“That is opposes the plan for further development as proposed in all the States of the upper division until such time as a compact is negotiated for division of the 7,500,000 acre-feet of water allocated to the States of the upper division by the terms of the Colorado River compact” (memorandum of State engineer to Governor, January 26, 1946, p. 84).

“It was the recommendation of the group, in which this office fully concurs, that our representatives in Congress be asked to oppose all items of the development plan as proposed by the report of the Bureau in all of the States except these listed in the initial construction program, until appropriate understandings are reached between the States of the upper division with reference to transportation of water from the basin of the Colorado River system, and within the States until proper and adequate safeguards are provided for protection of present and future beneficial use of water in the basin” (memorandum of State engineer to Governor, January 26, 1946, p. 85).

“According to the report, it will be necessary for the States to determine their respective equities in the water supplies in the Colorado River before final comprehensive plans can be formulated. Our office concurs fully with this statement.

“It is my own thought that next in importance to division of water in the States is the consummation of an agreement concerning all phases of transportation of water from the Colorado River Basin” (memorandum of State engineer to Governor, December 14, 1945, pp. 86 and 87).

*War Department*

“Under the terms of the Colorado River compact, ratified by the seven basin States and approved by Congress,

division was made of the water of the Colorado River between the upper and lower basin but no final agreement has been reached among the States as to the amount to be allocated to each State. This situation precludes the selection of a definite comprehensive plan of development for the whole of the Colorado Basin from the 134 potential projects reported upon until a definite allocation of the available water is made" (letter from Secretary of War, pp. 89-90).

*Department of Agriculture*

No comment.

*Federal Power Commission*

"In the interest of development of the water resources of the basin, it would be well if the States, acting separately or jointly, would recommend a group of projects for each State, the stream-flow depletion occasioned by which would fall assuredly within the ultimate allocation of the Colorado River water which may be made to each. It appears in this connection that an early settlement of the difference between the Colorado Basin States, as suggested by the Bureau, is necessary and is in the best interest of all parties concerned.

"While the report 'makes no attempt to interpret the Colorado River compact or any other acts or contracts relating to the allocation of Colorado River water among the States and among the projects within the State,' it is believed that eventually a qualified agency, such as the Bureau of Reclamation, should suggest a program by which the States could use to best advantage the water allocated to them. The States which are being asked to submit lists of projects which would fall within the range of water which eventually would be allotted to them might properly expect such guidance, since with a deficient water supply to meet the possible requirements selections as between projects will have to be made" (comments (6) and (12) of letter from Federal Power Commission).

(3) "*Consumptive Use*" Versus "*Stream Depletion*"

*Arizona*

"Arizona is using out of the main stream of the Colorado River and out of the tributaries of the Colorado in Arizona, a grand total of 1,407,000 acre-feet of water per year" (Arizona comments, p. 16).

(NOTE.—This estimate of present use is based on the "stream depletion" theory.)

*California*

"Water requirements should be based upon 'consumptive use' wherever it may occur and not upon 'depletion' as used in the report under review, since the Colorado River compact apportions waters on the basis of 'consumptive use' and not on 'depletion'" (California comments, p. 52).

*Colorado*

"In estimating available water supplies and depletions, it [the report] utilizes methods in the lower basin which differ from those applied to the upper basin" (Colorado comments, p. 55).

"Colorado notes that water utilization and depletion estimates of the report are in terms which are not consistent throughout both basins and in all States. Although the reported depletion quantities are said to represent the resulting effects upon outflows from the upper basin at Lees Ferry, and from the lower basin at the international boundary, that rule appears to have been applied only on the lower Gila River at and below the Phoenix vicinity in Arizona. All other depletion estimates presented in the report are based on the rule of evaluation at the site \* \* \*" (Colorado comments, p. 58).

*Nevada*

No comment.

*New Mexico*

No comment.

*Utah*

No comment.

*Wyoming*

No comment.

*War Department*

No comment.

*Department of Agriculture*

No comment.

*Federal Power Commission*

No comment.

(4) *Urgency for Early Development and Obstacles to That Development*

*Arizona*

"The Wellton-Mohawk division and the Yuma-Mesa division of the first unit of the Gila project are very desirable and their immediate authorization and construction are very much in the national interest as well as in the interest of the State of Arizona, and I am sure they are feasible from every point of view.

"The immediate authorization and construction of the Bridge Canyon-Central Arizona project is essential in the national interest and in the interest of the State of Arizona and the people of the central valleys of Arizona, in furnishing a supplemental water supply to lands now inadequately irrigated in order to preserve the civilization now existing in the State of Arizona and to prevent possible economic chaos, for the reason that irrigation of lands in central Arizona has been expanded beyond the water supply of central Arizona, both by diversion from

the surface streams and by pumping from the underground reservoirs to such a great extent that I am advised by engineers that the people of Central Arizona are now using approximately 800,000 acre-feet of water per year more than comes into that area; in other words, they are exhausting underground reservoirs at a rate in excess of 800,000 acre-feet per year. Such a practice, of course, endangers the entire economy of Arizona and creates a very real danger to the economy of the United States and to the national interest" (Arizona comments, p. 17).

#### *California*

"Large hold-over surface storage as indicated in the report is required in meeting the requirements of the Colorado River compact and in conserving and utilizing as far as it is ultimately possible the waters of the Colorado River system (California comments, p. 52).

"\* \* \* it is recommended that an immediate and intensive investigation and study be made and reported upon by the Bureau of Reclamation, in cooperation with interested agencies, concerning possible hydroelectric projects upstream from Lake Mead on the Colorado River with a view to authorization and construction at the earliest practicable date; provided, it be found that such projects are of nonconsumptive-use character, are feasible from engineering, and economic standpoints, are consistent with the primary purpose of furnishing water supplies for domestic and irrigation uses in accordance with the Colorado River compact, and will not be inconsistent with a comprehensive plan for progressive development of the Colorado River system (California comments, p. 53).

"It is recommended that the All-American Canal project and the San Diego aqueduct, which are now under construction, be completed without delay (California comments, p. 53).

"The determination of the share of water belonging to each State must precede a selection of projects for a comprehensive plan of development. The report recognizes this, but recommends that projects be selected for an initial stage of development prior to such determination. In this the report fails to distinguish between conditions in the lower basin, where water requirements of existing and authorized projects exceed the available supply, and those in the upper basin, where available water supply substantially exceeds the water requirements of existing and authorized projects. This recommendation also fails to differentiate between consumptive-use projects and comparatively nonconsumptive hydroelectric projects" (California comments, p. 52).

#### *Colorado*

"For many years the State has been urging the investigation and issuance of reports on specific projects within its borders. These investigations and reports

have reached various stages of completion. Based thereon, and because of known information on these projects, the State is able and desires to urge an early issuance of reports on, and consideration for, early construction of a group of projects hereinafter mentioned. These projects are all within the Colorado River Basin and will cause a depletion of water supplies assuredly within the ultimate allocation of Colorado River water which may be made to the State. Consideration of these projects for construction should not be delayed pending the consummation of an upper Colorado River Basin compact" (Colorado comments, pp. 61-62). (Also see Colorado's comments under "Division of Water.")

#### *Nevada*

"We feel that several of the Nevada projects, all of which are comparatively small, should be listed, if and when that time comes, with fairly early priorities. We are also interested in joining with the State of California in promoting an early priority and appropriation for the early construction of the Bridge Canyon project because of its great value and necessity for additional power very much needed throughout the area capable of being served by it" (Nevada letter from State engineer).

#### *New Mexico*

"The Hammand and the Pine River extension projects are both apparently much needed projects upon which construction should be started in the near future" (New Mexico comments, p. 72).

#### *Utah*

After recommending eight projects for construction as the next stage of development it is said: "I cannot emphasize too strongly the vital need for this program of water development in Utah in the period immediately ahead. The extent to which the program is carried out will in a large measure determine the extent to which Utah can provide a livelihood for its growing population and develop its rich and abundant natural resources for the welfare of the Nation. It is indeed regrettable that this large and potentially wealthy State is unable to provide economic opportunities for its young people, forcing many of them, after being reared and educated at the expense of Utah citizens, to migrate elsewhere as they arrive at the age when they could contribute to the production and economy of the State" (Utah comments, p. 81). (Also see Utah's comments under "Division of water.")

#### *Wyoming*

"We desire to emphasize our remarks with reference to the initial construction program proposed in the 1945 draft of the Colorado River report, pages 13 to 17, inclusive, mentioned in our memorandum of December 14, 1945.



"We believe this program is sound and that it should be included in the final draft of March 1946. In any event we endorse the initial construction program mentioned therein as our definite recommendations for initial projects for Wyoming" (memorandum of State engineer to Governor, October 12, 1946, p. 83).

#### *War Department*

"Included in the list of 134 projects studied are projects for two locations where authorization for construction by the War Department has already been provided in the Flood Control Act approved December 22, 1944, namely, the Holbrook project, Arizona, on Little Colorado River, and the Alamo Dam and Reservoir on Bill Williams River" (letter from Secretary of War, p. 90).

#### *Department of Agriculture*

"We believe that the development and protection of the resources of the Colorado River Basin is of such importance and magnitude that all the appropriate agencies of Government should be utilized in formulating a coordinated resource use and development plan" (par. 11 of letter from Secretary of Agriculture).

#### *Federal Power Commission*

"It is pointed out here, however, that the studies now under way by the Commission staff indicate that the potential power from at least two Colorado main-stem hydroelectric plants and from the Colorado-Spanish Fork diversion plants will be required to supply the growing power demands of the Great Basin to 1970. Analyses of load growth in the southwestern United States indicate that the development of many of the Colorado River hydroelectric possibilities is required to meet the power demands of the next 25 years in all of the States which are dependent upon Colorado River power."

#### (5) *Basin-wide Concept*

##### *Arizona*

No comment.

##### *California*

"The statement in the report that the economic feasibility of an initial group of projects is 'comprehended' by the showing of economic feasibility on a basin-wide basis is unwarranted. Projects should be analyzed and reported upon individually as to their engineering and economic feasibility and findings made relative thereto as required by law" (California comments, p. 52).

"It is recommended that, in determining whether any project shall be authorized for construction, the following economic criteria be followed:

"(a) Costs allocated to flood control, navigation, and propagation of fish and wildlife be nonreimbursable;

"(b) Costs allocated to irrigation be repayable within 40 years (exclusive of the permissible development period), without interest;

"(c) Costs allocated to hydroelectric power be repayable within 50 years with interest;

"(d) Costs allocated to municipal water supply and other miscellaneous purposes be repayable in a period not to exceed 40 years, with interest if determined to be proper; and

"(e) The sums required under (b), (c), and (d), based upon findings of the Federal Government, will probably be repaid to the United States within the times specified" (California comments, p. 53).

#### *Colorado*

"The report is unsound in that it recommends that the States approve projects for the so-called initial stage of development without there being available at the same time adequate data and information for the determination of the desirability, economic feasibility, or probability of authorization and construction of individual projects. Only in instances where detailed investigations are completed and individual project reports are available can there be a worth-while selection of any projects.

"The report is unsound in that it contemplates a general group authorization of projects for construction rather than a specific authorization of individual projects" (Colorado comments, p. 56).

#### *Nevada*

No comment.

#### *New Mexico*

No comment.

#### *Utah*

No comment.

#### *Wyoming*

No comment.

#### *War Department*

No comment.

#### *Department of Agriculture*

No comment.

#### *Federal Power Commission*

No comment.

#### (6) *Miscellaneous Comments*

##### *Arizona*

No comment.

##### *California*

"The method utilized in the report in calculating irrigation benefits based upon gross farm income is fallacious because such procedure would not preclude the inclusion of projects which result in no net benefit to the farmer. While it is recognized that there are indirect nonfarm benefits from the development of irrigation projects, it is believed that the projects which result

in the greatest direct benefit to the farmer make for the greatest local, State, and National indirect benefits and that calculation of irrigation benefits both direct and indirect should be related to the increase in net farm income to be obtained from the construction and operation of an irrigation project and not to the increase of gross farm income" (California comments, p. 52).

"With reference to the alleged indirect 'benefit' in increased taxes, it would appear that insofar as irrigation development is concerned such 'benefit' is already included in the irrigation 'benefit' based upon gross crop value, which assumedly would reflect all costs, including taxes. Regardless, the propriety of considering increased taxes as a 'benefit' is open to serious question, when used as a justification for Federal subsidization of the capital cost of reclamation projects. These comments apply, as well, to the reference in paragraph 48 to increased taxes, in connection with proposed hydroelectric power development" (California comments, p. 27).

*Colorado*

"The report is unsound in implying that each individual State should allocate water to specific projects within such State. Colorado adheres to the appropriation doctrine of water law and thereunder water users are entitled to water in accordance with the priority of their individual appropriations. Any change on such system in Colorado will require a constitutional amendment" (Colorado comments, p. 56).

"Colorado objects to the report in its present form and to the conclusions and recommendations therein contained, and recommends that it not be transmitted to

the Congress unless and until the requisite corrections, modifications, and additions are made in accordance with these views and recommendations" (Colorado comments, p. 55).

*Nevada*

No comment.

*New Mexico*

No comment.

*Utah*

No comment.

*Wyoming*

"It is our recommendation that the following lands be included in the Bureau report for further investigation and development:

	<i>Acres</i>
West Side unit .....	46,270
Daniel unit .....	3,560
Elkhorn unit .....	7,970
Eden unit .....	1,600
LaBarge unit .....	1,700
Seedskadee .....	21,070
Opal .....	25,100
Henry's Fork .....	1,600
	<hr/>
Total .....	108,870
Little Snake .....	2,520
	<hr/>
Total .....	111,390
Miscellaneous areas .....	37,610
	<hr/>
Total .....	149,600"

(State engineer's memo to Governor, January 26, 1946, p. 84).

# Comments of the State of Arizona

EXECUTIVE OFFICE

STATE HOUSE

PHOENIX, ARIZ.

NOVEMBER 22, 1946.

Mr. WILLIAM E. WARNE,  
*Acting Commissioner, Bureau of Reclamation,  
Department of the Interior, Washington, D. C.*

DEAR MR. WARNE: We in Arizona have reviewed the Colorado River comprehensive report on the development of the water resources of the Colorado River Basin for irrigation, power production, and other beneficial uses in Arizona, California, Colorado, Nevada, New Mexico, Utah, and Wyoming, by the United States Department of the Interior, under the supervision of the Bureau of Reclamation, dated March 1946, Project Planning Report No. 34-8-2, together with your letter of June 6, 1946, addressed to the Secretary of the Interior, as suggested in your letter of June 13, 1946, to me.

The report constitutes a very great contribution toward the progress, development, and welfare of the Colorado River Basin and discloses that a very thorough investigation has been made of possibilities of development in the basin. I desire to congratulate the Bureau and its personnel on the success achieved in the very difficult work which it is apparent from the report has been performed.

We view the report as an inventory of possible projects within the basin and as such we consider it most helpful.

We understand that there are listed alternative projects so that in many instances, if one project listed is constructed, such construction may ultimately eliminate another listed project, and we take it as a general proposition that as to many of the projects listed further investigation and detailed reports will be necessary before the Bureau of Reclamation is in a position to recommend authorization for construction of such projects.

I believe that it is now possible and very desirable for each of the States in the Basin to recommend for construction projects within that State for which the stream-flow depletions will assuredly be within the allocation of Colorado River water which has been made to that State, or which will be made to that State.

I note the suggestion that the States should now agree upon allocations of specific quantities of water to the

respective States. I agree that it is now possible and desirable that allocation be made by subcompact to the respective States in the upper basin where no allocation as between them has yet been made by compact, contract, or otherwise, apportioning among them the 7½ million acre-feet of water per annum which is apportioned to them jointly in perpetuity by the Colorado River compact. To that end I joined in a request that a Federal representative be appointed to assist in negotiations between the upper-basin States of an upper-basin compact, subordinate and subsidiary to the Colorado River compact.

Arizona is participating in such negotiations for the reason that a part of Arizona is in the upper basin as defined by the Colorado River compact. It is hoped that an upper-basin compact will be negotiated and submitted to the various State legislatures for ratification and to Congress for approval within a reasonable time in view of the complex nature of the problems involved.

The apportionment among the States of the lower basin of the water apportioned to the lower basin by the Colorado River compact has been effected by the Colorado River compact, the Boulder Canyon Project Act, the California Limitation Act, the Mexican treaty, the contract between the United States and the State of Arizona, the contract between the United States and the State of Nevada, and the contracts between the United States and agencies of the State of California.

The Colorado River compact (art. III (a) and (b)) apportions to the lower basin 8½ million acre-feet of water annually in perpetuity. In consideration of the passage of the Boulder Canyon Project Act and its becoming effective, the Legislature of California adopted the California Limitation Act (ch. 16, California Stats. 1929), as required by the Boulder Canyon Project Act, which limits California's use of water of the Colorado River irrevocably and unconditionally, and for the benefit of Arizona, Colorado, Nevada, New Mexico, Utah, and Wyoming, to 4,400,000 acre-feet of the 8½ million acre-feet apportioned to the lower basin, in perpetuity, for use each year by the Colorado River compact.

Of the 8½ million acre-feet apportioned to the lower basin there is thus left 4,100,000 acre-feet which cannot lawfully be used anywhere except in Arizona and Nevada and those small parts of New Mexico and Utah

which are in the lower basin as defined by the Colorado River compact. Nevada has a contract with the United States, acting through the Secretary of the Interior, for delivery of 300,000 acre-feet per year for use in Nevada, which it is believed is as much as Nevada can reasonably expect to put to beneficial use.

Deducting the 4,400,000 acre-feet for California and the 300,000 acre-feet for Nevada, there is left 3,800,000 acre-feet of apportioned water which cannot lawfully be used anywhere except in Arizona and those small parts of Utah and New Mexico which are in the lower basin.

It is indicated by your report that the total ultimate possible use of water of the Colorado River system in those parts of Utah and New Mexico which are in the lower basin, including all present and possible future uses, will amount to not more than 131,000 acre-feet per year. There is thus left 3,669,000 acre-feet per year which cannot be used lawfully anywhere except in Arizona.

Arizona is using out of the main stream of the Colorado River and out of the tributaries of the Colorado in Arizona, a grand total of 1,407,000 acre-feet of water per year. Thus there is left for Arizona, of the apportioned water in the main stream of the Colorado River, 2,262,000 acre-feet for additional apportionment and beneficial consumptive use. This quantity of water is apportioned water and does not include any water legally usable elsewhere in either the upper basin or in the lower basin and ample provision has been made for the ultimate possible uses in Nevada and those portions of Utah and New Mexico which are in the lower basin.

Arizona has a contract made with the United States, acting through the Secretary of the Interior, under which the United States agrees to deliver the quantity of water hereinabove indicated from its storage on the main stream of the Colorado River for beneficial consumptive use in the State of Arizona. The State of Arizona has appropriated \$200,000, matched by an equal amount from the Bureau of Reclamation, with which funds the Bureau of Reclamation and the State of Arizona have cooperated and are now cooperating in making investigations and surveys concerning projects in Arizona for the utilization of the water above referred to, which investigations and surveys are now nearing completion. It is believed that final reports of the Bureau of Reclamation on some projects in Arizona will be completed and submitted in the very near future.

In 1937, by Executive order, the Bureau of Reclamation was authorized to construct works for the development and irrigation of 150,000 acres of land in the first unit of the Gila project in Yuma County, Ariz. Considerable progress has been made in the construction of such works and part of that land is now in cultivation

and will be available shortly for settlement by veterans of the armed forces of the United States.

Further investigations by the Bureau of Reclamation have indicated that it would be more in the public interest to leave out of development a portion of the land in the Yuma-Mesa division, which was included in the original plans, and to rearrange the project boundaries and in lieu of the lands recommended to be eliminated on the Yuma-Mesa division of the Gila project, to include lands of approximately equal acreage in the Wellton-Mohawk division of the Gila project. Accordingly it is hoped that the next Congress will pass a bill reauthorizing the Yuma-Mesa division as reduced and authorizing the Wellton-Mohawk division, both in the first unit of the Gila project. The Wellton-Mohawk division is referred to in the comprehensive report on pages 164 and 170-172, and it is not made clear in the report that the Wellton-Mohawk division is not a new project, but constitutes merely a reorganization of the first unit of the Gila project which has been previously authorized, and I would appreciate it if your report made that fact clear.

It is hoped that the Bureau of Reclamation will soon complete its report on the Bridge Canyon and central Arizona project.

Arizona, therefore, desires to select two projects for immediate construction—the first unit of the Gila project, including the reduced Yuma-Mesa division and the Wellton-Mohawk division thereof, and the Bridge Canyon and central Arizona project. We are informed that consumptive uses of water on the first unit of the Gila project, including the Yuma-Mesa division and the Wellton-Mohawk division, will not exceed 600,000 acre-feet per year, and that consumptive uses on the Bridge Canyon and central Arizona project will not exceed 1,100,000 acre-feet per year. These combined quantities of 1,700,000 acre-feet, deducted from the 2,262,000 acre-feet to which Arizona has a clearly established right, leaves 562,000 acre-feet of main stream water to which Arizona has a clearly established right for future and further development along the main stream of the Colorado River in the Parker area and in Mohave Valley, and in the Little Colorado River Basin.

You will note that in these figures of water supply and use we have not taken into account any of the surplus water. Arizona, under our contract with the United States, is assured of delivery by the United States, for use in Arizona, of one-half of the surplus in the main stream of the Colorado River in the lower basin, less one twenty-fifth of such surplus which Arizona has agreed may be utilized in Nevada in the event they should ever be able to use it.

In addition there is left in the main stream of the Colorado River 222,000 acre-feet of water in the lower basin

and there is also left in the main stream of the Colorado River in the lower basin all of the surplus, which it now appears may constitute a sizable quantity of water; however, it appears that at this time I should not propose projects that would use any part of that surplus water, leaving such projects for future consideration when the probable future course of development of Colorado River Basin as a whole has become more apparent. I do not desire to predicate the development of either of the projects herein selected upon the use of any water which might later be withdrawn by any other State, nor do we desire in any way to embarrass or prejudice developments in any other State in the basin.

The Wellton-Mohawk division and the Yuma-Mesa division of the first unit of the Gila project are very desirable and their immediate authorization and construction are very much in the national interest as well as in the interest of the State of Arizona, and I am sure they are feasible from every point of view.

The immediate authorization and construction of the Bridge Canyon and central Arizona project is essential in the national interest and in the interest of the State of Arizona and the people of the central valleys of Arizona, in furnishing a supplemental water supply to lands now inadequately irrigated in order to preserve the civilization now existing in the State of Arizona and to prevent possible economic chaos, for the reason that irrigation of lands in central Arizona has been expanded beyond the water supply of central Arizona, both by diversion from the surface streams and by pumping from the underground reservoirs to such a great extent that I am advised by engineers that the people of central Arizona are now using approximately 800,000 acre-feet of water per year more than comes into that area; in other words, they are exhausting underground reservoirs at a rate in excess of 800,000 acre-feet per year. Such a practice, of course, endangers the entire economy of Arizona and creates a very real danger to the economy of the United States and to the national interest.

In view of the rapid exhaustion of underground reservoirs, we in Arizona have determined that two things are necessary: we must adopt an underground water code which will prevent overpumping and we must obtain a supplemental supply of water by the diversion of water from the main stream of the Colorado River to central Arizona.

Bridge Canyon and central Arizona project will make possible and bring about the diversion of main stream water to the central valleys of Arizona.

We are working on an underground water code. The Legislature of Arizona appropriated \$40,000, to be matched by an equal amount from and utilized by the United States Geological Survey, cooperating with the State Land and Water Commissioner of Arizona, in

making investigations and compiling information concerning the underground water supply of Arizona. I am informed that such studies are now sufficiently advanced to permit the drafting of an adequate underground water code for Arizona and that a bill has now been drawn for presentation to the legislature which convenes in January 1947. I confidently expect that at that session an adequate, workable, and satisfactory underground water code will be adopted.

I believe that the Bridge Canyon and central Arizona project will be found feasible and highly beneficial from every point of view and that it will be found that the people of central Arizona, utilizing the main stream water to be delivered to that area through the proposed works, with the aid of revenue from the hydroelectric energy that will be generated at Bridge Canyon Dam, will be able to repay the costs properly chargeable to irrigation and power within a reasonable time to the Treasury of the United States.

The Mexican treaty allocates to Mexico, and limits Mexico's use of Colorado River water to, 1,500,000 acre-feet of water per year. The figures used in this letter make due allowance for such Mexican allocation and Arizona's proposed use of the water allocated to her does not in any way infringe on Mexico's supply.

In the following table I summarize Arizona's understanding of the water supply in the lower basin and of the apportionment of water in the lower basin and of the quantities of water available to Arizona, which table, I believe, makes our position clear:

*Available supply and apportionment of water in the lower basin*

	<i>Acre-feet</i>
Virgin flow at Lees Ferry.....	16, 271, 000
Less apportionment to upper basin (art. III (a) Colorado River compact).....	7, 500, 000
	<hr/>
	8, 771, 000
Natural gain from tributaries Lees Ferry to Boulder Dam.....	1, 060, 000
	<hr/>
	9, 831, 000
Natural gain from tributaries Boulder Dam to Mexican border.....	1, 466, 000
	<hr/>
	11, 297, 000
Less losses natural and reservoir, estimated....	1, 075, 000
	<hr/>
	10, 222, 000
Allocated to Mexico by treaty.....	1, 500, 000
	<hr/>
	8, 722, 000
Apportioned to lower basin (art. III (a) and (b) Colorado River compact).....	8, 500, 000
	<hr/>
Not apportioned to lower basin but present in lower basin.....	222, 000
Potential uses of water in other States of the lower basin apportioned to lower basin.....	8, 500, 000

*Available supply and apportionment of water in the lower basin—Continued*

	<i>Acre-feet</i>
Potential uses in California limited by	
California Limitation Act.....	4,400,000
Nevada contract.....	300,000
Ultimate possible uses Utah and New Mexico.....	131,000
	<hr/> 4,831,000
Usable only in Arizona.....	3,669,000
Present uses in Arizona from main stream and tributaries, including Gila.....	1,407,000
	<hr/> 2,262,000
Left for Arizona, additional main-stream water (consumptive uses).....	2,262,000
	<i>Acre-feet</i>
Consumptive use, Yuma-Mesa and Wellton-Mohawk divisions of Gila project.....	600,000
Consumptive use, Bridge-Canyon and central Arizona project.....	1,100,000
	<hr/> 1,700,000
Left in main stream apportioned to Arizona for future development and consumptive use in Arizona.....	562,000

## THE COLORADO RIVER

(All of the water-supply figures in this table are from your report.)

We in Arizona are making economic studies and studies of the benefits which will accrue to the State and to the Nation from the construction of the projects herein selected. We expect that the information thus obtained will be available for consideration by the appropriate congressional committees at the next session of Congress.

I assure you of my appreciation of the opportunity given me to make comments upon the report, and of my desire, which I am sure is shared by all of the people of Arizona, to cooperate with the United States and with our sister States in every way to the end that the greatest possible development may be made of the use of the waters of the Colorado River in the best interests of the basin and of the United States.

Sincerely,

(Signed) SIDNEY P. OSBORN,  
Governor.

# Comments of the State of California

EARL WARREN, *Governor*

STATE OF CALIFORNIA

DEPARTMENT OF PUBLIC WORKS

SACRAMENTO

FEBRUARY 28, 1947.

HON. J. A. KRUG,

*Secretary of the Interior, Washington, D. C.*

DEAR SIR: Your proposed report, entitled "The Colorado River," was received on June 22, 1946, and has been reviewed in accordance with the provisions of Public Law 534, Seventy-eighth Congress, second session. On June 24, 1946, the report was referred to the division of water resources of this department for review and report thereon.

The report of the division of water resources, prepared in collaboration with the Colorado River Board of California, has been received and is transmitted herewith. I concur in the conclusions and recommendations set forth in the report of the division of water resources and request that it be considered as expressing the views and recommendations of the State of California on your proposed report entitled "The Colorado River."

Yours very truly,

(Signed) C. H. PURCELL,  
*Director of Public Works.*

## INTRODUCTION

In accordance with section 1 of the Flood Control Act, 1944 (approved December 22, 1944, 58 Stat. 887), the proposed report of the Secretary of the Interior, entitled "The Colorado River," was transmitted on June 13, 1946, to the director of public works, the official designated by Gov. Earl Warren as his representative in such matters, for his views and recommendations thereon. The report was received by the director of public works on June 22, 1946, and referred by him to the State engineer and chief of the division of water resources on June 24, 1946, for review. The report was referred by the State engineer on June 24, 1946, to the Colorado River Board of California and the State department of natural resources for review and comment.

The 90-day period, as provided by the Flood Control Act, 1944, for consideration of the report by the affected

States expired on September 17, 1946. Upon request of several affected States, the Secretary of the Interior agreed to withhold transmission of his report to the Congress "for an additional 90 days, or, in other words, for a period of at least 180 days from the date on which the report was received by the affected States." Subsequently, the director of public works, because of unavoidable delays, requested the Secretary of the Interior to withhold transmittal of his report to the Congress until submission on February 15, 1947, of the views and recommendations of the State of California.

This review has been prepared by the State division of water resources in collaboration with the Colorado River Board of California.

The proposed report of the Secretary of the Interior as originally submitted was in mimeographed form, comprising 392 pages and 11 maps. Later a printed edition of the report was issued, comprising 293 pages, with the same maps included in the original document. The report is divided into three main parts, namely:

1. Proposed report of the Secretary of the Interior, consisting of a letter, dated June 6, 1946, from William E. Warne, Acting Commissioner, Bureau of Reclamation, to the Secretary of the Interior, which letter was approved on June 7, 1946, by Oscar L. Chapman, Acting Secretary of the Interior.

2. Regional directors' report, dated March 22, 1946.

3. Substantiating material, with a foreword and the following chapters: I. The Natural Setting, II. Claiming the Basin, III. Dividing the Water, IV. Developing the Basin, V. Using the Water, VI. Power From Water, VII. Wealth from Water, VIII. Cooperating Interests in the Basin; and the following appendixes: I. Water Supply, Colorado River, and II. Eleven Colorado River Basin Maps.

It is stated in the letter of the Acting Commissioner to the Secretary of the Interior, dated June 6, 1946, that the report submitted is "a comprehensive report on the development of the water resources of the Colorado River Basin for irrigation, power production, flood and silt control, and other beneficial uses in the States of Arizona, California, Colorado, Nevada, New Mexico, Utah, and Wyoming." However, in the regional directors' report, the proposed report is characterized as an "inventory of potential projects" and it is stated that these "potential projects considered as a group in-

dicade in general the ultimate potentialities of future developments."

The conclusions expressed in the Acting Commissioner's letter are as follows:

(a) "There is not enough water available in the Colorado River system for full expansion of existing and authorized projects and for development of all potential projects outlined in the report, including those possibilities for exporting water to adjacent watersheds.

(b) "The formulation of an ultimate plan of river development, therefore, will require selection from among the possibilities for expanding existing or authorized projects as well as from among the potential new projects. Before such a selection for ultimate development can be made it will be necessary that, within the limits of the general allocation of water between upper basin and lower basin States set out in the Colorado River compact, the Colorado River Basin States agree on suballocations of water to the individual States."

In the Acting Commissioner's letter are listed 134 potential projects or units of projects which are stated to be in addition to existing and presently authorized projects or extensions of projects. These 134 projects which would be operated for irrigation, power, and flood control, would comprise 136 reservoirs (including some alternates) with an aggregate capacity of 51,493,850 acre-feet and 38 power plants with a total installed capacity of 3,658,000 kilowatts, generating 19.4 billion kilowatt-hours of energy per year. It is stated in the report that these reservoirs, together with canals, pumping plants, and other works, would furnish an irrigation supply for 1,533,960 acres of new land and a supplemental supply for 1,122,270 acres of presently irrigated lands. Of these projects, 100 are listed under "Upper basin," with an estimated total cost of \$1,216,227,200, and 34 are listed under "Lower basin," with an estimated aggregate cost of \$1,701,120,000. The report also makes some reference to a number of potential transmountain diversion projects in the upper basin, which, if built, would consume over 3,000,000 acre-feet of water, as stated in the report. In addition to the foregoing projects there is an item in each list entitled "Transmission Grid," which has an estimated cost of \$255,000,000 for the upper basin and \$288,150,000 for the lower basin, making totals of \$1,471,227,200 and \$1,989,270,000 for the upper and lower basins, respectively, or a grand total of \$3,460,497,200 for the entire basin for all items. The foregoing estimates of cost are stated to be based upon current construction costs.

It is further stated in the letter of the Acting Commissioner that "There are, in addition to the projects listed in the foregoing table, six existing Indian projects which now have an irrigated area of 2,470 acres. It is planned to enlarge these projects (Fort Mojave, Havasupai, Hualapai, Hopi, Moapa, and Uncompahgre) by

an additional irrigable area of 30,200 acres, which, when completed, would cause an estimated depletion of 73,000 acre-feet annually."

With respect to economic justification of the projects as listed, the following statement is contained in the letter of the Acting Commissioner:

"Estimates of the annual benefits from construction of the above potential projects have been made for illustrative purposes to show the probable economic justification of the ultimate comprehensive development. On the basis of average annual benefits and annual costs based on current prices, the ratio of benefits to costs is approximately 1.00 to 1.00, which is a conservative estimate."

In the report estimates of capital costs of the individual projects are presented, but estimates of annual costs and analyses as to economic justification are presented only for the group as a whole.

With respect to recommendations, the Secretary of the Interior, in approving the letter of the Acting Commissioner, approves the following statement: "I concur generally in the recommendations of the regional directors as summarized in paragraph 70, page 22, of their report."

The recommendations of the regional directors are as follows:

"The following recommendations are made in view of the fact that there is not enough water available in the Colorado River system to permit construction of all the potential projects outlined in the report and for full expansion of existing and authorized projects, and that there has not been a final determination of the respective rights of the Colorado River Basin States to deplete the flow of the Colorado River:

"(1) That the States of the Colorado River Basin, acting separately or jointly, recommend for construction, as the next stage of development, a group of projects, the stream flow depletions of which will assuredly fall within ultimate allocations of Colorado River water which may be made to the individual States.

"(2) That the States of the Colorado River Basin determine their respective rights to deplete the flow of the Colorado River consistent with the Colorado River compact.

"(3) That additional investigations, summarized below, and appropriations to the Department of the Interior for use by the various agencies within that Department for these investigations, be approved.

"(a) The Bureau of Reclamation to continue and expand its detailed investigations of potential projects within the States of the Colorado River Basin to obtain adequate information by which the Department of the Interior in cooperation with the basin States can formulate a comprehensive plan for use of all the water resources of the basin and select and recommend projects for successive stages of development.



“(b) The Geological Survey, National Park Service, Fish and Wildlife Service, Grazing Service, Bureau of Mines, Office of Indian Affairs, and General Land Office to initiate or continue to conduct such investigations and studies as required by the Secretary of the Interior to formulate and carry out the comprehensive plan.”

The regional directors' report summarizes the information and findings set forth under the eight chapters and two appendixes under the section entitled “Substantiating Material,” draws certain conclusions, the substance of which are set forth in the letter of the Acting Commissioner, and makes the recommendations as given above.

The conclusions of the regional directors' report are:

(a) “Future development of the water resources of the Colorado River Basin is needed to relieve economic distress in local areas, to stabilize highly developed agricultural areas, and to create opportunities for agricultural and industrial growth and expansion throughout the Colorado River Basin. Such development should be comprehended in a basin-wide plan for ultimate development of all water resources of the basin.

(b) “The potential projects outlined in this report will form the basis for future detailed investigations and the selection and construction of sound projects.

(c) “Considered as a group, these projects are an index of the over-all results and benefits to be expected from the development and utilization of all the available waters of the Colorado River system. They indicate also the engineering feasibility and economic justification of an over-all plan for basin development.

(d) “Planning has progressed sufficiently to make possible a selection from among the potentialities of a group of projects to comprise a construction program for the next stage of basin development. These projects should be key features of or should fit into the final comprehensive plan to be developed through continued investigations and planning.

(e) “There is not enough water available in the Colorado River system for full expansion of existing and authorized projects and for all potential projects outlined in the report, including the new possibilities for exporting water to adjacent watersheds.

(f) “The need for a determination of the rights of the respective States to deplete the flow of the Colorado River consistent with the Colorado River compact and its associated documents therefore is most pressing.

(g) “It is concluded that future development of the water resources of the Colorado River Basin would benefit the national and local economies and a plan for development of all the water resources of the basin should therefore be effectuated, that the selection of a group of projects comprising the next stage of development would represent a logical step in effecting that

plan, and that detailed investigations to develop the succeeding stages should be continued.”

This review of the proposed report of the Secretary of Interior entitled, “The Colorado River,” dated June 7, 1946, is presented under the following subject headings: (1) Colorado River Compact and Relevant Statutes, Decisions, and Instruments; (2) Analysis of Regional Directors' Report; (3) Water Supply; (4) Water Requirements; (5) Potential Projects; (6) The Silt Problem; (7) Electric Power; (8) Economics of Potential Projects; (9) Review by State Department of Natural Resources; (10) Concluding Comments; and (11) Recommendations.

#### COLORADO RIVER COMPACT AND RELEVANT STATUTES, DECISIONS, AND INSTRUMENTS

The development of the Colorado River is affected in many respects by a series of statutes, decisions, and instruments. The volume of reference material is large, and any complete reference would be burdensome, therefore the following is intended only as an index of some of the most pertinent material. For convenience of reference, the following are listed:

(a) Colorado River compact, signed at Santa Fe, New Mexico, November 24, 1922 (Federal Reclamation Laws, Annotated, 1943, pp. 363, et seq.).

(b) The Reclamation Act of June 17, 1902 (32 Stat. 388), and amendments thereto.

(c) The Boulder Canyon Project Act, approved December 21, 1928 (45 Stat. 1057).

(d) Contracts as executed by the Secretary of the Interior (pursuant to the Project Act), with various water using and power agencies.

(e) Decisions of the United States Supreme Court, particularly—

(1) *Arizona v. California* (283 U. S. 423);

(2) *Arizona v. California* (292 U. S. 341);

(3) *Arizona v. California* (298 U. S. 558).

(f) Reclamation Project Act of 1939, approved August 4, 1939 (53 Stat. 1187), and amendments thereto.

(g) Boulder Canyon Project Adjustment Act, approved July 19, 1940 (54 Stat. 774).

(h) Flood Control Act, 1944, approved December 22, 1944 (58 Stat. 887).

(i) Treaty between the United States of America and the United Mexican States, ratified by the Senate of the United States of America, April 18, 1945, and effective November 8, 1945 (Treaty Series 994, U. S. Government Printing Office: 1946).

