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PRELIMINARY REPORT

Colorado Water Conservation Board

Memorandum on

TREATY WITH MEXICO RELATING TO THE UTILIZATION OF THE WATERS OF CERTAIN RIVERS

With special reference to
the portions of the Treaty relating
to the Colorado River

by

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CONFIDENTIAL

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Gentlemen:

I am transmitting herewith my analysis of the recently negotiated treaty with Mexico relating to the utilization of the waters of certain rivers. My analysis is directed principally to those provisions of the treaty relating to the Colorado River.

I recommend support of the ratification of the treaty for the reasons set forth in the memorandum.

Respectfully submitted,

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INTRODUCTION

The Department of State of the United States has negotiated a treaty with Mexico relating to the uses of the water of the Colorado River, the Lower Rio Grande below Fort Quitman, and the Tijuana River. This treaty was signed on February 3, 1944 and transmitted by the President to the Senate of the United States on February 15, 1944. The provisions of the treaty dealing with the Colorado River are well within a formula which the majority of the members of the Committee of Sixteen of the Colorado River Basin, approved at Santa Fe, New Mexico in April, 1943.

The following is a discussion of those portions of the treaty which relate to the Colorado River and their effects upon the uses of water in the United States. The discussion is divided into several sections. The first section consists of a summary and conclusions. The next section is a general discussion of the international and domestic situation which exists on the border streams which make a treaty desirable. Those terms of the treaty relating to the Colorado River are then discussed and conclusions of the writer are given concerning the effect of the terms of the treaty on water uses in the United States. California's position next is outlined in some detail. Her major objections to the treaty are given together with a discussion of those objections.

For reference a description of the Lower Colorado River Basin outlining present development, prospective future

development and the features in the vicinity of the border appears as Appendix A. Some difference of opinion exists as to the water supply and present beneficial consumptive use on the Gila River. This matter is important when considering interstate relations of the Colorado River under the terms of the Colorado River Compact. Discussion of this item appears in Appendix C.

Appendix D is a discussion of reservoir evaporation, desilting water, channel losses below Boulder Dam, and probable spills from Lower basin reservoirs under ultimate conditions.

All detailed tables appear in Appendix B.

SUMMARY AND CONCLUSIONS

1. The terms of the treaty are fair and equitable to each country. They correct for all time an intolerable condition that was developing with respect to the use of the waters of the international streams.

2. The treaty, if ratified, will remove a cloud from future development in the United States. With the amount of water to be received by Mexico remaining uncertain, development of large projects in the United States for the use of substantial quantities of Colorado River water were hazardous, since the water supply could be adversely affected by the terms of a treaty negotiated in the future allocating water to Mexico.

3. The terms of the treaty with respect to the allocation of waters of the Colorado River are in accordance with the provisions of the Colorado River Compact agreed to by the seven Colorado River Basin States. This compact provides for the apportionment of certain water for the use of Mexico, should a treaty be negotiated providing for such use.

4. The terms of the treaty with respect to the Colorado River are more favorable than the formula which was approved at Santa Fe in April, 1943 by the majority of the Committee of Sixteen of the Colorado River Basin.

5. More than sufficient water will be available from the Colorado River system to supply all uses in the United States and Mexico for many years beyond the time that the costs of present constructed works in the Colorado River basin, including Boulder Dam, All American Canal, and the Los Angeles Aqueduct, are amortized. It is entirely possible that all practicable development in the United States can be made without conflict with the uses of water by Mexico under the terms of the treaty.

6. It is estimated the terms of the treaty will require a delivery of water from above Imperial Dam for use of Mexico of 400,000 to 500,000 acre-feet per annum. Under the most adverse combination of circumstances this amount would not exceed 600,000 acre-feet. The balance of the deliveries to Mexico will be made from return flow and desilting water.

7. The terms of the treaty will not adversely affect the use of the water apportioned to the Upper and Lower basins in the United States by Article III (a) and (b) of the Colorado River Compact; namely, 16,000,000 acre-feet. In addition to the 16,000,000 acre-feet a substantial amount will remain for use in the United States, as indicated in the following table which is based upon the water supply for the 46-year period 1897 to 1943, inclusive.

Item No.	Item	Acre-Feet
1	Upper Basin, primary use	7,500,000
2	Lower Basin, main stream and tributaries above Gila - primary use	7,500,000
3	Lower Basin, Gila	1,000,000
4	Minimum additional for use in the basin from surplus to be allocated under Art. III (f) and (g) of the Compact	1,395,000
5	Total for consumptive use in the United States, including reservoir evaporation and desilting water	17,395,000

Item 4 may be as much as 1,800,000 acre-feet and item 5 as much as 17,800,000 acre-feet.

8. At the time further apportionment of the waters of the Colorado River are made under Article III (f) and (g) of the Compact, if the Lower basin should choose to charge all main stream Lower basin reservoir evaporation and

desilting water to the water which might be apportioned to it at that time, the net remaining amount for use out of the surplus would average between 500,000 and 900,000 acre-feet.

9. Present contracts for the purchase of electrical energy generated at Boulder Dam will not be adversely affected by the treaty. On the other hand, the amount of firm energy that can be generated in periods of low runoff might be increased by the terms of the treaty.

10. The State of California has contracts with the Secretary of Interior for the delivery of an aggregate of 5,362,000 acre-feet of water from Lake Mead, providing such water is available under the terms of the Colorado River Compact and the provisions of the Boulder Canyon Project Act. 4,400,000 acre-feet of the water is to be supplied from water allocated by Section III (a) of the Colorado River Compact, namely, from the 7,500,000 acre-feet allocated by that section for beneficial consumptive use by the Lower Basin. The remaining 962,000 acre-feet must come from unapportioned surplus. The contracts for the delivery of this water are not firm since this type of water cannot be apportioned until each basin is consuming all of the water allocated to it under the Colorado River Compact, and, in any event, such allocation cannot be made prior to 1963.

11. Nevertheless, if the uses of water by California under her contracts are made within the terms of the Compact and the provisions of the Boulder Canyon Project Act, and if the water covered by the California junior priorities is recognized in the future by an allocation to them, under Article III (f) and (g) of the Compact, then the terms of the treaty will not curtail such use. This is on the assumption that there should be charged to all water uses the actual reservoir evaporation and desilting water required to effectuate those uses.

12. The amount of water to be received by Mexico from the Colorado River under the terms of the proposed treaty probably does not exceed the amount Mexico would have received under the offer made in 1929, which offer has frequently been interpreted to mean a delivery of 750,000 acre-feet to Mexico. Such offer included, in addition to the 750,000 acre-feet, main canal losses, and in addition thereto Mexico would have received all drainage water accruing to the stream below the point of delivery.

13. If the treaty is not ratified, arbitration of the problem by Mexico is certain to be called for. If the problem were arbitrated, the results of arbitration could well be more unfavorable to the United States, including California, than the terms of the treaty. Not only would the quantity of water be involved but the problem of the

quality, both with respect to silt and salt would be raised by Mexico. These questions are now resolved for all time by the treaty.

14. Further delay in resolving the problem would be extremely dangerous to the basin, including California, due to material increased uses that would be made by Mexico of the waters of the Colorado River, made possible by the regulated supply she is now receiving and which she will receive for many years.

GENERAL

Over a period of years an intolerable situation from both a domestic and an international standpoint has gradually developed with respect to the use by the United States and Mexico of the waters of the border streams.

From the Upper Rio Grande (above Ft. Quitman) the convention of 1906 allocated 60,000 acre-feet of water for use by Mexico in the Juarez Valley. To limit Mexico to the taking of only this amount of water, it became necessary to construct what is known as the American Canal, heading in the upper Rio Grande immediately above the point where the river ceases to be the boundary between the two countries. All water normally released from Elephant Butte reservoir for use in the United States below El Paso is diverted through this canal and the 60,000 acre-feet of water allocated to Mexico is permitted to flow down the stream to the International Dam for diversion by the Mexican canal, the Acequia Madre.

On the Lower Rio Grande below Ft. Quitman about 70% of the water is furnished by Mexico. Development by Mexico of the water of her tributaries of the Rio Grande for consumptive use purposes has been fairly rapid since 1926. Among the various works that have been constructed is the Azucar Dam and reservoir near the mouth of the San Juan River, one of the principal Mexican tributaries, which enters the stream immediately above the Lower Rio Grande Valley (Brownsville area). The dam forming the Azucar reservoir has no outlet to pass water from the San Juan to the main stream even though

some of San Juan water at times was used for the irrigation of areas in the Lower Valley.

The Mexican Government then constructed a gravity heading (the Retamal) for which no dam was necessary above two-thirds of the headings which supply water to the United States area. This Mexican gravity heading during low water periods could practically dry the stream and deprive the United States water users of water formerly used by them.