#### ANALYSIS OF REGIONAL DIRECTORS' REPORT

The regional directors' report constitutes a summary of the entire report on the Colorado River. It covers briefly all the salient features that are presented in greater detail in the “substantiating material” to which the bulk of the report is devoted. Accordingly, detailed comments presented herein, although directly relating chiefly to the directors' summary report, may

be appropriately considered as relating also to the substantiating material. In presenting these detailed comments the subject headings and numbered paragraphs of the directors' report have been followed. However, certain comments are included with direct reference to the "substantiating material" and the letter of transmittal to the Secretary of the Interior.

#### *"Scope and Purpose"*

Paragraph 2 contains certain broad statements with respect to the report, which, it is believed, may be misunderstood, or may convey unwarranted implications. For example, with reference to the inventory of 134 projects or units of projects presented in the report as possibilities for future development within the natural drainage basin of the Colorado River, it is stated that "estimates of costs, benefits, possible reimbursability and depletory effect on stream flow are presented."

The report does present estimates of capital cost but does *not* contain estimates of annual costs for these projects, individually. Estimates of annual cost are presented only for the group as a whole and without substantiating details. Indications are that the estimates of capital cost are rough preliminary approximations and that cost estimates will be increased materially when and if further surveys and explorations are made and detailed plans are prepared.

The report presents estimates of annual "benefits" and compares them with estimated annual costs for the entire group of 134 projects but not for individual projects. This comparison of estimated "benefits" to cost has no relevancy to the showing of economic feasibility required by existing reclamation law, for the reason that the law requires that economic feasibility be determined by a showing that payments for water and other revenues properly credited to *any* project will be sufficient to repay reimbursable costs and other necessary charges. Furthermore, the law requires that reports on engineering and economic feasibility be made for proposed projects *individually*, not for basin-wide groups of projects which are not interrelated nor interconnected. In addition, the estimate of annual "benefits" is questionable in itself with respect to both irrigation "benefits" and power "benefits." Detailed comments with respect to these matters are presented subsequently herein under the heading "Summary of Annual Benefits and Costs of Potential Projects" and in section 8.

The statement in paragraph 2 implying that the report presents "possible reimbursability" may be misunderstood. Such figures as are presented in the report as to reimbursability, even for the entire group of 134 in-basin projects, indicate clearly that revenues will be insufficient to repay reimbursable costs together with other necessary charges in accordance with existing reclamation law, and the report so states. No showing

is made in the report as to reimbursability of *individual* projects, as definitely required by existing reclamation law.

In view of the foregoing, the statements in paragraph 2 that the report provides a basis for planning development "on a sound basis" and that it is intended to serve "as a guide in the selection of projects," do not appear warranted. The data and analyses presented with respect to engineering plans, water supply and requirements, costs and economic feasibility do not provide a "sound basis" nor do they offer an adequate or proper "guide" in the selection of additional projects. Much additional engineering and economic data and analyses are needed and should be furnished to the interested States and to the Congress before a proper selection of sound and worthy projects can be made and enable work to proceed in the formulation of a comprehensive plan of development. Such additional data and analyses are also essential to an intelligent consideration by the Congress of possible requests for authorization of any new projects.

The purpose of the report is further indicated in the statement appearing in the letter dated June 6, 1946, from the Acting Commissioner to Secretary of the Interior, as follows:

"The report is submitted to you pursuant to section 9 of the Reclamation Project Act of 1939 (53 Stat. 1187) and pursuant to section 15 of the Boulder Canyon Project Act (45 Stat. 1057). Upon clearance with the affected States and with the Secretary of War, copies of the report, together with comments, if any, of the affected States, and of the Secretary of War, will be submitted for your transmittal to the President and, subsequently, to the Congress."

The provisions of the Federal acts referred to contemplate the submission to the Congress of reports looking to the authorization of new projects. Obviously the report under review does not provide a proper or adequate basis for authorization of any individual new project, or for a basin-wide plan of development. It is only a preliminary progress report presenting a broad outline of potentialities, by an inventory of possible new projects. The report does not constitute a plan, such as is called for by section 15 of the Boulder Canyon Project Act, either with respect to individual projects or basin-wide developments; nor does it comply with the requirements of section 9 of the Reclamation Project Act of 1939.

The report does offer a proper basis for a request for the appropriation of funds for continuation of investigations and studies looking to the formulation of a comprehensive plan and the selection of projects making up such plan in cooperation with the interested States. Any request for authorization predicated upon the report should be restricted accordingly.

*"Description of Area"*

Although reference is made in the report to potential projects for exportation of water from the Colorado River Basin, the report, for the most part, is limited to the natural drainage basin of the Colorado River within the United States. This is an artificial limitation which does not accord with the Colorado River compact, the Boulder Canyon Project Act, and related legislation. The Colorado River compact defines the "Colorado River Basin" as "all of the drainage area of the Colorado River system and *all other territory within the United States of America to which the waters of the Colorado River system shall be beneficially applied.*" [Emphasis supplied.] It is obvious that a comprehensive plan for the development of the Colorado River system should include not only projects within the natural drainage basin but also projects for exportation of water from the basin for use in adjacent areas within the seven Colorado River Basin States.

The omission of information and data on potential exportation projects results in an incomplete picture, not only from the standpoint of potentialities of basin development but also as to related costs and economic aspects. The report should include full data and information on all projects, existing and potential, having to do with the regulation, control and utilization of waters of the Colorado River system.

It is noted (par. 6) that, in describing the natural drainage basin of the Colorado River, the Salton Sea Basin in California, embracing the Imperial and Coachella Valleys, is excluded therefrom, although discussed as a part of the lower Colorado River Basin. The reason given in the substantiating material for this distinction is that "whatever Colorado River water reaches it cannot return by gravity flow to the parent stream." However, it should be pointed out that over a period of many centuries the Colorado River flowed into and out of the Salton Sea Basin and that the recurrence of such an event is or will be prevented only by river regulation and levee protection along the river. Although it does not appear to be material, since the waters of the Colorado River system are now and may be used legally for irrigation and other purposes, both within and without the natural drainage basin, it is believed that the distinction made is unwarranted. The Salton Sea Basin should be considered to be a part of the drainage basin of the Colorado River as was done in former reports of the Bureau of Reclamation.

Paragraph 13 refers to the construction of Boulder Dam and its functions. The report fails to state one of the most important functions of the Boulder Canyon project; namely, that, in conformity with article VIII of the Colorado River compact, waters stored by Boulder Dam are dedicated, to the extent necessary, to the sat-

isfaction of the prior perfected rights of appropriators in the lower basin to the natural flow of the Colorado River. This was and is one of the chief purposes of the Boulder Canyon project. Only by reason of the construction of Boulder Dam and the storage of waters thereby to serve the prior established rights in the lower basin is it possible for junior appropriators in the upper basin to use the waters of the river. Such uses might have been enjoined, before the Colorado River compact and Boulder Canyon project were provided.

*"Problems of the Basin"*

In the discussion of the problems of the basin the report (par. 18) refers to the situation in the Phoenix area of Arizona with the statement that "population pressure, with its attendant demand for farm homes, has resulted in an overdevelopment of the water resources of the Phoenix area." The facts in regard to overdevelopment in that area are well known and recognized. Most of the overexpansion of irrigated lands has been brought about by extensions of underground pumping. It is reported that this has occurred with full knowledge on the part of responsible water users, and the officials concerned with water in Arizona, as to the amount of water available for use and the practical limit of development from the waters of the Salt and Gila Rivers and tributaries. It is understood that there has been an intense activity to develop new irrigated lands during recent years, and this activity has resulted partly from the opportunity for large profits with high crop prices and partly from the desire to develop lands and to establish rights to the use of water prior to the passage of a State water code. Such a code providing for control of use of underground water has been under active consideration by the Arizona Legislature. Had such a code been in effect, it would have prevented such overexpansion of underground pumping, which is responsible for most of the over-all indicated water shortage of the Phoenix area.

Paragraph 20 refers briefly and inadequately to the silt problem of the Colorado River. Detailed comments with respect thereto are presented in section 6 of this review.

Paragraph 24 refers to the water treaty between the United States and Mexico, which necessitates certain facilities and arrangements for delivery of water to Mexico. It is important to point out that there are many matters with respect to the administration and the interpretation of the treaty which are still to be worked out. Domestic legislation is needed and should be enacted to clarify certain sections of the treaty, properly to protect the interests of water users in the United States, and to provide for effective administration. The vital effect of the treaty on American interests and the

amount of water available for use within the United States warrants a much more detailed consideration of the problems involved than the report contains.

Paragraph 25 refers to present and future possible diversions or exportations from the basin into the adjacent basins. It is stated that "an ultimate diversion of 3,380,000 acre-feet annually from the upper basin is physically possible apparently at reasonable cost but the exportation of this amount would substantially limit potential within-basin uses." Just what is meant by the expression "at reasonable cost" is not disclosed in the report, since no cost figures or economic analyses are presented therein for these possible additional exportation projects. It is not known nor does the report reveal whether such projects would be economically feasible under existing reclamation law. The statement is of chief significance in revealing the grave danger of over-developing the water resources of the Colorado River system, since the combined water requirements of potential in-basin and out-of-basin projects far exceed the amount of water that will be available for new projects in the upper basin under the Colorado River compact. The report shows an annual water requirement, in terms of main stream depletion, for all of these potential projects, together with existing and authorized projects in the upper basin, of over 9,000,000 acre-feet, as compared to an annual supply available to the upper basin under the compact of 7,500,000 acre-feet.

At about the time the Colorado River compact was signed exports from the upper basin were estimated at 104,000 acre-feet, and it was further indicated that the probable maximum ultimate exportation would total 421,000 acre-feet annually (p. 173, Fall-Davis report, S. Doc. 142, 67th Cong., 2d sess.).

It now appears from the report that the possible annual export from the upper basin, 3,380,000 acre-feet, would amount to over eight times the total annual amount, 421,000 acre-feet, anticipated at the time the Colorado River compact was executed.

The situation revealed by the data presented demonstrates the necessity for an allocation of water among the States in the upper basin and the selection of projects which will fall within individual State allocations.

Paragraph 26 states that "the All-American Canal and the Colorado River aqueduct are now exporting about 2,500,000 acre-feet of water from the lower Colorado River for use in California," and that "potential expansion of these diversions to 5,300,000 acre-feet is possible but would likewise conflict with potential uses within the basin."

The question whether water diverted by the All-American Canal to Imperial Valley constitutes an exportation or a use within the basin is immaterial. The report omits the important fact that the Imperial Valley area, served by the All-American Canal project, has

established rights initiated during the 1890's—rights among the earliest on the river—to the use of 10,000 second-feet of Colorado River water. The Colorado River compact and the Boulder Canyon Project Act recognize that these rights must be served by waters stored by Boulder Dam. The All-American Canal rights are also fully covered by contracts between the United States and Imperial irrigation district and Coachella Valley county water district.

The rights to export water to the urban centers on the coastal plain of southern California through the Metropolitan aqueduct are also covered by early filings and a contract between the Metropolitan water district of southern California and the United States. In addition, the city of San Diego has established rights covered by appropriation and by contract with the United States, which will be served through the Metropolitan aqueduct.

The report, in implying that these diversions of Colorado River water in California constitute "potential expansion," is in error in that it fails to point out that these rights are not only already established by appropriation and contract with the United States but also that the works have already been constructed to utilize this water; that the All-American Canal has been completed and is already in operation, except for the Coachella branch thereof, and that it is built to a capacity of 10,000 second-feet, sufficient to deliver approximately 4,000,000 acre-feet annually of Colorado River waters; that the agencies to be served by the All-American Canal have committed themselves by contract to repay the entire cost of these facilities under the reclamation laws; that the Metropolitan aqueduct has been constructed by the Metropolitan water district of southern California with funds provided by that district, and that with exception of a few features this aqueduct is built to full capacity, adequate for a diversion of 1,200,000 acre-feet annually; that a branch aqueduct is now being constructed from the Metropolitan aqueduct to the city of San Diego and the city has underwritten the cost thereof; and finally, that southern California agencies have expended or obligated themselves to spend in excess of \$500,000,000 for the Boulder Dam project and works and facilities in connection therewith.

#### *"Water Supply"*

Paragraph 28 presents estimates of available water supply in the Colorado River system in terms of long-time average "virgin flow." Paragraphs 29, 33, and 34 present estimates of water requirements in terms of "stream depletion," of existing, authorized, and potential projects, including totals under each category by States, and subtotals for the upper basin and lower basin. These subjects are treated in detail in sections 3 and 4 of this review.

*"Division of Water"*

Paragraph 30 states that the Colorado River compact signed at Santa Fe, N. Mex., on November 24, 1922, was made effective by subsequent ratification by the seven basin States, and by the enactment of the Boulder Canyon Project Act. Actually, the compact became effective, under the terms of the Boulder Canyon Project Act, through its ratification by six basin States, including California, and the passage of the California Limitation Act by the California Legislature in 1929. The subsequent ratification of the compact by the State of Arizona, in 1944, has only the effect of subjecting Arizona to the compact.

Paragraph 30 states that the report "makes no attempt to interpret the Colorado River compact or any other acts or contracts relating to the allocation of Colorado River water among the States and among projects within the States." However, a number of interpretations of the compact and related legislation are made or indicated in the report. As examples, interpretation—faulty interpretation—is involved in the use of "stream depletion" as representative of consumptive use requirements; also in the use of the flow at the international boundary as constituting the available water supply for apportionment and use under the compact.

*"Future Development of Water Resources"*

Paragraph 31 and subsequent paragraphs refer to the inventory of potential projects listed or referred to in the report. Paragraph 31 states that the presentation with respect thereto "is intended to be of use in the selection of projects which will comprise ultimately the final comprehensive plan." The data and analyses presented with respect to engineering plans, water supply and requirements, capital and annual costs, and economic feasibility, are inadequate as a basis for selection of additional projects or the formulation of a "final comprehensive plan." Much more detailed data and analyses will be required before an intelligent selection can be made or plans formulated for comprehensive development.

It is correctly stated that before a plan can be formulated and a selection of projects can be made it is necessary that a determination be made as to the allocation of water among the States of the Colorado River Basin under the terms of the Colorado River compact and related legislation. It should be pointed out in this connection, for clarity, that the allocation or division of water among the States must be made separately among States of the upper basin on the one hand and the States of the lower basin on the other.

In discussing future development, the report does not properly stress the propriety and justice of giving first consideration to providing the necessary water sup-

plies for existing operating projects and authorized projects under construction. The rights of existing projects and present water users should be fully protected and given first consideration in the planning of future developments on the Colorado River. New projects should be limited to the water supply that can be made available on an assured basis after fully meeting the requirements of projects already existing and in operation or authorized and under construction.

Paragraph 31 again uses the term "stream depletion" and similar terms in discussing allocation of water under the Colorado River compact and the selection of projects within such allocations. The compact does not set "stream depletion" as a standard for allocations of water but deals with "beneficial consumptive use" alone.

Paragraph 31 concludes with the statement that "it should be possible, prior to a final settlement of water rights, to select a group of projects which are urgently needed, or which will be key units of the comprehensive plan for construction as the next stage of the development." With respect to this statement, distinction must be made between the upper basin and the lower basin. As far as the lower basin is concerned, no new consumptive-use projects should be selected or authorized until a determination is made of the respective rights of the lower-basin States under the Colorado River compact, the Boulder Canyon Project Act and other relevant factors. As shown in a later section of this review, the water supply which will be available to the lower basin is sufficient only for existing operating projects, other projects which have been authorized and are under construction, and those for which commitments have been made. Accordingly, until a determination has been made of the rights of each lower-basin State, it will not be possible to determine how much water, if any, may be made available for any new consumptive-use project.

The situation in the upper basin, however, is quite different from that in the lower basin in that the water requirements of existing and authorized projects, as estimated in the report, are only about a third of the 7,500,000 acre-feet apportioned to the upper basin by the Colorado River compact. With this leeway it would appear that some new consumptive use projects may be authorized and constructed before a final division of water is reached among the upper-basin States. However, until a settlement has been reached as to the division of water among the States of the upper basin, authorization of new projects involving large consumptive uses of water should be carefully weighed. Each such project should be limited to a total consumptive use assuredly within the water allocations considered to be minimum for the State for which the project is to be constructed, after due allowances for the rights and requirements of existing and authorized projects.

Mr. H. W. Bashore, former Commissioner of Reclamation, and now acting as Federal representative and chairman of the Upper Basin Compact Commission, made the following statement at the annual convention of the National Reclamation Association in Omaha, Nebr., on October 10, 1946:

"In order to have a workable plan for basin-wide development of the Colorado River Basin which is fair to all it is necessary to find out how much water each State of the upper division contributes to flow of the Colorado River at Lees Ferry under virgin conditions, how much it must contribute to satisfy the terms of the Colorado River compact and the treaty with Mexico, how much it feels it should have for projects within its boundaries and how much it can share with its sister States. Furthermore, until this is done any further authorizations for new individual projects in the Colorado Basin, particularly if in compliance with existing reclamation laws as to repayment, will have to travel a slow and laborious pace with special legislation for each."

Projects in either basin for the primary purpose of developing hydroelectric power, largely nonconsumptive in effect, could and should be authorized and constructed when found to be justified and needed, in advance of the final determination of the division of water among the States under the Colorado River compact. Such projects should be consistent with the primary purposes of furnishing water supplies for irrigation and domestic purposes, should not be inconsistent with a comprehensive plan of progressive development, and should be economically sound under existing standards of feasibility.

Paragraph 33 and table I, under paragraph 34, present figures, on a basin-wide basis, as to water requirements in terms of main stream depletion. The ultimate requirements of existing and authorized projects are estimated on this basis at about 11,000,00 acre-feet annually, with estimated present use of about 7,000,000 acre-feet. The requirements of potential projects are estimated at about 9,000,000 acre-feet annually, including some 3,000,000 acre-feet for export projects. These combined requirements of existing and potential projects aggregate over 20,000,000 acre-feet annually, and thus exceed the average water supply available for use in the United States, as estimated in the report, by about 25 percent.

Paragraph 33 states that "predominant among existing or authorized projects which could be further developed are those in the lower basin made possible by construction of Boulder Dam." Again, in paragraph 34, reference is made to possible depletions "which would result from the extension of existing projects." As to such projects in California, it should be pointed out that works and facilities have already been constructed to

provide substantially for full development. No "further development" or "extension" is contemplated beyond that provided for by the works and facilities already substantially completed, under plans formulated many years ago. Nowhere in the report is the true status of existing and authorized projects in California adequately presented.

#### *"Potential Projects"*

Paragraph 35 refers to the 134 potential projects or units of projects within the natural drainage basin, and states that these "considered as a group indicate in general the ultimate potentialities of future development." Any consideration of the ultimate potentialities of future development should include, in addition to within-basin projects, the possible projects for exportation of water from the basin. Without full information with respect to all potential projects for utilization of Colorado River system waters, little or no assistance is given the interested States in the selection of projects.

Paragraph 36, in reciting the areas of lands which would be irrigated or benefited by the 134 potential in-basin projects, is not pertinent since it is already conceded, in the report in paragraph 33 and table I, there is not sufficient water supply to serve the 134 projects.

Paragraph 37 summarizes estimates in the report with respect to potential projects for hydroelectric power development and estimates of the power output therefrom. It is stated that the annual potential output (estimated at 9.2 billion kilowatt-hours for potential plants in the upper basin and 10.2 billion kilowatt-hours in the lower basin) "could be maintained substantially even with full development of the river system for irrigation and other purposes." Neither data nor analyses are presented to substantiate these estimates as to total energy output nor are the characteristics of the output revealed.

Adequate data and analyses are not shown regarding the possible marketing of the potential power output. It is evident that a large amount of additional studies and investigations is required with respect not only to plans and costs of potential hydroelectric-power development and power output but also with respect to power marketing.

Table II under paragraph 41 lists the 134 potential projects within the natural-drainage basin of the Colorado River, together with the estimated capital cost of each project, aggregating \$2,185,442,000 with the inclusion of \$362,100,000 for "transmission grids." It is stated that the capital cost estimates are "preliminary estimates based on construction costs January 1, 1940." Estimates based upon current prices, shown in the letter, dated June 6, 1946, from the Acting Commissioner of Reclamation to the Secretary of the Interior, are about 60 percent greater than 1940 estimates. The aggregate cost

for the 134 projects and transmission grids is stated as \$3,460,497,200.

The report states (par. 31) that "Detailed information is available for a substantial number of potential developments and only data of a reconnaissance nature for others \* \* \*" The capital cost estimates, even for projects on which more detailed information is available, are not only "preliminary" but are, apparently in some instances, rough approximations. For example, the capital cost of the Wellton-Mohawk project in Arizona is estimated in table II at \$10,600,000; the corresponding estimate in the Acting Commissioner's letter of June 6 is \$16,960,000, or 60 percent in excess of the former; but the most recent known estimate by the Bureau of Reclamation for this project, based upon 1946 prices, is \$24,376,948 (p. 73, hearings on H. R. 5434—a bill reauthorizing the Gila Federal reclamation project—House Committee on Irrigation and Reclamation, 79th Cong. 2d sess.). According to the testimony of a representative of the Bureau of Reclamation at these hearings, the difference of about \$8,000,000 between the latter two estimates, both based on then current prices, was due principally to the fact that the preliminary estimate in the report did not make proper allowance for the cost of works and facilities, found to be required after more detailed plans had been prepared. Other similar discrepancies have been observed as between the estimates in the report under review and estimates contained in other recent reports of the Bureau.

It may be noted that table II, which lists the potential projects within the basin, names only one such project in California, the Palo Verde Mesa project. This project would provide for the irrigation of about 16,000 acres of mesa lands adjoining the existing Palo Verde irrigation district. Actually, this is not a potential project in the same sense as the other potential projects listed, inasmuch as it is included within the water contract executed in 1933 between the United States and the Palo Verde irrigation district.

#### *"Summary of Annual Benefits and Costs of Potential Projects"*

Paragraph 42 refers to the analysis in the report regarding economic feasibility, which is based upon "estimates and approximations" with respect to the 134 potential within-basin projects listed in the inventory. It is stated that—

"This analysis is presented to indicate the economic feasibility of a comprehensive plan for ultimate development of the water resources of the basin. All projects are considered integral units of a basin plan and as such their economic feasibility is comprehended by the finding of feasibility for the over-all basin plan."

Paragraph 43 refers to allocation of costs, which is not presented, but which should be made as provided in section 9 of the Reclamation Project Act of 1939.

Paragraph 44 sets forth a summary of the purported showing of economic feasibility, based upon a comparison of so-called annual "benefits" and annual costs.

The procedure followed in the report, of purporting to show economic feasibility of each of a large group of projects by the pooling of estimates of annual costs and benefits of the group as a whole, is unsound. The benefit-cost ratio, as applied, is fallacious. The estimates presented as to the entire group of projects do not justify any individual project. It is essential that each new project be reported on individually as to engineering and economic feasibility and permanency of development.

A more complete discussion of this subject will be found in section 8 of this review.

#### *"Extended Benefits to the West and to the Nation"*

Paragraph 46 refers to the value of improved irrigated land as ranging from \$75 to \$300 an acre, and states that the reclaiming of the million and a half acres of new land envisaged under the 134 potential projects listed in the inventory "would probably add more than one-quarter billion dollars to taxable values \* \* \*" Only the best of the irrigated lands in the Colorado River Basin would have a value under normal conditions of \$300 an acre. As against such a value, the cost estimates in the report indicate that for a considerable part of the potential projects, the probable costs per acre range from \$400 to \$700.

With reference to the alleged indirect "benefit" in increased taxes, it would appear that insofar as irrigation development is concerned such "benefit" is already included in the irrigation "benefit" based upon gross crop value, which assumedly would reflect all costs, including taxes. Regardless, the propriety of considering increased taxes as a "benefit" is open to serious question, when used as a justification for Federal subsidization of the capital cost of reclamation projects. These comments apply, as well, to the reference in paragraph 48 to increased taxes, in connection with proposed hydroelectric power development.

#### *"Reimbursement and Flood Control Allocation"*

Paragraph 53 briefly summarizes such analyses as are presented in the report regarding cost allocations and estimated revenues from water and power for the 134 potential within-basin projects. The only cost allocation in the report is that for flood control, which is estimated at a capital amount of \$25,000,000, based on an estimated annual flood control benefit of \$1,000,000. Payments for water and power are estimated at a total of \$80,500,000 annually, comprising \$8,000,000 from ir-

rigation water users; \$500,000 from municipal water users; and \$72,000,000 gross revenue from hydroelectric power, nearly 90 percent of the total. It is estimated in the report that \$57,500,000 annually would be available for repayment of reimbursable costs and other fixed charges after meeting operation and maintenance charges.

In the absence of cost allocations, as among power, irrigation, and other functions and purposes, no proper analysis of economic feasibility on a repayment basis can be made, and none is shown in the report. However, the report states (ch. VII) that "it is quite likely, however, that when interest charges are considered the cost of the entire development will not be fully reimbursable." This statement reflects capital cost estimates on 1940 prices. The deficiency in revenues for meeting reimbursable costs would be correspondingly greater with capital costs based on current prices.

#### *"Construction Program"*

Paragraph 54 states that "there is need for proceeding at an early date with the construction of certain of the potential projects" and cites various immediate needs for water and electric power.

Paragraph 55 suggests that the affected States select projects for the next stage of development, comprising "those for which there is an immediate need and for which adequate water rights consistent with the Colorado River compact and its associated and dependent documents are assured"; and that when such a selection is decided upon, "it may be presented to the Congress as a program for authorization of construction."

The construction program as outlined makes no reference to projects already authorized and under construction. So far as California is concerned, priority in any immediate construction program should be given to the completion of the All-American Canal project. This project was authorized by the Congress in 1928. Repayment contracts were executed in 1932 and 1934 and construction has been under way since 1934. The project should be completed before new projects, particularly those of doubtful engineering feasibility and economic justification, are undertaken.

Another California project now under construction is the San Diego aqueduct. This project, though being constructed by the Navy, is mentioned in the report as a potential project (table CII). It is being constructed to meet a critical water shortage in a populous urban area. It is nearing completion and should be completed as rapidly as possible.

The program and procedure outlined for possible authorization of an initial group of new projects superficially appear, in general, to be reasonable. However, the statement in paragraph 55 that the economic feasibility of such an initial group of projects "would be

comprehended in the finding of feasibility for the overall ultimate development of the basin" is without justification. Each new project, in accordance with existing reclamation law, should be considered individually on its merits, on the basis of need, engineering feasibility including availability of water, and economic soundness based upon the ability to repay the reimbursable costs and other necessary charges.

An initial construction program could and should include hydroelectric power development when found needed and justified. Such projects are largely non-consumptive in effect. Discussion of such projects in the lower basin will be found in section 7 of this review.

#### *"Conclusions"*

The conclusions in paragraph 67 closely parallel or relate to the statements contained in paragraphs 54 and 55 with respect to construction program. Therefore, the foregoing comments may be considered to apply to paragraph 67 as well.

The conclusion in paragraph 68, as to the pressing need for determination of the rights of the respective States to the waters of the Colorado River system under the provisions of the Colorado River compact and related legislation, necessarily follows from the finding in the report that there is not enough water available in the Colorado River system to meet the requirements of existing and authorized projects, as well as all possibilities for new projects. Obviously, unless and until such a determination is made, the amount of water that may be available to meet the consumptive use requirements of new projects in the several States of the Colorado River Basin is an unknown quantity; a final selection of projects within each State's share of the water cannot be made; and no plan of comprehensive development of the Colorado River system can be formulated. Such determination of the division of water among the States is particularly essential in the lower basin because of the fact that the water supply that will be available to the lower basin under full basin development is not sufficient to meet the consumptive use requirements of existing operating projects and projects already authorized and under construction together with other recognized commitments.

#### *"Recommendations"*

Recommendations (1) and (2) under paragraph 70 should be modified in accordance with the recommendations presented at the conclusion of this review.

#### WATER SUPPLY

Factors of fundamental importance in the formulation of a proper comprehensive plan for the development of the water resources of the Colorado River and



its tributaries are adequate information on (a) the amount, location, occurrence, availability, and quality of the water supply; (b) location, extent and area of service, and unit water requirements thereof; and (c) works required to adequately serve the areas and the cost of such works.

The data and analyses in this section under the heads "Available Water Supply in Entire Basin," "Available Water Supply in Upper Basin," and "Available Water Supply in Lower Basin" have been prepared by the Colorado River Board of California.

*Stream Gaging Stations*

With respect to item (a) above, measurements have been made of flow of the main Colorado River and tributaries for varying periods. In chapter V of Substantiating Material, in the report under review, are listed 64 stream-gaging stations on the principal streams and tributaries with the average annual historical flow for the period of record and for the 1931-40 period, segregated as to the number of stations among the seven divisions of the basin as follows: Green, 10; Grand, 7; San Juan, 8; Little Colorado, 4; Virgin, 5; Boulder, 6; and Gila, 24. The longest periods of complete records as given in the report are Colorado River at Glenwood Springs, 1900-43; Green River at Green River, Utah, 1906-43; and Colorado River at Yuma, 1903-43. The stations with shortest records are Agua Fria River above Lake Pleasant, Ariz., 1933-43; Dolores River at Gateway, Colo., 1938-43; Santa Clara River below Gunlock, Utah, 1939-43.

In addition to the foregoing stream-gaging stations, there are other stations listed in United States Geological Survey Water Supply Paper 1009 (1944), making a total of over 300 stations for a coverage of 242,000 square miles of drainage area or an average of 1 station for about 800 square miles. The records of those stations are the primary basis for estimating the available water supply of the Colorado River and its tributaries. One of the most important of these stations is that at Lee Ferry on the Colorado River above the Paria River. This station has been in operation since June 1921. A station on the Paria River at its mouth has furnished records since October 1923. The sum of these two records furnishes the flow at Lee Ferry as that point is defined in the Colorado River compact.

*Stream Flow*

In appendix I of the report under review, certain information and data are given with respect to the water supply of the Colorado River. In table CXXXVII are given the recorded and estimated historical annual flows of the Colorado River at Lee Ferry for the period 1897 to 1943, inclusive. The average annual flow for the pe-

riod is given as 14,400,000 acre-feet, with a maximum flow of 23,295,000 acre-feet in 1909 and a minimum flow of 3,966,000 acre-feet in 1934. The estimated virgin or full natural flow of the Colorado River at Lee Ferry is set forth in table CXL of appendix I by years for the period 1897 to 1943, inclusive. The average annual virgin flow for that period is given in the table as 16,270,000 acre-feet, with a maximum of 25,255,000 acre-feet in 1909 and a minimum of 5,501,000 acre-feet in 1934. It may be noted that the foregoing figures show a wide variation in the estimated annual flows, the minimum being about one-third of the average and less than a quarter of the estimated maximum annual virgin flow for the period. This wide variation clearly indicates the need of ample carry-over storage to utilize beneficially the bulk of the waters of the Colorado River and its tributaries.

In appendix I, also, are given the estimated virgin flows of Salt River at Granite Reef Dam of 1,484,000 acre-feet for the period 1895 to 1943 and 1,264,000 acre-feet for the period 1923 to 1943, inclusive, and of the Virgin River at Virgin City, Utah, of 161,000 acre-feet for the period 1909 to 1943 and 143,000 acre-feet for the period 1923 to 1943, inclusive.

The average annual virgin flow at Boulder Dam site for the period 1897 to 1943 is estimated in appendix I as follows:

	<i>Acre-feet</i>
Average virgin flow at Lees Ferry.....	16, 270, 000
Average virgin gain to Boulder Dam site.....	1, 060, 000
	17, 330, 000
Average virgin flow at Boulder Dam site....	17, 330, 000

The virgin flow of the Colorado River at Laguna Dam (above mouth of Gila River) is estimated in appendix I as follows:

	<i>Acre-feet</i>
Virgin flow, Colorado River at Boulder Dam....	17, 330, 000
Plus tributary inflow, Boulder Dam to mouth of Gila.....	150, 000
Less natural channel losses.....	1, 030, 000
	16, 450, 000
Virgin flow, Colorado River at Laguna Dam (above Gila River).....	16, 450, 000

The annual virgin flows of the Gila River are estimated in appendix I for the period of 1897 to 1943, into the Phoenix area, at Gillespie Dam, and at mouth of the river, with average annual flows, respectively, of 2,279,000, 1,752,000, and 1,272,000 acre-feet. The large losses as estimated between Phoenix, Gillespie Dam, and the mouth of the river, are to be noted. The estimated annual virgin flows into the Phoenix area vary from a minimum of 712,000 acre-feet in 1934, to a maximum of 7,945,000 acre-feet in 1905.

The long time average annual virgin flow at the international boundary is calculated in appendix I as follows:

	<i>Acre-feet</i>
Average annual virgin flow, Colorado River at Laguna Dam.....	16,450,000
Average annual virgin flow of the Gila River at mouth.....	1,270,000
<hr/>	
Average annual virgin flow, Colorado River at international boundary.....	17,720,000

Referring to the estimated virgin flow of the Colorado River at Lees Ferry, as set forth in table CXL of the appendix I of the report under review, the average flow for the 10-year period 1931 to 1940, inclusive, is 12,214,000 acre-feet per year, with a maximum flow of 18,169,000 acre-feet in 1938 and a minimum flow of 5,501,000 acre-feet in 1934. For the 20-year period 1924 to 1943, inclusive, the average annual flow is estimated at 14,571,000 acre-feet with a maximum flow of 22,355,000 acre-feet in 1929 and a minimum of 5,501,000 acre-feet in 1934. Particular attention is called to the foregoing estimated averages of annual virgin stream flow at Lees Ferry of 12,214,000 acre-feet, for the 10-year period 1931 to 1940, inclusive, and 14,571,000 acre-feet for the 20-year period 1924 to 1943, inclusive, as compared to that for the 47-year period 1897 to 1943, inclusive, of 16,270,000 acre-feet. This comparison definitely shows how misleading it is to deal in average annual figures of water supply when formulating a plan of water development.

#### *Inadequacy of Estimates in Report*

The foregoing information and any information or data given in the report under review on water supply are inadequate for the purpose of preparation of a comprehensive plan for the development and utilization of the water resources of the Colorado River system. The report is lacking in information as to the amount, occurrence, and availability of water supplies as related to the proposed area of service.

In comparing water supply and water requirements, the report estimates the water supply available in terms of the natural or virgin flow in the main stream at the international boundary, rather than at actual or potential places of use throughout the basin. In turn, water requirements and use of water are estimated in terms of depletion of the main stream flow as at the international boundary, instead of in terms of consumptive use at actual or potential places of use. The report omits a definition of "consumptive use," although definitions of "return flow" and "stream depletion" are included in the list at the end of the "Foreword." The estimates of stream depletion are not set forth for individual projects and are not sufficiently substantiated by supplementary data. No estimates are presented of water supply available separately to the upper basin and to the lower basin, under full basin development and within the provisions of the Colorado River compact.

The first prerequisite of engineering feasibility of any irrigation or other water supply project is a showing as to the availability of a dependable and assured water supply at the place of use. In view of the recognized shortage of water available in the Colorado River system to meet all requirements, there is grave danger of overexpansion. If overexpansion occurs, it will threaten the security of existing projects, as well as do untold harm to new projects. For these reasons quantitative estimates of the available water supply should be made as realistically and accurately as possible with the data available, and should be made individually for actual and potential places of use, with due consideration of the natural losses which occur under virgin conditions, but which in part are or will be prevented and made available for beneficial use. Operation of reservoirs to control and regulate the stream flow will result in reduction of the areas overflowed during flood seasons, and with channel rectification to confine the reduced flows of the river will prevent a large part of the loss which occurs under natural conditions. Diversion and beneficial use of water at projects upstream from channel areas where substantial losses naturally occur will further reduce and possibly eliminate such losses. Therefore, estimates of water supply based on virgin conditions and estimates of use based on depletion of the virgin flow of the river at the international boundary are not applicable. This fact is revealed in the report itself. For example, in paragraph 28 of the regional directors' report, under the heading "Water Supply," the statement is made that from the virgin flow of the river at the international boundary there is to be subtracted 1,500,000 acre-feet annually as representing the Mexican burden, "leaving for consumption in the United States an average of 16,220,000 acre-feet *plus such water as was consumed under virgin conditions by natural losses, preventable in part with full basin development.*" [Emphasis supplied.] Despite this statement in the report no showing is made as to the amount of natural losses which will be prevented with full basin development and thus be available for use. The amount of the natural loss which could be saved and beneficially used in the lower basin alone, under full development, is estimated on the basis of figures presented in the report under review and other Bureau reports, at nearly 1,500,000 acre-feet a year average, a quantity of considerable importance.

The report contains the statement that "Fundamental to a division of the water is a knowledge of the quantity, quality, and flow characteristics of the water available. Virgin conditions of the Colorado River are considered for this purpose." It is thus recognized that quantity of water available is one of the fundamentals which must be known. Consideration of "virgin conditions" and "depletory effects" of projects on the flow of the

main stream does not provide a proper basis for allocation of water among the individual States and projects for consumptive use. For example, although the report uses the estimated virgin flow of the Gila River at its mouth as a measure of the available supply in the Gila River system, information in the report demonstrates that the supply at the places of actual use, far upstream from the mouth of the Gila River, is much greater than the natural flow at the mouth. Practically all the irrigated land in the Gila River Basin is in or upstream from the Phoenix area. The report contains in the chapter "Dividing the Water" the statement that "Under virgin conditions the average flow of the Gila near Phoenix is estimated to have been 2,282,000 acre-feet, of which probably only about 1,270,000 acre-feet reached the Colorado because of losses in the lower river area." Data in table CXLVI include estimates by individual years of the total natural inflow to the Phoenix area. These data and the statement quoted are ample proof that the supply of water available for consumption in the principal irrigated area of the Gila River Basin is approximately twice the quantity estimated by the Bureau.

Data in the report and data presented by Commissioner Bashore, on page 8 of Senate Document No. 39, Seventy-ninth Congress, first session, indicate that of the natural losses in the channel of the Colorado River between Boulder Dam and the mouth of the Gila River, approximately 400,000 acre-feet could be prevented and put to beneficial use by full control of the stream flow. This factor is not accounted for in the computation of available water supply in the report. In order that States may carry out the recommendation of the report and determine their individual allocations of water under the compact, it is essential that they know the amount of water which will be available for consumption at existing and potential places of use throughout the Colorado River system.

In paragraph 30 of the Regional Directors' report is the following statement:

"This report makes no attempt to interpret the Colorado River compact or any other acts or contracts relating to the allocation of Colorado River water among the States and among projects within the States."