The United States in the face of these conditions, and with threats of additional depletions of its water supply, conceived the so-called Federal Project No. 5, which would divert water from the Lower Rio Grande also without a dam and above a point where it would be practicable for the Mexican Government to divert. The other features of the project consisted of a long canal to carry the water from the point of the diversion to an off-channel reservoir and thence to a terminal reservoir which in turn was to supply a canal intended to furnish water by gravity to the various canals serving the Lower Valley, thereby making unnecessary the operation of major pumping plants which now serve those canals.

The intention of Project No. 5 was to convert from an international to a domestic status water required for the irrigation of lands in the Lower Valley, making this area independent of Mexico. The project was authorized for construction by the Congress and an initial appropriation was made to start work.

On the Colorado River the United States constructed

the All-American Canal which made the United States interests (the Imperial Irrigation District) independent of Mexico, in that further use of the Alamo Canal for the benefit of the United States was not necessary.

Mexico during the past few years has been rapidly increasing its use of water in Lower California under plans outlined and prepared by its Department of Agriculture. Approximately 1,800,000 acre-feet were diverted for use in 1943. This use of Colorado River water was far short of that which had been visualized by the Mexican Department of Agriculture as the ultimate use. Plans have been prepared and laterals were being projected for the irrigation of an area which would have required the diversion of some 2,000,000 acre-feet of water per year. With the large excess of controlled water which will flow to Mexico for several years, Mexico's use could be materially increased. As a part of the plans for the use of water in Mexico, investigations were under way for the construction of a diversion structure on the main river in Mexico below the lower boundary. Such structure, in the absence of a treaty, could be constructed without regard to its effect on interests in the United States.

After full development in the United States the operation of the All-American Canal, together with the storage works in the United States, ultimately could have deprived Mexico of her equitable share of the use of the waters of the Colorado River.

With the question of the use of border waters unresolved there exists a cloud over large water development in the United States on both the Lower Rio Grande and the Colorado River. Such cloud, however, in the Lower Rio Grande was largely removed by the authorization for construction of Project No. 5. With respect to the Colorado River basin the Colorado River Compact recognizes the probability of the negotiation of a treaty with Mexico and allocates water of a certain class to take care of the obligations of such a treaty. The possible effect of the terms of a treaty which might be negotiated sometime in the future was becoming an increasing deterrent to the planning of large projects for the use of Colorado River water. In the upper basin the question is continually arising as to what will happen if curtailment must be made at any time in the future in order to enable the basin to make its deliveries at Lee Ferry under the terms of the Colorado River Compact. Each time a large project is authorized for construction other interests within the basin which have ambitions for the development of projects in the future wonder whether under curtailment such projects will have a junior status and must give way first in case of required curtailment to meet the terms of the Compact. The uncertainty of the Mexican situation has intensified this difficulty. It would be possible for the terms of a treaty to require delivery of water to Mexico in such amounts as would necessitate the Upper basin making deliveries in excess of

75,000,000 acre-feet in a ten-year period.

A similar situation exists in the Lower Basin. Both California and Arizona have plans for the utilization of all the water of the Colorado River system that is not utilized in the Upper basin. ~~The potentialities of~~ If the plans of these two states are ~~such that~~ feasible this ~~could~~ might be done. However, it has been certain that at some time some of the water of the basin would be allocated by treaty for use by Mexico. The uncertainty of the amount of the allocation has made uncertain the extent to which the Lower basin states could afford to go in the planning and financing of large water development projects.

These uncertainties and deterrents to sound planning for future development of water supplies in the basins and the financing the projects for the use of those waters will now be removed if the treaty is ratified. Each basin will know the amount of water available for its development and the three states in the Lower basin will have a pretty fair knowledge of what will be available for use under their existing contracts with the Secretary of the Interior.

The unhealthy maneuvering by each country for a more favorable position will be removed by the terms of the treaty, which terms are considered to be equitable and fair to both countries.

If the treaty is not ratified, it is certain that Mexico, under the 1929 Pan-American Arbitration Treaty, will ask that the problems concerning the international water be arbitrated. Arbitration could and probably would result in

greater allocations of water to Mexico than provided by the proposed treaty.

Even if the question were not arbitrated, further delay in the negotiation of a treaty would be extremely dangerous to the interests of the basin, due to material increase in uses of Colorado River water by Mexico.

EXPLANATION OF TREATY PROVISIONS RELATING TO COLORADO RIVER

The articles relating specifically to the Colorado River are all contained in Part III of the treaty. General articles in other parts of the treaty also are important to the Colorado River basin.

Articles 10, 11, and 15 of the treaty provide for the amounts, points and manner of delivery to Mexico of Colorado River water by the United States. Article 10 provides that the United States shall deliver to Mexico, in accordance with a schedule to be furnished by her, a minimum of 1,500,000 acre-feet of water from any and all sources, and that when surplus water is in the river the United States will undertake to deliver up to but not exceeding 1,700,000 acre-feet per year, the availability of surplus to be determined by the United States section of the commission, with the further provision that Mexico can acquire no right to the use of waters of the Colorado River system "for any purpose whatsoever" in excess of 1,500,000 acre-feet annually. In the event it is difficult for the United States to deliver the minimum quantity of 1,500,000 acre-feet on account of extreme drouth or other conditions the amount delivered shall

be reduced in the same proportion as consumptive uses in the United States are reduced.

The treaty provides for three general points of delivery - the limitrophe section of the river, a point on the land boundary near San Luis, Sonora, and the point where the Alamo or other equivalent canal crosses the upper land boundary. Deliveries in the limitrophe section of the river are to be made from any waters reaching that section "whatever their origin". From the time that Davis Dam and reservoir are placed in operation until January 1, 1980, 500,000 acre-feet of the water allocated to Mexico shall be delivered to the Alamo canal by means of the All-American Canal and 1,000,000 acre-feet shall be delivered in the limitrophe section of the river. After January 1, 1980, 375,000 acre-feet shall be delivered through the All-American Canal and 1,125,000 acre-feet in the limitrophe section of the river.

In Article 15, which provides for the scheduling of the deliveries of water to Mexico, certain minimum and maximum limitations on the scheduling are fixed. Two schedules are provided for, one for the delivery of water by the All-American Canal for the two periods, and one for the delivery of water in the limitrophe section of the river. The treaty itself schedules minimum rates of delivery accounting for 900,000 acre-feet of the total minimum guaranteed delivery of 1,500,000 acre-feet. The minimum schedule was so designed as to account for practically all of the firm return flow that might reach the river below Imperial Dam

under ultimate conditions of development, thereby making it possible for the United States to receive credit for such return as against its obligation to deliver the 1,500,000 acre-feet. There is a further provision that Mexico cannot call for more than 5,500 c.f.s. at any time, the purpose of which was to keep the maximum deliveries within the capacity of the available facilities.

It may be possible that at some time in the future by mutual agreement Imperial Dam may be used to deliver water to Mexico by some means other than through the All-American Canal. For example, water might be delivered to Sonora lands through an extension of the canal constructed to serve the first unit of the Gila project. In the event such agreement is made, the deliveries through the All-American Canal shall be reduced by the amount of the deliveries to other points on the land boundary. This is covered by paragraph B of Article 15.

Paragraph C of Article 15 is important. It gives the United States the option of supplying winter water for the months of October to February, inclusive, through the Alamo Canal from any source whatsoever in lieu of the use of the All-American Canal for this purpose. This permits the United States to supply such water from drainage returns reaching the river between Imperial Dam and the present heading of the Alamo Canal should this become desirable due to the scarcity of water. A similar provision for summer deliveries would not be significant since the summer schedule

for delivery of water to Mexico in the limitrophe section of the river will always be sufficiently high to encompass practically all drainage water reaching the stream between Imperial Dam and the lower boundary.

Paragraph D of Article 15 is a declaration of intention on the part of the United States to deliver additional quantities of water through the All-American Canal providing ~~such~~ this can be done without being detrimental to the United States, and providing further that the delivery of such additional quantities will not have the effect of increasing the total amount of water delivered to Mexico. This will permit Mexico to receive larger quantities of clear water during the period when the silt problem is the greatest, if this can be done without detriment to the United States.

In paragraph D Mexico also declares her intention to cooperate with the United States by attempting to curtail deliveries of water through the All-American Canal if necessary to make full use of all available water supply. Such curtailment might be desirable in periods of low water supply in order that the United States shall get credit for all available return flow reaching the stream below Imperial Dam.

Paragraph E of the Article 15 provides for the manner in which the 200,000 acre-feet of surplus shall be delivered to Mexico if such surplus is available.

Paragraph F gives Mexico the privilege of changing her schedules by not more than 20% of any monthly quantity upon 30 days' notice, but such change shall not result in any change

in the maximum and minimum limits fixed by the schedule.

Paragraph G provides that water delivered to the limitrophe section of the river under Schedule I may be increased any year if the amount delivered through the All-American Canal under Schedule II is correspondingly reduced; provided the limitations as to the rates of delivery shall always be correspondingly increased and reduced.