Apparently the Bureau of Reclamation has failed to recognize that its use of the "depletion" theory, presumably as a basis for use by the States in determining allocations, is in itself an interpretation of the compact. Moreover, it is an interpretation lacking justification under the terms of the compact, which terms relate solely to "beneficial consumptive use." The compact contains no reference to "depletion" as a basis of measuring uses. The meaning and practical application of the term "consumptive use," as used in the compact and the Mexican treaty, were discussed by Mr. R. J. Tipton, consulting

engineer for the State of Colorado, during the congressional committee hearings on the treaty. Mr. Tipton stated (hearings, pp. 1225 and 1226):

"It is very practical to use as a measure the *consumptive use*, because *many gaging stations are installed throughout the irrigated area, and many more will be installed for the purpose of determining for compact administration what the various States are consuming.* \* \* \* The amount of these *consumptive uses* is readily ascertainable by measuring the inflow to the areas and the outflow from the areas; \* \* \* [Italics supplied.]

In other words, consumptive uses, whether for irrigation, domestic, industrial or similar purposes, or for reservoir evaporation, should be measured at the point of use. In order to follow out the expressed policy of not attempting interpretations of the compact, the report should include, on a parallel with the data on "depletions," corresponding data showing water available for consumptive use at points where such water is to be used and, also, actual consumptive uses of present projects and estimates for prospective projects.

#### *Available Water Supply in Entire Basin*

##### *Basis of estimates*

Fundamentally, the water supply of the Colorado River system constitutes, and should be estimated on the basis of, the flow available in the main stream and tributaries for consumptive use at actual or potential places of use under full development. Accordingly, estimates are presented herein to show the amount of water available for consumptive use in areas corresponding, as nearly as practicable on the basis of the data at hand, with the principal areas of present and potential use throughout the basin. The estimates are based on the meager data in the report under review and on data from other sources, including past studies by the Bureau of Reclamation. Unfortunately the data do not include sufficient information on the area above Lees Ferry to permit reliable estimation of the available water supplies at different places of use within the upper basin. This lack of information necessitates use of the estimated virgin flow of the Colorado River at Lees Ferry as a measure of the water supply in the upper basin. Even the estimate of virgin flow at Lees Ferry is based on unsatisfactory data. The earliest measurements of actual stream flow near Lees Ferry (actually at Lees Ferry about 1 mile upstream) were made in 1921. Flows prior to that date are estimated from records of flow at other points on the river. Estimates of the flow at Lees Ferry under virgin conditions are made by adding to the recorded or estimated historic flow the estimated consumptive uses above that point. Moreover, the consumptive use in each year must be estimated from unsatisfactory data as to acreage irrigated, reservoir losses, effect of water shortages, and other influences.

The estimates of the virgin flow at Lees Ferry for the years shown in the report (table CXL) probably are as accurate as can be made on the basis of the data available. The amount of water, as measured at actual or potential places of use in the upper basin under conditions of full development, probably would exceed those estimates somewhat because of the reductions of natural losses that would be effected by regulation and beneficial use of stream flow. It is believed, however, that natural losses in the upper basin are not sufficient in quantity to cause significant differences.

In the lower basin, however, natural losses are of much greater significance than in the upper basin, mainly because of the difference between the two areas in topography, climate, and character of stream runoff. In the lower basin the valleys are wider, stream gradients are gentler, and areas overflowed during floods are larger than in the upper basin. Stream flow under natural conditions fluctuates more widely and rapidly, so that channels are less stable in the lower basin. The climate is warmer and the growing seasons are longer in the lower basin, and losses from evaporation and transpiration are correspondingly greater than in the upper basin. In preparation of the estimates of water supply set forth in this review, consideration was given to these differences and to the larger quantities of losses in the lower basin that can be and are being prevented by control and beneficial use of the water.

#### *Estimated available water supply*

The average annual quantity of water in the entire Colorado River system that would be available for consumptive use under full development of the basin is estimated herein at 19,200,000 acre-feet over a long period, such as 1897 to 1943, inclusive; at 14,300,000 acre-feet, without withdrawals from hold-over storage, over a 10-year critical period of subnormal water supply, such as 1931 to 1940, inclusive; and at 15,600,000 acre-feet, without withdrawals from hold-over storage, during a 17-year subnormal period such as 1930 to 1946, inclusive. The data indicate that, during deficient periods, in order to equate the flow with the long-term average, the total withdrawal from hold-over storage on the main stream and tributaries upstream from the mouth of the Gila River would have to be about 44,000,000 acre-feet during a period such as 1931-40 and about 52,700,000 acre-feet during a period such as 1930-46; and the total withdrawal from hold-over storage on the Gila River system would have to be about 5,000,000 acre-feet and 8,500,000 acre-feet during those respective periods. The figures for available supply represent the estimated average annual quantities of water that would be available during the respective periods, without withdrawal from hold-over storage during critical periods, to supply con-

sumptive use requirements of projects within the basin and projects for exportation of water to adjacent basins, to supply Mexico with the annual quantity provided for by the treaty, and to supply reservoir losses. The accuracy of the estimates is adversely affected by the scarcity of basic data available. The estimates deal in averages and consequently should not be considered as conclusive with respect to available supply. However, they provide the best preliminary indication of the water supply available at places of use with the data at hand.

The components of the estimated total quantities for the long-term and subnormal periods are shown in table 1. Detailed explanation of each numbered item in the table is given in the subparagraph bearing the same number following the table.

TABLE 1.—*Estimated annual water supply available for consumptive use from Colorado River system under full development*

Source of supply	Estimated average supply (thousand acre-feet per annum)		
	Long-term period (1897-1943)	Critical periods <sup>1</sup>	
		1931-40	1930-46
(1) Colorado River and tributaries above Lees Ferry . . . . .	16,300	12,200	13,500
(2) Tributaries, Lees Ferry to mouth of the Gila River . . . . .	600	300	300
(3) Gila River system . . . . .	2,300	1,800	1,800
(4) Entire Colorado River system . . . . .	19,200	14,300	15,600

<sup>1</sup> Without withdrawal from hold-over storage.

#### EXPLANATION OF ITEMS IN TABLE 1

(1) Colorado River and tributaries above Lees Ferry. The figure 16,300,000 acre-feet is the estimated long-term average virgin flow at Lees Ferry as shown in table CXL of the report under review. The figure 12,200,000 acre-feet is the average of the estimated virgin flows at Lees Ferry for the critical period 1931 to 1940, inclusive, shown in table CXL. The figure 13,500,000 acre-feet is estimated herein on the basis of the figures in table CXL and the records of the United States Geological Survey for the years 1944, 1945, and 1946.

(2) Tributaries, Lees Ferry to mouth of Gila River. In the absence of more adequate data the assumption is made herein that the increase in supply between Lees Ferry and the mouth of Gila River would be the net increase in the flow of the main river between Lees Ferry and Boulder Dam, plus the tributary inflow between Boulder Dam and Gila River, minus the channel loss in Colorado River below Boulder Dam. The equation for the long-term average is 1,100,000 plus 100,000 minus 600,000 equals 600,000, and the equation for both deficient periods is 800,000 plus 100,000 minus 600,000 equals 300,000. All quantities are in acre-feet per annum. The 1,100,000 acre-feet is in round numbers the Bureau's estimate of the long-term "Average virgin gain to Boulder Dam site." The 800,000 acre-feet annual average for the deficient periods is taken from the tabulation

given by Commissioner Bashore on page 8 of Senate Document 39, and is presumably based on the estimated average for the 21-year period 1923 to 1943, inclusive, shown in the report. The figures represent the Bureau's estimates for the periods 1897-1943 and 1931-40, respectively, of the average annual virgin tributary inflow minus the natural losses in this section of the river, and are used herein because the report lacks data from which the proper figures could be determined. The proper figures would be the estimated total quantities of water available for consumptive use on the tributaries minus the estimated channel loss to be expected in this section of Colorado River after full development of the basin. However, the figures 1,100,000 acre-feet for the long-term average net inflow and 800,000 acre-feet for the 10-year-period average are considered conservative, since there should be a somewhat greater quantity available for consumptive use on the tributaries and a somewhat smaller loss in the river channel after full development, so that the amounts available for use would be accordingly greater than the amounts shown. The assumption is made herein that the average would be the same for the 17-year period 1930-46 as for the 10-year period 1931-40. The figure 100,000 acre-feet is the estimated average annual tributary inflow between Boulder Dam and Gila River. The corresponding figure in the report is 150,000 acre-feet, which is an estimate based on very sketchy data and is presumed to represent average inflow for the periods 1913-15 and 1929-43. The inflow probably would be a little larger than 100,000 acre-feet a year for the long-term period and a little smaller for the subnormal periods, but as the differences would be less than the probable errors in the basic data the same figure is used herein for all three periods. The figure 600,000 acre-feet is an estimate of the annual channel loss that would occur in Colorado River between Boulder Dam and the mouth of Gila River under conditions of full development. In the report the Bureau estimates the annual loss under virgin conditions at 1,030,000 acre-feet. On the basis of data submitted in Senate Document 39 it is estimated herein that complete regulation of the flow by means of reservoirs and confinement of the regulated flow by channel rectification would effect about 400,000 acre-feet a year reduction in this channel loss, and that the remainder, 600,000 acre-feet a year, would be the average loss in deficient periods as well as the long-term average, since under full development the average annual flow below Boulder Dam would be about the same for all periods.

(3) Gila River system: The estimate of the average annual "Total natural inflow to Phoenix area," as shown in table CXLVI of the report, is 2,279,000 acre-feet. In view of the capacities of existing hold-over surface storage reservoirs on the Gila River system, totaling several million acre-feet, the additional large capacities of underground reservoirs in the Phoenix and other upstream areas, and the opportunities for additional prevention of natural losses by beneficial use, the safe annual yield of the Gila River System for beneficial consumptive use is conservatively estimated herein at 2,300,000 acre-feet. The average annual water supply available during critical periods such as 1931-40 and 1930-46, without withdrawal from hold-over storage, is estimated herein at 1,800,000 acre-feet. This estimate is based principally on the figures contained in table CXLVI of the report, together with estimates for the years 1944 to 1946, using unpublished United States Geological Survey records. Existing projects are using more than the estimated safe annual yield, by overdrawing the supply. In the past, official reports from Arizona have claimed that the average annual supply of the Gila River system available for consumptive use is as much as 2,900,000 acre-feet.

### *Available Water Supply in Upper Basin*

#### *Total water supply*

Since the Colorado River compact provides for a division of the available water of the Colorado River system between the upper basin and the lower basin, a clear distinction must be made between the actual total water supply in the upper basin and that part of the total that is available for consumptive use in the upper basin under the terms of the compact. The amount of the total supply in the upper basin should properly be determined by taking the sum of the amounts at existing and potential places of use in all the subareas upstream from Lees Ferry, with due care to avoid duplications. However, because of the lack of reliable information as to water supplies at actual or potential places of use throughout the area upstream from Lees Ferry the estimates contained in the report of the flow of Colorado River at Lees Ferry under natural conditions are taken as the best available measure of the total actual quantity of water in the upper basin. The estimated annual average for the period 1897-1943 is 16,300,000 acre-feet and the estimated annual average for the critical period 1931-40 is 12,200,000 acre-feet, based on the data in table CXL of the report.

#### *Water supply available for consumptive use in upper basin*

Article III (a) of the Colorado River compact apportions to the upper basin the beneficial consumptive use of 7,500,000 acre-feet per annum from the available water in the Colorado River system. On the other hand, article III (d) provides that the States of the upper division (Colorado, New Mexico, Utah, and Wyoming) will not cause the flow of the Colorado River at Lees Ferry to be depleted below an aggregate of 75,000,000 acre-feet for any 10 consecutive years. Thus, the availability of the 7,500,000 acre-feet a year for consumptive use in the upper basin is conditional upon compliance with the terms of article III (d). This is one of the most serious problems confronting the water users of the upper basin.

The apportionments under article III (a) mean the actual consumptive use in any one year. The term used in article III (a) is "per annum." Owing to the effects of periods of low stream flow, the long-term average quantity available for use in the upper basin may be somewhat less than 7,500,000 acre-feet a year. Studies have been made to determine the physical limitations on consumptive use in the upper basin during periods of water shortage. Those studies indicate that the upper basin, during a critical period such as 1931-40, would not have more than 6,077,000 acre-feet available

for irrigation, domestic, and similar purposes, which, together with the estimated 831,000 acre-feet of reservoir losses, would result in a total consumptive use of 6,908,000 acre-feet. Thus, the long-term average quantity available for consumptive use in the upper basin is indicated to be an amount between 6,900,000 and 7,500,000 acre-feet. The assumption is made that there would be constructed in the upper-basin hold-over storage reservoirs of sufficient aggregate capacity to regulate the supply so that the consumptive-use requirements in the upper basin could be provided without depleting the flow of the Colorado River at Lees Ferry below a total of 75,000,000 acre-feet in any 10 consecutive years, as required by article III (d) of the compact. It should be noted that both figures of upper-basin use include estimated net reservoir losses.

If no hold-over storage were provided, the water supply available for consumptive use in the upper basin would average considerably less than 6,900,000 acre-feet a year during a critical 10-year period such as 1931-40. The estimated total virgin flow of the Colorado River at Lees Ferry during that critical period, as computed from the data in table CXL in the Bureau report, is in round numbers 122,000,000 acre-feet. In order not to deplete the total flow at Lees Ferry below 75,000,000 acre-feet during a period such as 1931-40, the upper basin could use from the virgin flow of the Colorado River system only 47,000,000 acre-feet total for the period, or an average of only 4,700,000 acre-feet a year.

#### *Hold-over storage requirements in upper basin*

If the water supply available for consumptive use in the upper basin during a critical period such as 1931-40 is to be greater than 4,700,000 acre-feet a year, hold-over storage must be provided above Lees Ferry. The estimates, by years, of the virgin flow at Lees Ferry indicate that the flow, during a period such as 1931-40, would determine the minimum amount of hold-over storage that would be required in the upper basin, under full development, in order that the water users in the upper basin could comply fully with the terms of the compact. The 10-year period 1931-40 is the critical period of record with respect to this requirement. In order to have available 6,900,000 acre-feet a year for consumptive use in the upper basin during such a 10-year period (see case I, table 2) the hold-over storage capacity must be sufficient to permit a total withdrawal of approximately 22,000,000 acre-feet during the period. If the average supply available for consumptive use in the upper basin is to be 7,500,000 acre-feet a year (see case II, table 2) the total withdrawal from hold-over storage during that 10-year period must be approximately 28,000,000 acre-feet. These conclusions are illustrated by the figures in table 2.

TABLE 2.—*Estimated minimum withdrawal from hold-over storage required to regulate the water supply for the upper basin under the provisions of the Colorado River compact*

[Based on critical period 1931 to 1940, inclusive]

Item	Case I	Case II
Average annual virgin flow at Lees Ferry.....	<i>Acre-feet</i> 12,200,000	<i>Acre-feet</i> 12,200,000
Minimum average annual flow at Lees Ferry under compact.....	7,500,000	7,500,000
Average annual virgin flow available to upper basin.....	4,700,000	4,700,000
Assumed average annual consumptive use in upper basin.....	6,900,000	7,500,000
Required average annual withdrawal from upper basin hold-over reservoirs.....	2,200,000	2,800,000
Required 10-year total withdrawal from upper basin hold-over reservoirs.....	22,000,000	28,000,000

The figures for required total withdrawal from upper-basin reservoirs are based on the estimated average water supply during the 10-year critical period, 1931-40, and should therefore be considered merely indicative of the large volumes of hold-over storage capacity that will be required to regulate the water supply for the upper basin under the provisions of the Colorado River compact. Accurate determination of the required withdrawals from hold-over storage and the corresponding gross storage capacities required can be made only after exhaustive analyses of hydrologic data and storage possibilities with studies of reservoir operation on a monthly basis, and detailed studies of methods of coordinating the operation of a number of widely separated storage reservoirs.

The magnitude of the problem of providing the hold-over storage in the upper basin is not readily discernible in the report under review, since the estimated costs are not allocated among the several functions of the projects. However, Commissioner Bashore presented in Senate Document 39 (p. 9), Seventy-ninth Congress, first session, a list of potential hold-over storage reservoirs, with cost figures, which appear to be the amounts that would be allocated to hold-over storage, based on 1940 prices. Of the 17 upper-basin reservoirs included in Mr. Bashore's list, only 13 are assigned the hold-over storage function in the report. The total gross capacity of these 13 reservoirs would be 30,000,000 acre-feet and the live capacity, as nearly as can be ascertained from the information in the report, about 23,000,000 acre-feet. The cost figures given in Senate Document 39 indicate that the total amount allocated to hold-over storage in the 13 projects would be approximately \$273,000,000. On the basis of current prices, the corresponding amount would be approximately \$435,000,000.

*Available Water Supply in Lower Basin*

*Total water supply*

In the absence of more detailed information, the assumption is made that the total quantity of water available in the lower basin comprises (1) the estimated residual flow at Lees Ferry after depletion by consumptive use in the upper basin, (2) the estimated net gain from tributaries to Colorado River between Lees Ferry and the mouth of the Gila River, and (3) the estimated safe yield of the Gila River system. The residual flow at Lees Ferry (item 1) is estimated as follows: For the long-term average the quantity will be the estimated average annual virgin flow minus the use in the upper basin under the terms of the compact: that is, 16,300,000 acre-feet minus 7,500,000 acre-feet (actually, the average use may be somewhat less than 7,500,000 acre-feet), or 8,800,000 acre-feet a year. For a critical period the minimum average annual residual flow at Lees Ferry under the terms of the compact will be 7,500,000 acre-feet. The 17-year period 1930 to 1946, inclusive, is the critical period of record with respect to the water supply in the lower basin. The current dry period may not be over, and its 17-year duration to date is not necessarily an index to the longest duration that may be expected of periods of subnormal flow. The explanations of items (2) and (3) are set forth following table 1.

Estimates of the component parts and of the total average annual water supply in the lower basin within the periods specified, without withdrawal from hold-over storage in the lower basin, are shown in the following tabulation:

TABLE 3.—*Estimated water supply available in lower basin*  
[Estimated annual average supply (thousand acre-feet per annum)]

Source	Long-term (1897-1943)	Critical period (1930-46) <sup>1</sup>
(1) Colorado River at Lees Ferry . . . . .	8,800	7,500
(2) Tributaries, Lees Ferry to mouth of Gila River <sup>2</sup> . . . . .	600	300
(3) Gila River system <sup>2</sup> . . . . .	2,300	1,800
(4) Total supply . . . . .	11,700	9,600

<sup>1</sup> Without withdrawal from hold-over storage.  
<sup>2</sup> See table 1, items (2) and (3), and explanations, following table 1.

In order to equate the total water supply available in the lower basin during a critical period such as 1930-46 with the long-term average supply, the total minimum withdrawal from hold-over storage on the main stream and tributaries upstream from the mouth of the Gila River would have to be about 27,000,000 acre-feet, and the total withdrawn from hold-over storage on the Gila River system would have to be about 8,500,000 acre-feet. Hold-over storage on the Gila River system comprises both surface and underground reservoirs. The required

average annual withdrawal from hold-over storage on the main stream and tributaries upstream from the mouth of the Gila River would be about 1,600,000 acre-feet a year as a minimum during the critical period 1930-46. Commissioner Bashore, in his tabulation of the estimated average annual water supply in the lower basin, exclusive of the Gila River system (S. Doc. 39, p. 8), used the figure 1,500,000 acre-feet as the required average annual release, stating: "In explanation of Lake Mead draw-down of 1,500,000 in 1931-40 period, this is annual storage release required to make supply in low period equal long-term average supply. Plans contemplate sufficient storage on river to accomplish this." At the annual rate given by Commissioner Bashore, the 17-year total withdrawal from storage on the main stream and tributaries above the mouth of the Gila River would be 25,500,000 acre-feet.

The report under review presents no studies to show how the plans to provide the required amount of hold-over storage would be accomplished, or how the replenishment of hold-over storage in the lower basin would be correlated with the replenishment of the hold-over storage that would be required in the upper basin. It appears likely that the existing and potential surface and underground storage capacity on the Gila River system will be sufficient to regulate the water supply of that system completely. However, in the absence of more detailed information as to possibilities for hold-over storage and methods of operation, it appears doubtful whether the hold-over storage capacity required on the main stream and tributaries above the mouth of the Gila River for regulation of the water supply in the lower basin can be provided and operated to furnish an average annual release of 1,500,000 acre-feet during the most critical period of record.

If the assumption is made that the required hold-over storage capacity could be provided and operated on the main stream and tributaries above the mouth of the Gila River to furnish the release specified, the estimated average annual total water supply that would be available in the lower basin during a critical period such as 1930-46, based on the figure presented in this review, is 9,600,000 acre-feet, plus 500,000 acre-feet withdrawal from hold-over storage on the Gila River system, plus 1,500,000 acre-feet (Bureau figure) withdrawal from hold-over storage on the main stream and tributaries above the mouth of the Gila River—a total of 11,600,000 acre-feet a year, or approximately the same as the long-term average.

*Water supply available in lower basin for consumptive use in United States*

The foregoing estimate of total water supply in the lower basin exceeds the water supply available for consumptive use in the lower basin in the United States by

the amount required to fulfill the obligation imposed by the treaty with Mexico. The treaty "guarantees" Mexico 1,500,000 acre-feet of water annually from the Colorado River system. It is estimated that an additional 200,000 acre-feet a year will be required for regulation purposes, because of the difficulty of measuring accurately the large quantities involved and because of the difficulty of controlling precisely the rate of flow throughout the long time of travel over the distance between the point of release in the United States and the point of delivery at the international boundary. This figure of 200,000 acre-feet should not be confused with the 200,000 acre-feet that Mexico is entitled to receive in excess of the guaranteed quantity when there is a surplus available. In paragraph 28 of the regional directors' report, under "Water Supply," the statement is made that "Under the Mexican treaty *it is estimated* that Mexico will receive 1,500,000 acre-feet annually, \* \* \*." [Emphasis supplied.] The Bureau evidently includes no allowance for regulation or similar losses, on the presumption that it will be possible to so regulate a 16,000,000 acre-foot river as to deliver exactly the treaty guaranty of 1,500,000 acre-feet per year. This, it is submitted, is an impossibility. The treaty provides for a schedule under which Mexico may order, and is to receive, water at specified rates of delivery. In order to insure delivery of the full quantities ordered, the authorities in the United States will necessarily make excess deliveries, at least part of the time, because of the difficulty of precise regulation. It was established in the hearings on the treaty that Mexico is not to be charged with any quantity of water she may receive and use in excess of her orders. Therefore, the figure for the Mexican treaty burden should include, in addition to the guaranteed 1,500,000 acre-feet a year, an allowance for regulation purposes. In making plans to utilize every acre-foot of the long-time average water supply of the Colorado River system the minimum allowance for regulation purposes should be 200,000 acre-feet.

The net annual average water supply available in the lower basin for consumptive use in the United States is estimated herein at 11,600,000 acre-feet minus 1,700,000 acre-feet for the Mexican treaty burden, or 9,900,000 acre-feet. This is the estimated amount that will be available, after full development of the entire basin, to meet all beneficial consumptive-use requirements in the lower basin, including net losses from all reservoirs constructed in the lower basin.

#### *Quality of Water*

In the chapter "Dividing the Water," in the report, appears the statement that "Fundamental to division of the water is a knowledge of the quantity, *quality*, and

flow characteristics of the water available." [Emphasis supplied.] Despite this statement, the subject of water quality is not given adequate consideration in the report. It is mentioned in one or two places, including chapter VIII, where some discussion by the United States Geological Survey appears, under the subject "Quantity and Quality of Water." But nowhere in the report are factual data given as to the past, present, or estimated future mineral content of the water at points throughout the Colorado River system.

If the people of the basin States and Congress are to act intelligently in planning development of the river, they must have complete information on a number of very important questions relating to quality of water. For example: What will be the effect on the quality of water at Lees Ferry when the upper-basin States are consuming each year their allocation of 7,500,000 acre-feet? Would the quality of the water at Lees Ferry be different if the upper-basin State were exporting out of the basin 3,000,000 or 1,000,000 acre-feet a year? Will the place of use of the water within the upper basin have any effect on quality—that is, are some areas more highly mineralized than others—so that if the former are irrigated the return flow will have a higher or more injurious salt content than if the latter areas were irrigated instead? What is the anticipated mineral content of the water at Parker Dam and at Imperial Dam under full development of the river? What effects on crops would result from use of water with varying contents and character of salts? What are the reasonable limits in the salt content of water for various types of soils and crops? What are the comparative irrigation requirements for growing crops with water of various salt contents? Are there any feasible possibilities of improving the quality of irrigation water by the removal of dissolved solids, if the concentration under future conditions becomes injurious to plants? What would be the cost of the treatment? These are but a few of the questions concerning quality of water which should be considered in the formulation of a comprehensive plan.

The problem of water quality is of great importance in the administration of the treaty with Mexico. There appears to be a considerable difference of opinion on the subject of water quality between those who negotiated the treaty on behalf of United States and those who negotiated for Mexico. Negotiators for the United States testified in the hearings before the Senate Committee on Foreign Relations that the treaty was perfectly clear, that the Mexican negotiators fully understood that the allotment of 1,500,000 acre-feet to Mexico was "without regard to quality" and that the United States would receive credit under the treaty for what-



ever water appeared in the boundary section of the river, even if it were of such poor quality as to be unfit for irrigation use. On the other hand, the Mexican negotiators told the Mexican Senate that the treaty was very clear and that there was no question as to the obligation of the United States to deliver, in fulfillment of the treaty, 1,500,000 acre-feet a year of good quality water, that is, of a quality at least as good as that of the water delivered to projects in the United States; furthermore, that, inasmuch as the treaty dealt primarily with a division of the water for irrigation and domestic purposes, it must of necessity follow that the water would have to be of a usable quality.

The treaty makes no direct reference to quality of water. The ambiguity of the treaty with respect to the subject, shown by the diametrically opposite interpretations of the negotiators, creates a serious problem. The final decision will greatly affect the burden of the Mexican treaty on the water users of the United States. If the Mexican interpretation were upheld, the annual quantity of water that would be required in fulfillment of the treaty might be several times the annual quantity that would be required if the interpretation of the negotiators for the United States were upheld.

The quality of the water in the river at Lees Ferry may, in the future, become involved in an interpretation of the Colorado River compact. The compact also contains no direct reference to quality of water. But the question may arise as to whether the lower basin is obligated under the compact to accept water of inferior quality, or whether the upper basin might be required so to plan its future development as not seriously to impair the quality of the water as it existed at the time the compact was signed.

The report is correct in stating that quality is one of the fundamentals that must be considered in any division of water; however, the report fails to include adequate information on this subject. Until this information is collected and made available, plans for proceeding with development of the river will be under a serious handicap.

WATER REQUIREMENTS

The report under review presents for the seven divisions and States of the Colorado River Basin general information on the present irrigation development and uses of water in the basin and also on estimated future water requirements of existing and potential projects, in terms of depletion of the main stream as at the international boundary, which are summarized in four tables as follows:

*Present irrigation development in Colorado River Basin*

[Table CXVIII of report under review]

State	Upper basin		Lower basin		Total (acres)
	Irrigated (acres)	Irrigable <sup>1</sup> (acres)	Irrigated (acres)	Irrigable <sup>1</sup> (acres)	
Arizona . . . . .	6,000	0	835,930	166,900	1,006,830
California . . . . .	0	0	460,900	342,100	<sup>2</sup> 803,000
Colorado . . . . .	770,170	32,670	0	0	802,840
Nevada . . . . .	0	0	11,000	0	11,000
New Mexico . . . . .	38,000	0	19,770	0	57,770
Utah . . . . .	274,820	0	23,500	0	298,320
Wyoming . . . . .	236,070	11,470	0	0	247,540
Total . . . . .	1,325,060	44,140	1,351,100	509,000	3,229,300

<sup>1</sup> Lands that will be irrigated under present development.  
<sup>2</sup> Includes 713,000 acres outside the natural Colorado River drainage area.

*Present and potential stream depletion in upper basin*

[Compiled from table LXXIII of report under review]

Division	Estimated average annual depletion (acre-feet)						Total ultimate depletion
	Existing or authorized projects				Potential projects		
	Present depletion		Future increase		Consumed in basin	Exported	
	Consumed in basin	Exported	Consumed in basin	Exported			
Green . . . . .	847,000	81,500	17,000	32,000	1,077,000	1,137,700	3,192,200
Grand . . . . .	789,000	98,300	65,000	421,000	481,000	1,492,000	3,346,300
San Juan . . . . .	380,000	4,000	0	21,000	770,000	92,000	1,267,000
Evaporation from power reservoir . . . . .					831,000		831,000
Reserved for pasture irrigation . . . . .					500,000		500,000
Total . . . . .	2,016,000	183,800	82,000	474,000	3,658,000	2,721,700	9,136,500

## Present and potential stream depletion in lower basin

[Compiled from table CXVII of report under review]

Division	Estimated average annual depletion (acre-feet)						Total ultimate depletion
	Existing or authorized projects				Potential projects		
	Present depletion		Future increase		Consumed in basin	Exported	
	Consumed in basin	Exported	Consumed in basin	Exported			
Little Colorado.....	71,700				48,700		120,400
Virgin.....	73,900				105,000		178,900
Boulder.....	373,400	2,535,000	719,000	2,798,000	587,000	112,000	7,124,400
Gila.....	1,151,000				1,616,000		2,767,000
Reservoir losses.....	713,000		66,000		91,000		870,000
<b>Total.....</b>	<b>2,383,000</b>	<b>2,535,000</b>	<b>785,000</b>	<b>2,798,000</b>	<b>2,447,700</b>	<b>112,000</b>	<b>11,060,700</b>

## Present and potential stream depletion in the Colorado River Basin

[Table CXXI of report under review]

State and Division	Estimated average annual depletion (acre-feet)						Total ultimate depletion
	Existing or authorized projects				Potential projects		
	Present depletion		Future increase		Consumed in basin	Exported	
	Consumed in basin	Exported	Consumed in basin	Exported			
<b>Arizona:</b>							
San Juan.....	10,200	0	0	0	39,000	0	49,200
Little Colorado.....	58,700	0	0	0	48,700	0	107,400
Virgin.....	5,100	0	0	0	12,700	0	17,800
Boulder.....	208,400	0	571,000	0	346,000	0	1,125,400
Gila.....	1,135,000	0	0	0	1,608,000	0	2,743,000
Subtotal.....	1,417,400	0	571,000	0	2,054,400	0	4,042,800
California: Boulder.....	145,000	2,535,000	148,000	2,798,000	64,000	112,000	5,802,000
<b>Colorado:</b>							
Green.....	115,000	0	0	0	324,000	75,000	514,000
Grand.....	776,000	98,300	65,000	421,000	295,000	1,492,000	3,147,300
San Juan.....	238,000	4,000	0	21,000	251,000	85,000	599,000
Subtotal.....	1,129,000	102,300	65,000	442,000	870,000	1,652,000	4,260,300
<b>Nevada:</b>							
Virgin.....	23,800	0	0	0	36,000	0	59,800
Boulder.....	20,000	0	0	0	177,000	0	197,000
Subtotal.....	43,800	0	0	0	213,000	0	256,800
<b>New Mexico:</b>							
San Juan.....	68,400	0	0	0	450,000	0	518,400
Little Colorado.....	13,000	0	0	0	0	0	13,000
Gila.....	16,000	0	0	0	8,000	0	24,000
Subtotal.....	97,400	0	0	0	458,000	0	555,400
<b>Utah:</b>							
Green.....	358,000	81,500	0	32,000	264,000	975,700	1,711,200
Grand.....	13,000	0	0	0	186,000	0	199,000
San Juan.....	63,400	0	0	0	30,000	7,000	100,400
Virgin.....	45,000	0	0	0	56,300	0	101,300
Subtotal.....	479,400	81,500	0	32,000	536,300	982,700	2,111,900
Wyoming: Green.....	374,000	0	17,000	0	489,000	87,000	967,000
Pasture irrigation in upper basin.....					500,000		500,000
Reservoir losses.....	713,000		66,000		922,000		1,701,000
<b>Total.....</b>	<b>4,399,000</b>	<b>2,718,800</b>	<b>867,000</b>	<b>3,272,000</b>	<b>6,106,700</b>	<b>2,833,700</b>	<b>20,197,200</b>

*Erroneous Use of "Stream Depletion" as Basis of Estimates*

The foregoing estimates of water requirements based on stream depletion, as presented in the report under review for both existing and potential projects, reflect an extremely limited viewpoint of what the effect of such projects would be on the flow in the main river at the international boundary. Such a measure of the water requirements of existing and potential projects does not give a true picture and is not in conformity with the Colorado River compact and related legislation. The only proper measure of water requirements on the Colorado River is "consumptive use," which is the term used in the Colorado River compact and related legislation. Consumptive use should be measured at actual or potential places of use, the same as water supply. Although stream depletion, if correctly applied, may in some instances be substantially equivalent to consumptive use, it is not, in fact, exactly equivalent to, or synonymous with, consumptive use. In particular, stream depletion differs materially from consumptive use for conditions in the lower basin, both on the main stream and tributaries, and as used and applied in the report under review is erroneous.

The report is not only incorrect in the theory that consumptive use may be expressed as depletion of the main stream but is also inconsistent in the application of the theory. Stream depletion is confused with consumptive use in several places in the report. Statements and tabulations indicate that the estimates of the amount of main stream depletion that would result from future diversions in the upper basin are based largely on estimates of the actual consumptive use of water per acre irrigated in existing projects. On the other hand, the estimate of the quantity of water used in the Gila River Basin is based not on the actual quantities consumed by projects throughout that basin but on the amount that the estimated virgin flow of the Gila River at its mouth is depleted by upstream uses. Despite this procedure, however, estimates of the depletion of the Gila River are shown in tables CXVII and CXXI under the column heading "Consumed in basin," which is misleading.

*Water Requirements in Upper Basin*

The data and analyses presented in this section under this and subsequent headings have been prepared by the Colorado River Board of California.

Although consumptive use in the upper basin probably is not reflected exactly, as assumed in the report under review, by a corresponding "depletion" in river flow at Lees Ferry, the difference between consumptive use and depletion of the main stream may be relatively

small, since so far as known natural channel losses in the upper basin are relatively small. For this reason and because of the lack of more adequate data, the estimates in the report under review of main stream depletion are assumed herein as the measure of consumptive-use requirements in the upper basin. According to the report, the ultimate long-term average requirements for existing and authorized projects are about 2,800,000 acre-feet a year. The allowable upper limit of additional consumptive use of water in the upper basin will be determined by three conditions. First, if the water supply for consumptive use in the upper basin after full development could be made available, by provision of adequate hold-over storage, in the amount of 7,500,000 acre-feet a year as apportioned under article III (a) of the compact, there would be available for consumptive use by new projects approximately 4,700,000 acre-feet a year. Second, if the water supply that could be made available for consumptive use, with adequate hold-over storage provided, is limited by physical difficulties during critical periods to about 6,900,000 acre-feet a year (as set forth in sec. 3 on water supply), including 2,500,000 acre-feet for existing and authorized projects, the consumptive use requirements of new projects would be limited to about 4,400,000 acre-feet a year during such periods. Third, if no hold-over storage were provided, the total available water supply for consumptive use during critical periods would be about 4,700,000 acre-feet a year (as set forth in sec. 3 on water supply) and the maximum permissible consumptive use requirements of new projects would be only about 2,200,000 acre-feet a year.

The figures for estimated water supply and water requirements demonstrate the urgent need for allocation among the individual States of the upper basin of the water supply available, under the terms of the compact, for consumptive use, before authorization of additional projects that would require any considerable amounts of water. Moreover, and of equal importance, if the upper basin is to derive maximum feasible benefit from the water apportioned by article III (a), provision must be made for construction in the upper basin of hold-over storage reservoirs of sufficient aggregate capacity to regulate the water supply as shown by the analysis in table 2 in section 3 of this review. Construction of the required hold-over storage dams should be concurrent with or precede construction of new projects that would consume large additional amounts of water in the upper basin.

*Water Requirements in Lower Basin*

*Water requirements of existing projects*

The report does not contain a clear presentation of the facts regarding water supply and consumptive-use

requirements in the lower basin and regarding existing contracts and agreements pertaining to the use of water. The report does not set forth clearly the assumptions that were made by the Bureau as to the individual water requirements of existing and authorized projects in the lower-basin States. Because the estimated water supply available for use in the lower basin as hereinafter shown is slightly less than the estimated requirements of existing and authorized projects, and because there is not general agreement among the lower-basin States relative to interpretation of the Colorado River compact, all available facts should be made known.

The data in table 4 herein and the succeeding explanatory subparagraphs are presented in order to help clarify the situation and to give information on the existing California agreement as to the allocation among the various agencies of the quantities of water provided for in existing contracts between the California agencies and the United States. The data in table 4 show that the average annual water requirements of existing and authorized projects in the lower basin will total 10,150,000 acre-feet, or slightly more than the estimated average annual supply available of 9,900,000 acre-feet under full development, for use in the lower basin in the United States.

TABLE 4.—Estimated water requirements of existing and authorized projects in lower basin

	Average annual requirements (acre-feet)
(1) Main stream reservoir evaporation losses (net).....	1 780,000
<i>Existing (operating) and authorized projects</i>	
Nevada, Utah, and New Mexico	
(2) Projects within lower basin.....	440,000
Arizona	
(3) Projects in Gila River Basin in Arizona.....	2,270,000
(4) Projects on other tributaries.....	130,000
(5) Colorado River Indian Reserva- tion.....	300,000
(6) Yuma project in Arizona.....	250,000
(7) Gila project:	
North and South Gila Valley.....	60,000
Yuma Mesa.....	560,000
(8) Total requirements in Arizona.....	3,570,000
California (as limited by contracts)	
(9) Palo Verde Valley and Palo Verde Mesa.....	300,000
(10) Yuma project in California.....	50,000
(11) All-American Canal.....	3,800,000

<sup>1</sup> Does not include losses from proposed Bridge Canyon or Marble Canyon Reservoirs estimated at 90,000 acre-feet a year.

	Average annual requirements (acre-feet)
(12) Metropolitan water district and San Diego water authority....	1,212,000
(13) Total requirements in California.....	5,362,000
Total project requirements in lower basin.....	
	10,152,000
	(Say) 10,150,000

#### EXPLANATION OF ITEMS IN TABLE 4

(1) Net ultimate losses from existing and authorized reservoirs on Colorado River below Lees Ferry are estimated by the Bureau in table CII of the report at 779,000 acre-feet a year. The figure is rounded to 780,000 in table 4.

*Nevada, Utah, and New Mexico.*—(2) Existing projects and commitments within lower basin: Contracts executed under the terms of the Boulder Canyon Project Act by the Secretary of the Interior provide for the ultimate use of 300,000 acre-feet of water a year on projects in Nevada. Miscellaneous projects in those parts of Utah and New Mexico that are within the lower basin will require ultimately about 140,000 acre-feet a year, as estimated by the Bureau in terms of main stream depletion. Actual consumptive use would be greater than 140,000 acre-feet, but, since no better data are available, the figure 140,000 acre-feet is used herein. Although the total of 440,000 acre-feet exceeds the total requirements of existing and authorized projects in those parts of the three States that are within the lower basin, most of the excess is covered by commitments under existing contracts.