Certain phases of the allocation and scheduling articles are important. Attention is called to the fact that delivery of water to Mexico is from waters of the Colorado River "from any and all sources" and also "that the United States shall deliver all waters allocated to Mexico wherever these waters may arrive in the bed of the limitrophe section of the Colorado River" except the water to be delivered to the All-American Canal and at the land boundary near San Luis, Sonora, and that "such waters shall be made up of the waters of the said river whatever their origin x x x". The phrase "from any and all sources" and statement "whatever their origin" mean that there shall be included as a part of the deliveries to Mexico and there shall be charged against the allocation to Mexico any drain water or waste water accruing to the river from the United States projects, regardless of their quality, either from the standpoint of silt or dissolved solids.

Attention is called to the part of Article 10 which states that "Mexico shall acquire no right beyond that provided by this sub-paragraph by the use of the waters of the

Colorado River system for any purpose whatsoever in excess of 1,500,000 acre-feet annually". The phrase "for any purpose whatsoever" is significant. It is conceivable that it will be necessary for Mexico to use some of the waters allocated to her for sluicing purposes, not only to remove sand from her canals but to carry the sand and silt down the stream to the Gulf. Such sluicing water must be taken from the 1,500,000 acre-feet that is allocated to Mexico. The net amount remaining for diversion by Mexico may therefore be less than 1,500,000 acre-feet, but she will have no additional claim on the United States for the delivery of additional water for sluicing or any other purposes such as salinity control.

The provision for reducing deliveries to Mexico in the event of drought in the same proportion as consumptive uses in the United States are reduced applies to conditions in both the upper and lower basins. It is certain that severe droughts will be felt in the upper basin prior to the time they are felt in the lower basin. If curtailment of uses in the upper basin results on account of the drought, proportionate reduction would be made of deliveries of water to Mexico, on the basis however of the relationship between the curtailment to the total consumptive use in the United States.

The amount of water to be delivered through the All-American Canal has some significance. If the major diversion structure constructed by Mexico on the stream provided for in Article 12 (discussed in the next paragraph) is located in Mexico below the lower boundary some 90,000 acres of land

now irrigated in Mexico will be too high to be served by the canal extending from the diversion structure to the Alamo Canal in Mexico. The 375,000 acre-feet to be delivered to the upper portion of the Alamo Canal by the All-American Canal after January 1, 1980 will be about sufficient to serve such 90,000 acres of land. Until that time a minimum delivery up to 500,000 acre-feet from the All-American Canal is provided for. During this first period when the silt problem will be greater than it will be during the latter period, 500,000 acre-feet of clear water is guaranteed to Mexico. This delivery will not interfere with the operation of United States facilities because of surplus water in the river.

Article 12 provides for the construction of certain works by Mexico and the United States, ~~and Mexico,~~ including a major diversion structure for the diversion of a ~~major~~ greater part of the waters allocated to Mexico, and the Davis storage dam and reservoir, both of which are to be constructed within a five-year period. The major diversion structure is to be constructed by Mexico at its expense, and simultaneously therewith, there are to be constructed, at Mexico's expense, such levees, drainage facilities and other works and improvements to existing works as are, in the opinion of the commission, deemed to be necessary to protect lands within the United States against damage from floods or seepage that might result from the construction, operation, and maintenance of the diversion structure. p 28

~~The~~ article 12 also provides that the United States shall construct or acquire in its own territory such works as may

be necessary to convey a part of the water of the Colorado River allocated to Mexico to the Mexican diversion points on the international boundary line. Such works will include the canal and other works necessary to convey water from the lower end of the Pilot Knob wasteway to the international boundary and a canal to connect the main diversion structure if this structure should be built in the limitrophe section of the river with the Mexican system of canals at a point on the international land boundary near San Luis, Sonora. ~~The~~ The article provides that such works required or constructed shall be operated and maintained by the United States section at the expense of Mexico, and that Mexico shall pay the cost of any sites or right of way required for such work. ~~The~~ This article also provides for the construction, operation, and maintenance of the gaging stations necessary for the administration of the terms of the treaty.

If the main diversion structure for Mexican uses is constructed in the limitrophe section of the river, the design and construction shall be under the control of the Commission. If it is located entirely in Mexico, such is not the case. However, in either event, the required protective works shall be determined by the Commission.

Article 13 is a general article providing for the study, investigation and preparation of plans for flood control on the Colorado River from the Imperial Dam to the Gulf of ~~Mexico~~ California.

Article 14 provides for the payment by Mexico of a portion of the cost of the construction of Imperial Dam and the

Imperial Dam-Pilot Knob section of the All-American Canal; and provides further for the payment by Mexico of the proportionate part of the total costs of the operation and maintenance of such facilities. It provides further that in the event the return from the sale of hydroelectric energy becomes available for the repayment of a portion of the cost of these works, Mexico's obligation for repayment shall be reduced in the same proportion as the total costs are reduced.

Certain general provisions are important so far as the Colorado River is concerned. Article 17 provides for the use of the channels of the international rivers for the discharge of flood or other excess water without limitation by either country and with the provision that neither country shall have any claim whatever with respect to damage caused by such use. In other words, while the water schedules furnished by Mexico cannot call for delivery in excess of 5,500 ~~c.f.s.~~ cubic feet per second, yet the United States may use the channel of the river to carry water released for flood control from Lake Mead or any other reservoirs constructed and operated on the stream or its tributaries without Mexico having any right to claim damage which might be caused by such releases. Each country, however, declares its intention to operate its facilities in such a manner consistent with normal operation as to avoid, as far as feasible, material damage in the territory of the other.

Article 27 is a transitory article providing that Articles 10, 11, and 15 of the treaty, which are the allocation, point of delivery, and scheduling articles, shall not be applied

during the five-year period or until Davis Dam and the major Mexican diversion structures are placed in operation. Until such works are placed in operation, these articles give Mexico the right to construct and operate at her expense a temporary diversion structure in the bed of the Colorado River for the purpose of diverting water into the Alamo Canal, providing that the plans for such structure, its construction, and operation shall be subject to the approval of the United States section. The United States declares its intent during the five-year transitory period to use its best possible efforts to cooperate with Mexico to the end that the irrigation requirements for lands irrigated in Mexico during the year 1943 shall be satisfied; water therefor, however, being water not required for use in the United States.

EFFECT OF THE TREATY PROVISIONS ON THE USES OF COLORADO RIVER WATER IN THE UNITED STATES

General

At the time the Colorado River Compact was negotiated, the commissioners of the seven states visualized the possibility of the negotiation of a treaty with the United Mexican States which would allocate waters of the Colorado River for use in Mexico. Specific provisions were made in the Compact for the use of certain waters for that purpose. The allocation section of the Compact is quoted as follows:

"ARTICLE III

'(a) There is hereby apportioned from the Colorado River system in perpetuity to the Upper Basin and to the Lower Basin, respectively, the exclusive beneficial consumptive use of 7,500,000 acre-feet of water per annum, which shall include all water necessary for the supply of any rights which may now exist.

'(b) In addition to the apportionment in paragraph (a), the Lower Basin is hereby given the right to increase its beneficial consumptive use of such waters one million acre-feet per annum.

'(c) If, as a matter of international comity, the United States of America shall hereafter recognize in the United States of Mexico any right to the use of any waters of the Colorado River System, such waters shall be supplied first from the waters which are surplus over and above the aggregate of the quantities specified in paragraphs (a) and (b); and if such surplus shall prove insufficient for this purpose, then the burden of such deficiency shall be equally borne by the Upper Basin and the Lower Basin, and whenever necessary the States of the Upper Division shall deliver at Lee Ferry water to supply one-half of the deficiency so recognized in addition to that provided in paragraph (d).

'(d) The States of the Upper Division will not cause the flow of the river at Lee Ferry to be depleted below an aggregate of 75,000,000 acre-feet for any period of ten consecutive years reckoned in continuing progressive series beginning with the first day of October next

succeeding the ratification of this compact.

'(e) The States of the Upper Division shall not withhold water, and the States of the Lower Division shall not require the delivery of water which can not reasonably be applied to domestic and agricultural uses.

'(f) Further equitable apportionment of the beneficial uses of the waters of the Colorado River System unapportioned by paragraphs (a), (b), and (c) may be made in the manner provided in paragraph (g) at any time after October first, 1963, if and when either Basin shall have reached its total beneficial consumptive use as set out in paragraphs (a) and (b).

'(g) In the event of a desire for a further apportionment, as provided in paragraph (f), any two signatory States, acting through their Governors, may give joint notice of such desire to the Governors of the other signatory States, and to the President of the United States of America, and it shall be the duty of the Governors of the signatory States and of the President of the United States of America forthwith to appoint representatives, whose duty it shall be to divide and apportion equitably between the Upper Basin and Lower Basin the beneficial use of the unapportioned water of the Colorado River System, as mentioned in paragraph (f), subject to the legislative ratification of the signatory States and the Congress of the United States of America."

Attention is directed to subsection (c) which provides specifically that should a treaty be negotiated with Mexico the waters allocated to Mexico should first come from waters in addition to those apportioned by subsections (a) and (b), or, in other words, waters in excess of 16,000,000 acre-feet per annum. The subsection provides further that, should such surplus over the 16,000,000 acre-feet be insufficient to satisfy the Mexican allocation, the deficiency should be borne equally by the upper and lower basins. Attention is directed also to provisions of subsection (f). This subsection recognizes all waters covered by subsections (a), (b),

and (c) as apportioned waters. It then specifically provides that any water in excess of that apportioned by subsections (a), (b), and (c) may be apportioned after October 1, 1963 if and when either the upper or the lower basin shall have reached its total beneficial consumptive use of waters apportioned under subsections (a) and (b).

It is probable that for many years, extending well beyond the time (1988) when the costs of Boulder Dam ~~(1988)~~ and all other works presently constructed in the basin are amortized, ample water will be available under all conditions to supply all uses in the United States and the obligation of the United States to Mexico under the terms of the treaty. The following discussion relates, therefore, to that time when the two nations may be using for consumptive-use purposes all the water supply available in the basin.

Effect on uses of water for consumptive use in the United States

An analysis of the water supply records indicates that the minimum guaranteed delivery of 1,500,000 acre-feet to Mexico will all be supplied from water over and above that apportioned by subsections (a) and (b) of Article III of the Colorado River Compact.

It is estimated a minimum of 1,395,000 acre-feet will be available to take care of additional uses in the United States of water which may be apportioned under Article III (f) and (g) of the Compact. This quantity might be as much as 1,800,000 acre-feet. Such quantity includes whatever reservoir evaporation and desilting water is required to make the

balance of it usable. If the Lower basin chooses to charge all reservoir losses and desilting water to surplus, to be apportioned in the future under Article III (f) and (g) of the Compact, then the remaining amount of water subject to apportionment under those articles for net use is estimated at not less than 500,000 acre-feet. It may be as much as 900,000 acre-feet.

The burden on the water above Imperial Dam imposed by the treaty obligations will be influenced by two main factors, viz; the areas on which Arizona will use the major part of its share of the Colorado River, and the amount of desilting water required under far-future conditions. Under the most favorable combination of circumstances it is estimated the demand on water above Imperial by Mexico will be limited to the 375,000 acre-feet to be delivered through the All-American Canal. Under the most unfavorable combination of circumstances the maximum demand on water above Imperial Dam to satisfy the treaty obligations to Mexico is estimated at 600,000 acre-feet.

Only two general regions are available on which to utilize the 2,800,000 acre-feet, or major portions thereof, for which Arizona has a contract with the Secretary of the Interior for delivery from Lake Mead. (See Appendix A - Description of Lower Colorado River Basin). One of these two regions is the Lower Gila Valley extending from the eastern side of the present Yuma Project, several miles up the Gila River. It includes

the Yuma mesa land. The gross Gila project area is about 645,000 acres, with possibly 500,000 acres irrigable. Works have been constructed to irrigate a part of the Yuma Mesa Division of the first unit of the project. The net area in the first unit is about 120,000 acres. If the entire Gila project is irrigated, it is estimated the total return flow reaching the river below the Imperial Dam may be as much as 1,180,000 acre-feet per annum.

The other region where large quantities of Colorado River water can be used in Arizona comprises irrigable areas along the upper Gila River and its tributaries. More land exists in this region than there will be water to irrigate. Return flow and waste waters from such areas, if irrigated, will reach the Gila River, and, due to their quality, will not be reused in the United States. Such returns and waste water will flow into the Colorado River and will be available for use by Mexico and will be charged against her allocation. Such waters also will be subject to regulation by a reservoir to be constructed for water conservation and flood control purposes in the lower reaches of the Gila. (See Dwg. 500-371, Appendix A).

If the use of water on the Yuma Project is reduced to a minimum by lining its canals and if only 80,000 acres of the Gila project are irrigated and the balance of Arizona's main stream water (aside from that consumed on Arizona's projects along the Colorado River and its tributaries above Parker Dam and in the Parker Valley)

part of the state, it is estimated the return flow to the limitrophe section of the river will be approximately 806,000 acre-feet per annum of which 426,000 acre-feet will be subject to regulation by the reservoir mentioned above.

If reservoir losses and desilting water are charged against primary uses the total return flow reaching the river below Imperial Dam from the primary use would be less than the above amounts. However, return flow from secondary uses by Arizona probably would exceed the reduction due to charging reservoir evaporation and desilting water to primary uses.

In addition to the return flow under the two conditions discussed above there will be available below the Imperial Dam water used for desilting purposes. The amount of this water has been variously estimated from 200,000 to 400,000 acre-feet per annum. For purposes of conservatism in this discussion, it is assumed that this water will amount to only 100,000 acre-feet per annum. The 100,000 acre-feet will be only 2% to 2-1/2% of the total water which will be diverted by the Imperial Dam.

If the major portion of Arizona's water is used on the Gila project, none of the return flow will be subject to control, and the amount that will be usable to supply deliveries to Mexico will depend somewhat upon the schedule submitted by Mexico for such delivery. With a schedule most favorable to the use of the maximum amount of the return flow, the total demand on account of the treaty provisions on water above Imperial Dam is estimated at about 428,000 acre-feet. This

includes the 375,000 acre-feet to be delivered to Mexico through the All-American Canal. It is estimated that the maximum possible demand on water above Imperial Dam under the most unfavorable schedule of deliveries to Mexico would be 571,000 acre-feet.

If the major portion of Arizona's water is used in the central part of the state, it is estimated the maximum demand on water from above Imperial Dam will be about 594,000 acre-feet.

Therefore six hundred thousand acre-feet is taken as a round figure to represent the maximum burden that will be placed upon the water above Imperial Dam to satisfy United States' obligation to Mexico under the terms of the treaty. This amount will be reduced to the extent that the water used for desilting purposes exceeds 100,000 acre-feet per annum.

With 600,000 acre-feet as the maximum demand on water from above Imperial Dam to satisfy the United States' obligation to Mexico under the terms of the treaty, the treaty will not cause interference with the free use by the United States of water allocated to the Upper and Lower basins by the Colorado River Compact. A substantial amount of water will remain for further apportionment under Article III (f) and (g) of the Compact. This is shown in the following two tables, A and B. Table A is based upon the average water supply of the Colorado River for such a period as 1897-1943, inclusive. It may be noted that a minimum of

1,395,000 acre-feet (Item 11) would be available for apportionment under Article III (f) and (g) of the Compact after all other demands had been satisfied. The quantity available for further apportionment under the above Article of the Compact may amount to as much as 1,800,000 acre-feet. In other words, the table indicates that after taking care of Mexican requirements a total of at least 16,395,000 acre-feet will be available for beneficial consumptive use in the United States above Imperial Dam. This amount includes reservoir evaporation and desilting water. The amount may be as much as 16,800,000 acre-feet. This is in addition to the consumptive use on the Gila River.

Table B is based upon the lowest ten-year (1931-1940) water supply occuring during such a period as 1897 to 1943. It may be noted that the total reservoir drawdown for the ten-year low water period, in order to satisfy Lower basin requirements including the 1,395,000 acre-feet of III (f) water, (if this were all apportioned to the Lower basin) would be 16,700,000 acre-feet. Such a drawdown if occurring infrequently is not considered excessive. In the studies of the Bureau of Reclamation for the operation of Boulder Dam for the generation of hydroelectric energy, the Bureau assumed that under 1988 conditions the drawdown for such a period as 1930-40, inclusive, would be somewhat in excess of 16,000,000 acre-feet. This is indicated on U. S. Bureau of Reclamation drawings Nos. 45-D-13242 and 45-D-13244, dated October 25, 1940.

Table A

Summary of Colorado River Water Supply above Imperial Dam
Ultimate Conditions
(Long time average 1897-1943)

				Acre-feet
Water Supply				
1.	Virgin flow into Lake Mead			17,400,000
2.	Inflow Boulder to Imperial Dam			195,000
3.	Total water supply			17,595,000
Demand				
4.	Upper Basin (Incl. res. evap.)		7,500,000	
	Lower Basin			
5.	California (senior priorities)	4,400,000		
6.	Arizona) Incl. New	2,800,000		
7.	Nevada) Mex. and Utah	300,000		
8.	Total (Incl. prorata res. evap. and desilting water)		7,500,000	
9.	Channel losses Boulder to Imperial Dam		600,000 (1)	
10.	Delivery to Mexico in addition to return flow and desilting water		600,000 (2)	
11.	Minimum est. of remainder to supply any allocations made under Art. III (f) and (g) of the Compact, including prorata res. evap. and desilting water		1,395,000 (3)	
12.	Total demand			17,595,000

(1) May not exceed 300,000 acre-feet.
(2) Maximum. Most probable 400,000 to 500,000 acre-feet.
(3) May be as much as 1,800,000 acre-feet.