*Arizona—Existing (operating) and authorized projects.*—(3) Projects in Gila River Basin in Arizona, 2,270,000 acre-feet: The estimated safe annual yield of the Gila River system for beneficial consumptive use in Arizona (including net reservoir losses) is 2,270,000 acre-feet. Existing projects are using more than that quantity by overdrawing the supply. The average annual quantity available for consumptive use in the entire Gila River Basin is conservatively estimated herein at 2,300,000 acre-feet, of which approximately 30,000 is assumed to be available for use in New Mexico. The figure 30,000 is reflected in the estimate of 440,000 acre-feet a year ultimate use by miscellaneous projects in Nevada, Utah, and New Mexico.

(4) Projects on other tributaries, 130,000 acre-feet: The total area of existing small projects on tributaries in Arizona, other than the Gila, is about 44,000 acres, as shown in the report. The report gives total annual "depletions" of 67,200 acre-feet for these projects; however, on the basis of "consumptive use," the annual requirements, with an adequate supply, as proposed, are estimated in this review at 130,000 acre-feet.

(5) Colorado River Indian Reservation, 300,000 acre-feet: This project is in Parker Valley on the Colorado River. The irrigable area is 100,000 acres, of which approximately 10,000 acres are now irrigated. Since this is an Indian project, development of which was started in the 1870's, it is presumed to have a firm right to the use of the amount of water necessary to irrigate the entire area. On the basis of available data, the consumptive-use requirement is estimated herein at 3 acre-feet per acre per year and the total annual requirement at 300,000 acre-feet.

(6) Yuma project in Arizona, 250,000 acre-feet: Table XCV in the report shows 52,300 acres irrigated in that part of the Yuma project that is in Arizona. The consumptive use per

acre chargeable to this area is higher than the use in the Colorado River Indian project, because the Arizona part of the Yuma project extends to the lower Mexican boundary. Thus, a large part of the return flow from the Yuma project in Arizona does not reach Colorado River within the United States, and should be charged to the project as consumptive use under the terms of the compact.

(7) Gila project, 620,000 acre-feet: The figures 60,000 acre-feet and 560,000 acre-feet, for the north and south Gila Valley areas of 15,000 acres and the Yuma Mesa area of 51,000 acres, respectively, are the estimated requirements shown in a statement presented to the House Committee on Irrigation and Reclamation by the Bureau of Reclamation during the hearings on the proposed bill for reauthorization of the Gila project, H. R. 5434, Seventy-ninth Congress, second session. The Gila project was originally authorized in 1937 upon a finding of feasibility that was based on a report, dated December 1934, by Porter J. Preston, Bureau of Reclamation engineer. The 1934 report recommended a canal system for 139,000 acres on the Yuma Mesa, which would require, according to the report, 556,904 acre-feet of water a year on the basis of a pumping requirement of 4 acre-feet per acre. In the hearings on H. R. 5434, the report submitted by the Bureau of Reclamation stated that the Yuma Mesa area of the Gila project had been reduced to 51,000 acres and would require 11 acre-feet of water per acre per annum, and that there is no assurance of any return flow from the Yuma Mesa reaching the Colorado River in the United States. Therefore, the entire amount that will be pumped to the Yuma Mesa must be considered as consumptive use. Moreover, at 11 acre-feet per acre per annum, the Yuma Mesa area of 51,000 acres as now contemplated will use a total of 561,000 acre-feet of water a year, or substantially the same quantity as that contemplated for 139,000 acres in the feasibility report of 1937.

(8) The estimated ultimate total annual consumptive use requirements for all existing projects in the State of Arizona is 3,570,000 acre-feet.

*California—Existing (operating) and authorized projects.*—All the California projects for diversion and use of Colorado River water are completed or under construction. They are the projects that were contemplated at the time of the enactment of the Boulder Canyon Project Act in December 1928. The agencies representing these projects have made individual contracts with the United States for water from the Colorado River. The contracts, executed from 1930 to 1934, were made under and in conformity with the limitation on the use of Colorado River water by California, imposed by the terms of the Boulder Canyon Project Act. Before the contracts were executed, the United States required that the users of Colorado River water in California agree on priorities and amounts of water to be received under the limitation provisions of the act. The California agencies concerned signed an agreement, apportioning among themselves that part of the waters of the Colorado River that is available to California under the compact and the Project Act, and setting up a schedule of priorities. Each contract with the United States includes the terms of the agreement and the schedule of priorities. California is the only State in the basin which has so defined its use of Colorado River water and the priorities for such use.

(9) Palo Verde Valley and Palo Verde Mesa, 300,000 acre-feet: This project includes the lands of the Palo Verde irrigation district, started in the 1870's, and has one of the oldest water rights on the Colorado River. The annual quantity of water estimated for this project under the California agreement is 300,000 acre-feet.

(10) Yuma project in California, 50,000 acre-feet: The part of the Yuma project in California includes lands of the Yuma Indian Reservation and lands of the Bard irrigation district. The Bard district was overlooked in the report although the canal system that serves these lands is under the control of the Bureau of Reclamation. The total developed area in the California part of the Yuma project is approximately 15,000 acres. In the California priority agreement the United States reserved, as a second priority, water for the 15,000 acres, and water for an additional 10,000 acres lying outside the present river protective levees but adjacent to the present developed areas. These facts are not mentioned in the report. It is estimated herein that 50,000 acre-feet of water a year will meet the ultimate requirements.

(11) All-American Canal project, 3,800,000 acre-feet: This project, together with Boulder Dam, was authorized by the Boulder Canyon Project Act of December 1928. Development of the area under the All-American Canal was commenced in the late 1890's by construction of a canal which started at a point on Colorado River, a short distance above the Mexican boundary, crossed the line and extended about 60 miles through Lower California, Mexico, to a point where it recrossed the boundary into the United States. The first water through this canal reached Imperial Valley in June 1901. The report is in error in the statement that " \* \* \* construction of an international canal was finally begun in 1902 by the California Development Co." Since the water rights for the area are based on a series of filings made in the 1890's, for the diversion of 10,000 second-feet from the Colorado River, they are among the senior rights on the river. The fact that the rights cover the entire area included in the project is recognized by the provision in the Boulder Canyon Project Act that no charge shall be made for the storage of water and the delivery thereof to lands under the All-American Canal in Imperial and Coachella Valleys. After the filings were made, diversions by junior appropriators on the Colorado River were increased to the extent that they interfered with the rights of the senior appropriators in the Imperial Valley. Lawsuits which would have involved the entire Colorado River Basin were threatened. One of the main purposes of the Boulder Canyon Project Act was to make stored water available to the senior appropriators in order to replace the natural flow that was being taken from them by junior appropriators in other parts of the basin. The act authorized construction of the All-American Canal to be started when the Secretary of the Interior had executed a contract for repayment of the cost. The contracts were signed by the water users, and construction was started in 1934. Delivery of all the Imperial irrigation district's water supply through the All-American Canal began February 13, 1942. Construction of the Coachella branch of the canal was started in 1938. The Imperial irrigation district now covers more than 870,000 acres. It includes nearly all the lands to be served by the All-American Canal in Imperial Valley. According to the report, the area in Coachella Valley that is to be served by the All-American Canal is 85,000 acres. The annual quantity of Colorado River water estimated for the All-American Canal project under the California water agreement is 3,800,000 acre-feet. Actual diversions by the Imperial irrigation district have been, in several years, very little less than this total amount.

(12) Metropolitan water district and San Diego County water authority, 1,212,000 acre-feet: The two districts include all the coastal area of California that is to be served with domestic water from the Colorado River. The aqueduct of the Metropolitan water district of Southern California, including Parker Dam, has been completed at a cost of over \$200,000,000. Diver-

sions from the river to the aqueduct were commenced in November 1939. The branch aqueduct for the San Diego water authority, which is to be supplied through the Metropolitan water district's aqueduct, is nearly completed. Although these two districts hold separate contracts with the United States for Colorado River water, provisions have been made for serving them jointly.

In chapter V of the report the present construction of the San Diego aqueduct is mentioned; however, the San Diego project is listed among the potential projects of the Boulder division, and the water requirements of the San Diego aqueduct are included under the heading of potential projects in table CII. Since construction of the aqueduct is nearly completed, the requirements for San Diego should have been included in table CII with those for other existing or authorized projects. The Metropolitan water district contract is for 1,100,000 acre-feet a year and the San Diego contract is for 112,000 acre-feet a year. In view of the continuous rapid expansion of this entire coastal area, there is no doubt that the full quantities of water provided for in these contracts will be needed.

(13) The total requirement for consumptive uses of existing projects in California is 5,362,000 acre-feet a year. The corresponding total shown in the report for "Existing or authorized projects in California," table CII, is 5,626,000 acre-feet. The Bureau figure does not include the water for San Diego, which if added would give a total of 5,738,000 acre-feet. It is not contended that the amount shown in the report, with the addition of San Diego's water, is not correct if these projects were to be developed to their ultimate requirements. However, in the interest of making all facts known, the report should have given information on the details of the California agreement and pointed out that the total annual quantity of water specified for delivery under existing contracts between the California agencies and the United States, is 5,362,000 acre-feet.

#### *Water deficit in lower basin*

Comparison of the estimated average annual quantity of water available for consumptive use, under full development, with the estimated average annual consumptive-use requirements of existing and authorized projects indicates a deficit in the water budget for the lower basin, as follows:

	<i>Acre-feet</i>
Supply available, under full development.....	9,900,000
Consumptive-use requirements of existing and authorized projects.....	10,150,000
Indicated average annual deficit.....	250,000

The indicated average annual deficit is approximately 2½ percent of the estimated annual supply available

for consumptive use. If the estimated net losses from the proposed Bridge Canyon and Marble Canyon Reservoirs are added to the figures for consumptive-use requirements, the indicated deficit is 340,000 acre-feet a year, or about 3 percent of the estimated supply.

The amount of the indicated deficit is not large. However, the important facts revealed by the analysis are that the consumptive-use requirements of existing and authorized projects in the lower basin exceed the water supply that will be available to the lower basin within the United States under full basin development, and that, if these requirements are fully met, no water will be available for any new consumptive-use projects in the lower basin. New projects in the lower basin could be provided with water for consumptive use only at the expense of the projects now operating or authorized. Thus, the answer as to the availability of an assured water supply for any new project in the lower basin depends definitely and finally upon the determination of the individual rights of the lower-basin States to the use of Colorado River water.

### POTENTIAL PROJECTS

In table II of the regional directors' report, and also in the letter of the Acting Commissioner to the Secretary of the Interior, dated June 6, 1946, are listed 134 projects in the Colorado River Basin, 100 in the upper basin at an estimated cost of \$1,471,227,200 (including \$255,000,000 for transmission grid), and 34 in the lower basin at an estimated cost of \$1,989,270,000 (including \$288,150,000 for transmission grid), or a total of \$3,460,497,200, based upon current construction prices.

#### *Physical Works*

The following table sets forth the potential projects with estimated current construction costs, as listed in the letter of the Acting Commissioner, dated June 6, 1946. It is stated in that letter: "The 134 potential projects or units of projects as described in the report are in addition to the existing and presently authorized projects or extensions of projects."

*Potential projects in the Colorado River Basin*

Project and unit	Location of project	Source of water supply	Purpose to be served <sup>1</sup>	Estimated construction costs <sup>2</sup>
<b>Upper Basin</b>				
Sublette.....	Wyoming.....	Green River.....	I, F, P.....	\$58,400,000
West Side.....	do.....	do.....	I, F.....	
Daniel.....	do.....	do.....	I, F.....	
Elkhorn.....	do.....	do.....	I, P, F.....	
Paradise.....	do.....	New Fork River.....	I.....	
Eden.....	do.....	Big Sandy Creek.....	I.....	
Lower Big Sandy.....	do.....	do.....	I.....	
LaBarge.....	do.....	LaBarge Creek.....	I, F.....	
Fontenelle.....	do.....	Fontenelle Creek.....	I, F.....	

See footnotes at end of table.

Potential projects in the Colorado River Basin—Continued

Project and unit	Location of project	Source of water supply	Purpose to be served <sup>1</sup>	Estimated construction costs <sup>2</sup>
Seedskaedee	Wyoming	Green River	I	
Opal	do	Hams Fork	I, F	\$5,760,000
Lyman	do	Black and Smith Forks	I, F	6,928,000
Henry's Fork	Wyoming, Utah	Henry's Fork	I, F	2,352,000
Flaming Gorge	do	Green River	P, F, H, S	16,000,000
Red Canyon	Utah	do	P, F	6,560,000
Little Snake River	Wyoming, Colorado	Little Snake River tributaries	I, P, F	34,400,000
Upper Yampa	Colorado	Yampa River	I, F	3,680,000
Wessels	do	do	I, F	1,760,000
Mount Harris	do	Tributaries of Yampa River	I, F	5,280,000
Great Northern	do	Elkhead Creek and Elk River	I, F	4,320,000
Yellow Jacket	do	White River and Milk Creek	I, F	7,520,000
Deadman Bench	Colorado, Utah	Yampa River	I, P, F, H, S	38,080,000
Maybell	Colorado	do	I	1,120,000
Cross Mountain	do	do	P	8,000,000
Lily Park	do	do	P, F	3,040,000
Josephine Basin	do	White River	I	480,000
Piceance	do	Piceance Creek	I, F	1,280,000
Moon Lake Extension	Utah	Duchesne River and tributaries	I, F	12,640,000
Fruitland	do	Red Creek	I, F	640,000
Castle Peak	do	Duchesne River	I, F	8,480,000
Mosby	do	Deep Creek and Whiterocks River	I, F	1,760,000
Vernal	do	Ashley Creek	I, F	2,400,000
Jensen	do	Brush Creek	I, F	480,000
Minnie Maud	do	Minnie Maud Creek	I, F	160,000
Green River pumping	do	Green River	I	640,000
Echo Park	Colorado	do	P, F, H, S	68,800,000
Split Mountain	Utah	do	P, F, H, S	36,800,000
Emery County	do	Cottonwood Creek	I, F	4,000,000
Buckhorn	do	Huntington Creek	I, F	1,920,000
Gunnison Valley	do	Green River	I	1,760,000
Desolation Canyon	do	do	P, F, H	33,600,000
Rattlesnake power	do	do	P, F, H	36,800,000
Troublesome	Colorado	Troublesome Creek	I, F	3,536,000
Muddy Creek	do	Muddy Creek	I, F	800,000
Gore Canyon	do	Colorado River	P	6,080,000
Fourmile	do	Fourmile Creek	I, F	960,000
Cattle Creek	do	Cattle Creek	I, F	688,000
Capitol Creek	do	Snowmass Creek	I	208,000
Woody Creek	do	Roaring Fork	I	272,000
Silt	do	Rifle Creek	I, F	2,112,000
West Divide	do	Middle Willow Creek	I, F	2,080,000
Hunter Mesa	do	Buzzard Creek	I, F	2,400,000
Roan Creek	do	Carr Creek	I, F	976,000
Collbran	do	Plateau Creek	I, F, M	3,104,000
Grand Valley Extension	do	Colorado River	I	664,000
Cisco Thompson	Colorado, Utah	do <sup>3</sup>	P, I, F, H, S	54,784,000
Tomichi Creek	Colorado	Tomichi Creek	I, F	2,976,000
Cochetopa Creek	do	Cochetopa Creek	I, F	1,840,000
Ohio Creek	do	Anthracite and Castle Creeks	I, F	1,728,000
Lake Fork	do	Lake Fork	P, F	2,080,000
Sapinero	do	Gunnison River	P, F	12,480,000
Fruitland Mesa	do	Curecante and Sapinero Creeks	I, F	5,600,000
Smith Fork	do	Smith Fork	I, F	3,520,000
Paonia	do	East Muddy Creek and North Fork	I, F	2,240,000
Minnesota	do	Minnesota Creek	I, F	1,312,000
Leroux Creek	do	Leroux Creek	I, F	4,480,000
Grand Mesa	do	Currant, Surface, and Tongue Creeks	I, F	3,072,000
Ouray	do	Uncompahgre River	P, I, F	6,560,000
Redlands	do	Gunnison River	I, F	587,000
Saucer Valley	do	Disappointment Creek	I, F	1,504,000
Nucla	do	Horsefly and Cottonwood Creeks	I, F	2,400,000
San Miguel	do	Anderson, Naturita, Dry Creeks and San Miguel River	I, F	10,544,000
West Paradox	do	West Paradox, Deep, and Geysers Creeks	I, F	1,024,000
Dewey	Utah	Colorado River	P, F, H, S	60,800,000
Moab	do	do	P, F, H, S	15,840,000
Pack Creek	do	Mill Creek	I, F	1,240,000
Hatch Creek	do	Hatch Creek	I, F	640,000
Dulce-Chama-Navajo	Colorado	Navajo River	I, F	2,603,200
South San Juan	New Mexico	San Juan River	I, F	56,000,000
Curracas	Colorado	do	I	57,600
O'Neal Park	do	Piedra River	I	1,408,000
Hammond	New Mexico	San Juan River	I	1,160,000
Shiprock	do	do	I, F	33,825,600
Emerald Lake	Colorado	Pine River	P, F	9,920,000

See footnotes at end of table.

## Potential projects in the Colorado River Basin—Continued

Project and unit	Location of project	Source of water supply	Purpose to be served <sup>1</sup>	Estimated construction costs <sup>2</sup>
Pine River Extension	Colorado, New Mexico	Pine River	I	\$2,936,000
Florida	Colorado	Florida River	I, F	3,664,000
Animas-La Plata	Colorado, New Mexico	Animas and La Plata Rivers	I, P, F, S	101,654,400
McElmo	Colorado	McElmo Creek	I, F	624,000
Montezuma Valley Extension	do	Dolores River	I, F	2,080,000
Dolores	Colorado, Utah	do	I, F, S	19,520,000
Blanding	Utah	Recapture Creek	I, F	907,200
Navajo Indian project	Colorado	San Juan River	I, F, S	4,656,000
Bluff	Utah	do	P, F	30,400,000
Gooseheads	do	do	P, S, F, H	8,320,000
Slick Horn Canyon	do	do	P, S, F, H	10,080,000
Great Bend	do	do	P, S, F, H	16,000,000
Fremont	do	Fremont River	I, F	1,280,000
Torrey	do	do	I, F	320,000
Escalante	do	Escalante River	I, F	1,440,000
Dark Canyon	do	Colorado River	P, F, S, H	168,000,000
Glen Canyon	Arizona	do	P, F, S, H	102,400,000
Transmission grid				255,000,000
Subtotal, upper basin				1,471,227,200
<b>Lower Basin</b>				
Snowflake	Arizona	Showlow and Silver Creeks	I, F, S	4,160,000
Black Creek	do	Black Creek	I, F, S	2,880,000
Holbrook	do	Little Colorado River	I, F, S, C	2,080,000
Winslow	do	Clear and Chevelon Creeks	I, F, S	30,400,000
Kanab Creek	do	Kanab Creek	I	320,000
Hurricane	Utah-Arizona	Virgin River	I, P, S, F	14,720,000
Santa Clara	Utah	Santa Clara River	I, F, S	2,720,000
Panaca Valley	Nevada	Meadow Valley wash	I, F	2,080,000
Moapa Valley	do	Muddy River	I, F, S	1,120,000
Moapa Valley pumping	do	Lake Mead	I	4,480,000
Marble Canyon Kanab Creek	Arizona	Colorado River	P, F, S, H	611,200,000
Coconino	do	Little Colorado River	P, S, H	6,400,000
Bridge Canyon	do	Colorado River	P, I, F, S, H	234,400,000
Virgin Bay pumping	Nevada	Lake Mead	I	2,080,000
Las Vegas pumping	do	do	I, M	13,440,000
Davis Reservoir pumping	do	Davis Reservoir	I	800,000
Big Bend pumping	do	Colorado River	I	1,120,000
Fort Mojave	do	do	I	1,280,000
Mojave Valley	Arizona	do	I	3,040,000
Alamo	do	Bill Williams River	F, P, H	5,120,000
Palo Verde Mesa	California	Colorado River	I	4,960,000
Wellton-Mohawk	Arizona	do	I	16,960,000
Sentinel	do	Gila River	F, H	24,000,000
River rectification and control	California-Arizona	Colorado River	F	8,000,000
Central Arizona	Arizona	do	I, F, P, M, U	692,480,000
Salt River				
Paradise Valley				
San Carlos				
Charleston				
Safford Valley				
San Francisco				
Duncan-Virden Valley				
New Mexico				
Chino Valley	do	Granite and Willow Creeks	I	240,000
Hassayampa	do	Hassayampa River	I, F	10,640,000
Transmission grid				288,150,000
Subtotal, lower basin				1,989,270,000
Total, Colorado River Basin				3,460,497,200

<sup>1</sup> Symbols used: I=Irrigation, F=flood control, P=power, H=hold-over storage for river regulation, S=silt retention, M=municipal, U=underground water recharge, C=channel improvement. In addition many potential reservoirs would have value for recreation and fish and wildlife conservation.

<sup>2</sup> Preliminary estimates based on current construction costs.

<sup>3</sup> Half the water required for this project would be diverted from the Gunnison River by exchange.

In chapter V of the section of the report under review entitled "Substantiating Material," a general description of each of the foregoing listed projects is given together with some information with respect to locations and capacities of reservoirs, general locations and lengths of canals, areas of land to be served, and installed capacities of power plants where such plants are part of the

project. However, no detailed estimates are presented in the report of the cost of the works included in the projects and no pertinent data necessary for making such estimates are given.

Factors which would govern the engineering and financial feasibility of a project are entirely lacking in the report. For example, information relative to a pro-



posed dam is not presented as to type, dimensions, foundation conditions, accessibility of site, availability of construction materials and electric power, improvements flooded, rights-of-way, construction quantities in dam and appurtenant works, and unit prices of construction.

With respect to canals, similar information as for dams is not given. No data are available in the report as to dimensions and type of conduit, terrain through which the conduit would be constructed, accessibility, availability of construction materials, and rights-of-way involved.

With reference to electric-power installations, the report fails to submit any information on the accessibility of the power-plant sites and transmission-line locations, pertinent data on materials anticipated to be encountered in tunnel construction and other matters which must necessarily have an important bearing on the engineering and financial feasibility of a project.

#### *Water Utilization Studies*

No water supply or water utilization studies for individual projects are presented in the report and no statement is included to indicate that such studies had been made. The report admits that the total water requirements of the projects presented considerably exceed the long time mean run-off from the Colorado River Basin and that the more desirable projects would have to be selected. Without water supply and water utilization studies for individual projects, it is not possible to determine if the projects are even practical.

The water-supply utilization studies should be presented on a monthly basis for a 40- or 50-year period, including the critical period of run-off. It would appear that the water supply available over the critical period is entirely inadequate for complete development of the basin and that large amounts of hold-over storage will be required. Substantial amounts of such hold-over storage under complete development would be required in the upper basin in order that the flow at Lees Ferry be not depleted below 75,000,000 acre-feet in any ten consecutive years, as required by article III (d) of the Colorado River compact. Water-supply studies are required to determine if this hold-over storage is feasible. The hold-over storage would have to be replenished in seasons of heavy run-off, and such seasons may be of such infrequent occurrence that hold-over storage may be impracticable.

The water-supply utilization studies should be presented for each operating, authorized, and proposed project, starting with those on the upper tributaries first and proceeding downstream. These studies should show the annual supply available, the net amount stored or released from storage, the gross diversion, the net consumptive use in the project, and the supply available to the next downstream project. These water-utiliza-

tion studies should be summarized by basins and by States. The feasibility of the development of the Colorado River Basin outlined in the report from the water-supply standpoint cannot be determined without the inclusion of water-utilization studies.

#### *Underground Storage*

In chapter V of the report under review, mention is made of the development of ground-water resources in the Green, Grand, Little Colorado, Virgin, Boulder, and Gila divisions, and a general description is given of the underground basins in which ground water has been utilized.

In chapter VIII of the report, the Geological Survey discusses generally ground-water conditions in both the upper and lower basins and points out the need for a systematic study of the subject with the view of utilizing the underground basins in the interests of conserving water.

Apparently there has been no extensive or thorough investigation of the underground basins of the Colorado River Basin with the view of their utilization in a comprehensive plan of development of the waters of the Colorado River system. Such an investigation might result in a program of incorporating underground storage as a part of the final physical plan.

#### THE SILT PROBLEM

Although the silt problem is one of the most important of the several problems to be solved in connection with the development of the Colorado River, it is not so recognized in the report. There is some discussion in the report of the silt problem, as it existed in the lower river and in the delta prior to the building of Boulder Dam and of the difficulties which have subsequently developed in controlling the channel below Boulder Dam. The silt problem is mentioned briefly in connection with the Gila River and in several other parts of the report. But the real significance of the silt problem and its menace to continued agricultural and power production, as well as possible solutions of the problem and the difficulties which will be encountered in trying to perfect these solutions, are almost entirely overlooked in the report.

Few realize that the Colorado River, in its natural state, had an average silt content exceeded by only one or two rivers in the world. Daily tests of the water in the main canal of Imperial irrigation district prior to the building of Boulder Dam showed, on several occasions, a silt content of as much as 30 percent by volume. For the entire month of August 1930 these tests showed an average silt content of approximately 15 percent by volume. It was in reality the silt content of the river, rather than the quantity of water, which created the

flood problem in the lower river. It was because of this fact that the location of Boulder Dam and the height to which it could be constructed were exceptionally favorable. About 95 percent of the river's silt originates above Boulder Dam. The great reservoir capacity created by the dam offered relief from the silt problem in the lower river for many years, providing an opportunity to study and find a permanent solution for the problem.

It is certain that agricultural development on the Colorado River system, particularly in the lower basin, will endure for no longer than the silt is controlled. Many think that with the construction of Boulder Dam and other dams on the Colorado River system, the future of agriculture is firmly secured. So, no doubt, did people think who were living on rivers like the Tigris and Euphrates, when civilization flourished there. But that civilization has passed, and so will the civilization on the Colorado River unless a permanent solution is found for the silt problem. In a sense, we are now at intermission time. The struggle to control silt on the main stream and tributaries in the lower basin, prior to the building of Boulder Dam and other dams was most difficult and costly. Now it has been eased; for the present it is no longer a problem, and the cost of dealing with it has been largely eliminated for the irrigation projects. However, 100 years can pass very swiftly. To state that the effects of mistakes made now in developing the river may not be felt for that period is no answer to the people of subsequent generations who may suffer because of those mistakes. It is true that, during this period, the cost of the dams, canals, and facilities used in developing the river can no doubt be amortized; but history has shown that it may never be possible to amortize the civilization and the institutions which will have become dependent upon these works.

Past experience on irrigation projects in the lower basin has clearly demonstrated the impossibility of successfully controlling the silt at river-diversion structures or in the canal systems of the projects. The operators of the early canal systems had an advantage that would not be available to the operators of newer systems under similar conditions. The designers and builders of the older irrigation systems had the silt problem in mind. Canals and farm ditches were built on grades steep enough to keep the silt moving. This is not true of the newer systems, which are constructed to convey and distribute desilted water. Therefore, even if it were possible in the future to regain storage capacity in reservoirs, as has been suggested, by sluicing out the silt, the projects downstream could not cope with the silty water. The same may also be said in regard to the suggestion that density currents in reservoirs be used to carry the finer silt through the reservoir and into the river below, thus extending the life of the reservoir. These finer

silts, if carried onto project land, would ruin the productivity of the soil by filling the pores and making the soil impermeable. Moreover, in the past, there was always sufficient surplus water in the river, at least during the greater part of the year, to sluice into the lower delta the silt removed by desilting operations. In the future, with the river fully developed, this surplus will not be available, since, according to the report, it is planned to utilize the entire flow of the river for irrigation and other consumptive purposes. Hence, any accumulation of silt in the flow of the lower river would be passed on down to the last project, which, in this case, will be in Mexico. The Mexican projects could do no desilting, as there would not be sufficient surplus water available to sluice the silt into the Gulf. It would seem that such a situation could not be tolerated. A permanent solution for the silt problem must be found which will keep the silt away from project-diversion works and canal systems.

What plans are being considered for such a solution? What are the possibilities of providing a solution and what will it cost? In this connection, what are the possibilities and costs of land management, reforestation, prevention of overgrazing, erosion control, excavation of silt from reservoirs and transportation to areas for disposal, and other possibilities of controlling the silt problem? What are the plans of the Bureau of Reclamation in connection with the proper sequence of construction of additional dams in the Colorado River system? This sequence of construction is of great importance and deserves careful study in order that the hold-over storage capacity and power output may be extended for the greatest possible period. As an example, it would appear to be an economic mistake to construct the Bridge Canyon Dam unless, at the same time, other dams were constructed on the main river and tributaries above Bridge Canyon. Otherwise the relatively small storage capacity of Bridge Canyon Reservoir would be completely filled by silt in a very few years. It is not known what the effect will be, or what difficulties will be encountered, in attempting to pass silt down the river over a dam that has been filled completely with silt, nor whether a high-head power plant could be operated successfully with such silty water. Moreover, without upstream dams for regulating purposes, the output of a power plant at Bridge Canyon Dam would be limited by the natural flow of the river, which varies so greatly with different seasons of the year and from year to year that only a small percentage of the total power capacity could be considered as "firm."

Since Boulder Dam was completed, over a million acre-feet of silt have been deposited in Lake Mead. However, this is only about one-third the dead storage provided for silt retention. From the time that Bridge Canyon Dam is completed until its reservoir is filled

with silt, the amount of silt that enters Lake Mead will be insignificant compared to the amount that enters under present conditions. Careful study should be made as to the most desirable sequence of construction of dams with reference to silt and other major factors.

No matter how big a reservoir may be, it will eventually be filled with silt if the silt continues to flow in the river. Since the possibilities of building dams are limited, a permanent solution of the silt problem must prevent, in large measure, the entrance of silt into the run-off from the drainage basin. No plan for the comprehensive development of the Colorado River will be adequate or complete, nor can the safe extent of such development be determined, without careful consideration of these questions.

**ELECTRIC POWER**

Full development of the water resources of the Colorado River necessarily includes the production and transmission of hydroelectric power made possible by the construction of storage works for the regulation and utilization of the waters of the Colorado River and its tributaries.

In chapter VI in the section of the report entitled "Substantiating Material" there is presented a general discussion of the present electric-power situation in the

upper- and lower-basin States, including present use and estimated load growth and tabulations of the potential hydroelectric-power plants in the two basins. In the upper basin 29 potential hydroelectric plants are listed, with an aggregate installed generating capacity of 1,713,000 kilowatts and an estimated firm generation of 9,241,000,000 kilowatt-hours annually.

Power developments in the upper basin are summarized in the report under review as follows:

Item	Kilowatts	Kilowatt-hours
Present installed capacity:		
Hydroelectric .....	57,217	
Fuel-burning .....	43,865	
Total .....	101,082	
Present load requirements (1943) .....	52,404	238,870,000
Potential installed generating capacity, hydroelectric .....	1,713,000	
Potential firm output .....		9,241,000,000
Estimated load requirements (1980) .....	330,000	1,885,000,000
Estimated increase in load requirements (1943-80) .....	277,596	1,646,130,000
Estimated energy available for export (1980) .....		7,594,870,000

The nine potential hydroelectric-power plants in the lower basin are listed in table CXXXI of the report as follows:

*Potential hydroelectric power plants in lower basin*

[Table CXXXI of report under review]

River basin power plant	Project	River	Installed capacity (kilowatts)	Annual firm generation (kilowatt-hours)
Colorado River:				
Marble Canyon .....	Marble Canyon-Kanab Creek .....	Colorado .....	22,000	164,000,000
Kanab Creek .....	do .....	do .....	1,250,000	6,570,000,000
Bridge Canyon .....	Bridge Canyon .....	do .....	650,000	3,440,000,000
Gila River:				
Buttes .....	Central Arizona .....	Gila .....	5,800	8,000,000
Horseshoe .....	do .....	Verde .....	<sup>1</sup> 10,000	<sup>1</sup> 37,000,000
Hooker .....	do .....	Gila .....	3,000	8,000,000
Virgin River: <sup>2</sup>				
Virgin .....	Hurricane .....	Virgin .....	2,000	3,000,000
Bench Lake .....	do .....	do .....	800	2,000,000
Warner Valley .....	do .....	do .....	1,800	10,000,000
Total .....			<sup>3</sup> 1,945,400	<sup>3</sup> 10,242,000,000

<sup>1</sup> Would be used to replace loss of generation at Stewart Mountain plant.

<sup>2</sup> In addition to the firm energy shown there will be 17,800,000 kilowatt-hours generated annually to be used as replacement for energy now being generated at the LaVerkin plant, project pumping, and secondary energy.

<sup>3</sup> Net increase in installed capacity 1,935,400 kilowatts and net increase in annual firm generation 10,205,000,000 kilowatt-hours.

Power developments in the lower basin power area are summarized in the report under review as follows:

Item	Kilowatts	Kilowatt-hours
Present installed generating capacity: <sup>1</sup>		
Hydroelectric .....	1,959,625	
Fuel-burning .....	1,142,452	
Total .....	3,102,077	
Present load requirements (1943) .....	2,100,000	11,174,024,000
Potential installed generating capacity, hydroelectric .....	<sup>2</sup> 1,935,400	

Item	Kilowatts	Kilowatt-hours
Potential firm output .....		<sup>2</sup> 10,205,000,000
Estimated load requirements (1980) .....	5,300,000	30,000,000,000
Estimated increase in load requirements (1943-80) .....	3,200,000	18,825,976,000
Estimated energy deficiency (1980) .....		8,620,976,000

<sup>1</sup> Existing, authorized, and planned installed capacity.

<sup>2</sup> Excludes Horseshoe plant, 10,000 kilowatts installed capacity, and 37,000,000 kilowatt-hours output for replacement.

With respect to costs and benefits from electric-power production from the potential projects presented in the report under review, the following is quoted from the concluding paragraph of chapter VI thereof:

"Further investigation and study will be necessary before cost allocations of all multiple-purpose potential projects can be determined. However, results of preliminary studies indicate that the sale of firm commercial energy at an average rate of approximately 4 mills per kilowatt-hour would provide for repayment of the power features and would provide additional funds which could be applied toward repayment of other project features."

As elsewhere stated in this review, information and data are lacking which would be needed in estimating the cost, capital or annual, of the power features, or the electric-power output therefrom. Also, necessary reservoir-operation studies are not presented which would determine the firm kilowatt capacity and energy output under varying conditions. Only a detailed analysis could determine those values and the cost and value of the electric power produced from any project presented in the report under review.

An initial construction program could and should include hydroelectric-power developments when found needed and justified. Such projects are considered non-consumptive in effect. The present expanding power demands in the Pacific Southwest are having to be met by the installation of about 700,000 kilowatts of steam-electric generating capacity to meet the peak demands estimated for the year 1948. At the time such capacity becomes available it will be fully absorbed, and it is anticipated that further capacity at the rate of 150,000 to 200,000 kilowatts per year will be required to keep up with prospective growth. Additional hydroelectric-power development on the lower river will be desirable and necessary to meet these expanding power demands.

An immediate and intensive study should be made with respect to new hydroelectric-power projects, upstream from Lake Mead, with a view toward authorizing and constructing, at the earliest practicable date, such hydroelectric-power projects as can be built and operated on a sound economic basis, will furnish electric power at reasonable cost, will be consistent with the primary purposes of furnishing water supplies for irrigation and domestic uses, and will not be inconsistent with a comprehensive plan of progressive development.

## ECONOMICS OF POTENTIAL PROJECTS

In chapter VII of the section of the report under review entitled "Substantiating Material" and in the regional directors' report a presentation is made of the benefits that would result from the development of

potential projects within the Colorado River Basin as set forth in the report, which are compared with estimated costs thereof. Annual estimated over-all costs and benefits of the 134 potential projects within the Colorado River Basin are presented as follows:

<i>"Annual benefits</i>	
Irrigation benefits.....	\$65,000,000
Power benefits.....	72,000,000
Flood-control benefits.....	1,000,000
Municipal benefits.....	500,000
	<hr/>
Total measurable annual benefits.....	138,500,000
	<hr/>
<i>Annual costs</i>	
Operation and maintenance.....	23,000,000
Amortization of construction cost (\$2,185,442,000) in 50 years, at 3 percent.....	85,000,000
	<hr/>
	108,000,000
	<hr/>
<i>Ratio of benefits to annual costs.....</i>	<i>1.3 : 1"</i>

In the Acting Commissioner's letter to the Secretary of the Interior, dated June 6, 1946, the capital cost based upon current prices is given as \$3,460,497,200, with a benefit-cost ratio of approximately 1.00 to 1.00.

Attention is called particularly to statements in the regional directors' report as to the economic feasibility of the projects. Paragraphs 42, 43, and 44 of that report, in that regard, read, in whole or in part, as follows:

"42. A definite analysis of a basin-wide development of water resources cannot be presented until a final selection of projects has been made. The following estimates and approximations are based on development of all potential within-basin projects summarized in the report. This analysis is presented to indicate the economic feasibility of a comprehensive plan for ultimate development of the water resources of the basin. All projects are considered integral units of a basin plan and as such their economic feasibility is comprehended by the finding of feasibility for the over-all basin plan. \* \* \*

"43. It is expected that an allocation of costs as provided in section 9 of the Reclamation Project Act of 1939, and acts amendatory thereof or supplementary thereto, would result in an equitable and appropriate distribution of allocable costs among the purposes to be served.

"44. Estimates of benefits from irrigation, power production, municipal water supplies, and flood control are summarized in the following table. The increase in gross crop income is taken as the measure of the benefits from irrigation. For the purpose of illustration, power benefits are determined as the gross income from the sale of electric energy at an assumed rate of 4 mills a kilowatt-hour, delivered to load centers. Returns

from the sale of water for municipal purposes are not subject to a precise analysis, but a gross annual return of \$500,000 is assumed as a measure of the municipal benefits. Flood-control benefits resulting from the construction of numerous dams and other structures are measured by the decrease in average annual flood damages along the Colorado River and its tributaries. These benefits indicate that a basin-wide plan for full development of the water resources could return to the Nation \$1.30 for each dollar required to construct, maintain, and operate the projects. \* \* \*

Analyzing a group of 134 individual projects scattered over a basin area of 242,000 square miles in seven States and which, for the most part, are not dependent one upon another, does not appear logical nor necessary, particularly since the group in its entirety will not be constructed for many decades. During such period construction costs may vary widely as well as the demands for service and the benefits resulting from construction of projects. Each project should be considered on its individual merits, and in its relation to a general plan, tested, first, as to its need; second, as to its engineering feasibility; and, third, as to its economic justification in order to establish its priority in a program of development in the basin.

The following criteria should be utilized in determining the financial feasibility and economic justification of each project analyzed: (1) Costs allocated to flood control, navigation, and propagation of fish and wildlife to be nonreimbursable; (2) costs allocated to irrigation to be repayable within 40 years (exclusive of the permissible development period), without interest; (3) costs allocated to hydroelectric power to be repayable within 50 years with interest; (4) costs allocated to municipal water supply and other miscellaneous purposes to be repayable in a period not to exceed 40 years, with interest if determined to be proper; and sums repayable under (2), (3), and (4) to be probably repaid within the times specified.

As a part of the investigation and study leading to a finding of feasibility of an individual project, determinations should be made relative to the following: (1) Availability, suitability, and adequacy of the water supply; (2) engineering feasibility of constructing the required works; (3) adequacy of cost estimates; (4) adaptability and suitability of the lands to irrigation, if an irrigation project; (5) available market for project water—domestic, irrigation, and industrial uses; and (6) available market for project power—domestic, industrial, commercial, and mining.

It is stated in paragraph 3 of the regional directors' report that it is made pursuant to the Reclamation Act of June 17, 1902, and acts amendatory thereof or supple-

mentary thereto. Section 9 of the Reclamation Project Act of 1939, referred to in paragraph 43 of the regional directors' report, contains the provisions of the reclamation law now in effect regarding feasibility standards and repayment. In spite of the provisions of the law, pursuant to which the report is made, the report embarks upon an entirely new basis of purported showing of economic feasibility which does not conform with existing law.

There is no justification in existing reclamation law for the consideration of economic feasibility of proposed projects on a basin-wide basis, or by a comparison of estimated "benefits" and costs. Existing reclamation law requires that each proposed project be considered individually on its own merits and that a showing be made of engineering feasibility and of economic feasibility, based on the sufficiency of water payments and revenues from all sources to meet reimbursable costs and other necessary charges and expenses. All the projects previously authorized and constructed by the United States on the Colorado River system, including large developments such as the Boulder Canyon project, have been considered individually as to engineering feasibility and economic justification on a repayment basis. There appears to be no reason at this time for treating new projects on a different basis.

Reclamation projects may and often do comprise several integrated units which are definitely interrelated, interdependent, and interconnected. However, the 134 potential within-basin projects for which the analysis is made comprise many scattered possible developments, a large number of which have no necessary interconnection or significant interrelation. The fact that they all happen to lie within a natural drainage basin does not warrant consideration of their economic feasibility as a group. If, in fact, it were proper to analyze economic feasibility on a basis of basin-wide development, such an analysis should comprehend not only the potential within-basin projects but also potential exportation projects. However, such an analysis of economic feasibility, even though properly made, cannot be considered as "comprehending" the economic feasibility of individual projects that are unrelated, disconnected, and not interdependent. Furthermore, since no adequate showing of economic feasibility on a basin-wide basis could be made until there has been a selection of projects which will be within the available water supply, the purported showing of economic feasibility is of no significance or value.

The analysis of economic feasibility in paragraph 44 purports to show a ratio of "benefits" to cost of 1.3 to 1, based on 1940 costs. If the analysis of annual cost is based upon current prices, this indicated ratio of "bene-

fits" to cost is, as stated in the Acting Commissioner's letter to the Secretary of the Interior, reduced to approximately 1 to 1. But with more accurate cost estimates based on detailed plans, it appears that the indicated benefit-cost ratio could well be reduced to less than 1 to 1.

It is admitted in the report under review that "There is not enough water available in the Colorado River system for full expansion of existing and authorized projects and for all potential projects outlined in the report, including the new possibilities for exporting water to adjacent watersheds." Yet the report proceeds to find the 134 projects as a group are economically feasible based in part upon irrigation benefits of approximately one-half of the total, to be derived from the application of the admittedly insufficient water supply on 2,656,230 acres of land and, in addition, for the utilization of 500,000 acre-feet of water annually on unspecified pasture lands in the upper basin.

Aside from the fact that annual "benefits" are not a proper criterion under existing reclamation law in any showing of economic feasibility on proposed projects, the estimate presented in the report of annual "benefits" is in part fallacious and in part questionable.

The irrigation benefits for the entire group of 134 projects are calculated in the report under review on the basis of estimated increase of gross crop income anticipated to be obtained by the furnishing of a new irrigation supply to the lands in the prospective areas of service. Such procedure does not preclude the inclusion of projects which would result in no net benefit to the farmer. While it is recognized that there are indirect nonfarm benefits from the development of irrigation projects, it is believed that the projects which result in the greatest direct benefit to the farmer produce the greatest local, State, and National indirect benefits and that calculations of irrigation benefits both direct and indirect should be related to the increase in net farm income to be obtained from the construction of the projects and not to gross farm income.

In this connection it should be noted that in a recent report presented by the Bureau of Reclamation to the House Irrigation and Reclamation Committee at the hearings during the second session of the Seventy-ninth Congress on H. R. 5434—a bill to reauthorize the Gila Federal Reclamation project—a purported showing of economic feasibility with respect to the Wellton-Mohawk unit of the project was presented on the benefit-cost basis. In this showing the irrigation "benefit" was estimated on the basis of "net" crop income rather than "gross" crop income. No reason appears for this inconsistency in treatment of the subject.

The report itself demonstrates that only a relatively small part of gross crop income represents the farmer's

ability to repay project costs. While the report presents \$65,000,000 as the annual irrigation "benefit" of the 134 projects, it also shows (ch. VII) that the water users on such projects could pay annually only \$8,000,000. The use of the benefit-cost ratio as to irrigation is demonstrably fallacious.

The largest item of estimated annual "benefits" shown in the report is \$72,000,000 for "power benefits." This constitutes the estimate of gross revenue from sale of hydroelectric power at an assumed rate of 4 mills per kilowatt-hour delivered at load centers. This estimate is not supported by adequate data. The estimated energy output is unsubstantiated. The dependability of energy output and capacity is not shown. The ability of the market to absorb the power and the time required therefor are not shown. The location of load centers for delivery and transmission facilities required for delivery are not revealed. No showing is made as to whether the power could actually be sold at a price of 4 mills per kilowatt-hour. This would obviously depend upon where the power was delivered. Furthermore, no analyses are presented to demonstrate that the 4-mill price would cover the actual costs of power production and transmission, including interest and amortization of capital costs of multiple-purpose works properly allocated to power and of capital costs of direct power facilities, plus the expense of operation and maintenance, replacement, and other proper charges. Power projects are not considered individually, as they should be, in connection with the market for the power output therefrom. In view of these several deficiencies in the information contained in the report, the estimate of power "benefits" on the basis of gross power revenue appears speculative.

The pooling of power revenues on a basin-wide basis is without justification under existing reclamation law and is not in the best interests of sound development. Heretofore, in cases of production of hydroelectric power, incidental to the primary objectives of an irrigation project or of a multiple-purpose integrated development, power revenues properly have been used to help repay the cost of irrigation. However, the pooling of power revenues as proposed in the report or in effect using power revenues from hydroelectric-power developments to help pay for widely separated irrigation projects that are unrelated to and disconnected from such power projects, appears to be designed to lift infeasible irrigation projects into a theoretical status of feasibility.

The pooling of irrigation payments or water revenues on a basin-wide basis is similarly without justification in existing law and is not in the interest of sound development. The law requires each project, whether single or multiple-purpose in scope, to be considered

individually on its own merits and to pay its own reimbursable cost.

REVIEW BY STATE DEPARTMENT OF  
NATURAL RESOURCES

As previously stated herein, the proposed report of the Secretary of Interior was referred on June 24, 1946, to the State department of natural resources for review and comment. On July 8, 1946, the director of natural resources, Warren T. Hannum, replied in part as follows:

"This report [proposed report of the Secretary of Interior] has been reviewed by the division of fish and game and they report that the proposed project has little effect on the fisheries and wildlife in that portion of the Colorado River bordering the State of California. No recommendations are made other than to concur in the general recommendations of the Fish and Wildlife Service appearing on page 334 (mimeographed copy) of the report."

The recommendations referred to above are.

"It is recommended that—

"1. All reservoirs provide suitable dead storage capacity to meet the requirements for protection of fish and wildlife; such capacities to be advocated upon the basis of the surveys to be made in compliance with recommendation 12 hereinafter.

"2. Release of water from all impoundages be sufficient to safeguard adequately or improve fishing conditions in streams below reservoirs through stabilized flows. To determine the minimum adequate amounts to meet fish and wildlife needs detailed surveys will be required.

"3. In respect to all reservoirs, operation of the gates shall be at such rates as will give adequate protection to fish and wildlife as shown by detailed surveys to be made hereafter.

"4. Diversions, where necessary, be adequately screened for fish protection.

"5. Plans for each headwater reservoir be presented to the Fish and Wildlife Service for study prior to construction in order to permit determination of advisability of incorporating therein provision for fish ladders or similar devices to facilitate natural spawning.

"6. Where reservoirs are to be established on streams subject to mine tailings, oil, industrial, sawmill wastes, and other forms of pollution, provisions be made to remove the hazard.

"7. Engineering studies be conducted to determine the feasibility of sill dyking to provide as extensively as possible shallow lateral pools with stable water spawning and rearing areas for fish and feeding and resting areas for wildlife.

"8. Studies be made of all reservoirs to determine those, if any, which should be designated as wildlife refuge and management areas.

"9. Adequate facilities be provided at each reservoir for access by the public for appropriate fishing, hunting, and other forms of recreation.

"10. Engineering plans of all reservoirs provide for outlet facilities so constructed as to release water from as close to the bottom of the reservoir as is practicable.

"11. Hatchery facilities be provided for such increased stocking as may be required for new reservoir construction to satisfy fishing demands. This should include doubling the present capacity of the fish-cultural station at Springville, Utah, for the production of legal-sized trout. It is estimated that the cost of the latter will be about \$56,200. In addition, a modern combination trout-bass fisheries station should be constructed near Page Springs in Oak Creek Canyon about 40 miles south of Flagstaff, Ariz., at a cost of approximately \$105,000. To supplement the facilities of this new hatchery, the Williams station should be further developed for the necessary incubation of trout eggs not possible at Page Springs, at a cost of about \$20,000.

"12. An allotment be established to provide for surveying the proposed reservoirs within the basin to determine their possible effects on fish and wildlife so as to mitigate damages and to increase benefits. Such a task is beyond the present personnel and appropriation limits of the Fish and Wildlife Service. To make the essential field surveys, the estimated costs for the fiscal year 1946 are \$132,000 for personnel and expenses."

CONCLUDING COMMENTS

The following comments and conclusions are submitted with respect to the proposed report of the Secretary of the Interior entitled "The Colorado River," approved June 7, 1946:

1. The proposed report does not comply with the authorization and directive contained in section 15 of the Boulder Canyon Project Act wherein the Secretary of the Interior is "authorized and directed to make investigation and public reports on the *feasibility of projects* for irrigation, generation of electric power, and other purposes in the States of Arizona, Nevada, Colorado, New Mexico, Utah, and Wyoming for the purpose of making such information available to said States and to the Congress, and of formulating a comprehensive scheme of control and the improvement and utilization of the waters of the Colorado River and its tributaries" [Emphasis added], in that the projects have not been analyzed individually as to their feasibility and a *comprehensive scheme* has not been formulated. The report represents essentially a catalog of potential proj-

ects with a general description thereof and it recognizes the fact that there is not sufficient water in the Colorado River system to serve all of them.

2. Factors and data which govern the engineering and financial feasibility of the proposed projects are lacking in the report.

3. The report does not furnish the necessary data or information for a determination by the affected States of their respective rights to the use of the water of the Colorado River and its tributaries or for a basis for selection of projects by the individual States or for authorization by the Congress of any project.

4. Based upon the figures in the report for water supply and water requirements for the potential projects and the existing and authorized projects, it is apparent that many of the potential projects will necessarily have to be eliminated in order that the existing and authorized projects be fully satisfied as to their water needs and rights.

5. The necessary analyses and data for an evaluation of the electric power estimated to be produced at the several power plants of the potential projects are not presented in the report.

6. Large hold-over surface storage as indicated in the report is required in meeting the requirements of the Colorado River compact and in conserving and utilizing as far as it is ultimately possible the waters of the Colorado River system.

7. Since quality of water determines its usefulness, this feature is one of primary significance and should have corresponding attention. More complete and detailed information is required on the quality of water in the various reaches of the Colorado River and its tributaries and the effect of the contemplated future development on such quality, particularly in the lower reaches of the river as it may be an important element in the administration of the Mexican treaty and of the Colorado River compact.

8. Little consideration is given to proposed trans-mountain or export projects in the upper basin which, if constructed, would play an important role in an ultimate comprehensive plan of development and utilization of the water resources of the Colorado River system.

9. Water requirements should be based upon "consumptive use" wherever it may occur and not upon "depletion" as used in the report under review since the Colorado River compact apportions waters on the basis of "consumptive use" and not on "depletion."

10. The determination of the share of water belonging to each State must precede a selection of projects for a comprehensive plan of development. The report recognizes this, but recommends that projects be selected for an initial stage of development, prior to such determination. In this, the report fails to distinguish between conditions in the lower basin, where water re-

quirements of existing and authorized projects exceed the available supply, and those in the upper basin, where available water supply substantially exceeds the water requirements of existing and authorized projects. This recommendation also fails to differentiate between consumptive use projects and comparatively nonconsumptive hydroelectric projects.

11. The statement in the report, that the economic feasibility of an initial group of projects is "comprehended" by the showing of economic feasibility on a basin-wide basis, is unwarranted. Projects should be analyzed and reported upon individually as to their engineering and economic feasibility and findings made relative thereto as required by law.

12. Detailed water-supply and water-utilization studies, which are not presented in the report under review, should be made for each project and for the entire comprehensive plan in order to determine the feasibility of the development from a water-supply standpoint.

13. The report should contain estimates of water supply on the basis of the critical periods of subnormal flow, which are controlling, as well as on the long-term average basis.

14. An extensive and thorough investigation should be made of the underground basins of the Colorado River Basin with the view of their possible utilization in the comprehensive plan of development of the waters of the Colorado River system.

15. The method utilized in the report in calculating irrigation benefits based upon gross farm income is fallacious because such procedure would not preclude the inclusion of projects which result in no net benefit to the farmer. While it is recognized that there are indirect nonfarm benefits from the development of irrigation projects, it is believed that the projects which result in the greatest direct benefit to the farmer make for the greatest local, State, and National indirect benefits and that calculation of irrigation benefits, both direct and indirect, should be related to the increase in net farm income to be obtained from the construction and operation of an irrigation project and not to the increase of gross farm income.

16. Since the ultimate life of the Colorado River projects is measured by the silt factor, the study of this subject should be a major feature of a comprehensive report. Special attention should be given to the silt problem in the Colorado River Basin with the objective of solving the problem at its source or otherwise controlling the silt load in the stream so as to prevent damage to irrigated lands and to the storage capacities in the reservoirs.

## RECOMMENDATIONS

1. It is recommended that, since the proposed report of the Secretary of the Interior is only a preliminary



progress report and does not constitute a basis for the authorization of any new project therein mentioned, no such project be authorized until hereafter reported upon in accordance with section 9 of the Reclamation Project Act of 1939, and with opportunity to the affected States to submit comments pursuant to the Flood Control Act, 1944, approved December 22, 1944 (59 Stat. 887).

2. In response to recommendation (2) set forth in paragraph 70 of the regional directors' report, which suggests a determination of rights, it is recommended that negotiations be initiated forthwith among the States of the lower basin, acting through their respective Governors, for the purpose of determining the rights of each of the States of the lower basin to the use of the waters of the Colorado River system, in accordance with the Colorado River compact, the Boulder Canyon Project Act, and relevant statutes, decisions, and instruments.

3. In response to recommendation (1) set forth in paragraph 70 of the regional directors' report, which invites submission of projects for construction, it is recommended—

A. That an immediate and intensive investigation and study be made and reported upon by the Bureau of Reclamation, in cooperation with interested agencies, concerning possible hydroelectric projects upstream from Lake Mead on the Colorado River with a view to authorization and construction at the earliest practicable date; provided, it be found that such projects are of non-consumptive-use character, are feasible from engineering and economic standpoints, are consistent with the primary purpose of furnishing water supplies for domestic and irrigation uses in accordance with the Colorado River compact, and will not be inconsistent with a comprehensive plan for progressive development of the Colorado River system.

B. That no new consumptive-use projects in the lower basin be authorized until a determination has been made of the rights of each State of the lower basin to the use of the waters of the Colorado River system in accordance with the Colorado River compact, the Boulder Canyon Project Act, and relevant statutes, decisions, and instruments.

C. That prior to determination of the allocation of the waters of the Colorado River system among the States of the upper basin, new consumptive-use projects in that basin be authorized under the following conditions:

(a) That the consumptive use of each project be assuredly within such water allocation as is considered to be minimum for the State for which the project is to be constructed, after due allowance for all existing and authorized projects;

(b) That, concurrently with the construction of any new projects in the upper basin which involve large additional use of water, hold-over storage capacity be

provided in that basin, to such extent as may be required to assure that the flow of the river at Lees Ferry will not be depleted below that required by article III (d) of the compact.

4. It is recommended that the seven basin States, acting through their respective governors, proceed to negotiate and enter into an agreement for the implementation of article III (d) of the compact.

5. It is recommended that the All-American Canal project and the San Diego aqueduct, which are now under construction, be completed without delay.

6. It is recommended that, in any allocation of the waters of the Colorado River system, the established water rights of existing and authorized projects be at all times recognized and protected.

7. It is recommended that, in determining whether any project shall be authorized for construction, the following economic criteria be followed:

(a) Costs allocated to flood control, navigation, and propagation of fish and wildlife be nonreimbursable;

(b) Costs allocated to irrigation be repayable within 40 years (exclusive of the permissible development period), without interest;

(c) Costs allocated to hydroelectric power be repayable within 50 years with interest;

(d) Costs allocated to municipal water supply and other miscellaneous purposes be repayable in a period not to exceed 40 years, with interest if determined to be proper; and

(e) The sums required under (b), (c), and (d), based upon findings of the Federal Government, will probably be repaid to the United States within the times specified.

8. It is recommended that the procedure followed in the proposed report, of purporting to show economic feasibility of each of a large group of projects by the pooling of estimates of annual costs and benefits of the group as a whole, be disapproved as unsound, in that the benefit-cost ratio, as applied, is fallacious and the estimates presented as to the entire group of projects do not justify any individual project; and that each new project be reported upon individually as to need, engineering, and economic feasibility and permanency of the development; and that the views and recommendations of the affected States be obtained thereon before submission to the Congress for approval as required by the Flood Control Act, 1944.

9. It is recommended that additional investigation and studies on the Colorado River system be diligently prosecuted and reported on by the Department of the Interior and other Federal agencies concerned, in cooperation with the States of the basin, and that appropriations be authorized in amounts adequate for that purpose; and that, in particular, such investigations and

studies include adequate coverage of (a) water supplies at point of use for individual projects, on the basis of critical drought periods; (b) water requirements of individual projects on the basis of consumptive use and not on the basis of main-stream depletion; (c) project and reservoir operations; (d) silt and its control and prevention; (e) present and future quality of water; and (f) financial analysis of individual projects; and to that end the State of California will cooperate with the Department of the Interior in the investigation and planning of projects contemplating use of waters of the Colorado River system in order to assist in the formulation of a comprehensive plan, founded upon sound principles of engineering and economics, for the full

## THE COLORADO RIVER

development of the water resources of the Colorado River system.

Submitted by:

(Signed) A. D. EDMONSTON,  
*Assistant State Engineer.*

Approved:

(Signed) EDWARD HYATT,  
*State Engineer.*

Approved:

COLORADO RIVER BOARD OF  
CALIFORNIA,

By (Signed) EVAN T. HEWES,  
*Chairman and Ex-officio Commissioner.*

SACRAMENTO, CALIF., February 28, 1947.

# Comments of the State of Colorado

STATE OF COLORADO

COLORADO WATER CONSERVATION BOARD

DENVER, COLORADO

DECEMBER 17, 1946.

The SECRETARY OF THE INTERIOR.

SIR: On behalf of the State of Colorado, and pursuant to section 1 of the act of December 22, 1944 (58 Stat. 887), there is herewith transmitted the comments, views, and recommendations of the State of Colorado concerning Project Planning Report 34-8-2 of the Bureau of Reclamation, Department of the Interior, dated March 1946, and entitled "A Comprehensive Report on the Development of the Water Resources of the Colorado River for Irrigation, Power Production, and Other Beneficial Uses in Arizona, California, Colorado, Nevada, New Mexico, Utah, and Wyoming."

These comments, views, and recommendations are submitted under the authority of chapter 265, Session Laws of Colorado of 1937 creating the Colorado Water Conservation Board and defining its functions and in accordance with the designation of such board by the Governor, pursuant to section 1 of the act of December 22, 1944 (58 Stat. 887), as the official State agency to act in such matters.

Respectfully submitted.

(Signed) JOHN C. VIVIAN,  
*Governor and Chairman of the Board.*

(Signed) CLIFFORD H. STONE,  
*Director of the Board.*

(Signed) C. L. PATTERSON,  
*Chief Engineer.*

(Signed) R. J. TIPTON,  
*Consulting Engineer.*

(Signed) JEAN S. BREITENSTEIN,  
*Attorney.*

DECEMBER 1946.

To the SECRETARY OF THE DEPARTMENT OF THE INTERIOR:

Pursuant to the act of December 22, 1944 (58 Stat. 887), the State of Colorado herewith submits its comments, views, and recommendations concerning the plans and proposals of Project Planning Report No. 34-8-2, of the Bureau of Reclamation, Department of

the Interior, dated March 1946, and entitled "A Comprehensive Report on the Development of the Water Resources of the Colorado River Basin for Irrigation, Power Production, and Other Beneficial Uses in Arizona, California, Colorado, Nevada, New Mexico, Utah, and Wyoming." In submitting these views and recommendations, consideration has been given to the regional directors' report, conclusions, recommendations, and substantiating materials, data, statement, and appendixes, together with the letter of transmittal, dated June 6, 1946, from the Commissioner of the Bureau of Reclamation to the Secretary of the Interior.

## SUMMARY OF COMMENTS, VIEWS, AND RECOMMENDATIONS

Colorado objects to the report in its present form and to the conclusions and recommendations therein contained and recommends that it not be transmitted to the Congress unless and until the requisite corrections, modifications, and additions are made in accordance with these views and recommendations. As a summary of the detailed views and recommendations hereinafter contained, Colorado submits:

1. The report improperly treats the upper basin differently from the lower basin in the following particulars:

(a) It includes areas located outside the natural basin of the river but within the States of the lower basin which are now or shall hereafter be beneficially served by water diverted from the Colorado River system and at the same time excludes similar areas in States of the upper basin;

(b) It ignores the allocations of water made by the Colorado River compact, the provisions of the Boulder Canyon Project Act, and the California Self-Limitation Act and contemplates increased uses of water by existing projects and additional uses of water by projects yet to be constructed, contrary to the provisions of the compact and the above-mentioned statutes;

(c) In estimating available water supplies and depletions it utilizes methods in the lower basin which differ from those applied to the upper basin.

2. By failing to interpret and construe the contracts between the Secretary of the Interior and the States and water users of the lower basin for the delivery of water

from Lake Mead, the report engenders further interstate controversy in that—

(a) It endeavors to impose upon the States the burden of interpreting, construing, and applying these contracts;

(b) It fails to disclose that any "surplus" water delivered to California water users under these contracts is not firm water since surplus water as defined under the compact may not be apportioned between the two basins by interstate compact before 1963;

(c) It fails to disclose that the aggregate amounts of water for delivery to the States and water users of the lower basin from Lake Mead under the contracts are inconsistent with the allocations of water made to the lower basin by the Colorado River compact, because in the contracts with Arizona and Nevada recognition is made of reservoir and channel conveyance losses while in contracts with California water users such losses are ignored.

3. The report is inconsistent in that water supplies for existing and potential projects for the diversion of water from the natural basin of the Colorado River for use in other basins in Colorado are estimated as sums or totals from one basin to another, whereas in other States of the upper basin the estimates include descriptions of individual projects.

4. The report is misleading and inconsistent in that it lists individual projects and presents estimates of construction costs, benefits to the Nation, and collectible revenues based upon the assumption that all of such projects will be constructed and operated to the limits of their ultimate capacities. At the same time the report concludes that inadequate water supplies will prohibit the construction of some of these projects. Thus in the total figures for costs, returns, and benefits, consideration is given to projects which cannot be constructed.

5. The report is unsound in that it fails to give consideration to the desirability and feasibility of individual projects and thus fails to furnish any true and usable guide for a development program.

6. The report is unsound in that it attempts to present a comprehensive development plan, but ignores the elementary fact that the desired orderly development will result from the construction from time to time of individual projects which upon full and complete investigation prove to be feasible, justified, and needed, and which will be desired by local beneficiaries after their repayment obligations are known.

7. The report is unsound in recommending that all seven of the States of the Colorado River Basin jointly agree upon a determination of their respective rights to deplete the flow of the Colorado River before major development may proceed. The Colorado River compact apportions water between the upper basin and the lower basin. Neither basin is concerned with the apportionment between States of the share allocated to the

other basin and neither basin should be restricted or delayed in its development by the failure of the other basin States to divide the water apportioned to that basin by the Colorado River compact. Colorado recognizes the desirability of an allocation of water to the individual States comprising the upper basin. While it is true that compact negotiations are in progress among the States of the upper basin, and that the construction of additional major projects should await allocation of water to the States, there are projects which will assuredly use water falling well within the equitable share of the State where located and which should not be made to await any final allocation of water.

8. The report is unsound in implying that each individual State should allocate water to specific projects within such State. Colorado adheres to the appropriation doctrine of water law and thereunder water users are entitled to water in accordance with the priority of their individual appropriations. Any change in such system in Colorado will require a constitutional amendment.

9. The report is unsound in that it recommends that the States approve projects for the so-called initial stage of development without there being available at the same time adequate data and information for the determination of the desirability, economic feasibility, or probability of authorization and construction of individual projects. Only in instances where detailed investigations are completed and individual project reports are available can there be a worth-while selection of any projects.

10. The report is unsound in that it contemplates a general group authorization of projects for construction rather than a specific authorization of individual projects.

Colorado believes that each and all of the foregoing views are fundamental and important and recommends that the report be modified to conform therewith. The report is a good inventory of development potentialities, as known at the present time, and it contains much valuable engineering data and factual information. It must be recognized that as a complete list of all construction potentialities or possibilities of using Colorado River water, the report is far from complete.

Upon the making of the report as modified in accordance with the objections, views, and recommendations noted above, Colorado believes that the Bureau of Reclamation will have satisfied the requirements of section 15 of the Boulder Canyon Project Act. There will remain, however, for the future, the task of investigating and reporting on individual projects for construction.

There follows a detailed statement of the comments, views, and recommendations of the State of Colorado. Reference is there made in paragraph 12 to particular

projects in Colorado for consideration as near-future development probabilities.

## DETAILED VIEWS AND RECOMMENDATIONS

### *Introduction*

The report contains much valuable engineering data and factual information concerning the resources, needs, and problems of the territory covered by it. This information concerns the waters of the Colorado River and its tributaries in the United States and includes estimates of the existing and present status of water utilization in each of the affected States, and of power production in the region therein designated the Colorado River Basin. The report also contains a list of so-called potential projects or units of projects considered possible of future construction, together with preliminary estimates of their probable construction costs under both prewar and current conditions, and with estimates (expressed as totals, rather than by individual projects) of the aggregate benefits to the Nation, of the total revenues probably collectible from combined water and power users, and of total depletions, reported in part as subtotals by States and in part unallocated among the States.

Colorado appreciates the value of this factual information, and recognizes that much labor, time, and money has been devoted to the preparation of the report. However, after a careful consideration of its contents, and its plans and proposals, the view reached by the State of Colorado is that the report should be modified, to eliminate its inconsistencies, improve its accuracy and completeness, and increase its utility and value to the affected States and to the Congress. To such ends, Colorado respectfully recommends that the report be modified before being adopted by the Secretary of the Interior and before being transmitted to the President and to the Congress. These comments shall be deemed objections to the plans and proposals of the Department of the Interior and the Bureau of Reclamation unless and until the report shall have been modified in accordance with these views and recommendations as hereinafter outlined.

### *Inconsistent Treatment of Areas Outside of Natural Basin*

The so-called comprehensive report purports to cover the Colorado River Basin. Considered in the light of the proposal of the report that affected States make determinations consistent with the Colorado River compact, the report is neither comprehensive nor consistent with the Colorado River compact, since it relates to and covers a territory which differs from the Colorado River Basin as defined in the compact. The Colorado River compact, negotiated at Santa Fe, N. Mex., November 22, 1922, divides the Colorado River Basin at Lees Ferry

into an upper basin and a lower basin, and in article II thereof defines the Colorado River Basin to include all the drainage area tributary to the Colorado River system in the United States, and also all parts of the States of Arizona, California, Colorado, Nevada, New Mexico, Utah, and Wyoming which (though outside of said natural basin) "are now or shall hereafter be beneficially served by waters diverted from the Colorado River system." The territory covered by the report conforms to the compact definition in the lower basin, but departs therefrom in the upper basin. It includes areas outside the natural basin in California, but excludes similar areas in Colorado, and in other States of the upper basin which are parts of the Colorado River Basin as defined in the Colorado River compact. This different treatment of the upper and lower basins, and of the States of California and Colorado, is a matter to which the State of Colorado heretofore has objected, for the reason that such different treatment is not conducive to amicable relations and understandings between the two basins and the two States. The State of Colorado urges and recommends that the report be modified so as to treat both basins and all States alike, and to make it consistent in all respect with the Colorado River compact.

### *Inconsistent Treatment of Out-basin Projects in Utah and Colorado*

With respect to enterprises and projects which divert water from the Colorado River system above Lees Ferry for use outside the natural basin, the States of Utah and Colorado are not treated alike in the report. Such diversion enterprises and projects in Utah are listed by name and individually, each with specified depletion estimations. Similar diversion enterprises and projects in Colorado are not listed by name or individually, and their estimated depletions are reported merely as aggregate diversions by tributary stream basins. Colorado urges again that the report be modified so as to treat all affected States alike in the above-mentioned and all other respects.

### *As a Comprehensive Plan for Development the Report is Incomplete and Misleading*

The report contains a list of so-called potential projects. Actually, this list constitutes an inventory of development possibilities which in most instances await detailed investigations and individual project reports. It presents estimates of construction costs, benefits to the Nation, probable collectible revenues from combined water and power users, and water-supply depletions, for what is described as a stage of ultimate development. These estimates are based on the assumption, among others, that all the so-called potential projects listed in the report will be constructed and operated to the limits

of their assumed ultimate capacities. At the same time the report concludes that inadequate water supplies will prohibit the construction of some of the so-called potential projects. Thus, these conclusions are inconsistent with each other, in that the reported total construction costs include estimates for projects which, if not constructed, will require no financing, and the reported total benefits and collectible revenues are misleading, since they include items that cannot be realized. The assumption of the report that all the so-called potential projects, or their alternates, will be constructed, disregards the findings which ultimately must be made as to individual project desirability, financial feasibility, and economic justification, and hence disregards the probability of authorization and appropriations by the Congress, which must be based on subsequent detailed investigations and reports on each project possibility. It likewise entirely overlooks the possibility of private development.

Upon investigation, some of the so-called potential projects will no doubt be discarded as undesirable or infeasible, and those which are financed and constructed will have been designed upon a basis which, instead of ultimate and largest possible capacities, will give consideration to essential needs and to proper and more economical capacities. The report speaks of "full development in the United States"—meaning a stage of development which is fixed by available water supplies, and which is something less than the ultimate stage for which estimates of construction costs, benefits, and collectible revenues are presented, but the report fails to submit information or estimates as to the supplies of water to become available for use with full development in the United States, or as to the construction costs to be encountered, or the benefits and collectible revenues to result from that stage of development.

*Channel Losses in the Upper Basin Must Be Estimated and Used in Computation of Water Supply and Depletions*

The report contains estimates of so-called "present" uses or depletions. Included in the reported "present" totals are items representing the present uses by existing in-basin and diversion enterprises. Colorado notes that the existing total depletions summarized in the report for the upper basin are not in agreement with the depletions employed in appendix I to estimate the water supplies at Lees Ferry.

The report also contains allowances for future uses of water by projects now under construction or authorized, and for future increased uses by reason of assumed expansions to ultimate limits under existing projects. Together, the estimated existing uses, plus the above-mentioned allowances, represent the so-called "present"

status of utilization or depletion of Colorado River water. Colorado notes that the water utilization and depletion estimates of the report are in terms which are not consistent throughout both basins and in all States. Although the reported depletion quantities are said to represent the resulting effects upon outflows from the upper basin at Lees Ferry, and from the lower basin at the international boundary, that rule appears to have been applied only on the lower Gila River at and below the Phoenix vicinity in Arizona. All other depletion estimates presented in the report are based on the rule of evaluation at the site and, to indicate their resulting effects upon outflows at Lees Ferry or the international boundary, it becomes necessary to allow for and subtract the losses which the water, if not consumed at the site, would suffer incident to its conveyance to Lees Ferry or the international boundary.

To make the necessary corrections in reported depletion quantities, information is necessary concerning channel conveyance losses. The report contains estimates of channel conveyance losses under virgin conditions on the Gila River below Phoenix, which appear to have been employed to estimate the depletions in Arizona shown in the report. It also contains estimates of channel conveyance losses under virgin conditions on the lower Colorado River below Boulder Dam. These appear to have been employed to calculate the outflows to Mexico across the international boundary, but to have been disregarded in estimating the depletions in California. The report contains no information concerning channel conveyance losses along the Colorado River and its tributaries above Boulder Dam, or in the upper basin above Lees Ferry.

Colorado recommends, since this information is essential for the determinations of water supplies available for utilization, and for the appropriate adjustment and maintenance of interstate relations, that the report be modified to include estimations of channel conveyance losses under virgin, present (existing), and full development conditions.

*Water Supplies and Depletions Should be Presented in Terms Comparable to Those of the Colorado River Compact*

In order that affected States may make use of, so far as possible, the plans, proposals, and recommendations of the report, it is essential that all determinations and estimations of water supplies, stream-flow depletions, and water utilization and disposal be in terms, directly comparable with apportionment provisions of the Colorado River compact. A necessary first step, in order that both basins may know what further developments are possible, and what further uses of water are permissible, within presently authorized limits, is a comparison be-

tween present uses or depletions within each basin and the quantities of water heretofore apportioned to each basin by the Colorado River compact.

While there may be disagreement among individual States concerning interpretations of some provisions of the compact, there appears to be no basis for dispute between the two basins concerning these facts: (1) By articles III (a) and (b) thereof, the Colorado River compact apportioned 7,500,000 acre-feet of water per annum to the upper basin, and 8,500,000 acre-feet per annum to the lower basin; and (2) by article III (f) the compact specified that at any time after October 1, 1963, if and when either basin shall have reached the total beneficial consumptive use of said quantities of water, further equitable apportionment may be undertaken of the surplus water over and above the quantities heretofore apportioned, and over and above the surplus awarded to Mexico by the treaty between the United States and Mexico.

According to the report the so-called "present" depletions or uses, in the two basins, may be summarized as follows: Upper basin, existing 2,200,000 acre-feet, increase allowance 556,000 acre-feet, total "present" 2,756,000 acre-feet; lower basin, existing 4,918,000 acre-feet, increase allowance 3,583,000 acre-feet, total "present" 8,501,000 acre-feet. Under the apportionment provisions of the Colorado River compact, and upon the findings of the report, as to present depletions of streamflows or uses of water, it is apparent that new and additional projects may be constructed in the future in the upper basin, with aggregate uses or depletions up to 4,744,000 acre-feet annually, without thereby exceeding the apportionment to the upper basin heretofore made by the compact. In the lower basin, however, no new or additional projects can be undertaken, until after October 1, 1963, except to the extent that possible future expansions under existing projects recognized by the report be correspondingly curtailed or prohibited.

The State of Colorado suggests that the report contains plans and proposals which disregard this patent fact, and recommends that the report be modified to correct this omission.

#### *Comprehensive Planning Must Conform to Orderly Construction of Desired and Justified Projects*

Concerning recommendation 3, paragraph 70, of the regional directors' report, the State of Colorado concurs in and approves of that portion of the proposal involving increased appropriations by Congress and expenditures by the Bureau of Reclamation and other agencies of the Department of the Interior, in order that more complete and accurate data concerning the production, use, and disposal of waters of the Colorado River system may become available to the Congress and the affected States.

This is also necessary to continue and expedite the completion of detailed investigations and individual project designs and reports, to the end that an orderly and progressive development of the Colorado River Basin, as defined by the Colorado River compact, may be assured. Such a development will provide supplemental water supplies as needed for municipal, irrigation, and industrial purposes and provide adequate and regulated supplies of water for lands that await reclamation by irrigation. Incidental to such reclamation development, will be the production of hydroelectric power the improvement of recreational advantages, and other opportunities in the public interest.

However, Colorado cannot subscribe to that proposal of the report which claims or infers that such appropriations and expenditures are necessary or desirable in order for the Department of Interior to formulate and carry out a comprehensive plan of development at this time or in the near future. Instead, the orderly and progressive development, above mentioned, should be carried on by the construction from time to time of those individual projects which, upon investigation, (1) are feasible, justified, and needed; (2) are within each State's equitable but as yet unestablished share of water; (3) are desired by local beneficiaries after their repayment obligations are known; and (4) entail construction costs which may be financed by congressional appropriations or otherwise.

Experience teaches that the necessary investigational program will require many years to complete; that the construction of some projects may be carried on while investigations of others are underway; that neither the needs of future generations nor the dictates of financial policies can be anticipated too far in advance. Hence the view of Colorado is that any plan for the comprehensive and ultimate development of the Colorado River Basin, which might now be formulated by the Department of Interior, will be modified from time to time. Further, Colorado points out that the report itself recognizes that a comprehensive plan is contingent in a major way upon the ultimate determination of the apportionment of water to the individual States. It can be reasonably expected that upon the determination of such allocations, each affected State will exert an important influence in shaping the development within its borders and within its share of Colorado River water, consistent with common operational features on the river and the provisions of the Colorado River compact.

#### *Joint Action of All Seven States Is Not Necessary to an Allocation of Water*

The report recommends "that the States of the Colorado River Basin determine their respective rights to deplete the flow of the Colorado River consistent with

the Colorado River compact." This proposal implies that all controversies concerning the waters of the Colorado River can and should be resolved promptly by the collective action of all seven affected States. As previously pointed out, the first necessary step toward carrying out this proposal involves the apportionments heretofore made by the Colorado River compact to the upper basin and to the lower basin, recognizing that further apportionments between the two basins, over and above those heretofore made, cannot be undertaken under the compact until after 1963.