Table B

Summary of Colorado River Basin Supply above Imperial Dam
Ultimate Conditions
(Average of 10-year low water period 1931-1940)

			Acre-feet
Water supply available to Lower Basin			
1.	Lees Ferry from Upper Basin		7,500,000
2.	Inflow Lees Ferry to Boulder Dam		650,000
3.	Inflow Boulder to Imperial Dam		175,000
4.	Total Water Supply (without res. drawdown)		8,325,000
Demand			
5.	California (senior priorities)	4,400,000	
6.	Arizona) Incl. N. Mex. and Utah	2,800,000	
7.	Nevada)	300,000	
8.	Total (Incl. prorata res. evap. and desilting water)	7,500,000	
9.	Losses Boulder Dam to Imperial Dam	500,000	
10.	Delivery to Mexico in addition to return flow and desilting water	600,000	
11.	Uses of water which might be allocated under Article III (f) and (g) of the Compact item 11 of the preceding table (incl. prorata res. evap. and desilting water)	1,395,000	
12.	Total Lower basin demand - if all of item is apportioned to the Lower basin		9,995,000
13.	Total annual reservoir drawdown		1,670,000
14.	Total ten-year reservoir drawdown		16,700,000

SIX STATES COMMITTEE
Arizona - Texas - Colorado
New Mexico - Utah - Wyoming
R. J. TIPTON
Consulting Engineer

Drawn GHP MAR 1944 55C
Prepared by Colo Water Cons Board

STAGES OF GREAT SALT LAKE
VERSUS
VIRGIN FLOW AT LEES FERRY
AND AT
BOULDER DAM

COLORADO WATER CONSERVATION BOARD
CLIFFORD H. STONE, Director
C.L. PATTERSON, Chief Engineer R.J. TIPTON, Consulting Engineer
March 1944

NEW TITLE

Gage of Great Salt Lake redrawn from U.S.G.S. Water Supply Paper 517 and extended from later papers.

5 year Progressive Mean Vi

5 year Progressive Mean Flo
in terms of percentage o

Lake Mead in terms of percentage of the mean

Lees Ferry

PERCENTAGE OF THE MEAN

ELEVATION IN FEET ABOVE SEA LEVEL

500-2292

It may be noted that tables A and B are based on the theory that reservoir evaporation and desilting water are a part of beneficial consumptive use. If, in the future, all surplus is apportioned under Article III (f) and (g) of the Compact to the Lower basin, it is estimated that the net amount available for use above Imperial Dam (does not include the Gila River) by that basin, providing the Upper basin consumes 7,500,000 acre-feet and the Mexican deliveries are made, will range between 8,000,000 acre-feet and 8,400,000 acre-feet. This net is after all reservoir evaporation, estimated at 800,000 acre-feet and desilting water estimated at 100,000 acre-feet, is taken care of.

The runoff of the Colorado River system for the period 1931-1940 was the lowest since at least 1850. A good correlation exists between the stage of Great Salt Lake and the runoff of the Colorado River system. Storms in general furnish precipitation to both the Great Lake basin and the Colorado River basin. A record exists of the stage of Great Salt Lake since 1850. The minimum stage occurred during the period 1931-1940. On the attached graph is indicated the stage of the lake, together with five-year progressive means of the estimated water supply of the Colorado River at Lees Ferry and at Boulder Dam. The close correlation between the several items may be noted.

During the period of record of the stage of Great Salt Lake there has been a progressive increase in the consumption of water tributary to the lake. Therefore, under

present conditions of development within the basin the stage of the lake would not be as high as it was during the early part of the record. However, the change in depletion would not be sufficiently great to bring the high peak which existed prior to 1900 down to the peak which existed during the 1920's, nor would the stage of the 1950's be brought as low as the low stage in the middle 1930's.

Therefore, it may be concluded that the recent low water period in the intermountain region, including the Colorado River basin, was by far the lowest that has occurred since at least 1850.

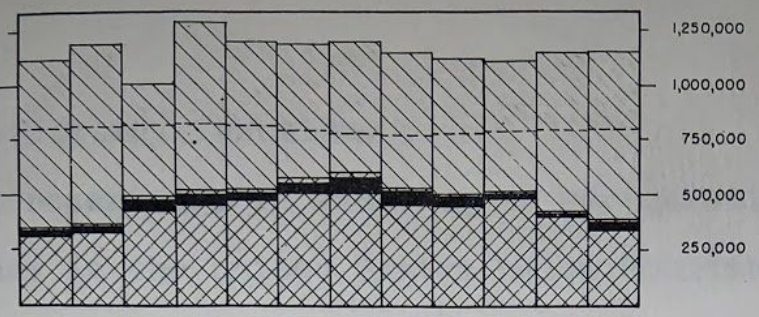
It may be noted also from an inspection of the drawing that the period 1897-1940, inclusive, includes two low periods and one high period. It is probable that on a long time basis the average annual water supply above ~~Imperial~~ Boulder Dam available for use in the Colorado River basin may be greater than the 17,400,000 acre-feet assumed above.

Operation of Davis Reservoir and Effect of Treaty Provisions on Power Contractors

The operation of Lake Mead during the period of amortization of the cost of construction of Boulder Dam and its appurtenances has been so conceived as to generate 4,330,000,000 kwh. of firm energy at the beginning of the amortization period, and 3,880,000,000 kwh. of firm energy at the end of the amortization period. In addition to the release of water for the generation of firm energy additional amounts ~~will~~ may be released for flood control purposes, some of which will be used for the generation of secondary energy.

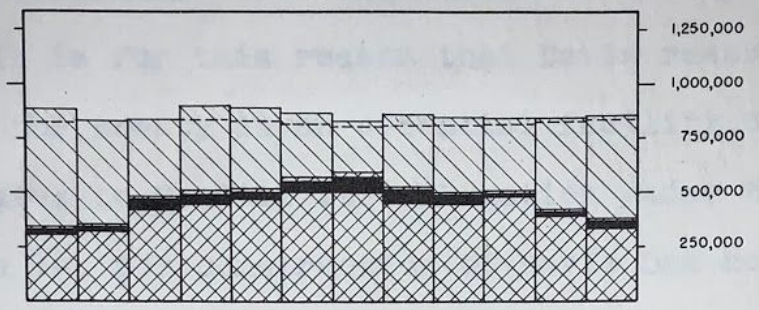
The demand for water for irrigation and municipal purposes in the Lower basin below Boulder Dam will not be parallel with the releases made from Lake Mead for the generation of electrical energy. The releases for power purposes will be fairly uniform throughout the year, being somewhat higher in the winter period than in the summer period. The demand for water for municipal and irrigation purposes, on the other hand, will be relatively low during the winter period and high during the summer period.

A reregulating reservoir below Boulder Dam has always been considered a part of the project, the function of such reservoir to be primarily ~~to~~ reregulating the water released for the generation of energy to make the regimen of this water equivalent to the requirements for its use below. Since the time Boulder Dam was conceived Bullshead reservoir, (Davis Dam), has always been considered the reservoir which would

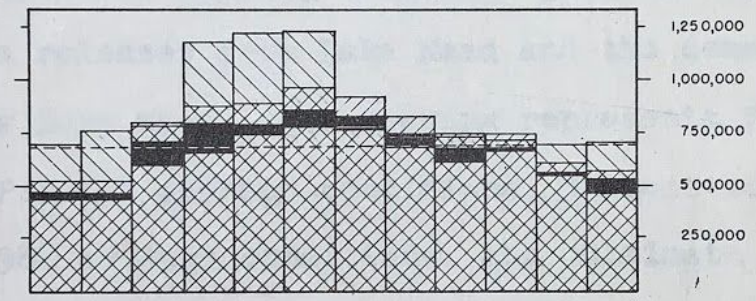


ESTIMATED AVERAGE CONDITIONS - PRESENT

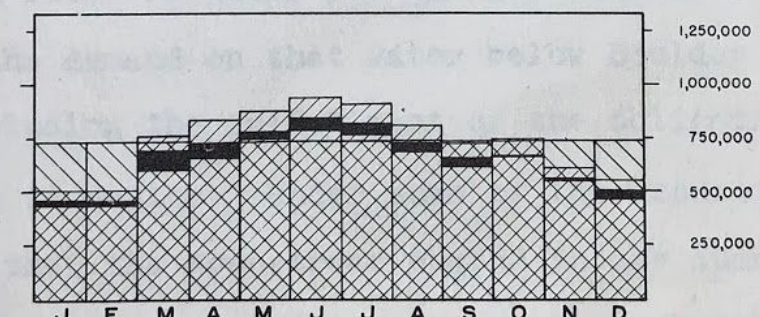
RELEASES IN ACRE FEET



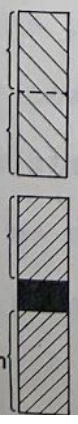
ESTIMATED LOW WATER CONDITIONS - PRESENT



ESTIMATED AVERAGE CONDITIONS - 1988
(TOTAL DELIVERY TO MEXICO FROM ALL SOURCES 1,700,000 ACRE FEET)



ESTIMATED ULTIMATE CONDITIONS
(ALSO LOW WATER CONDITIONS - 1988)



For Flood Control and Secondary Energy

For Firm Energy

Releases from Lake Mead for Generation of Power and Other Purposes.