Colorado recognizes the necessity and desirability of the States of the Colorado River Basin determining their respective rights to deplete the flow of the Colorado River consistent with the Colorado River compact. That all of the States of the upper basin accept this recommendation of the report and assume that responsibility is evidenced by the fact that since the report was issued these States have initiated compact negotiations for two principal purposes, namely, (1) to determine relative rights of the respective States of the upper basin in the beneficial consumptive use of the 7,500,000 acre-feet of water per annum heretofore apportioned in perpetuity from the Colorado River to the upper basin by article III (a) of the Colorado River compact; and (2) to determine the relative obligations of the States of the upper division imposed by article III (d) of the Colorado River compact, not to cause the flow of the Colorado River at Lees Ferry to be depleted below an aggregate of 75,000,000 acre-feet for any period of 10 consecutive water-years. These negotiations were initiated under the compact clause of the Federal Constitution.

However, Colorado does not concur in the implied and often repeated assertion that controversies concerning the waters of the Colorado River can and should be resolved by joint action of all seven of the Colorado River Basin States nor does the State concede that an adjustment of all controversies in both the upper and lower basins must be settled before major developments of the water resources of the river may proceed. There are controversial matters peculiar to each basin which are unrelated to those in the other, the adjustment of which will permit development to go forward in one basin although unresolved questions remain in the other basin.

It is pertinent to point out that after initiation of compact negotiations by the States of the upper basin it was found necessary to appoint an engineering committee to review the water supply and depletion estimates and other factual information contained in the report, and to supply data not included in the report which is recognized to be necessary or desirable for the negotiation and consummation of a workable compact. It is here suggested that this fact indicates the need for

a modification of the report and the inclusion in it of data and information which it does not now contain.

#### *In Colorado There May Be No Allocations to Specific Projects*

It is asserted in the report that all the States have not made final allocations of water among projects within their borders. This implies and amounts to a proposal that final allocations to individual projects are necessary and must be made in advance of their construction. Colorado points out that no official or agency of the State is authorized to comply with or carry out such a proposal. No such authority could be granted by the legislature to any official under the constitution of the State. The right to divert and use water in Colorado is based upon prior appropriation for beneficial purposes. Any change of principle or method would require the amending of the State constitution.

Under section 8 of the Reclamation Act of 1902 the Secretary of the Interior is required to appropriate and divert water for reclamation projects in conformity with the State laws regulating appropriation, use, and distribution of water supplies. And it must be noted that when new projects are constructed, the rights of existing appropriators must be recognized and protected in order that such new projects may not adversely affect established water uses.

Colorado must, therefore, request that, on the basis of the existing laws of the State respecting water rights, that all statements contained in the report which directly or indirectly imply that final allocation to individual projects is necessary and must be made in advance of further project construction by the Bureau of Reclamation or any other public or private agency, be eliminated.

#### *Controversies Over Contracts for Lake Mead Water Should Be Resolved by the Secretary of the Interior*

The report asserts that "there is not complete agreement among the States regarding the interpretation of the compact and its associated documents—the Boulder Canyon Project Act, the California Self-Limitation Act, and the several contracts between the Secretary of the Interior and individual States or agencies within the States for the delivery of water from Lake Mead." Its authors say "this report makes no attempt to interpret the Colorado River compact or any other acts or contracts relating to the allocation of Colorado River water among the States and among projects within the States."

It is the view of Colorado that the long-standing controversies among the States in the main result from these contracts made by the Secretary of the Interior with California and agencies thereof. It is likewise the position of Colorado that the amount of water which may be delivered under these contracts must be in strict



compliance with the provisions of the Colorado River compact and the Boulder Canyon Project Act. Such compliance is specified by the contracts themselves. Yet certain provisions of these contracts raise controversies which admittedly must be settled before an ultimate plan of development may be realized in the lower basin.

The report contemplates the future expansion of existing or authorized projects in California, including the Coachella. These allowances will make the total "present" use of Colorado River water in California 5,802,000 acre-feet annually. Under the California self-limitation statute California is limited to 4,400,000 acre-feet annually plus one-half of the surplus as defined by the Colorado River compact. Under that compact the surplus may not be allocated between the two basins until after 1963. These increased and expanded uses would exceed the California share by 1,402,000 acre-feet annually. The failure to recognize and apply the limitation self-imposed by California makes the report misleading.

Colorado respectfully suggests that since the Secretary of the Interior executed these contracts on behalf of the Government, it is incumbent upon him to interpret them separately and in connection with the Colorado River compact and the Boulder Canyon Project Act. Unless these questions are otherwise resolved, it would seem unreasonable and contrary to public policy for the Department of the Interior, without interpreting the acts, statutes, and contracts above mentioned, to submit this report, presaging a plan of development to the Congress.

#### *Initial Stage of Development*

Among the plans and proposals is recommendation 1, paragraph 70 of the regional directors' report, "that the States of the Colorado River Basin, acting separately or jointly, recommend for construction, as the next stage of development, a group of projects, the streamflow depletions of which will assuredly fall within ultimate allocations of Colorado River water which may be made to the individual States." Elsewhere the report speaks of affected States deciding from among "known potentialities" which projects they desire to have the Bureau of Reclamation consider for construction. At another place the report says that detailed information is available for a substantial number of potential developments and only data of a reconnaissance nature for others, but from all information available it should be possible prior to a final settlement of water rights (by compact if possible, or litigation if necessary), to select a group of projects which are urgently needed, or which will be key units of the comprehensive plan for construction as the next stage of development. Colorado, as herein previously mentioned, says the so-called potential proj-

ects listed in the report might, more appropriately, be termed an inventory of development possibilities that largely await detailed investigation and individual project reports. As an inventory of development possibilities in Colorado, the list is incomplete. It fails to include development possibilities upon which investigations have been initiated by the Bureau of Reclamation since the list was compiled, and others which local interests and State officials and agencies have since brought to the attention of the Bureau of Reclamation. Considered as a list of known potentialities, Colorado asserts that the data contained in the report, or elsewhere available through individual project reports, concerning the so-called potential projects in the State are wholly inadequate for determining at this time the desirability, or economic feasibility, or probability of authorization and construction of individual projects. Much of the data is largely of a reconnaissance nature.

The concept that "the economic feasibility of the group of projects included in the next stage of development would be comprehended in the finding of feasibility for the over-all ultimate development of the basin," is subject to challenge from the data appearing in the report, wherein annual costs to the Nation, if based on construction costs estimated in the Commissioner's letter, may be found to exceed the annual benefits to the Nation, which in turn are subject to question since they are based on estimated gross values of crop and power production. Inasmuch as the report plans that "when the next stage of development has been decided upon, it may be presented to the Congress for authorization of construction," it would seem to be equally as feasible, and perhaps would involve less delay, to plan to submit to the Congress each individual project report as it is completed (where such submission to Congress is required under existing law), and thereby provide for an orderly and progressive development in accordance with both local needs and public interest. In this connection, note the views and recommendations of the State of Colorado set forth in the foregoing paragraph 7.

#### *Colorado Projects*

It is respectfully suggested by Colorado that the list of projects submitted by the report does not provide a basis for an intelligent selection by the State of projects for construction. For many years the State has been urging the investigation and issuance of reports on specific projects within its borders. These investigations and reports have reached various stages of completion. Based thereon, and because of known information on these projects, the State is able and desires to urge an early issuance of reports on and consideration for early construction of a group of projects hereinafter mentioned. These projects are all within the Colorado River

Basin and will cause a depletion of water supplies assuredly within the ultimate allocation of Colorado River water which may be made to the State. Consideration of these projects for construction should not be delayed pending the consummation of an upper Colorado River Basin compact. These projects do not constitute an exclusive list and the list should be subject to expansion as investigations proceed. The projects, with brief references to their nature and investigational and authorization status, are as follows:

#### *Paonia project*

This project was authorized in 1939 and since that time \$900,000 has been appropriated for its construction. The sum of \$848,470.50 now remains available to the Bureau of Reclamation to proceed with actual construction. Because of change in design, increase in costs, and necessary repayment arrangements, it was found necessary to seek a reauthorization or amended authorization. The necessary district organizations of water users have been set up. More recently the water users have agreed to increase their unit obligations for the water and have, with the concurrence of the State, suggested a longer repayment period. The final report has been completed and the project is before the Department of the Interior for approval and for submission to the Congress for reauthorization. The project will provide supplemental water supplies for presently irrigated lands. The storage facilities of this project provide a capacity of 14,000 acre-feet.

#### *Pine River extension*

This project will provide laterals and distribution facilities for the conveyance to project lands of water stored by the Vallecito Reservoir, located in southwestern Colorado. The Vallecito Dam and Reservoir is a Bureau of Reclamation project completed in December 1942. It stores 125,000 acre-feet of water. The existing facilities below the dam do not serve all of the lands which may and are intended to be irrigated with water stored in Vallecito Reservoir. The Pine River extension constitutes a unit of the project. Investigations of the Pine River extension have proceeded to the point where a report of the regional director, region 4, Bureau of Reclamation, is expected in the very near future. Obviously in the interest of the water users under the Pine River project, as well as in the interest of the Government, in order to make stored water available for irrigation of land, the Pine River extension should be considered for early construction.

#### *La Plata project*

This project is located in southwestern Colorado. It includes two units, namely, the Long Hollow Reservoir, to provide storage facilities for the irrigation of lands in Colorado, and the Stateline Reservoir, to store water for

the irrigation of lands in New Mexico. Both reservoirs are located in the La Plata River Basin and are intended to regulate the flow of water of that river to provide supplemental water supplies for presently irrigated lands. These project units have been under investigation for 10 years, or more. A number of reports have been issued. The water users in Colorado have created a district to contract with the Government. The erratic flows of the La Plata River created interstate controversies which resulted in an interstate compact which apportioned the water between New Mexico and Colorado and made necessary at times the rotation of water use between water users of the two States. This resulted in serious reductions of available water for long-established farm units in Colorado. The entire area has suffered seriously from drought conditions. The only solution is construction of both units of the La Plata project. Eventually these units may be and can become a part of a larger project ultimately to be investigated involving the interbasin diversion of water into the La Plata River. The State has conferred on numerous occasions with interested water users and more recently considered with the local interests and the Bureau of Reclamation a proposed final report. It is expected that this report will be completed in the office of the regional director, region 4, Bureau of Reclamation, in the near future and will be ready for submission to Congress. Because of this situation Colorado urges early consideration of the construction of both units of this project. Conferences with the officials of New Mexico have resulted in an agreement between the two States. New Mexico, we believe, will join in this request.

#### *Florida project*

This project has long been under investigation. A final report is scheduled for early consideration by the regional office, region 4, Bureau of Reclamation. Available information is adequate to indicate to the State that the investigation of this project should be expedited in order that it be considered for construction. The project is located in southwestern Colorado and will provide supplemental water supplies for presently irrigated lands.

#### *Dolores project*

This project is located in southwestern Colorado and will divert waters from the Dolores River for the irrigation of lands which are under dry-farm operations. A major portion of the project lands lies in Colorado but a part of them is in Utah. The proposed project lands are highly productive, but in the event of drought conditions may be subjected to serious crop losses. Irrigation supplies are needed upon presently nonirrigated lands in order to bring about diversified farming and assure more stabilized farm conditions. The project

has long been under investigation. Colorado urges that these investigations be expedited in order that the project may be considered for construction.

#### *Silt project*

This project is located near Rifle, Colo., and will store water diverted from Rifle Creek to make available supplemental water supplies for presently irrigated lands. The project has long been under investigation and some preliminary reports have been issued thereon. A final report is in the process of preparation and is scheduled for early consideration by the office of the regional director, region 4, Bureau of Reclamation. Colorado requests that the scheduled issuance of this report be followed and that the project may be considered for construction.

#### *Collbran project*

This project is located near Grand Junction, Colo. It has been under investigation for many years. Originally this proposed development was for the irrigation of lands, now under cultivation with inadequate water supplies, located in the Plateau Valley. In recent months a revised plan for this project to also provide municipal water supplies for the city of Grand Junction and vicinity, and to afford an incidental production of power, has been under investigation by the Bureau of Reclamation. It has been found necessary to expedite this investigation due to the population growth in Grand Junction and the recognition of the desirability of providing stock and domestic water supplies for the area in the vicinity of Grand Junction. It is now indicated that the present source of municipal water for Grand Junction will be adequate for a period of only about 3 years, and that water for this purpose must be obtained from other sources within that time. Upon the basis of present data and information it seems highly probable that this project may be economically justified under the provisions of the 1939 Reclamation Act. Because of this urgent need for domestic water supplies, as well as the desirability of providing supplemental supplies for irrigation of lands in Plateau Valley, Colorado urges that the investigation on this project be completed and a report issued early this year in order that the project may be considered for construction.

#### *Little Snake development*

The Little Snake River, a tributary of the Colorado River, crosses and recrosses the Colorado-Wyoming boundary line. For a number of years the Bureau of Reclamation has conducted investigations concerning the so-called ultimate development of the Little Snake River, including exportations from and importations to the Little Snake River Basin, and including the proposed construction in the near future of a relatively small project to serve lands in Colorado and Wyoming

requiring supplemental water supplies for dependable irrigation and to irrigate some new lands in both States. Two small reservoir projects, one located in Colorado and the other in Wyoming, have been investigated. A report has been anticipated by the two States for a number of years. Interstate relations on this river are such that the two affected States expect to enter upon compact negotiations. Commissioners for this purpose have been appointed by the two States. The adjustment of interstate relations is dependent in a major way upon a settled plan of development in the Little Snake Basin. Colorado urges that the investigation of these proposed reservoir units of the Little Snake project be expedited in order that any such project development which may be found economically feasible may be considered for construction.

#### *Investigation of Specific Projects Recommended by Southwestern Water Conservation District*

When the Colorado Water Conservation Board held its meeting to consider the proposed report of the Secretary of the Interior on the development of the water resources of the Colorado River Basin, the Southwestern Water Conservation District, a legal entity created under State statutes, specifically requested that the board urge the Bureau of Reclamation to initiate the investigation of a number of proposed projects needed in Archuleta County in Colorado in order to properly serve that section of the State. The State concurs in this request and includes herein the descriptions submitted by the Southwestern Water Conservation District of these proposed project developments as follows:

"(1) *Mill Creek*.—This proposed project will supply supplemental water to lands now under irrigation that can never be supplied from any other project. Development of the project would require a storage reservoir and approximately 10 miles of diversion and distribution canals. In most instances the existing canals would only require enlarging. A minimum of 1,500 acres of farming and pasture lands would be serviced by this project.

"(2) *Four Mile and Turkey Creek Lakes*.—It will be noted that in the report of July 3, 1945, there is an indication of an overlapping between the Four Mile and Turkey Creek and the Dutton Park projects. Further study may determine that due to the limited drainage area that would supply the water to Four Mile and Turkey Creek Lakes no water would be available for the Dutton Park area. Therefore we want to list only 6,000 acres for supplemental water and 13,000 acres of new farming and pasture land. The proposed development requires the enlargement of the lakes as well as the existing ditches.

"(3) *Dutton Park*.—This project could and would be serviced by canals and possibly a small reservoir in the

O'Neal Park project which is now listed by the Bureau of Reclamation.

"(4) *Buckles and Harris Lakes*.—This project would require new dams to increase the capacity of the lakes and the enlargement of existing ditches and some new ditches. This project would probably serve only part of the land in Coyote Park and should be considered in case the Dulce-Chama-Navajo project listed by the Bureau of Reclamation never materializes."

*Report in Its Present Form Should Not Be Submitted for the Approval of the Congress*

The report purports to be an inventory of water supplies, existing water utilization, and development possibilities of the Colorado River. It is indicative of the integrated relationship of individual project potentialities, but its value for this purpose is limited to the information contained therein being used only to develop an integrated plan when and as presently undetermined factors are resolved and further material information made available. As pointed out herein, certain material considerations necessary for a comprehensive plan of development cannot be disregarded; otherwise the report would result in further confusion and intensify future controversies. For instance, as elsewhere explained herein in detail, (1) the report contains plans for utilization of Colorado River water which if realized would be contrary to the Colorado River compact; (2) potential project developments are included which are contingent upon, and may be modified by, the future apportionment of water among the affected States; (3) necessary interpretation of basic legal instruments, which constitute the law of the river, remains unanswered; (4) inventoried potentialities admittedly exceed available water supplies; (5) material inconsistencies in the report exist and potential developments of prime importance to some of the States are not properly reflected thereby because of the failure of the report properly and consistently to cover all territorial areas of development in the States comprising the Colorado River Basin, as defined by the Colorado River compact; (6) important and necessary factual data and information for the operation of the river under conditions of comprehensive development, and material in effectuating a progressive, integrated plan are not found in the report; (7) and it follows that no reliable basis for the economic justification of the plan of project development, set forth in the report, is established.

Intimately related with these considerations is the fact that areas susceptible of development through the utilization of Colorado River water are located in four different regions under the organization of the Bureau of Reclamation. Two of these regions comprise areas outside of the natural basin of the Colorado River. Appar-

ently the directors of these two regions had no part in the preparation of the report. There exists a necessity of integrating the activities and plans of separate regions interested in the use of Colorado River water within and without the natural basin in portions of States which are a part of the Colorado River Basin as defined by the Colorado River compact. Project plans for the diversion of water from the natural basin must envision the appropriate plans for water utilization within tributary areas of the Colorado River Basin. This is particularly important in such States as Colorado, where a policy is followed, heretofore approved by the Bureau of Reclamation, of protecting present and prospective uses of water within the natural basin in the State in connection with plans for transmountain diversion projects. A program for the integration of the activities of these interested regions in cooperation with the interested States for the furtherance of State programs should be initiated.

In view of this situation, it seems inconceivable that the report in its present form and at this time should be transmitted to the Congress for its approval. It is Colorado's view that the report constitutes a compliance with section 15 of the Boulder Canyon Project Act (45 Stat. 1057), if modified in accordance with the views and recommendations herein contained, and the data and information contained therein will aid the States and the Government in the progressive formulation of a comprehensive plan and in the development of a program of individual project authorization.

## ENGINEERING DATA

### *Discrepancies in Basic Data*

Data concerning the flow of the Colorado River at Lees Ferry are presented in appendix I by years for the period 1897-1943. These consist of estimates by the Bureau of Reclamation for the period 1897-1921, and of records by the United States Geological Survey for subsequent years. Colorado notes that the United States Geological Survey has also published estimates for the period 1897-1921 which differ in most years, and in some by substantial amounts, from the Bureau of Reclamation estimates presented in the report. Such discrepancies in the basic data reported by cooperating agencies are confusing, and have required the engineering committee of the Upper Colorado River Basin Compact Commission to undertake correlation studies and make its own estimations.

### *Natural Conveyance Losses Above Lees Ferry*

The so-called virgin flow of the Colorado River at Lees Ferry was calculated in appendix I, for each year of the 1897-1943 period, as the sum of (1) the actual

flow as estimated or recorded, plus (2) the quantity of water estimated to have been consumed by the lands irrigated within the natural basin and to have been diverted from the natural basin for use outside. Expressed as an average for the period 1897-1943, the virgin flow of the Colorado River at Lees Ferry, thus calculated, is reported at 16,270,000 acre-feet annually. With respect to the quantities of water estimated to have been utilized upstream from Lees Ferry, attention has previously been directed to the fact that the quantities employed in appendix I (see par. 5, Detailed Views and Recommendations, above) to calculate virgin flows differ from the estimates of existing uses reported in the substantiating material. In both estimates the evaluations were made as of project sites—the quantities of water consumed by the irrigation of lands within the natural basin above Lees Ferry being calculated by multiplying the number of acres irrigated by a unit rate of consumptive use considered to be applicable in accordance with prevailing temperatures, and the quantities diverted from the natural basin being measured at project sites.

Colorado notes, however, that the report, disregarding the natural channel losses incident to the conveyance of water downstream to Lees Ferry, applies the full amount of the estimated upstream uses, or the stream depletions at project sites, to the flow at Lees Ferry. This erroneous assumption of the report, that water if not used and consumed upstream would arrive in full amount at Lees Ferry, has required the engineering committee of the Upper Colorado River Basin Compact Commission to undertake studies and make estimations of natural conveyance losses along the Colorado, Green, and San Juan Rivers and certain of their tributaries above Lees Ferry, particularly in the States of Utah and New Mexico.

#### *Sources by States of Stream Flow*

The report presents no information concerning the sources by States of the flow of the Colorado River at Lees Ferry. This omission of data, essential to determinations of respective rights and obligations of individual States above Lees Ferry, has further extended and complicated the work of the upper-basin engineering committee. The report should present estimates of the contributions of each State to the long-time average virgin flow of the Colorado River at Lees Ferry, together with similar information for a period such as 1931-40, when stream flows for 10 consecutive years were the lowest of record.

#### *Pasture Land Irrigation*

The report estimates that, ultimately, 500,000 acre-feet of water will be consumed annually by the irrigation for pasture purposes of 500,000 acres of land in the upper

basin. This is in addition to lands presently irrigated and to be served by so-called potential projects listed in the report. Colorado notes that, while this allowance of 500,000 acre-feet of water is included in the reported total ultimate depletions upstream from Lees Ferry, the report fails to describe the required facilities and works, or to include estimates of their construction costs. The report also fails to segregate this assumed future consumption of water among individual States, or to indicate the locations of the assumed pasture lands on the maps presented in appendix II. More definite and detailed information would facilitate both the plans for the development and the pending negotiations among affected States. Since the existing acreage irrigated in the upper basin includes hay lands from which the crops are harvested at times and at other times are used for the pasturing of livestock, it appears that the assumed future pasture lands might similarly be classified as "irrigated lands," without attempting to distinguish between methods of harvesting. The required works and facilities might properly be included with so-called potential projects as construction possibilities.

#### *Reservoirs Above Lees Ferry*

The so-called potential projects listed in the report include a number of possible reservoirs in the upper basin above Lees Ferry, at sites along the Colorado, San Juan, and Green Rivers, located generally below the lands irrigated in the upper basin. Their purposes include power production, flood control, silt detention, stream-flow regulation, and hold-over storage. The report presents estimates of construction costs and power production for each reservoir but fails to disclose information as to the status of upstream development assumed for purposes of estimating the power production. The total loss of water from the whole group of reservoirs is reported at 831,000 acre-feet per year, but the report fails to segregate the estimated total loss among individual reservoirs, or to explain the factors employed in estimating the reservoir losses. A comprehensive engineering investigation is required, including definite and detailed river and reservoir operation studies, the results of which should appear in the report, to the end that construction costs and water losses may be compared with project benefits, and to define the areas and interests that would benefit from operations of the reservoirs for their various intended purposes.

The affected States above Lees Ferry need to know how far development can proceed before any of the potential capacity of these reservoirs will be needed for hold-over storage purposes. They should be advised as to how much hold-over storage capacity will be needed when the uses of water and depletions of stream

flows above Lees Ferry have reached the quantity heretofore apportioned to the upper basin by the Colorado River compact. This is necessary to insure that flows at Lees Ferry will not be depleted below an aggregate of 75,000,000 acre-feet for any period of 10 consecutive years, such as 1931-40; and they should also be advised as to what the reservoir losses at that stage of development might total. Likewise, they should be informed that, when the 16,270,000 acre-feet of virgin flow at Lees Ferry has been depleted by 7,500,000 acre-feet, including upstream reservoir losses, the remaining flow at Lees Ferry might be equated to a flow of 8,770,000 acre-feet, provided that sufficient reservoir capacity be constructed and operated for hold-over storage and stream-flow regulation purposes; and they should be informed as to the possibilities for constructing the required reservoir capacities, as well as concerning the losses involved.

The report indicates that any studies made in connection with these so-called potential reservoirs appear to have been devoted to their assumed operations primarily for power purposes. The total power production at all the reservoirs will greatly exceed the needs for power in the natural drainage basin above Lees Ferry for 40 years, according to the forecast contained in the report. The report proposes to market this surplus power, in part, in areas outside the natural basin in Utah and Colorado (which areas are not covered by the report), but mainly in the lower basin market area where power deficiencies are anticipated in the near future.

Colorado points out that projects, under construction and proposed in Colorado, for diverting waters of the Colorado River system for irrigation use and for municipal and industrial purposes in the South Platte and Arkansas River Valleys in eastern Colorado—being areas within the Colorado River Basin as defined in the Colorado River compact—will also produce power sufficient in amount for the future needs of eastern Colorado for many decades in the future. Hence the report should not contemplate the marketing in eastern Colorado of surplus power produced at the reservoirs under discussion.

#### *Colorado River Water Supplies Available in the United States*

Conclusions of the report, respecting the water supplies of the Colorado River available in the United States, are based on the flow of the Colorado River at the international boundary, as calculated for so-called virgin conditions. Starting with the estimated virgin flow at Lees Ferry of 16,270,000 acre-feet annually, the aggregate combined effect of all tributary inflows to the river section below Lees Ferry (including the Gila River) and of all natural consumption of water and channel losses incident to the conveyance of Colorado River

water from Lees Ferry, and of Gila River water from the Phoenix vicinity, to the international boundary, is estimated in the report to have increased the virgin flow at the international boundary to an average of 17,720,000 acre-feet annually. Allowing for a future flow to Mexico averaging 1,500,000 acre-feet annually, as required by treaty, the report concludes that the remaining 16,220,000 acre-feet is the water supply of the Colorado River available for depletion in the United States.

Colorado says that this conclusion of the report is inaccurate, and is confusing if not misleading to the affected States and the Congress. It involves the implied assumption that the natural consumption of water and the channel losses of virgin-flow volumes and conditions will prevail undiminished in amount regardless of future stream-flow volumes and conditions—an assumption which, being contrary to known facts, is unjustified. In order to deplete the flow into Mexico from its estimated virgin volume of 17,720,000 acre-feet, to its future volume of 1,500,000 acre-feet as fixed by the treaty, it will be necessary to utilize in the United States a quantity of water materially greater than the reported 16,220,000 acre-feet annually. The amount by which the uses of water and depletions of stream flows in the United States will exceed 16,220,000 acre-feet annually, will be determined by the extent to which the natural consumption and losses of water, which prevailed under the stream-flow volumes of virgin conditions, are reduced, or prevented, or avoided, or are converted to beneficial consumptive uses, with development in the United States.

Colorado points out that existing developments and uses of water in the United States have already had the effect of reducing the natural losses under virgin conditions; that the estimated 1,030,000 acre-feet of natural or virgin channel loss in the section of the Colorado River from Boulder Dam to Laguna Dam has been materially reduced in amount since Lake Mead came into operation, by reason of the more regulated stream-flow volumes and the reduced flows to Mexico; that the estimated 1,007,000 acre-feet of natural or virgin channel loss in the section of the Gila River from the vicinity of Phoenix downstream, incident to the conveyance of 2,279,000 acre-feet of estimated natural or virgin conditions inflows to the Phoenix vicinity, has since been largely reduced in amount by the developments which store, divert, use, and consume the water supplies at and above the Phoenix vicinity; and that all such channel-loss reductions constitute savings or the salvage of water, which correspondingly add to the supplies available in the United States. The above-mentioned examples under present developments are in amounts which are subject to determination by comparative analytical studies.

## COMMENTS OF THE STATE OF COLORADO

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Colorado says that further reductions in the natural losses of virgin conditions will necessarily accompany the future progressive development in the United States; and that in the future, with full development in the United States, when the flow of the Colorado River at Lees Ferry has been reduced from its virgin volume of about 16,000,000 acre-feet to about half that amount, and when the flow of the Colorado River at the international boundary has been reduced from its virgin volume of about 17,700,000 acre-feet to about 1,500,000 acre-feet,

the further reductions in natural losses will further increase the supply of water available in the United States. The future salvage of water is subject to estimation from engineering data and studies with as much assurance of accuracy as estimations of the future depletions by so-called potential projects. Estimations of salvaged water clearly should be included in this report on the future development and full utilization in the United States of all the waters of the Colorado River system available to the States of the Colorado River Basin.

# Comments of the State of Nevada

STATE OF NEVADA  
OFFICE OF STATE ENGINEER  
CARSON CITY, NEV.

FEBRUARY 6, 1947.

HON. WILLIAM E. WARNE,  
*Acting Commissioner,*  
*United States Bureau of Reclamation,*  
*Washington 25, D. C.*

DEAR MR. WARNE: I have your letter of January 31, 1947, calling my attention to the fact that Nevada's comments on the Bureau's comprehensive report the Colorado River, is 6 weeks overdue.

In reviewing the Colorado River report I find there is little, if anything, I might say concerning it at this time that would be of much significance or importance.

In my opinion the report is a splendid piece of work. Everyone who is interested should realize that it does not set up any projects but is merely an inventory of all possible projects regardless of their respective merits. That is the view we take of it.

We feel that several of the Nevada projects, all of which are comparatively small, should be listed, if and when that time comes, with fairly early priorities. We are also interested in joining with the State of California in promoting an early priority and appropriation for the early construction of the Bridge Canyon project because of its great value and necessity for additional power very much needed throughout the area capable of being served by it.

Very truly yours,

(Signed) ALFRED MERRITT SMITH,  
*State Engineer.*



# Comments of the State of New Mexico

STATE OF NEW MEXICO

OFFICE OF STATE ENGINEER

SANTA FE

JANUARY 11, 1947.

HON. MICHAEL W. STRAUS,  
*Commissioner, Bureau of Reclamation,  
 Washington, D. C.*

DEAR COMMISSIONER STRAUS: I enclose herewith comments and criticisms, prepared by the office of the State engineer of New Mexico, of your Planning Report No. 34-8-2 of March 1946 on the Colorado River. This report is entitled "A Comprehensive Report on the Development of Water Resources of the Colorado River Basin for Irrigation, Power Production, and other Beneficial Uses in Arizona, California, Colorado, Nevada, New Mexico, Utah, and Wyoming."

The enclosed comments may be treated as stating the position of the State of New Mexico in reference to this report, pursuant to the provisions of the Flood Control Act, under the terms of which the report has been reviewed by this office.

I am sorry that the submission to you of this paper has been delayed. However, the untimely death of Mr. Thomas M. McClure, former State engineer, and the subsequent changes in the State administration, have caused an unavoidable delay. I trust that you would give the matters contained therein your careful consideration.

Yours very truly,

(Signed) JOHN H. BLISS,  
*State Engineer.*

STATE ENGINEER'S OFFICE,  
*Santa Fe, N. Mex., December 14, 1946.*

Following are certain New Mexico comments on the March 1946 report of the Bureau of Reclamation on potential projects for the development of the Colorado River Basin. This report has been revised and amended somewhat from the preliminary draft submitted by the Bureau and discussed at the Denver meeting of Colorado River representatives, November 10 and 11, 1944. Reference is here made to New Mexico's statement regarding this earlier report. Many of the observations and state-

ments therein still apply in general to the present report. It is an excellent summation and presentation of the factual data as they are known today. As far as this State's projects are concerned, however, these data are entirely too meager to be used as the basis for planning a specific development program or to determine the full potentialities of the available water supply. With the understanding that the report cannot be considered as a comprehensive plan for control, improvement, and utilization of the waters of the basin, the following comments on specific New Mexico projects are submitted.

In his letter to the Secretary of the Interior, the acting Commissioner of the Bureau lists the following projects for the utilization of San Juan River Basin waters in New Mexico, and their estimated 1945-46 costs:

Project unit	Location	Source of supply	Cost
Dulce-Chama-Navajo.	Colorado and New Mexico. <sup>1</sup>	Navajo River.	\$2,603,200
South San Juan . . . . .	New Mexico . . . . .	San Juan River.	56,000,000
Hammond . . . . .	do . . . . .	do . . . . .	1,160,000
Shiprock . . . . .	do . . . . .	do . . . . .	33,825,600
Pine River extension . . . . .	Colorado and New Mexico.	Pine River . . . . .	2,936,000
Animas-La Plata . . . . .	do . . . . .	Animas and La Plata Rivers.	101,654,000

<sup>1</sup> Listed as a Colorado project, although most of the lands lie in New Mexico. About 27,000 acres of scattered Indian projects in the State are planned for development, also.

In addition to the above projects, New Mexico presumably would participate in the irrigation of 500,000 acres of pasture lands in the upper basin.

The report lists the San Juan-Chama diversion project as an alternate to the South San Juan project since they would both utilize the same water supply. An average of 300,000 acre-feet of San Juan waters would be diverted annually to the headwaters of the Chama River in the Rio Grande Basin for irrigation and power development. Either of these projects would be directly affected by construction of a second alternate project, the San Juan-South Fork diversion to the San Luis Valley in Colorado, which could divert about 53,000 acre-feet of their potential water supply.

The break-down of the New Mexico acreages to be irrigated by these projects, as totaled in the report, is about as follows:

Project	Acreage of new land	Acreage to be supplied with supplemental water
Dulce-Chama-Navajo.....	12,200	(1)
South San Juan.....	75,000	(1)
Hammond.....	3,700	(1)
Shiprock.....	70,000	(1)
Pine River extension.....	(1)	(1)
Animas-La Plata.....	48,600	3,700
Small Indian projects.....	15,460	11,400
<b>Total.....</b>	<b>224,960</b>	<b>15,100</b>

<sup>1</sup> Acreages small; included in Colorado totals.

The costs listed in the report are those which it is estimated would be required if the projects were constructed at the present time. They are 60 percent higher than the figures given in the preliminary report which were based on January 1, 1940' prices. The estimated acreages to be irrigated in the various projects are based upon a net consumption of about 2.0 acre-feet per acre of irrigated land.

The Hammond and the Pine River extension projects are both apparently much needed projects upon which construction should be started in the near future. The Dulce-Chama-Navajo project probably would utilize a reservoir on the Navajo River jointly with the South San Juan project or its alternate, the San Juan-Chama diversion project, so that the projects would be more or less interdependent.

Preliminary data on the South San Juan project have been included in the current report at the request of New Mexico interests in the basin. This project contemplates the irrigation of a large area of white lands on the south side of the river, not considered in the preliminary report. The lands to be developed have not been classified and it is not known whether the irrigated lands would lie in one compact area or would be scattered in several areas along the canal. The lands are high and the growing season relatively short. Four reservoirs would be constructed on the contributing streams. A main canal almost 300 miles long would be carried to a point near the top of the Continental Divide west of Cuba and would then turn northwestward on to project lands. It has been assumed that a 300,000-acre-foot diversion will irrigate 75,000 project acres. Total costs have been estimated at \$56,000,000.

Cost estimates of this project are necessarily very preliminary in nature, since no detailed surveys have been made. It is believed however, that, considering the extreme length of the main canal, a large part of which traverses exceedingly rough broken terrain, the

estimates submitted are quite low. Further, the canal traverses a route at times almost 50 miles from the San Juan in dry country, which contributes water to the main stream only in periods of large floods. It is difficult to see how the available supply can irrigate 75,000 acres of lands unless most of the long main canal were lined. Also, it is highly improbable, as assumed in the report, that all the water not consumed by crops will return to the main stream. A return flow approaching zero would be a much more reasonable expectancy.

The Animas-La Plata project is still being studied by Bureau engineers. Estimated to cost \$101,000,000 it would irrigate 86,300 acres of new land in Colorado and New Mexico, would furnish a supplemental supply to 24,700 cultivated acres in the two States, and would develop power and control floods and silt of the upper Animas River. The project would furnish water to 48,600 acres of new land in New Mexico, of which 25,500 acres are within the Indian reservations, and would supplement the supply for 3,700 acres presently irrigated on the La Plata. The first unit of this project, the La Plata River project, involving construction of Long Hollow and State Line Reservoirs, has already been approved by interested parties in both States and should be constructed as soon as possible. Consideration of the larger project must await the project report thereon by the Bureau of Reclamation. The estimated stream-flow depletion of 2.0 acre-feet per acre is probably low for this project, though not so much so as in the case of the South San Juan project.

The Shiprock project would irrigate 70,000 acres of Navajo Indian lands on the south side of the San Juan River near Shiprock. The data on this project are still not sufficient to draw any final conclusions at the present time.

Small Indian projects, scattered chiefly over the Navajo reservation in New Mexico, are planned to irrigate 15,460 acres of new lands and to improve the water supply for 11,400 acres of land currently under cultivation. Stream-flow depletion from these developments would approach 100 percent of the diverted waters. Including the Shiprock and Animas-La Plata projects, the Office of Indian Affairs estimates that there are between 135,000 and 150,000 acres of Indian lands in New Mexico which may be irrigated from the San Juan and its tributaries. The lands would be utilized by an estimated 8,000 Indian families, a large percentage of which would have to be imported from outside New Mexico. Insofar as San Juan water in this State is used to support the Indians from other States, it would seem that these uses could well be charged against such States.

The alternate New Mexico project mentioned in the report is the transmountain diversion of San Juan waters to the Chama River in the Rio Grande Basin. If au-

thorized, it would supplant the South San Juan project. On the Rio Grande side the high heads through which the water would fall would be utilized to develop large amounts of power. The water supply would be utilized to irrigate about 75,000 acres of new lands of high potential value in the Rio Grande Basin. The report mentions the possibility of exchanging some of the transmountain supply with Colorado by permitting increased uses of Rio Grande water in the San Luis Valley. It should be pointed out that any such exchange would necessarily involve a revision of the Rio Grande compact, an unlikely procedure. To again quote the wording of the compact:

"Colorado agrees with New Mexico that in event the United States or the State of New Mexico decides to construct the necessary works for diverting the waters of the San Juan River, or any of its tributaries, into the Rio Grande, Colorado hereby consents to the construction of said works and the diversion of waters from the San Juan River, or the tributaries thereof, into the Rio Grande in New Mexico, provided the present and prospective uses of water in Colorado by other diversions from the San Juan River, or its tributaries, are protected."

In the summation of projects in the upper basin the Bureau estimates that New Mexico's increased water consumption for the San Juan projects listed would be 450,000 acre-feet per year. It is believed that the consumption actually would be much higher than this figure, probably near 1,000,000 acre-feet per year.

On page 148 of the Bureau report, table 64 lists the Dulce-Chama-Navajo and Pine River extension projects under "Colorado"; they should be "Colorado-New Mexico." On page 149, table 68 lists the San Juan-Chama project as serving "New Mexico-Colorado." It should be pointed out, that, in equal fairness, the Piedra-Rio Grande, the San Juan-South Fork and the Animas-Rio Grande projects are as much "Colorado-New Mexico" projects as the San Juan-Chama is a "New Mexico-Colorado" project. New Mexico insists that the latter project should be considered solely as a New Mexico project—as it is considered by compact agreement between the States.

That part of New Mexico within the lower basin of the Colorado River, comprising lands near the headwaters of the Gila and San Francisco Rivers and the upper Little Colorado River, is a comparatively small part of that basin. Two projects, the San Francisco and Duncan-Virden Valley units are included as a part of the large central Arizona project. In the tentative plan, about 2,000 acres of new lands in the San Francisco Basin are to be irrigated and 10,800 acres presently in cultivation in both basins are to be furnished a supplemental water supply. The location of presently irri-

gated lands, as shown in the report, is as follows: 2,500 acres in the San Francisco Basin; 5,500 acres in the Gila-Cliff and Redrock Valleys; and 2,800 in the New Mexico portion of the Duncan-Virden Valleys. It should be pointed out that the Gila River court decree determined that 2,960 acres of New Mexico land in the Virden Valley have water rights. Although no irrigation of new lands from the Gila River is contemplated in the report, additional studies may indicate the feasibility of enlarging and extending the present irrigated area. Stream depletions for the several areas have been estimated at about 2.0 acre-feet per acre. It is believed that this figure may be somewhat low.

No new irrigation projects on the headwaters of the Little Colorado in New Mexico are planned by the Bureau of Reclamation. The possibility of developing some additional areas in this basin, however, should not be overlooked.

The lower-basin projects listed in the report would seem to be reasonably adequate to take care of existing developments and presently contemplated extensions and additions. New Mexico, however, feels that no final plans for development of her lands can be made until additional and more detailed studies which will fully explore the potentialities of the areas are undertaken.

In conclusion, New Mexico believes that the report is a valuable summation of projects for development of the waters of the Colorado River Basin insofar as present studies and information is concerned. It is evident, however, that much additional investigation and study, as well as actual construction and development, are necessary before many of the problems of the basin can be worked out. Of the several million dollars made available by appropriations of funds set up in the Boulder Canyon Adjustment Act for investigation in the upper basin States, almost no moneys have been spent in this State. New Mexico is at a disadvantage until adequate investigations are made of all potential projects so that the most feasible and beneficial ones may be selected.

#### STATEMENT BY STATE OF NEW MEXICO

The preliminary draft of the Colorado River report of the Bureau of Reclamation was submitted to the members of the Colorado River Committee of Fourteen and Sixteen and their advisers in Denver, Colo., November 10 and 11, 1944. Because of lack of accurate data in many instances, and in part to the limited time given for its compilation, the report is admittedly tentative in nature and subject to some corrections of statement. It was submitted to the interested States for whatever comments or criticisms they might care to make before a

draft was prepared for submission to Congress on the first of the new year or as near thereafter as possible.

The report has been declared by Bureau representatives to be an inventory of existing and potential water-use projects in the Colorado River Basin. It does, however, in the upper basin, limit the number and extent of projects considered to keep consumptive uses within the limits defined by the Colorado River compact. It is comprehensive and becomes a plan of development insofar as it selects certain projects and rejects others in arriving at the over-all use in the upper basin. In the lower basin, on the other hand, this plan of selection has not been followed and the potential projects listed overrun compact allocations. Further, the upper and lower basin projects were not analyzed on the same basis, uses in the upper basin being circumscribed by the 10-year dry period, 1931-40, while lower-basin uses were measured by long-time average annual flows. Projects in the two basins were not, therefore, analyzed on a comparable basis. There is a danger that this difference may result in a more favorable consideration being given to lower-basin projects. It is suggested that the report be changed to make all projects comparable.

There seem to be differences of opinion among representatives of the seven States and even among the personnel of the Bureau itself regarding the exact status and possible effect of the Colorado River report. At the Denver meeting the question was the subject of considerable discussion and opinions were expressed (1) that the report constituted a comprehensive plan of development of the basin, (2) that it was merely an inventory of possible projects, (3) that it combined some of the features of both. Some committee members feared that it might have the effect, whether intentional or not, of establishing the broad outline of development and even of giving certain listed projects preference over others which additional investigation and analysis might prove to be more advantageous or feasible.

New Mexico asked the direct question whether the Colorado River report constituted a comprehensive plan or whether it was merely an inventory of possible projects. Mr. William E. Warne, Assistant Commissioner of the Bureau, replied that at the present time, considering the limited time available for its compilation and the deficiency of accurate data in many areas, the report could be no more than an inventory which would be amended and modified whenever additional studies or circumstances indicated their necessity. All seven States were in agreement that the report could not be approved by them as a comprehensive plan of development. There was too much at stake and too little information available to permit definite commitments at the present time or probably for many years to come.

In this connection we quote the following pertinent excerpts from the proceedings of the New Mexico Interstate Streams Commission meeting at Santa Fe, N. Mex., September 8, 1944, at which directors or representatives of the three regions of the Bureau affecting New Mexico were present. Mr. E. O. Larson, director of region 4, in describing potential New Mexico developments, opened his statement as follows:

Before explaining some of the projects, I believe it would be well to go back and explain what is going on in the Colorado River Basin. A few months ago Senator Hayden of Arizona, who is in charge of irrigation and highways on the Senate Postwar Planning Committee, suggested to the Commissioner of Reclamation that the Bureau prepare a comprehensive report on this region, similar to the one prepared a few months ago on the Missouri River which came out as a Senate document. While such a report would be an inventory of the potential irrigation projects in the Colorado River Basin it is more than just an inventory, it is essentially a general plan.

Later, during the discussion of the Gila River Basin, the following conversation took place between the State engineer and Mr. Harry S. Raschbacher, of the Bureau office at Phoenix, Ariz.:

Mr. McCURE. The thing we need on the Gila and the San Francisco is a survey and basic information of what dam sites and what water supply are available. We can't accept a plan unless we have that information.

Mr. RASCHBACHER. No doubt some basic data has been collected. We haven't gotten into that section. We were busy in the Little Colorado section and then we were going to take up the Colorado River. I understand there have been some investigations on dam sites, and the thought I have is just this, that the over-all proposition would have to be one for the benefit of both States and not primarily of one State only.

Mr. McCURE. How can we plan if we don't know how much water we have to play with? Back in 1938 or 1939 when they reached an agreement on your adjustment act in regard to the Boulder Canyon Project Act we gave the Bureau of Reclamation \$500,000 a year for 3 years. That's what they said they needed to make these surveys on every tributary, with, I presume, additional money they would get, and make these investigations and bring these things before us so we could make up our minds. We want some of that money spent on the Gila, San Francisco, and San Juan so we can make up our minds about them. We think it is time we got a play on that money.

Mr. RASCHBACHER. We have to turn in for the Colorado River Basin report an estimate on the cost of an upper Gila project. I suppose we'll pick out some one figure and say "This is the estimate," but we have no idea of saying this is the final answer.

Mr. McCURE. You ought to be careful how you word this comprehensive plan you have to turn in to Congress if you are not ready to give us the answer or let us help you.

It should be pointed out that the title of the Colorado River report itself might be changed. It is stated to be "A Comprehensive Report on the Control, Improvement, and Utilization of the Water Resources of the Colorado River Basin." At the present time at least it

could be more properly called "An Inventory of Projects for the Control — etc."

The following pages give comments and criticisms of the specific projects proposed for the development of New Mexico lands.

That part of the report covering the Gila River within the State is very preliminary in nature being based largely upon the C. C. Fisher report made by the Bureau in 1929-30, investigations by the State engineer's office, and statements and opinions expressed by local interests. No recent project surveys have been made in the area.

On the Gila River the report proposes construction of the Hooker Dam, at an estimated cost of \$13,300,000. This estimate is based upon the Fisher report, which contemplated a dam rising 300 feet above stream bed with 200 feet of dead storage. The large unusable storage pool was designed to maintain power head and to permit the irrigation of certain high bench lands in the Cliff area. The development of the bench lands was not found to be feasible. Conditions would seem to indicate a lower dam designed to fit a reduced plan, but this is a matter which must receive additional investigation and study by the Bureau.

The report indicates a total of 10,000 acres now irrigated in the Gila and San Francisco Basins with 2,000 acres of new lands irrigable on the San Francisco. The figure for total present irrigated acreage is about right but there seem to be some errors in the tables in which it is broken down by basins. On the Gila proper, about 4,600 acres are irrigated in the Cliff and Redrock Valleys and on the upper tributaries, and 2,900 acres are irrigated in the Virden Valley, which is the New Mexico portion of the Duncan Valley unit of 8,100 acres. In addition, there are 2,000 to 2,500 acres of new land which may be irrigated by present facilities or extensions thereof. This acreage could be further increased if investigation indicates an adequate water supply. In the San Francisco Basin about 2,500 acres are presently irrigated. The report indicates that there are perhaps 2,000 additional acres which might be irrigated under storage projects. This figure is tentative and cannot be accepted as final by New Mexico interests unless and until proved by necessary investigations. There is a great deal of good, arable land, particularly on the upper tributaries of this stream the development of which is limited only by the available water supply.

The report indicates that 10,000 acres of irrigated land in New Mexico could receive supplemental water and 2,000 acres of new land could be irrigated by proposed reservoir construction totaling \$13,300,000. It is not known whether this figure includes the proposed small dams on the San Francisco, but it is believed that it does not. It should be pointed out that the proposed Hooker Dam and the water supply available to it are sufficient

to serve not only present irrigated lands on the Gila River in New Mexico but the entire Duncan Valley in Arizona plus several thousand acres of new lands in the two States. The reservoir would probably furnish adequate flood control for the Cliff area but only partial protection for the lower valleys. Although it has been indicated to Bureau officials that the Gila interests prefer the construction of Hooker Dam to one farther downstream, which would flood existing irrigated areas, construction of a relatively low dam at one of the lower sites, such as Connor No. 4 site, should probably be considered from the standpoint of flood and silt control for these lower areas.

In neither the San Francisco nor Gila Basins have adequate studies been made by the Bureau and therefore no final plan nor even the broad outline of a plan for development of the water supplies can be made at this time.

In some of the tabulations of the report there are certain figures which should be adjusted. The second table on page 182 indicates 8,100 acres irrigated in the Duncan Valley unit. This might be more properly called the Virden-Duncan unit since it includes 2,900 acres in the Virden Valley in New Mexico. The New Mexico unit is shown as containing 5,500 acres, apparently in the Redrock and Cliff Valleys and adjacent tributaries. To produce the total of 10,000 acres irrigated in New Mexico, this figure should be reduced to 4,600 acres, which is probably a more representative figure for lands now in cultivation and irrigation. The tabulation includes no new lands to be developed under the Hooker project. As stated previously there are 2,500 acres or more which could be easily developed if floods were reduced and adequate water supply assured by storage. In the tabulation both of the above units have been included in the \$462,900,000 item, which is the irrigation portion of the cost of the Bridge Canyon and Coconino projects, while the cost of the Hooker Dam, which will supply water to both units, has not been included. The addition of the cost of this dam would also change the third table on page 181, increasing it by such cost instead of reducing the Bridge Canyon figure as was done in the table.

In discussing potential San Juan Basin development in New Mexico it should again be stressed that much of the data in the report are based on inadequate preliminary investigations which may or may not have arrived at the best possible development of the water supply of the region. Because of the rugged character of the country and in part to the spotty character of some of the arable areas, the development of large areas of new lands are expensive. Thus for the two largest basin projects, the Animas-La Plata and the Shiprock, the costs per acre of land benefited are beyond the pres-

ent ability of the lands to repay. The report states that if the alternate Shiprock project were built, increasing the area from 70,000 to approximately 200,000 acres of land, the per-acre costs of land benefited would be even higher than that indicated for the smaller project. Those points are mentioned here to emphasize the need for additional detailed studies of these and other potential projects for the development of the basin.

The report finds a potential irrigation development of 149,960 acres of new land and 15,100 acres of irrigated lands to be furnished supplemental water in New Mexico, exclusive of potential water exportations. It does not supply sufficient data to make a complete breakdown of these figures by projects. Approximate figures, however, may be as follows:

Project	New lands	Lands with supplemental water
Dulce-Chama-Navajo.....	12,200	.....
Hammond.....	3,700	.....
Shiprock.....	70,000	.....
Animas-La Plata.....	48,600	3,700
Scattered Indian projects.....	<sup>1</sup> 15,460	<sup>1</sup> 11,400
Total.....	149,960	15,100

<sup>1</sup> Computed by difference.

These lands are divided approximately as follows: 125,000 acres to Ute and Navajo Indians and 40,000 acres to the whites. These projects may or may not be acceptable as a general plan of basin development. New Mexico interests are particularly desirous that the Shiprock project be enlarged to include the arable portion of the large body of land south of the river and east of the Navajo Reservation line if the project is at all feasible. Another desired project is the development of the area between the San Juan and Animas Rivers south of Aztec. These and possibly other projects should receive careful consideration as investigations proceed.

In the matter of potential exportations from the basin both the text on page 146 (and possibly other places in the report) and the tables on pp. 148-149, and elsewhere resulting from the statement in the text are in error. The San Juan-Chama transmountain diversion is a New Mexico project for the diversion of San Juan River waters to the Chama River for use on New Mexico lands. It is not, as stated in the report, a Colorado project for which "a like amount (of water) would be diverted from the river and its tributaries in Colorado and used for the irrigation of the San Luis Valley." The statement is patently false since the report in no way provides or attempts to provide for diversions from the San Juan and its tributaries of "a like amount—for the irrigation of the San Luis Valley."

In this connection the following bit of history is pertinent: In late 1935 and the early part of 1936 the National Resources Committee and the States of Colorado, New Mexico, and Texas entered an agreement to undertake a joint investigation of the resources and utilization of the waters of the Rio Grande Basin above Fort Quitman, Tex., the work to be conducted by the various interested Federal agencies and by the States. As a part of the general investigation an agreement was entered into between the National Resources Committee and the Bureau of Reclamation, in which the Bureau agreed, in part, to "make such surveys and investigations \* \* \* (b) of the possibilities of transmountain diversion of water from San Juan River and tributaries to the basin of the Rio Grande, including storage and the design and estimates of costs of all necessary conduits and works; and (c) of the possibilities and cost of hydroelectric developments in the basin of the Rio Grande, including the economic feasibility and the possible markets for the income from the electric power to be generated \* \* \*." Under the general report and findings in the National Resources Committee report of February 1938 the following statement on page 118 is quoted: "The diversion of water from the Colorado to the Rio Grande Basin is permissible under the Colorado River compact, and it would afford New Mexico an opportunity to utilize, in greater or less measure, its share of the waters of the Colorado River Basin under that compact."

Article IX of the Rio Grande compact states: "Colorado agrees with New Mexico that in event the United States or the State of New Mexico decides to construct the necessary works for diverting the waters of the San Juan River, or any of its tributaries, into the Rio Grande, Colorado hereby consents to the construction of said works and the diversion of waters from the San Juan River, or the tributaries thereof, into the Rio Grande in New Mexico, provided the present and prospective uses of water in Colorado by other diversions from the San Juan River, or its tributaries, are protected." New Mexico agrees that in the development and use of the waters of the San Juan River, the States of Colorado and New Mexico will have to agree upon an equitable and just apportionment of their share of the waters of that stream. However, for the Bureau of Reclamation to attempt to make such adjustment itself—which it seemingly is trying to do in the present report—is beyond the province of this impartial fact-finding body.

In the Interstate Streams Commission meeting of September 8, 1944, above referred to, and also in the hearings before the Senate Subcommittee on Irrigation and Reclamation held at Albuquerque, N. Mex., October 2 and 3, 1944, officials of the Bureau of Reclamation discussed the San Juan-Chama diversion project and its

relationship to other potential uses of San Juan River waters. It was stated that such a project would have to be integrated with other potential uses of San Juan River waters and it was also indicated that there were possible conflicts in the use of this water. At no time was the statement or claim made that this water belonged to Colorado. Rather, in all of the discussions the proposed diversion was considered as a project permitting New Mexico to utilize a portion of her share of Colorado River waters in the Rio Grande Basin. The relative priority of basin or trans-basin projects does not enter into this discussion since the San Juan-Chama project and the use of San Juan waters in the San Luis Valley both come under the classification of exported waters.

One further reference might be made in this regard. The semiconfidential report of Mr. C. L. Patterson, chief engineer of the Colorado Water Conservation Board, to the members of that body, a copy of which was made available to New Mexico Committee of Sixteen members, treats the Bureau's statement regarding the San Juan-Chama diversion as a simple error in statement (which New Mexico also prefers to believe it to be). In the discussion of potential basin exports, he states under footnote (c), page 10, "San Juan-Chama, estimated cost \$19,968,000 for lands in New Mexico," and under footnote (a), page 11, "Figure of 1289 wrongly charges Colorado with San Juan-Chama diversions." In the tables to which these footnotes apply, the report makes no claim to the San Juan-Chama diversion as a Colorado project but makes it plain it is solely a New Mexico project for development of lands in that State.

It is evident, therefore, that the statement and tables referred to in the report are in error and should be corrected.

The present report does not attempt to evaluate or go into any detail regarding basin exportations, and it is realized that complete findings along this line are not possible at the present time or in a report of this nature. It is evident, however, that before final decisions are reached in basin planning, the merits of all potential projects for water use must be thoroughly considered from the standpoints of irrigation returns, power, and other factors and decisions made regarding their relative merits. Rather complete plans and estimates of diversions from the San Juan drainage to the Rio Grande watershed in both Colorado and New Mexico, including estimates of power production and power markets, have been made and are available in the National Resources Committee report above referred to.

It is noted that the present report indicates that only 247,000 acre-feet is allotted to the San Juan-Chama diversion for the 1931-40 dry period, whereas other Bureau reports indicate that nearly 400,000 acre-feet annually

would be available to this project. Part of this difference is due, of course, to the use of the 10-year dry period in the first instance and to average water production in the second. Another part is apparently due to the potential use of part of the Navajo River supply on the Dulce-Chama-Navajo project. New Mexico interests would like to know what other proposed uses, if any, above the Arboles Dam and Reservoir site (Shiprock project) are in direct conflict with this project as to available water supply. It will be necessary that New Mexico know the situation in this area of the San Juan before any final decisions could be made.

As indicated in the above discussion the statement on page 146 should be changed to show that the San Juan-Chama diversion is a New Mexico project. This would change the table on page 148 making the West Fork, East Fork, and Blanco Reservoirs serve the "Rio Grande Valley" in "New Mexico" and making the Navajo Reservoir serve the "Dulce-Chama-Navajo and Rio Grande Valley," areas in "Colorado and New Mexico and New Mexico," respectively. The second table on page 149 should show the San Juan-Chama project serving New Mexico instead of Colorado, and the totals in the third table at the bottom of the same page would be changed, with 92,000 acre-feet being exported to Colorado and 251,000 acre-feet exported to New Mexico uses. The tables on pages 149 and 150 would also have to be changed accordingly, and any other tables in which these figures appear.

In the San Juan and Gila River projects (as in the case of all storage projects discussed) the report charges total reservoir evaporations against the projects thereunder. There is some question in the interpretation of the Colorado River compact whether any reservoir losses in the upper basin are chargeable against that basin's allowable consumptive uses. Aside from this question, however, it should be pointed out that net reservoir consumptions are only the quantities by which losses within the storage basins resulting from reservoir operations exceed the former natural losses. Only the increased consumptions due to reservoir operations are chargeable against the upper basin and the respective projects.

In conclusion, New Mexico believes the following statements covering the Colorado River report are important and should receive the serious consideration of the Bureau of Reclamation and of all parties and agencies who will use the report in planning the development of the Colorado River Basin, particularly in this State:

1. At the present time, considering the deficiency of data in many of the areas, the report must be considered as a somewhat incomplete inventory of possible projects which must be subject to amendment and modification

whenever additional studies or circumstances indicate their advisability or necessity. New Mexico cannot approve it as a comprehensive plan of development or even as the rough framework for such a plan until a great deal more investigation and study have been made in New Mexico area.

2. In order to be comparable, projects in both the upper and lower basins should be analyzed according to identical basic assumptions, both as to water supply and as to compact allocations.

3. In the discussion of the individual projects certain obvious errors have been pointed out which should be

## THE COLORADO RIVER

corrected to make the report as accurate as possible. Also, certain statements and suggestions have been made which, it is believed, merit the consideration of this report and should be kept in mind in any subsequent surveys and investigations which may be made.

4. Since additional copies of the report did not become available to the various interested parties until the 1st of December, New Mexico reserves the right to supplement this statement should any of the interested water users call attention to any matters which have been omitted from the present statement or which should require additional discussion.



# Comments of the State of Utah

STATE OF UTAH  
OFFICE OF THE GOVERNOR  
SALT LAKE CITY

DECEMBER 14, 1946.

HON. J. A. KRUG,  
*Secretary of the Interior,*  
*Washington, D. C.*

DEAR SECRETARY KRUG: The comments by the State of Utah on the Colorado River report prepared by the United States Bureau of Reclamation, are due in Washington, D. C., on December 17, 1946. May I compliment you on the excellent job done by the Bureau in assembling this data and in covering the field so thoroughly.

Enclosed is an official letter to me by Ed. H. Watson, State engineer and also a member of the Upper Colorado River Basin Compact Commission, setting out a list of projects desired by the State of Utah, with brief comments thereon. This letter was unanimously approved by a very large group of Utah water users.

Accompanying this official letter is also a personal letter by Mr. William R. Wallace, who asks that all the water apportioned to the upper basin States under the Colorado River compact be divided early in 1947 in order to receive the approval of the assembled State legislatures. Other than this request, Mr. Wallace approves the official report. If all the water can be fairly divided by that time, we shall all be happy; but if it cannot, Utah would like each of the upper basin States to have an allotment well within the general allocations made by the Colorado River compact.

With kindest personal regards, I am,

Sincerely yours,

(Signed) HERBERT B. MAW,  
*Governor.*

THE STATE OF UTAH  
OFFICE OF STATE ENGINEER  
SALT LAKE CITY

DECEMBER 14, 1946.

The Honorable HERBERT B. MAW,  
*Governor of Utah,*  
*Salt Lake City, Utah.*

DEAR GOVERNOR MAW: A report of the United States Department of the Interior, prepared under the super-

vision of the Bureau of Reclamation, on the development of the water resources of the Colorado River Basin (Project Planning Report No. 34-8-2, dated March 1946), was submitted to the State of Utah in June 1946 for review and comment in accordance with the provisions of section I of the act of December 22, 1944 (58 Stat. 887). The time during which comments may be submitted to the Secretary of the Interior has been extended to December 17, 1946.

At your direction I have reviewed the report carefully. Assembling, as it does, into one document a complete summary of the present and potential developments of water resources in the entire Colorado River Basin, it provides a basis for over-all analysis of the basin's problems and no doubt will prove invaluable as a guide and stimulus to further development of this great western resource, the Colorado River. Development potentialities outlined would consume more water than is available in the Colorado River system. For this reason the report does not recommend a specific plan of development, but leaves to the respective States within the Colorado River Basin the selection of projects to be recommended for construction. The process of selection is complicated by the fact that as yet no division has been made among the respective States of the upper and lower Colorado River basins of the water allocated to each basin by the Colorado River compact, although in the upper basin a commission is now at work attempting to formulate a compact which will result in an equitable division of the water among the States.

In recommending projects for the next stage of river development in Utah, it is difficult to exclude any of the 35 potentialities outlined in the report which are within Utah's borders or would directly benefit the State. Undoubtedly, however, there is a greater or more immediate need for construction of some projects than for others. In preparing a recommendation, I have attempted to give fair consideration to such factors as economic need, cost-benefit ratio, the degree to which the project has been investigated, geographical distribution, and other factors. I have also confined the recommendation to those projects, the stream-flow depletions of which will assuredly fall within the allocations of water to be made to Utah. The projects listed in the accompanying table are recommended for the next stage of development in Utah.

The estimated stream-flow depletion for each project as shown in the table is consistent with depletion rates

used by the Bureau of Reclamation in the Colorado River Basin report. The cost estimates were taken from the report, except in the case of the central Utah, Gooseberry, and Ouray projects, where supplemental estimates were furnished by the Bureau upon request. The estimated construction cost for the Hurricane project includes all of the proposed features, including those required to provide a full water supply to 3,000 acres of land in Arizona, but the stream depletion estimated applies only to that part of the project which is in Utah.

Each of the projects listed is described in the report except that the report does not identify that part of the central Utah project which is here proposed as the first stage of development, and the report does not identify the Ouray project as such but it is incorporated with other potential developments into what is called the Moon Lake project extension.

The central Utah project, initial stage, is by far the largest and most important of the projects recommended for early construction. It is in fact simply an extension and enlargement of the Strawberry Valley project, which was constructed as one of the earlier undertakings of the Bureau of Reclamation. It would include construction of the following features:

1. An aqueduct from Rock Creek to the Strawberry Reservoir.
2. A dam at the Soldier Creek site on Strawberry River to provide an enlargement of the Strawberry Reservoir.
3. A new outlet tunnel from Strawberry Reservoir into the drainage area of Diamond Creek, a tributary of the Spanish Fork River.
4. Diamond Creek power plants Nos. 1, 2, and 3, with capacities totaling 72,000 kilowatts, regulation reservoirs at the Monks Hollow and Little Diamond sites on Diamond Creek, and necessary transmission lines.
5. The Wasatch aqueduct and other auxiliary canals and distribution works to distribute the imported water to places of use in the Bonneville Basin.
6. A new and higher dam at the Sevier Bridge site on the Sevier River.
7. The Bates Reservoir on Provo River.
8. The Echo Park Dam and power plant on the Green River in Colorado, together with necessary transmission lines.
9. The Starvation Reservoir on the lower portion of the Strawberry River.

The cost estimate for the first stage of the central Utah project is based on the assumption that all of the features mentioned except the three power plants on Diamond Creek will be built to the full capacities required for the ultimate project rather than for the lesser capacities needed for the first stage of development. Undoubtedly the ultimate cost of construction will be less if the works are built initially to their full stature rather than to approach that stature in stages, but the cost of the first-stage development could be very materially reduced if the necessary works were built only to the capacities necessary to accommodate the water made available by the initial development.

If constructed to its first stage, the central Utah project would provide water to approximately 25,000 acres of arable land not heretofore irrigated and furnish a supplemental water supply to 84,000 acres of irrigated land in Utah, Juab, Millard, Salt Lake, Sevier, Sanpete, and Piute Counties. It would provide in addition, more than 20,000 acre-feet of water annually to meet growing needs for domestic and industrial uses. The annual output of firm electrical energy would approximate 668,000,000 kilowatt-hours at the Echo Park plant and 415,000,000 kilowatt-hours at the three plants on Diamond Creek.

The Ouray project would furnish a supplemental water supply of 3,200 acres of land now irrigated and a full supply for 12,200 acres of rich arable land in the Ouray Valley of the Uintah Basin. New off-stream reservoirs would be required at the Halfway Hollow and Pelican Lake sites, with capacities of 32,200 and 5,200 acre-feet, respectively. Both would be supplied water by feeder canals from the Uintah and Whiterocks Rivers. Other canal construction would be required to convey the stored water to the land.

The eight projects recommended for construction in the next stage of river development would furnish a supplemental water supply for 163,100 acres of irrigated land and provide a full supply for 56,200 acres in Utah now largely unproductive. Of these lands, 8,200 acres requiring supplemental water and 13,000 acres requiring a fully supply are in the lower basin and the remainder (154,900 acres supplemental and 43,200 acres full supply) is in the upper basin.

Only two of the projects recommended have power features. The power characteristics of the central Utah project in the upper basin and adjacent areas have been described. The Hurricane project in the lower basin would produce 15,000,000 kilowatt-hours of firm power annually, in addition to replacement power, power required for project pumping and secondary energy.

Although these eight projects are presented as those which, in my opinion, would provide the greatest immediate benefit for the State of Utah, the resulting benefits by no means would be confined within the borders of the State. For instance, the Echo Park unit of the central Utah project actually is located in northwestern Colorado and is only a few miles from southern Wyoming. Energy from hydroelectric generators at Echo Park could reach out to a power-deficient area in the three States, including the booming Rangely Oil Field in Colorado. The Echo Park Reservoir, with a capacity of more than 5,000,000 acre-feet, would provide flood control and stream regulation on the Green and Colorado Rivers and would provide hold-over storage to help all of the States of the upper basin to meet their stream-

flow obligations at Lees Ferry in dry years, as required by the Colorado River compact. It is expected that part of the cost of constructing the project works could be assessed against these benefits. The Hurricane project would provide a full water supply to 3,000 acres of land in northwestern Arizona, in addition to the larger area in Utah.

I cannot emphasize too strongly the vital need for this program of water development in Utah in the period immediately ahead. The extent to which the program is carried out will in a large measure determine the extent to which Utah can provide a livelihood for its growing population and develop its rich and abundant natural resources for the welfare of the Nation. It is, indeed, regrettable that this large and potentially wealthy State is unable to provide economic opportunities for its young people, forcing many of them, after being reared and educated at the expense of Utah citizens, to migrate elsewhere as they arrive at the age when they could contribute to the production and economy of the State. The following quotations from "The Pacific Southwest Region", a December 1942 publication

of the National Resources Planning Board, will emphasize my point:

"Instead of gaining from migration, Utah lost by outward movement of its residents from 1920 to 1940. But, despite outward migration, its birth rate has been sufficient to produce a population gain each decade. In 1930 Utah had the highest rate of natural increase in the Nation and the fourth highest fertility rate of any State.

"The migration out of Utah, like that into other States, appears to result largely from a search for economic opportunities by persons in the working period of life. It reflects a lack of economic expansion within the State sufficiently rapid to provide employment for a labor force being constantly enlarged by Utah's high rate of natural increase."

The foregoing letter was unanimously approved by a large representative body of Utah water users.

Yours very truly,

(Signed) ED. H. WATSON,  
Upper Colorado River Basin Compact  
Commissioner.

Projects recommended for next stage of Colorado River development in Utah

Project	Source of water supply	Area irrigated (acres)		Firm annual power generation (million kilowatt-hours)	Estimated annual stream-flow depletion (acre-feet)	Estimated current construction cost
		New land	Furnished supplemental water			
Upper basin:						
Central Utah (first stage).....	Duchesne River and tributaries and Green River.	25,000	84,000	1,083	190,000	\$227,200,000
Vernal.....	Ashley Creek.....	1,900	22,300	.....	8,000	2,400,000
Jensen.....	Brush Creek.....	800	3,600	.....	2,500	480,000
Gooseberry.....	Gooseberry Creek.....	.....	21,800	.....	11,500	2,750,000
Ouray.....	Uintah and Whiterocks Rivers.....	12,200	3,200	.....	22,000	2,910,000
Emery County.....	Cottonwood Creek.....	3,300	20,000	.....	17,000	4,000,000
Subtotal.....	Upper basin.....	43,200	154,900	1,083	251,000	239,740,000
Lower basin:						
Hurricane.....	Virgin River.....	<sup>1</sup> 11,000	6,500	15	35,000	<sup>2</sup> 14,720,000
Santa Clara.....	Santa Clara River.....	2,000	1,700	.....	7,000	2,720,000
Subtotal.....	Lower basin.....	13,000	8,200	15	42,000	17,440,000
Total.....	Colorado River Basin.....	56,200	163,100	1,098	293,000	257,180,000

<sup>1</sup> Hurricane project will irrigate in addition 3,000 acres of new land in Arizona.  
<sup>2</sup> Represents cost of entire project, including features in Arizona.

UTAH WATER USERS ASSOCIATION

SALT LAKE CITY 1, UTAH

DECEMBER 14, 1946.

Hon. HERBERT B. MAW,  
State Capitol Building,  
Salt Lake City, Utah.

DEAR GOVERNOR MAW: On behalf of the Utah State Water Users Association, I respectfully ask that a copy of this letter be forwarded to the Honorable J. A. Krug,

Secretary of the Interior, covering the ideas of the Utah State Water Users Association in the development of that portion of the waters of the upper basin that will be allocated to Utah.

Recommendation: Representatives of Utah remain hopeful that the Compact Commission charged with the task of dividing the waters of the upper Colorado River Basin between the States of Wyoming, Colorado, New Mexico, Utah, and Arizona can make decision not later than February 1, 1947.

Then upon approval by the State legislatures, the representatives of the five States and of the United States can meet and work out a comprehensive plan of water use—such plan to provide for the concurrent development of all the waters allocated to each State.

In the event that representatives of these States require a longer time in which to agree upon a division of the waters, it is important that the development proceed well within the water right certain to be allocated to each State.

We have the statement made in the letter of June 6, 1946, from Acting Commissioner Warne to the Acting Secretary of the Interior Chapman, which reads: "I hope that the States of the Colorado River Basin will agree upon suballocations of water within the limits of general allocations made by the Colorado River compact. In addition, I suggest arrangements be made for Federal participation in any conferences among the

## THE COLORADO RIVER

States relating to such allocations of water." With this suggestion we fully agree.

At a meeting to be called as per the suggestion of Secretary Chapman, Utah will ask for acceptance by the States of the suggestion of Commissioner Warne. Utah will ask for the construction of the first unit of the Central Valley project, including the Echo Park project for power, flood control, and irrigation; the Jensen project; the Vernal project; Upalco project; the Joes Valley project; the Gooseberry project; the Ouray project; the Hurricane project; and the Santa Clara project.

To the officers and employees of the United States Bureau of Reclamation our compliments for a job exceedingly well done.

Very respectfully,

(Signed) WILLIAM R. WALLACE,  
*President, Utah State Water Users Association.*

# Comments of the State of Wyoming

STATE OF WYOMING

EXECUTIVE DEPARTMENT

CHEYENNE

OCTOBER 12, 1946.

Mr. MICHAEL W. STRAUS,  
Commissioner of Reclamation,  
Washington, D. C.

DEAR COMMISSIONER STRAUS: Enclosed you will find a copy of memos by the Wyoming State engineer, with reference to the reports of the Department of the Interior, under direction of the Bureau of Reclamation, on the Colorado River, dated October 1945 and March 1946.

Please consider all of these as the comments of Wyoming on your reports and the projects listed in the original report for initial construction to be those approved by Wyoming for initial construction.

Yours very truly,

(Signed) LESTER HUNT,  
Governor.

OCTOBER 12, 1946.

Memo to: Gov. Lester C. Hunt.

In re: Comments on Department of the Interior Report by Bureau of Reclamation on Colorado River dated October 1945 and March 1946.

DEAR GOVERNOR HUNT: Attached hereto are copies of memos dated December 14, 1945, January 26 and February 5, 1946, also memos to compact commissioners dated December 14, 1945, and February 6, 1946, all issued by this office with reference to the Colorado River reports of the United States Department of the Interior by the Bureau of Reclamation dated October 1945 and March 1946.

We desire to emphasize our remarks with reference to the initial construction program proposed in the 1945 draft of the Colorado River report, pages 13 to 17, inclusive, mentioned in our memo of December 14, 1945.

We believe this program is sound and that it should be included in the final draft of March 1946. In any event, we endorse the initial construction program mentioned therein as our definite recommendations for initial projects for Wyoming. Specifically, these proj-

ects and the ultimate depletion contemplated by them are—

<i>Sublette project:</i>	<i>Acre-feet</i>
<i>West Side unit</i> —29,050 acres of new land:	
Estimated depletion at 1.4 acre-feet per acre. . . . .	40, 670
37,000 acres supplemental supply, estimated depletion at 0.7 acre-foot per acre. . . . .	25, 900
<i>Daniel unit</i> —5,160 acres of new land:	
Estimated depletion at 1.4 acre-feet per acre. . . . .	7, 224
<i>Elkhorn unit</i> —134,030 acres of new land:	
Estimated depletion at 1.4 acre-feet per acre. . . . .	187, 642
<i>Seedskadee unit</i> —40,830 acres of new land:	
Estimated depletion at 1.4 acre-feet per acre. . . . .	57, 162
	<hr/>
Total estimated depletion for Sublette. . . . .	318, 598

*Kendall Reservoir*—We also recommend construction of Kendall Reservoir in the initial program as its storage will be needed for some of the units of the Sublette project.

<i>Eden project</i> —20,250 acres new land:	
Estimated depletion at 1.4 acre-feet per acre. . . . .	28, 350
<i>Lyman project</i> —3,100 acres new land:	
Estimated depletion at 1.4 acre-feet per acre. . . . .	4, 340
20,910 acres supplemental supply at 0.7 acre-foot per acre. . . . .	14, 637
<i>Little Snake project</i> —8,240 acres:	
Estimated depletion at 1.4 acre-feet per acre. . . . .	11, 536
10,320 acres supplemental supply estimated at 0.7 acre-foot per acre. . . . .	7, 224
Total estimated depletion:	
New lands. . . . .	336, 924
Supplemental supply. . . . .	47, 761
Total estimated present depletion. . . . .	374, 000

    Total estimated depletion to include initial program. . . . . 758, 685

A committee of representatives of water appropriators from the Green River Basin approved the first draft wherein it pertained to the initial construction program, and we want the proper officials in Washington to know that this proposed program meets our approval; and at this time we respectively urge that you call attention of the Bureau of Reclamation, through the Secretary of the Interior, to his memo and our other memos mentioned herein.

All of these memos should receive their consideration in connection with the comments of Wyoming on their report.

Copies of this memo and the earlier ones are enclosed for your use in making final comment on the report of

the Department of the Interior by the Bureau of Reclamation on the Colorado River.

Respectfully submitted.

(Signed) L. C. BISHOP,  
*State Engineer and Interstate Streams  
Commissioner.*

## STATE OF WYOMING

STATE ENGINEER'S OFFICE

CHEYENNE

FEBRUARY 5, 1946.

HON. LESTER C. HUNT,  
*Governor of Wyoming.*

DEAR GOVERNOR HUNT: The attached original memorandum of my comment on the United States Bureau of Reclamation preliminary report on the Colorado River and later supplement are self-explanatory.

A tentative draft of the supplement was mailed to all members of the Upper Colorado River Basin Compact Commission on January 26, and replies have been received to date from E. B. Hitchcock, Norman Barlow, and E. C. Gradert, and they have no corrections or additions to offer.

Please consider this memorandum and supplement as my final comments on the afore-mentioned report. Respectfully submitted.

(Signed) L. C. BISHOP,  
*State Engineer and Interstate Streams  
Commissioner.*

CHEYENNE, WYO., February 5, 1946.

The report by Mr. L. C. Bishop, State engineer of Wyoming, on his review of the Colorado River preliminary report of the United States Bureau of Reclamation, is hereby approved.

(Signed) LESTER C. HUNT,  
*Governor of Wyoming.*

## STATE OF WYOMING

STATE ENGINEER'S OFFICE

CHEYENNE

JANUARY 26, 1946.

Memo.

To: Gov. L. C. HUNT.

In re: Colorado River Preliminary Report by the United States Bureau of Reclamation.

DEAR GOVERNOR HUNT: This memorandum is supplemental to my memorandum on the above-captioned report dated December 14, 1945, and together they constitute my comments on an analysis of my review of the report as requested by you.

On January 7 and 8 a meeting of the committee appointed by you to negotiate for division of the 7,500,000 acre-feet of water allocated to the States of the upper division of the Colorado River system by the Colorado River compact and other interested water users was held at Rock Springs, Wyo., where my memorandum of December 14, 1945, was discussed and explained by me, and the Bureau report, wherein it pertains to development in Wyoming, was reviewed by the group and explained by Mr. Paul Berg and Mr. J. W. Funk, engineers of the United States Bureau of Reclamation.