Reservoir Evaporation below Boulder Dam and Secondary Uses

Mexican Requirements

Releases for Net Primary Uses below Boulder Dam and Channel Losses

Requirements for Consumptive Uses below Boulder Dam

COLORADO WATER CONSERVATION BOARD

CLIFFORD H. STONE, Director

C. L. PATTERSON, Chief Engineer R. J. TIPTON, Consulting Engineer

RELEASES FROM LAKE MEAD DURING TYPICAL PERIODS AND DEMAND ON THE RELEASES

serve the reregulating function.

Bullshead
~~Davis~~ reservoir, in addition to reregulating power releases for use in the United States below Boulder Dam, will also be used to reregulate the water required for deliveries to Mexico, in accordance with the schedules set up for such deliveries. It is for this reason that Bullshead ~~Davis~~ reservoir is recognized in the treaty as an essential facility to permit the United States to fulfill its obligation under the treaty. Contracts were let for construction of Davis Dam but work was stopped by WPB on account of the war situation.

The attached drawing indicates graphically the relation between releases from Lake Mead and the demand on those releases below Lake Mead. The drawing represents four conditions: Present average conditions, present low water conditions, assumed 1988 average conditions, and ultimate conditions which also represent assumed 1988 low water conditions. On the graphs are indicated water released for the generation of electrical energy, and the demand on that water below Boulder for various purposes, including the fulfullment of the obligation of the United States to Mexico. Under some of the conditions it may be noted that the downstream demand in the summer period is greater than the amount of water released from Boulder, but that the amount of water released from Boulder during the winter period is greater than the downstream demand. It is contemplated that the excess water released in the winter time will be stored in Davis reservoir and subsequently released to take care of the difference between the summer

releases and the demand below Davis.

The amount of Bullshead reservoir capacity required to regulate Lake Mead deliveries is estimated between 1,200,000 and 1,400,000 acre-feet depending upon the seasonal distribution of requirements below Davis Dam. Of this amount, about 300,000 acre-feet will be required for the reregulation of water delivered to Mexico. This is on the assumption that the Mexican water will be on top of water apportioned by Article III (a) and (b) of the Compact to the United States. It is also based on the assumption that some regulation will be afforded by the reservoir in the Gila which will control return flow. The amount of capacity required at Davis to reregulate water for Mexico could be further reduced by the operation of the Gila reservoir.

With Davis reservoir operating as contemplated, the terms of the treaty will in no way adversely affect the amount of electrical energy that can be generated at Boulder Dam and will in no way adversely affect the outstanding contracts for the purchase of such energy. Actually the terms of the treaty may benefit the power contractors and the United States during periods of low runoff during the amortization period.

In a recent report of the United States Bureau of Reclamation on the power possibilities at Boulder Dam, dated October 25, 1940, a table appears showing the amount of electrical energy that can be generated at Boulder under present and 1988 assumed conditions with both 78 per cent and 83 per cent

efficiency. The normal generation in 1988 is assumed to be 3,880,000,000 kilowatthours of firm energy. Tables in the Bureau report, however, indicate that shortages would have occurred under the 78 per cent efficiency condition in such years as 1933 to 1940, inclusive. The average generation for such years was estimated at 2,960 million kilowatthours. Under an assumed efficiency of 83 per cent shortages would have occurred in such years as 1934 to 1940, inclusive, during which the average estimated generation would have been 3,220 million kilowatthours.

However, the estimated inflow to Lake Mead for the low water period 1931-1940, as assumed by the Bureau, was 74,000,000 acre-feet, or an average of 7,400,000 acre-feet per year. The average flow past Lees Ferry for the same period, which resulted in the above inflow to Lake Mead, is estimated at 6,800,000 acre-feet.

It was apparently assumed by the Bureau of Reclamation that no call could be made upon the Upper basin for water for the generation of electrical energy even though shortages might exist. However, the treaty imposes an additional obligation on the river for consumptive use purposes and would require delivery from the Upper basin during the ten-year low water period of ~~600,000~~ 500,000 acre-feet more water than the Bureau of Reclamation assumed would have been delivered, which would have generated about ~~seven~~ six per cent more firm energy during that low water period than was estimated by the Bureau. Hence the treaty might benefit the power contractors in certain low water periods.

1 subject however to Mexican control of its Mexican subsidiary corporation owning and operating the Alamo Canal in Mexico.

THE CALIFORNIA SITUATION

General

Two groups of interests in California are opposing ratification of the treaty. These interests are the Imperial Irrigation District and those who have the so-called junior priorities for the use of Colorado River water. The latter group involves principally the Metropolitan Water District of Southern California and the City and County of San Diego. Those having contracts to purchase electrical energy generated at Boulder Dam also are opposing ratification, ~~but only in support of the other two groups~~. for reasons not clear.

The Imperial Valley Irrigation District

The Imperial Valley Irrigation District and its predecessor have always controlled the operation of the Lower Colorado River so far as the use of water by Mexico is concerned, and have in the past made all deliveries of Colorado River water to Mexico. Apparently the officials of this district have had in mind that if a treaty were negotiated for the delivery of water to Mexico, the district would ~~be called upon~~ continue to make such deliveries and would be able thereby to derive considerable financial benefit through payments from Mexican water users and through the generation of electric energy at the proposed Pilot Knob power plant. The terms of the treaty remove the control of the river, so far as fulfilling the international obligation is concerned, from the hands of the Imperial Irrigation District, and

make impossible the charging by that district for the deliveries of water to Mexico. It is assumed from this situation comes most of the opposition of the Imperial Valley group.

In the early 1900's certain California interests owning land in the Imperial Valley and other California and some Mexican interests controlling land in Lower California, being desirous of bringing those lands under cultivation by the use of Colorado River water, negotiated a contract with certain Mexican interests whereby a canal could be constructed heading on the Colorado River in the United States and passing through the upper part of Lower California around the sand hills which exist in that region and thence running back into the United States, crossing the boundary near Calexico to serve the lands in the Imperial Valley. This canal, known as the Alamo, was constructed to a nominal capacity of 10,000 cubic feet per second. In order to conform with the control required by Mexican law, the terms of the contract were written into a concession from the Mexican Government to the Mexican interests in Lower California, which interests were incorporated and later became a subsidiary of the Imperial Irrigation District. The concession was dated May 17, 1904 and was approved by the Congress of Mexico on June 10, 1904. The following are some of the pertinent provisions of the concession:

"Contract entered into between the Citizen General D. Manuel Gonzales Cosio, secretary of state and of development, in representation of the executive

government, and Lic. Ignacio Sepulveda, as representative of the Sociedad de Irrigation y Terrenos de la Baja California, S. A., to carry the waters of the Colorado River through Mexican territory and for the use of said waters.

"Article I. The Sociedad de Irrigacion y Terrenos de las Baja California, S. A., is authorized to carry through the canal which it has built in Mexican territory, and through other canals that it may build, if convenient, water to an amount of two hundred and eighty-four cubic meters per second from the waters taken from the Colorado River and territory of the United States by the California Development Company and which waters this company has ceded to the Sociedad de Irrigacion y Terrenos de la Baja California, S. A. It is also authorized to carry to the lands of the United States the water with the exception of that mentioned in the following article:

"Art. 2. From the water mentioned in the foregoing article, enough shall be used to irrigate the lands susceptible of irrigation in Lower California, with the water carried through the canal or canals, without in any case the amount of water used exceeding one-half of the volume of water passing through said canals."

x x x x x x x x x x x x x x x x x x x

It may be noted that the Mexican interests had a right to use water from the canal for the irrigation of lands in Lower California, but the amount of the water so taken from the canal was not to exceed one-half of the amount of water carried into Mexico by the canal. The canal went into operation and served lands both in Mexico and the United States until the All-American Canal was placed in operation in 1942. After the Imperial Irrigation District was formed, the canal has been operated by that district, and a subsidiary of the district has operated the Mexican portion of the canal, including some of its main laterals. Up until the time the All-American Canal went into operation, a maximum of about 228,000 acres of land had been irrigated under the Alamo

canal in Mexico, and about 440,000 acres in the Imperial Valley in the United States.

The average annual diversion through the Alamo Canal for the thirteen-year period preceding the placing in operation of Boulder Dam was 2,970,000 acre-feet. Based on estimates the maximum diverted for Mexican use was about 955,000 acre-feet in 1925.

At the time the All-American Canal was designed an excess capacity was provided in the canal from the Imperial Dam on the Colorado River to Pilot Knob. Apparently it was assumed that while excess water was in the river this capacity could be used to carry some of ~~this~~ the excess to a power plant at Pilot Knob, which could generate a substantial amount of electric energy for many years.

It may also have been assumed that whatever water was allocated to Mexico by treaty would be carried through the All-American Canal and be discharged through such power plant.

In the original contract between the Imperial Irrigation District and the Secretary of the Interior for the construction of the All-American Canal, including the Imperial Dam and the repayment of the cost of these facilities, the Imperial Irrigation District was to retain control of the operation of the entire system. The contract was later modified so that the United States would have control of the operation of the Imperial Dam and the All-American Canal down to and including Siphon Drop, through which is

and Pilot Knob Wasteway which discharges behind the Rockwood Heading gates into the

delivered water for the Yuma Reclamation Project. In other words, so far as the existing contract is concerned there still remains in the hands of the Imperial Irrigation District the canal from Siphon Drop on down to and including the Pilot Knob feature.

It is believed that prior to the negotiation of the treaty certain proposals were made by the Imperial Irrigation District to furnish water to the Mexican interests by way of the All-American Canal ~~and the Andrade heading of the~~ Alamo Canal. Available information would seem to indicate that such proposals involved in ~~general~~ effect a repayment by the Mexican government in the form of a service charge or rental of a part of the cost of Imperial Dam and All-American Canal down to and including Pilot Knob wasteway, and a similar service charge for the use of ~~the Andrade heading, and~~ the short reach of the Alamo Canal which is located in the United States. Such service charges were to have been in addition to the operation and maintenance charge. The service charge was to have been a perpetual charge so long as the facilities were used.

It has been reported that during the forty-year repayment period of the cost of the All-American Canal and Imperial Dam, Mexican payments to the Imperial Irrigation District would have equalled more than one-half the cost of the Imperial Dam and the Imperial Dam-Pilot Knob reach of the canal, even though not more than one-fifth of the capacity of the All-American Canal might have been used for the

delivery of water to Mexico and less than this proportion of the Imperial Dam.

It has been estimated that there could be generated at Pilot Knob power plant during an assumed amortization period from 1945-1985 an average of 160 million kilowatthours of electrical energy per year. This energy should have a value of not less than $320,000 per year. Amortization of the cost of the power plant and operation and maintenance and depreciation probably would amount to about $180,000 per year, leaving a minimum net profit of approximately $140,000 per year. The profit at the beginning of the amortization period is estimated at $260,000 per year.

The treaty contemplates that the Imperial Dam and the All-American Canal down to and including Pilot Knob waste-way, and any works located in the United States that are used solely for the purpose of delivering water to Mexico under the terms of the treaty, shall be under the control of the United States.

The reason for the very vigorous objections on the part of the Imperial Irrigation District interests becomes obvious. However, no other policy than that established by the treaty would be tenable. While none of the western states is in favor of any more federal control and operation of facilities for the use of the water in the west than is absolutely necessary, yet this is one instance where such control is necessary, an instance where the United States having obligated itself to make certain deliveries of water

to another nation must be in control of the works required for that purpose.

The terms of the treaty provide that Mexico shall repay the cost of the portion of Imperial Dam and the All-American Canal down to and including Pilot Knob wasteway which is used for delivery of water to Mexico as well as a proportionate part of the operation and maintenance costs. The treaty also provides that Mexico shall pay the entire cost of any facilities located in the United States that are used solely for the delivery of water to Mexico, as well as the entire cost of operation and maintenance of those facilities.

The Imperial Irrigation District obviously will be reimbursed for any works it now owns that will be taken over and used solely for the delivery of water to Mexico such as the Alamo Canal in the United States. It also obviously will be relieved of any obligation for the repayment of the cost of any part of the Imperial Dam and the All-American Canal that are not used for the delivery of water to it. It will, however, lose any profits which it may have visualized as accruing to it from the delivery of water to Mexico. It may also lose whatever large profits it may have visualized from the generation of hydroelectric energy at Pilot Knob. It appears sound policy that revenues from any energy generated by the deliveries of water to Mexico should accrue to the United States to be applied first to the repayment of the cost of power plants and next to the repayment of the cost

of any other works required to fulfill the international obligations that are not repaid by Mexico.

California Junior Priorities

Prior to the ratification of the Colorado River Compact by the various states other than California, California was required to limit by statute her use of waters allocated under Section III (a) of the Colorado River Compact to 4,400,000 acre-feet per year and ~~to limit her use to~~ not over one-half the surplus of the water not allocated by Sections III (a) and III (b) of the Compact. California passed this self-limiting statute, the pertinent terms of which are recited in the Boulder Canyon Project Act. California then set up a system of priorities covering the use of the 4,400,000 acre-feet of Article III (a) water and 962,000 acre-feet of surplus water. These priorities are listed below. In the table also is given the estimated present use under each priority.

Priority Number	Description	Acre-Feet	Totals	Est. Present Use under each Priority
1	Palo Verde Irrig. Dist. 104,500 acres			
2	Yuma Project 25,000 acres			
3 (a)	Imperial Irrig. Dist. and lands under the All-American Canal in the Imperial and Coachella Valleys			
(b)	Palo Verde Irrig. Dist. in "lower Palo Verde mesa" 16,000 acres			
	Total 1, 2, 3	3,850,000		2,650,000
4	Metropolitan Water Dist. of So. Calif. & the City of Los Angeles	550,000		85,000 (1)
	Total from "III (a)" water		4,400,000	2,735,000
5 (a)	Metropoligan Water Dist. of So. Calif. & the City of Los Angeles	550,000		
(b)	City & County of San Diego	112,000		
6 (a)	Imperial Irrig. Dist. & lands under the All-American Canal in the Imperial & Coachella Valleys			
(b)	Palo Verde Irrig. Dist. in "Lower Palo Verde mesa" 16,000 acres			
	Total for 6(a) and (b)	300,000		
	Total from surplus		962,000	none
	Total of all priorities		5,362,000	2,735,000

(1) Average for 1939 to 1943 inclusive. Includes water for filling Mathews reservoir. Diversions were 36,282 acre-feet and 34,598 acre-feet in 1942 and 1943 respectively.

The various California interests then negotiated contracts with the Secretary of Interior for the delivery of water from Lake Mead to satisfy the ~~various~~ several priorities.

The contracts for the delivery of water from Lake Mead are all made

> "subject to the availability thereof for use in California under the Colorado River Compact and the Boulder Canyon Project Act."

The contracts provide further:

> "The United States shall not be obligated to deliver water to the district when for any reason such delivery would interfere with the use of Boulder Canyon Dam and reservoir for river regulation, improvement of navigation, flood control, and of states or private perfected rights in or to the waters of the Colorado River or its tributaries in pursuance of Article III of the Colorado River Compact; and, this contract is made for the express condition and with the express covenant that the right of the district to the waters of the Colorado River or its tributaries, is subject to and controlled by the Colorado River Compact".

Attention is called to subsection (f) of Article III of the Colorado River Compact. This subsection provides that further equitable apportionment of the beneficial uses of the waters of the Colorado River system unapportioned by paragraphs (a), (b), and (c) may be made after October 1, 1963, if and when either basin shall have reached its total beneficial consumptive use as provided in paragraphs (a) and (b) of Article III of the Compact. Therefore, until ~~either~~ the upper basin is consuming its total allocation of 7,500,000 acre-feet or until the lower basin is consuming its total allocation of 8,500,000 acre-feet, no state in either basin can acquire any title to surplus, and it should be noted that

COLORADO WATER CONSERVATION BOARD
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ALLOCATIONS OF WATER IN THE COLORADO RIVER BASIN

Drawn by A.C.S. Revised March 1944
Traced by G.H.F. April 6, 1943

500-1892

any surplus apportioned in the future under subsection (f) must be from surplus after any treaty obligations are satisfied.

It is apparent, therefore, that the contracts held by California for the delivery of 962,000 acre-feet of surplus water are not firm contracts and are contingent upon what further apportionment might be made of waters of the Colorado River system after October 1, 1963. The status of the various California priorities in relation to the apportionment of water, as made by the Colorado River Compact and as visualized by the Boulder Canyon Project Act, is shown graphically on the attached drawing No. 500-1892. The drawing is self explanatory.

The amount that might be allocated to the junior priorities of California will be dependent upon negotiations by the commissioners of the seven states appointed by their respective governors in accordance with the procedure set up by Article III (g) of the Compact. Prior to the time that additional water is apportioned under the terms of the Compact, other states in the basin may be in a position to use some of the unapportioned surplus water before projects constructed to use such water under the junior priorities 5 and 6 of California are using any substantial amount of the unapportioned surplus. Therefore, the status of the contracts for the delivery of water to the junior priorities may be materially affected by the action of other states within the basin.

The reason for the concern on the part of the interests holding the junior priorities is apparent. However, the uncertain status of water for these priorities was not created by the terms of the treaty. That status existed under the terms of the Colorado River Compact at the time the priorities were set up. If the terms of the proposed treaty affect in any way adversely the status of these junior priorities, it is probable that their status would be even more jeopardized if the problems concerning the use of the waters of the Colorado River by the two nations were arbitrated, and it is certain that their status would have become increasingly more hazardous had treaty negotiations been long delayed, with the result of a further material increase in use of the waters of the Colorado River by Mexico.