The only change or alteration in my memorandum of December 14 was deletion of the paragraph on page 2, which reads as follows:

"We believe the report would reflect more nearly the facts if the statement in paragraph 45 concerning improvement to irrigation estimated at \$75 to \$300 per acre would be changed to read: '\$30 to \$300 an acre.'"

With this deletion, the memorandum was approved by the group and the report of the Bureau was approved wherein it pertains to their initial construction program, consisting of West Side, Daniel, Elkhorn, and Seeds-kadee units of Sublette project, including Kendall Reservoir, with a capacity of 340,000 acre-feet of water (Kendall Reservoir provides storage for Elkhorn, Daniel, and West Side units), also Lyman project and Little Snake River project, all being more particularly described in the earlier memorandum.

A resolution pertaining to the Bureau report was passed, as follows:

That this group go on record as favoring the United States Bureau of Reclamation report wherein it pertains to the initial development program.

That it opposes the plan for further development as proposed in all the States of the upper division until such time as a compact is negotiated for division of the 7,500,000 acre-feet of water allocated to the States of the upper division by the terms of the Colorado River compact.

That it is our recommendation that the following lands be included in the Bureau report for further investigation and development:

	<i>Acres</i>
West Side unit.....	46,270
Daniel unit.....	3,560
Elkhorn unit.....	7,790
Eden unit.....	1,600
LaBarge unit.....	1,700
Seeds-kadee.....	21,070
Opal.....	25,100
Henry Fork.....	1,600
<b>Total.....</b>	<b>108,870</b>
Little Snake.....	2,520
<b>Total.....</b>	<b>111,390</b>
Miscellaneous areas.....	37,610
<b>Total.....</b>	<b>149,000</b>

It was the recommendation of the group, in which this office fully concurs, that our representatives in Congress be asked to oppose all items of the development plan as proposed by the report of the Bureau in all of the States except those listed in the initial construction program, until appropriate understandings are reached between the States of the upper division with reference to transportation of water from the basin of the Colorado River system, and within the States until proper and adequate safeguards are provided for protection of present and future beneficial use of water in the basin. The reason for this is obvious, as in excess of 9,000,000 acre-feet of water is necessary if the entire plan for the upper basin is carried to completion, and we believe the time is now at hand to determine our equities in the allocated supply of 7,500,000 acre-feet per year before claims are made by some of the States to more than their equitable share of the water.

The group noted particularly the remarks in the Bureau report wherein it pertains to the necessity for the States to "determine their respective equities in the water supplies in the Colorado River before final comprehensive plans can be formulated, and passed a resolution urging early settlement of this item."

The group called attention to areas in excess of 149,000 acres of land that had been eliminated from previous drafts of the report for various reasons and passed the following resolution concerning same:

Whereas it is the considered opinion of this group that division of the beneficial consumptive use of 7,500,000 acre-feet per annum allocated to the States of the upper division by the Colorado River compact, and the determination of the obligation of the States of the upper division to deliver 75,000,000 acre-feet of water each 10-year period reckoned in progressive series at Lees Ferry, must be effected before full development of the Colorado River Basin can take place; and

Whereas we believe such a division of the beneficial consumptive use and determination of the obligation to deliver water at Lees Ferry is of prime importance and concern to the people of the States of the upper basin and upper division; and

Whereas we claim the right to the beneficial consumptive use of 1,168,200 acre-feet of water per annum and that our obligation to deliver water at Lees Ferry should not exceed 4,987,000 acre-feet in any continuing 10-year period reckoned in progressive series: Now, therefore, be it

*Resolved*, That we recommend to the Governor of Wyoming that he proceed as provided by article VI (c) of said Colorado River compact and notify the Governors of the States of Colorado, Utah, and New Mexico that Wyoming is desirous of proceeding to negotiate for division of the 7,500,000 acre-feet of water allocated to the States of the upper division by article III (a) of the Colorado River compact.

We are of the opinion that the possibility of reclaiming this area at some future time should be mentioned in the report and that water for its irrigation should be provided for in the compact between the upper-division States.

Those in attendance and participating in the Rock Springs meeting, in addition to the interstate streams commissioner, were Paul Berg, Palmer DeLong, and J. W. Funk, representing the United States Bureau of Reclamation; Leland U. Grieve, Richard J. Luman, Platt Wilson, Norman Barlow, Emil C. Gradert, H. Melvin Rollins, E. B. Hitchcock, David P. Miller, Joe Micheli, assistant compact commissioners; and Joe Budd, C. C. Feltner, Maurice Wren, J. H. Jacobucci, Adrian Reynolds, and Marshall Smith.

Please consider the original memorandum of December 14, 1945, with deletion of the paragraph on page 2, with reference to land values, and this supplement as my comment on the afore-mentioned preliminary report of the United States Bureau of Reclamation on the Colorado River Basin.

Respectfully submitted.

(Signed) L. C. BISHOP,  
*State Engineer.*

STATE OF WYOMING

STATE ENGINEER'S OFFICE

CHEYENNE, WYO.

DECEMBER 14, 1945.

*To All Assistant Compact Commissioners,  
Upper Colorado Basin in Wyoming.*

GENTLEMEN: We are now in receipt of a copy of the preliminary draft of the long-awaited Colorado River report of the United States Bureau of Reclamation.

Having been designated by Gov. L. C. Hunt to review this report and offer comments and recommendations, I have given this draft considerable study. Enclosed herewith for your information is a copy of my memorandum to the Governor.

In order that all of you may have the opportunity to review this report and my comments thereon, I plan to hold a meeting at the Park Hotel in Rock Springs, Wyo., on January 7 and 8, 1946.

It is my hope that all of you will be present at this important meeting. I plan to have an engineer of the Bureau of Reclamation present to explain the details and otherwise assist in this review.

As you have no doubt noted from the copy of the statement recently sent you, on expenditures from the Colorado River development fund, our State has received very little investigational work during the year which is coming to a close.

It was agreed sometime ago by members of the Committee of Fourteen, representing the upper-basin States, that the moneys allocated by this fund to the upper basin should be divided equally among them, but it seems that

all of the other States are receiving a lot more expenditures from the fund than Wyoming. We should make special inquiry concerning this item.

On November 3 I wrote Commissioner Bashore for a break-down of these data, but to date have not received a reply.

Payment of your expenses as an assistant interstate streams commissioner is authorized by law. Please secure receipts for all expenses in order that they may be included with your voucher to the State of Wyoming.

Wishing you the season's greetings, and looking forward to seeing all of you on January 7 and 8, I am,

Sincerely yours,

(Signed) L. C. BISHOP,  
State Engineer and Interstate  
Streams Commissioner for Wyoming.

#### STATE OF WYOMING

STATE ENGINEER'S OFFICE

CHEYENNE

DECEMBER 14, 1945.

Memorandum to Gov. L. C. Hunt.

In re: Colorado River Preliminary Report by the Bureau of Reclamation.

DEAR GOVERNOR HUNT: As requested by you, I have reviewed the above-captioned report and offer comments thereon, as follows: My first comment is to the effect that at long last the Bureau of Reclamation has completed a report on the water resources of the Colorado River Basin and offer a comprehensive over-all plan for their early development for irrigation, power production, flood control, and other beneficial purposes.

If the entire 128 new project units proposed are constructed, they will benefit 2,647,000 acres of land, 1,122,270 acres of which will be supplemental supply and 1,525,550 acres will be new lands.

According to the report, presently irrigated land in the upper basin totals 1,325,000 acres and the lower basin, 1,351,000 acres. This is 1.7 percent of the area of the entire basin. In the Green River Basin in Wyoming the presently irrigated area is 234,390 acres, which consumes 372,000 acre-feet of water.

There are 39,145 farms in the basin—20,677 in the upper basin and 18,468 in the lower basin.

Of the units proposed, 38 of them provide for hydroelectric plants to generate 3,500,000 kilowatts of power. Twenty-nine of these would be in the upper basin and their combined capacity would be 1,713,000 kilowatts.

Power and irrigation reservoirs proposed in the upper basin would control all floods, according to the report.

The estimated construction cost of all new projects is \$930,142,000 for the upper basin and \$1,255,000,000 for the lower basin.

According to the report, it will be necessary for the States to determine their respective equities in the water supplies in the Colorado River before final comprehensive plans can be formulated. Our office agrees fully with this statement.

As we see it, each basin should settle the division of their allocations of water under the Colorado River compact by an agreement or compact among themselves.

From paragraph 40 of the preliminary draft, I quote: "Each State also will need to select from the list of competitive projects within its boundaries the projects it desires to have constructed to consume its allocation of water."

Estimated measurable benefits to the entire basin are as follows:

<i>Direct annual benefits</i>	
Irrigation benefits.....	\$65,000,000
Power benefits.....	72,000,000
Flood-control benefits.....	1,000,000
Municipal benefits.....	500,000

Total measurable direct annual benefits... 138,500,000

<i>Annual costs</i>	
Operation and maintenance.....	23,000,000
Amortization of entire construction cost (\$2,185,442,000) in 50 years at 3 percent.....	85,000,000
Total annual costs.....	<u>108,000,000</u>

*Ratio of benefits to costs*  
Ratio of annual benefits to annual costs..... 1.3:1

The total estimated construction cost of all within-basin projects outlined in the report is \$2,185,442,000, based on January 1940 prices. Of this total, it is estimated that \$25,000,000 may reasonably be charged to flood control.

The initial phase of construction proposed is 30 projects; 21 in the upper basin and 9 in the lower basin.

Projects recommended for Wyoming are Sublette, consisting of West Side, Daniel, Elkhorn, and Seedskadee units, at a cost of \$27,845,000; Lyman project and Little Snake River project (first stage) (Wyoming-Colorado), at a cost of \$3,655,000. The total cost of Sublette project is estimated at \$36,500,000.

Under the West Side unit, there will be 29,050 acres of new lands and 37,000 acres of supplemental supply; the Daniel unit has 5,160 acres of new land and no supplemental supply; the Elkhorn unit has 134,030 acres of new land and no supplemental supply; and the Seed-



skadee unit has 40,830 acres of new lands and no supplemental supply.

Under the Lyman project there will be 3,100 acres of new land and 20,910 acres to receive supplemental supply.

Under the Little Snake River project (first stage) there will be 25,780 acres of new lands and 13,350 acres to receive supplemental supply; 8,240 acres of the new land and 10,320 acres to receive supplemental supply will be in Wyoming.

Estimated present and potential depletion of the Colorado River Basin include for Wyoming: Present depletion, 374,000 acre-feet with possible increase under present or authorized projects of 17,000 acre-feet; and for potential projects, 576,000 acre-feet, making a total estimated depletion of 967,000 feet.

The total depletions proposed for all the States is 20,197,200 acre-feet, while the available flow for use in the United States is 16,220,000 acre-feet after allowing 1,500,000 acre-feet for use in Mexico.

The total allocations by the Colorado River compact is 7,500,000 acre-feet to the upper basin and 7,500,000 acre-feet to the lower basin in perpetuity and the lower basin is allowed to increase its consumptive use by 1,000,000 acre-feet, making the total acre-feet allocated by the compact 16,000,000 acre-feet and by the treaty to Mexico, 1,500,000 acre-feet; making a total of 17,500,000 acre-feet.

Paragraph 73 reads:

There is not enough water available in the Colorado River system for full expansion of existing and authorized projects and for all potential projects summarized in the report. At present, however, more than sufficient water is available physically in the Colorado River system for all projects listed in the proposed initial program. A satisfactory, even if not a conclusive, showing of water rights for these developments can be made, but the need for a determination of the rights of the respective States in Colorado River water under the Colorado River compact and associated documents will become more and more pressing as additional developments are undertaken.

Paragraph 75, subsection (2), reads:

That the projects or units of projects listed in table 1, paragraph 55, and such related works as may be incidental thereto, constituting the initial state of development in the Colorado River in Arizona, Colorado, Nevada, New Mexico, Utah, and Wyoming, be authorized to be constructed, operated, and maintained by the Bureau of Reclamation, Department of the Interior, substantially in accordance with the plans set forth in this report, with such modifications, omissions, or additions to the works as the Commissioner of Reclamation, with the approval of the Secretary of the Interior, may find proper for carrying out the purposes of the initial development.

Paragraph 75, subsection (4), section (c):

That the water users shall be required to pay only that part of the estimated construction cost of the projects which, in the judgment of the Secretary of the Interior upon consideration of

all appropriate factors, they should reasonably be expected to repay in the maximum repayment period and on the terms and conditions available under the provisions of subsection 9 (d) of the Reclamation Project Act of 1939.

The estimated virgin flow (actual flow plus depletion from irrigation in the basin above) of the Colorado River at Lees Ferry is 16,270,000 acre-feet and at the international boundary of the United States and Mexico is 17,720,000 acre-feet.

The last paragraph on page 102 reads, in part, as follows:

In presenting possible exportations of water from the upper basin to the adjoining North Platte, South Platte, Arkansas, Rio Grande, and Bonneville Basins, it is contemplated that appropriate understandings will be reached between representatives of both the exporting and importing basins concerning the manner in which such projects shall be constructed and operated to safeguard within the upper basin the vested and future rights in irrigation; to preserve fishing and recreational facilities and scenic attractions; to maintain conditions of river flow for the benefit of local domestic uses and sanitary purposes; and to utilize the waters for irrigation, power, industrial development, and other purposes, in such a manner that the greatest benefits are realized.

It is my own thought that next in importance to division of water in the States is the consummation of an agreement concerning all phases of transportation of water from the Colorado River Basin.

In fairness to all water users in the basin, it should be agreed that in case there is the need for water at Lees Ferry to satisfy the terms of the Colorado River compact that before any regulation of interbasin water is made in any State of the basin that all transbasin flow be shut off until the obligation is entirely satisfied.

In our own State it is my recommendation to all concerned that we oppose all transbasin development in all of the States of the upper basin until proper and adequate safeguards are provided for the present and future beneficial use of water in the basin.

Transbasin developments from the Colorado River Valley watershed in Wyoming mentioned in the report are:

*South Pass project.*—Proposes diversion of annual average of 50,000 acre-feet of water per year from the flow of East Fork River, Big Sandy Creek, and Little Sandy Creek to Lander Creek, for use in the North Platte River Basin in Wyoming.

*Green River-Bear River diversion project.*—Two units are proposed to export 337,000 acre-feet of water annually from the Green River Basin to the Bear River Basin for irrigation of lands in Utah and Wyoming.

*Hams Fork-Twin Creek unit* would export 37,000 acre-feet of water annually from Hams Fork and LaBarge and Fontenelle Creeks to Twin Creek in the Bear River drainage for irrigation of Wyoming lands.

*Green River-Smith Fork unit* would export 300,000 acre-feet of water annually from Green River to Smith Fork, tributary Bear

River, by means of a 37-mile tunnel heading near LaBarge, Wyo., for irrigation of lands in Utah and Wyoming.

*Little Snake and North Platte diversion project* would export 51,000 acre-feet of water annually from North Fork of Little Snake River and Slater and Sandstone Creeks to the North Platte Basin for irrigation of lands in Colorado and Wyoming.

*Elk River-North Platte diversion project*, where a canal would conduct water from Little Snake Basin to the North Platte River Basin for use in Wyoming, and another canal would conduct water into the Little Snake River Basin in Wyoming from Elk River in Colorado for use in Colorado and Wyoming. (See p. 116 of the report.)

Reservoirs proposed for the Green River division in Wyoming are:

	<i>Acre-feet</i>
Kendall .....	340,000
Burnt Lake .....	25,000
Boulder Lake .....	180,000
LaBarge Meadows .....	10,000
Minnie Holden .....	5,000
Fontenelle .....	400,000
Middle Hams Fork .....	170,000
Bridger .....	30,000
Big Basin .....	107,000

Total new lands that would be irrigated from the Green River watershed in Wyoming is 283,030 acres and supplemental supply is to be furnished for 85,450 acres.

The foregoing covers present items of the report pertaining to Wyoming.

No comment is offered concerning projects reported in the other States as that concerns only the States in which the projects are located. I will add, however, that in my opinion representatives of all the States should get together at an early date and decide upon which of the projects proposed in this report can be constructed without possible or probable injury to the rights of other States. This should be done in advance of the compact in order that construction work may be started at an early date.

The plan outlined in this preliminary draft is one of the largest and most important conceived by the minds of men and the cooperation of all those interested in all the States is very necessary if the plan is to be carried out.

Copies of this memorandum are being mailed to the Wyoming Upper Colorado River Basin Compact Commissioners and other interested persons in the Green River and Little Snake River Basins.

Further comment is reserved pending a review of the report by representatives of the Green and Little Snake River Basins on January 7 and 8.

Respectfully submitted.

(Signed) L. C. BISHOP,  
State Engineer and Interstate Streams  
Commissioner for Wyoming.

# Comments of the War Department

## WAR DEPARTMENT

WASHINGTON

SEPTEMBER 25, 1946.

The honorable the SECRETARY OF THE INTERIOR.

DEAR MR. SECRETARY: Reference is made to letters from the Acting Commissioner, Bureau of Reclamation, dated June 10 and 13, 1946, to the Chief of Engineers and the Secretary of War, respectively, with which there were enclosed, for the information and comment of the War Department, copies of your proposed report on the Colorado River, Ariz., Calif., Colo., Nev., N. Mex., Utah, and Wyo. By letter dated June 26, 1946, the Chief of Engineers informed the Commissioner of the Bureau of Reclamation that the report would be promptly reviewed by the Department and the Secretary of War would inform you of any comments he desired to make.

The report is entirely factual and does not recommend the authorization of any project or group of projects for construction at this time. In addition to the existing or presently authorized projects, or extensions of projects, in the Colorado River Basin, 134 potential projects, or units of projects, are presented or discussed in the report. These potential projects do not, however, include possibilities for exporting water to adjacent watersheds although a number of such possibilities are also discussed in the report. The first cost of construction, including power-transmission grids, as estimated by the Bureau of Reclamation on the basis of January 1, 1940 price levels, is \$2,185,442,000. The corresponding annual charges, including \$23,000,000 for operation and maintenance, are estimated at \$108,000,000. Subject to availability of water supply, these potential developments would provide for the irrigation of 1,553,960 acres of new land and provide supplemental water supply for 1,122,270 acres; would include the installation of 3,658,400 kilowatts of hydroelectric-power capacity, with an estimated potential annual output of 19.5 billion kilowatt-hours; and would provide for control of floods and for municipal water supply. In addition, widespread recreational and fish and wildlife benefits, together with far-reaching benefits of an intangible nature, are antici-

pated. The ratio of evaluated benefits to annual costs is 1.3 to 1.0, based on the method of evaluating benefits used in the report.

In discussing the available water supply, the reporting agency points out that insufficient water is available in either the upper or the lower basin to permit full development of all the potential project units. The average annual flow available for depletion in the United States is estimated at 16,220,000 acre-feet. The estimated annual depletion of the potential projects is 8,940,400 acre-feet, which, with the present depletion and possible increase in depletions by existing or authorized projects estimated at 11,256,800 acre-feet, would total 20,197,200 acre-feet, or, roughly, 25 percent in excess of available annual supply. Under the terms of the Colorado River compact, ratified by the seven basin States and approved by Congress, division was made of the water of the Colorado River between the upper and lower basins, but no final agreement has been reached among the States as to the amount to be allocated to each State. This situation precludes the selection of a definite comprehensive plan of development for the whole of the Colorado Basin from the 134 potential projects reported upon until a definite allocation of the available water is made.

The recommendations of the report are, in effect, that the States of the Colorado River Basin select and recommend projects, or groups of projects, as the next stage of construction which are initially within the ultimate stream-flow allocations; that the States act to determine their respective rights to deplete stream flow consistent with the Colorado River compact; and that investigations by agencies of the Department of the Interior leading to the formulation of the comprehensive plan be continued. With respect to the last portion of the recommendation, it is assumed that these further studies will be made in consultation with the War Department and other interested Federal agencies with respect to the phases of the basin-wide plan not of primary interest to the Department of the Interior.

Included in the list of 134 projects studied are projects for 2 locations where authorization for construction by the War Department has already been provided in the

Flood Control Act approved December 22, 1944, namely, the Holbrook project, Arizona, on Little Colorado River, and the Alamo Dam and Reservoir on Bill Williams River. The Holbrook project, as outlined in the Bureau's report, consists of a reservoir of 117,000 acre-feet capacity at the Forks site on Little Colorado River about 15 miles above Holbrook, Ariz., and a canal passing downstream through the town to 2,400 acres of project lands west of Holbrook. The regulatory effects of the reservoir and channel improvement incidental to the project are expected to provide flood protection for downstream property. The Alamo project consists of a reservoir on Bill Williams River with a capacity below spillway crest of 946,000 acre-feet for flood control initially, with provisions for eventual use in conserving water for generating power. The authorized project at Holbrook consists of a levee along the Little Colorado River for protection of property in Holbrook, Ariz., and the authorized Alamo Reservoir is identical with the project proposed by the Bureau of Reclamation.

The War Department is currently making investigations of 21 stream basins, divisions of basins, and areas in the Colorado River watershed under authority for preliminary examinations and surveys provided by the Flood Control Acts of June 22, 1936, August 28, 1937, and June 28, 1938. The probable outcome of the investigations is not known at this time, but should any conflict arise between resulting plans for flood control and the plans proposed in the Bureau's report, it appears that appropriate adjustments can be made between the two Departments in order to accomplish the best overall use of the available water resources involved.

Although the report is submitted pursuant to section 9 of the Reclamation Project Act of 1939 and pursuant to section 15 of the Boulder Canyon Project Act, the report does not contain the usual finding of feasibility. It is, therefore, assumed that the report on the Colorado River, in effect, is an inventory of all physically feasible projects involving water conservation, power production, flood control, and other related features in the entire Colorado River Basin in the States of Wyoming, Utah, Colorado, New Mexico, Nevada, Arizona, and California, investigated by the Bureau and the various cooperating agencies over a period of many years. Although the report, based on assumed gross value of crops and on an assumed market for vast quantities of hydroelectric energy at 4 mills per kilowatt-hour, indicates a favorable economic ratio of 1.3 to 1.0, it does not necessarily follow that a separate analysis of any group of projects proposed for construction pursuant to the recommendations contained in the report should depend upon an analysis of feasibility and economic justification for those projects.

The data presented in the report of the Acting Commissioner of Reclamation is believed to be a valuable compendium of potentialities for water conservation and utilization in the Colorado River Basin and will assist materially in the formulation of an ultimate comprehensive and coordinated plan of development of the water resources available to the seven Colorado River Basin States.

Sincerely yours,

(Signed) ROBERT P. PATTERSON,  
*Secretary of War.*

# Comments of the Department of Agriculture

DEPARTMENT OF AGRICULTURE

WASHINGTON

SEPTEMBER 27, 1946.

Mr. MICHAEL W. STRAUS,  
*Commissioner, Bureau of Reclamation,  
Department of the Interior.*

DEAR MR. STRAUS: We appreciate the opportunity to comment on the Department of the Interior's Comprehensive Report on the Development of the Water Resources of the Colorado River Basin in response to Mr. Warne's letter of June 10, 1946, to Mr. Wiecking. We were recently advised by your office that the due date for comments has been extended.

The report, dated March 1946 and designated as "Project Planning Report No. 34-8-2," is not presented as a development plan—a view which our analysis of the preliminary and tentative nature of the document confirms. It is rather primarily a descriptive inventory of possible projects and a statement of problems to be worked out before a comprehensive and definite development plan can be formulated. As stated in the report, it is intended to serve as a means of indicating the potentialities for the development of the basin's water resources and as a guide to the selection of projects which may ultimately comprise the comprehensive plan. Therefore, we assume that the document has been prepared for informative purposes and not as a basis for legislative authorization.

Some 134 potential projects or units of projects are briefly described. A substantial number of these have been investigated in detail, but for others data of only a reconnaissance nature are available. Benefit-cost ratios for individual projects are not presented, but the over-all ratio of annual benefits to annual costs for all these projects as a group is computed at 1.3 to 1 at January 1940 prices and costs. Potential projects for the export of water from the Colorado River Basin to adjacent basins are discussed, but estimates of construction costs, benefits, or reimbursability for these are not presented in this report.

A preliminary estimate of the total construction cost of all the 134 within-basin projects is given at \$2,185,442,000 at January 1940 costs. The "total annual cost" is estimated at \$108,000,000. "Total annual benefits"

are estimated at \$138,500,000, of which \$65,000,000 consist of estimated increased gross crop returns at January 1940 prices; \$72,000,000 from power; \$500,000 from sale of municipal water; and \$100,000 from flood control. The preliminary estimate of the over-all benefit-cost ratio is given as 1.3 to 1. Other benefits not measurable in monetary terms are discussed. The report recognizes that a definite economic analysis cannot be made until a final selection of projects has been made.

The water supply in the Colorado River Basin is extremely limited. Consequently it is not possible for all potential projects to be constructed and for all existing or authorized projects to be expanded. The formulation of an ultimate plan, therefore, will, as the report states, require selection from among the possibilities for expanding existing or authorized projects as well as from among the potential new projects. The report emphasizes that (1) before such a selection can be made it will be necessary for the seven Colorado River Basin States to agree upon their respective rights to deplete the water supply of the river, or that the courts apportion available water among them; and (2) that each State also will need to select from the potential projects within its boundaries those it desires to have constructed to consume its allocation of water.

The report contains a wealth of engineering data, which should serve well the purpose of facilitating numerous actions necessary before the formulation of a comprehensive water-development plan for the basin can be effectively undertaken. However, from the agricultural standpoint, we feel that the report in its present form lacks data equally essential to sound decisions. The report recognizes that there are more potential projects than water supplies to support them. Therefore the most beneficial use of both land and water should be of paramount concern. But the report lacks data on the capabilities and relative productivity of the lands involved, especially in respect to the best use of water on the better lands.

More consideration, we believe, should also be given to needed ground-water controls; the whole problem of diversions from the Colorado must be considered in respect to use, depletion, and recharge of the several related ground-water basins. Another factor passed over lightly is the question of the amounts of water which

must be used to keep alkali accumulations to a safe level for crop production.

The use of gross crop values as a measure of irrigation benefits was discussed at some length in our letter to you of March 15, 1946, commenting on your Central Valley report. Similarly, that letter commented on the importance of computing individual benefit-cost ratios for each separable project rather than using a single over-all benefit-cost ratio for all projects combined. The statement that "All projects are considered integral units of a basin plan and as such their economic feasibility is comprehended by the finding of feasibility for the over-all basin plan" should be further qualified to avoid misinterpreting it to mean that, because the over-all benefit-cost ratio is favorable, therefore, each individual component project will also have a favorable ratio, i. e., be "economically feasible."

The over-all benefit-cost ratio presented is 1.3 to 1 at January 1940 construction costs and farm-commodity prices. Particularly in view of the phenomenal rise in construction costs since that date, and the apparent outlook for above-1940 costs for some time to come, we know you realize the precariousness of relying even upon this single over-all benefit-cost ratio as an indication of economic feasibility under present and immediately foreseeable conditions.

The Colorado River Basin is one of the most critical watersheds in the Nation, beset with problems of deterioration of land and water resources through erosion, flood damage, and sedimentation. We believe that the importance of proper watershed management merits

## THE COLORADO RIVER

more elaboration than was accorded this subject in the report. Certainly a truly comprehensive plan for the Colorado, as it is developed, must include a well-developed plan and program for use and management of the watershed lands, which are largely in public ownership, as well as of the stream itself.

We believe that the development and protection of the resources of the Colorado River Basin is of such importance and magnitude that all the appropriate agencies of government should be utilized in formulating a coordinated resource use and development plan.

The report is stated to be a "joint effort of numerous Federal, State, and local governmental agencies—all looking toward the formulation of a comprehensive plan for ultimate development of the basin's water resources." The Department of Agriculture would have been glad to have helped to make it a joint report in the commonly accepted sense of that term—an enterprise cooperatively planned, executed, and subscribed to throughout. That opportunity still exists. This Department will not only be glad to, but feels that it has a public responsibility to, participate on that basis in the development of the definite comprehensive plan toward which the present report is a beginning step—a truly comprehensive plan on which the several States and the several responsible agencies of the Federal Government can unite and, over the years, carry effectively into execution by cooperative effort.

Sincerely,

(Signed) CHARLES F. BRANNAN,  
*Assistant Secretary.*

# Comments of the Federal Power Commission

FEDERAL POWER COMMISSION

WASHINGTON 25, D. C.

DECEMBER 30, 1946.

Mr. MICHAEL W. STRAUS,  
*Commissioner, Bureau of Reclamation,  
Department of the Interior,  
Washington 25, D. C.*

DEAR MR. STRAUS: The comments herein with respect to the comprehensive report on the development of the water resources of the Colorado River Basin for irrigation, power production, and other beneficial uses in the seven basin States, by the Bureau of Reclamation, dated March 1946, are transmitted in response to Acting Commissioner Warne's letter of June 10, 1946, requesting the Commission's comments thereon. This is in accordance with the established procedures of the Federal Interagency River Basin Committee.

The report presents for consideration 134 potential projects, or units of projects, for use of water within the natural drainage basin of the Colorado River. Potential projects for the export of water from the Colorado River Basin to the adjacent basins are also discussed. The report does not contain recommendations for construction of projects or recommendations concerning the finding of feasibility of any plan or projects. It is the Commission's understanding that the report presents an inventory of the major potential projects to serve as a guide in the selection of projects to be included in a comprehensive construction plan, and that it is not intended that the listing of specific projects in the report will preclude the consideration of others which further investigations may show to be desirable.

The report states that there is insufficient water available in the Colorado River Basin to meet the combined requirements of a full development of existing and authorized projects, the potential projects outlined in the report, and the new possibilities for exporting water to adjacent watersheds. The long-time average annual flow of 17,720,000 acre-feet is but 220,000 acre-feet more than the average annual allotment for use, as is set forth by the Colorado River compact and the Mexican water treaty. Since the report further states that the possible average annual uses for Colorado River water are at least 20,000,000 acre-feet, it is manifest that selections must

be made from a list of possible projects for the comprehensive development of the Colorado River.

The Colorado River compact makes equal apportionments of 7,500,000 acre-feet of the available water to the upper and lower basins for exclusive beneficial consumptive use. In addition, the lower basin is given the right to increase its beneficial consumptive use of such water by 1,000,000 acre-feet per annum. If, as a matter of international comity, waters to Mexico are to be apportioned, such waters are to be supplied from the excess over the 16,000,000 acre-feet noted above, and, if such excess shall prove insufficient, the burden is to be borne equally by the upper and lower basins. Items in the compact there following modify the apportioning by agreement that the upper-basin States will not cause the flow at Lees Ferry to be depleted below an aggregate of 75,000,000 acre-feet in a period of 10 successive years next following the 1st of October next succeeding the ratification of the compact and allowing for a further apportionment for beneficial use of any water surpluses which may obtain after October 1, 1963.

Since the compact was agreed upon, Mexico has been allotted a fixed annual amount of 1,500,000 acre-feet so that the existing compact and treaty allocate 7,500,000 acre-feet annually to the upper basin and 8,500,000 acre-feet to the lower basin in the United States, and 1,500,000 acre-feet to be delivered at the international border for use in Mexico.

Even though these allocations have been made, the United States Bureau of Reclamation agent states that "There is no final agreement among the States of the Colorado River Basin as to the amount of Colorado River water to be allocated to individual States, nor have all of the States made final allocations of water among projects within their boundaries. There is not complete agreement among the States regarding the interpretation of the compact and its associated documents.

\* \* \* This report makes no attempt to interpret the Colorado River compact or any other acts relating to the allocation of Colorado River water among the States and among projects within the States."

The report states, therefore, that before a selection can be made of projects which will comprise a comprehensive plan for the development and utilization of the water resources of the basin, it will be necessary for the seven Colorado River Basin States to agree upon

their respective rights to deplete the water supply of the basin, or for the courts to apportion the available water among the States, and stresses the need for a determination of the rights of the representative States to deplete the flow of the Colorado River consistent with the Colorado River compact.

The four upper-basin States are meeting at the present time for the purpose of effecting an agreement for the division of the water allocated to the upper basin. It is not clear from the report whether additional agreements are necessary between the lower-basin States to enable the Bureau of Reclamation to proceed to adopt a plan for the lower basin. It is apparent that California, Nevada, and Arizona are at odds over the division of water, in spite of certain contracts with the United States Bureau of Reclamation for annual apportionment of the flow of 75,000,000 acre-feet which the upper-basin States must allow to pass Lees Ferry in any 10-year period. In fact, California has withdrawn from the Committee of Fourteen and it is understood expects to institute litigation to determine the legality of certain division contracts entered into by the United States Bureau of Reclamation and certain States and the Mexican water treaty.

The Commission staff has reviewed the report, having particular regard to the possibilities of developing hydroelectric power in and adjacent to the Colorado Basin, and makes the following comments:

(1) From Parker Dam downstream to the Imperial Dam there is some head not proposed for development but which might be developed for the purpose of generating power with the water passing Parker Dam on its way to the international border. Other possible main-stream head developments appear to have been considered.

(2) Glen Canyon Reservoir project, immediately above Lees Ferry on the main stream and below the mouth of San Juan River, has been considered at times for a dam some 200 feet higher than as proposed in the Bureau's report. This higher dam would create larger storage whereby increased silt control, low-flow regulation, and power generation could be accomplished. It would appear that the larger reservoir would be desirable to prolong the life of the reservoir system.

(3) Although general, the estimated costs of the projects appear to have been made on a conservative basis. The number and order of development of individual projects in the group which is finally adopted must depend upon closer estimates of cost and over-all benefits, upon the desires of the States concerned, and with careful consideration to the requirements of the best over-all plan to insure best and fullest utilization of the resources of the basin.

(4) A study to determine the storage capacity required to produce the maximum water yield should be

made. Such a study would be of assistance to the Bureau and the States in resolving differences and, in fact, in the selection prior to the final settlement of water rights, of a group of projects for immediate construction which would be consistent with a final settlement.

(5) Evaporation and siltation are the factors which along with flood-control requirements have a large bearing on the determination of reservoir sizes. Information on these factors set forth and analyzed between limits with respect to reservoirs would also be of material assistance in the development of mutually beneficial plans for the use of Colorado River water resources.

(6) In the interest of development of the water resources of the basin, it would be well if the States, acting separately or jointly, would recommend a group of projects for each State, the stream-flow depletion occasioned by which would fall assuredly within the ultimate allocation of the Colorado River water which may be made to each. It appears in this connection that an early settlement of the difference between the Colorado Basin States, as suggested by the Bureau, is necessary and is in the best interest of all parties concerned.

(7) At the present time the Commission staff has, under preparation a power-market survey of the Colorado River and a survey of Utah power requirements, the latter in cooperation with the State of Utah. It is believed that these studies will complement and supplement the further studies proposed by the Department of the Interior.

(8) The staff recognizes that the production of hydroelectric power in and adjacent to the Colorado River Basin must be subordinate to the superior requirements of municipal and irrigation water supply and must be in harmony with the terms and conditions of the Colorado River compact, the Mexican water treaty, and other controlling legal requirements. It is pointed out here, however, that studies now under way by the Commission staff indicate that the potential power from at least two Colorado main-stem hydroelectric plants and from the Colorado-Spanish Fork diversion plants will be required to supply the growing power demands of the Great Basin to 1970. Analyses of load growth in the southwestern United States indicate that the development of many of the Colorado River hydroelectric possibilities is required to meet the power demands of the next 25 years in all of the States which are dependent upon Colorado River power.

(9) In the process of selecting projects to be constructed, one or more of the States may find it to be more economical and desirable to disregard some of the potential irrigation projects within the natural drainage basin in order to make water available for export to adjacent basins. These States may be unable to use their full amount of water unless part is exported out of the natural drainage basin to more favorable lands



in other basins within these States. Although inter-basin diversions of this sort would lessen the power possibilities within the Colorado River Basin, there might be an increase in the power obtained from the water to be consumptively used within a given State. This is true in the case of the Colorado-Big Thompson diversion, wherein the fall on the eastern slope, where the water is to be used, is greater than the fall within the State to the west and south, and of the Strawberry Reservoir-Spanish Fork diversion from the Colorado to the Great Basin. On the other hand, the diversion of 2,000,000 acre-feet from the Colorado to the central Arizona project under the Bridge Canyon plan results in a net power loss in the order of 2,000,000,000 kilowatt-hours a year. No figures on gain or loss are available for the Blue-South Platte River, Colorado-Arkansas River, and other lesser diversions, but comparative studies should be made before any final plan is adopted.

(10) Consumptive use within the upper-basin States will also lessen the power potentiality of the river, and these losses are inevitable as development proceeds under the terms of the Colorado River compact and the Mexican water treaty. In fact, in the over-all plan, reservoirs for upstream regulation and silt control, and storages for flood control, low-flow augmentation, and irrigation, all will have a varying effect upon the power potentialities of the Colorado River Basin until a plan of development is finally formulated. Even then variation may be expected by reason of the fluctuations of annual flow and the apparent inflexibility of the 1,500,000 acre-feet allocated for use in Mexico. Based upon one proportioning of water, the Bureau reports a possibility of generating about 1,000,000 kilowatts of firm power in the upper basin and about 1,200,000 kilowatts in the lower basin.

(11) In view of the above factors, the following statement, quoted from the letter of the regional directors included in the report, is not understood: "The potential power output in both the upper and lower basins could be maintained substantially, even with full development of the river system for irrigation and other purposes."

(12) While the report "makes no attempt to interpret the Colorado River compact, or any other acts or contracts relating to the allocation of Colorado River water among the States and among the projects within the State," it is believed that eventually a qualified agency, such as the Bureau of Reclamation, should suggest a program by which the States could use to best advantage the water allocated to them. The States which are being asked to submit lists of projects which would fall within the range of water which eventually would be allotted to them might properly expect such guidance, since with a deficient water supply to meet the possible requirements selections as between projects will have to be made.

The Commission recommends that the Bureau continue to give full consideration in the choice of projects and the design of structures for the ultimate optimum development of hydroelectric power in and adjacent to the basin for commercial as well as for pumping purposes. It is noted in this connection that power benefits constitute more than one-half of the total benefits estimated in the report.

The Commission concurs in the recommendation that the Bureau of Reclamation continue to expand its detailed investigations of potential projects within the States of the Colorado River Basin to obtain adequate information by which, in cooperation with the basin States, a comprehensive plan can be formulated for the use of all the water resources of the basin, and projects selected and recommended for the successive stages of development.

In order to satisfy present demands for supplemental irrigation water and power, and looking toward the full development of the great resources of the Colorado River Basin at the earliest practical time, the Commission suggests that such projects as may not be in conflict with the final division of water be given priority of construction.

Sincerely yours,

(Signed) LELAND OLDS,  
Chairman.