The terms of the present proposed treaty are the best that could be had. Under such terms, potential uses in the basin in the United States can be crystallized and definitely fixed. The delivery of water to Mexico under the terms of the treaty does not conflict directly with water which might be available to the junior priorities of California under the terms of the Colorado River Compact because any water apportioned to them must be from waters in excess of the waters allocated by Articles III (a) and III (b), and water allocated to Mexico in accordance with Article III (c) of the Compact. However, in the future should water be apportioned to these junior priorities and no water is apportioned from surplus for the use of any other state, all

of the water covered by the junior priorities can be supplied after the Mexican obligation is taken care of, providing each priority bears its proportionate share of reservoir evaporation and desilting water. If such losses are taken all out of surplus then the amount available for apportionment to the California junior priorities will be reduced accordingly.

California's Major Objections and Answers thereto

California interests have raised a number of objections to the treaty, the most important of which are listed and discussed below.

1. After full development the water supply will be insufficient to meet lower basin obligations and the delivery of 1,500,000 acre-feet to Mexico.

As has already been shown, sufficient water will be available to meet the United States' obligation to Mexico and the amount of water apportioned to the lower basin by Article III (a) and III (b) of the Compact. These are the only firm apportionments of water to the lower basin. Any other obligations which the lower basin interests might have to deliver water in addition to that apportioned to the lower basin by Articles III (a) and III (b) of the Compact cannot be firm obligations because no water has been allocated by the Compact to it for that purpose and no allocation can be made for that purpose until after October 1, 1963. Future allocation must be made by commissioners appointed by the governors of the seven Colorado River basin states. However, sufficient water will be available to supply to the lower basin some water in addition to that

required to take care of the water apportioned by Articles III (a) and III (b) of the Compact.

2. California's contracts were the basis for a large bonded indebtedness and now stand to be injured or repudiated by the provisions of the treaty.

California has firm contracts for the delivery of only 4,400,000 acre-feet of water from Lake Mead. Contracts for the delivery of water to the so-called junior priorities, amounting to 962,000 acre-feet, are not firm contracts because no allocation of water for that purpose has been made by the Colorado River Compact. Such allocation must await the time when either basin is consuming the total amount of water allocated to it by the Colorado River Compact and such allocation in any event cannot be made prior to October 1, 1963. If the contracts to deliver water to junior priorities are in jeopardy they were in jeopardy at the time they were made. The provisions of the treaty represent the most favorable agreement that could be obtained. Arbitration or delay might, and probably would, result in allocation of water to Mexico greater than the allocations made by the treaty. The position of the junior priorities of California in this event would be more uncertain.

The terms of the treaty will not jeopardize the bonds that were issued to construct the large California projects. Repayments of the bonds may, however, be jeopardized by the lack of need for the facilities financed from the proceeds of the bonds. For example, during the year 1943 only 35,000 acre-feet were diverted through the

Los Angeles aqueduct, even though the population of Southern California has reached an all time peak, due to the many army camps and war industries located in that area as a result of the war. It appears probable that none of the junior water for the Los Angeles aqueduct will be needed prior to the time the outstanding bonds mature. It is not conceivable that Imperial Irrigation District bonds were sold on the basis of speculative returns from the sale of water to Mexico or the generation of energy at Pilot Knob power plant. Therefore it is not believed the terms of the treaty jeopardize in any way the outstanding bonds of the Imperial Irrigation District. The treaty does not effect adversely outstanding bonds of the power contractors.

3. Mexico is not entitled to more water than it used or could have used before the construction of Boulder Dam; namely, about 750,000 acre-feet per year.

Under natural flow conditions prior to the beginning of the low water period in 1931, Mexico could have used more than 1,500,000 acre-feet of water without shortage, after the present uses in the United States were satisfied. Moreover, Mexico had then a right to use up to one-half the water carried by the Alamo Canal. The average annual diversion by the Alamo Canal for the thirteen-year period immediately preceding the placing in operation of Boulder Dam was approximately 3,000,000 acre-feet. The maximum diversion was 3,423,511 acre-feet and the minimum was 2,049,954 acre-feet in the low water year of 1934. During eight of the years the diversions were well in excess of 3,000,000 acre-feet.

Therefore, Mexico had a right to use an average of 1,500,000 acre-feet under the Alamo Canal concession and had a right to use a maximum of 1,711,755 acre-feet prior to the placing in operation of Boulder. At least 60% of the Mexican allocation will be supplied from return flow and waste water. The water she will, therefore, receive under the treaty will not only be no more than she could have received under natural flow conditions before Boulder was placed in operation, but it will be of a much inferior quality. Moreover, it would be impossible to negotiate a treaty with Mexico limiting her use to 750,000 acre-feet. Her use in 1943 was approximately 1,833,000 acre-feet. In view of this and the fact that Mexico has projected plans which would require considerably more than 1,500,000 acre-feet per year, it appears certain that no board of arbitration would base an allocation of water to Mexico on the amount she was using prior to the placing in operation of Boulder dam.

4. The allocation of 1,500,000 acre-feet is double that heretofore offered Mexico.

(a) There seems little point to this contention. It must be understood that Mexico did not accept the offer of 750,000 acre-feet per year formerly made nor did the United States accede to the demand of Mexico for an annual delivery of 3,600,000 acre-feet. No agreement was reached at that time. It is just as pertinent to say that the present allocation to Mexico is only 40% of that which Mexico formerly demanded, as it ~~is~~ would be to say that the present allocation is double the amount which the United States offered.

(b) Further, the former offer did not limit the annual delivery of water to Mexico to 750,000 acre-feet. Under such offer, Mexico might have received more water than she will receive under the terms of the proposed treaty. In the 1929 offer the American Section of the International Water Commission suggested that 750,000 acre-feet per year be delivered to Mexico according to a schedule after Boulder Dam was built, and suggested there might be added to that amount sufficient water to compensate for losses in the main canal. It is assumed deliveries would have been made either to the Alamo Canal by the present heading or through the All-American Canal by way of Pilot Knob wasteway. In either case Mexico would have received in addition to the 750,000 acre-feet an estimated 200,000 or 300,000 acre-feet to compensate for canal losses. If deliveries had been made by the present heading Mexico would have received in addition to the above amounts whatever water was required for desilting purposes at the head of the Alamo Canal and all return flow accruing to the river below that point. The sum of these quantities might have exceeded the 1,500,000 acre-feet Mexico is to receive under the present treaty. If the 750,000 acre-feet was to have been delivered by means of the All-American Canal the amount received by Mexico would have exceeded by far the amount she will receive under the present treaty.

5. The allocation to Mexico is in violation of the Boulder Dam Project Act which specifically restricted its benefits to the United States.

This restriction is a self-serving one and does not bind the United States in its relations with another country. Mexico has no opportunity ~~for the~~ to regulate the waters of the river. At various times she has expressed a willingness to take care of a share of the cost of Boulder Dam or other reservoirs on the stream. It is doubtful whether a court of arbitration would consider as justified the taking by the United States through the operation of her projects of waters some of which could have been reasonably used by Mexico.

6. The power contractors have undertaken to pay the cost of Boulder Dam. The treaty operation may restrict the power capacity at Boulder.

This statement with respect to effects of treaty allocation is not true. The terms of the treaty will not reduce the amount of energy generated at Boulder Dam by one kilowatthour. Actually during low water periods the amount of firm energy generated might be increased by the operation of the treaty, as explained hereinbefore.

7. The treaty contemplates the construction of diversion and protective works, the feasibility of which has not been established.

It must be recognized that Mexico could construct a diversion structure below the lower boundary without a treaty. As a matter of fact, investigations were under way looking to the possibility of the construction of such works in the event a treaty was not negotiated. Substantial injury could result to United States interests by such action on the part of Mexico without any control being exercised by the

United States. The treaty provides that when such works are constructed at the same time there shall be constructed those works required to protect United States lands. The extent of such works must be determined by the Commission as a whole.

8. Imperial Valley is not protected against excessive runoffs from the Mexican canals to the Salton Sea.

At the present time Salton Sea is receiving something over 1,000,000 acre-feet, largely from wastes and return flow, from the Imperial Irrigation District lands in the United States. This is two-thirds of the total amount of water that is allocated to Mexico. The amount of land that Mexican users desired to irrigate, as compared with the amount of water she will receive from the Colorado River, would indicate that the amount of water wasted to the Salton Sea probably will be negligible. However, it is believed it will be possible to arrive at an agreement with Mexico whereby the waste can be limited to a reasonable amount.

9. There is no provision in the treaty for reimbursement to the Imperial Irrigation District for expenditures on works used by Mexico.

The only works not specifically covered by the treaty for reimbursement are those built by the Imperial Irrigation District in Mexico under the Mexican concession, ~~but~~ some of which are primarily for the benefit of the district. Any claim the district may have against Mexico for reimbursement of the cost of such works is not prejudiced in any way by the terms of the treaty. As a matter of fact, with the treaty in effect it should be easier for the Imperial Irrigation District

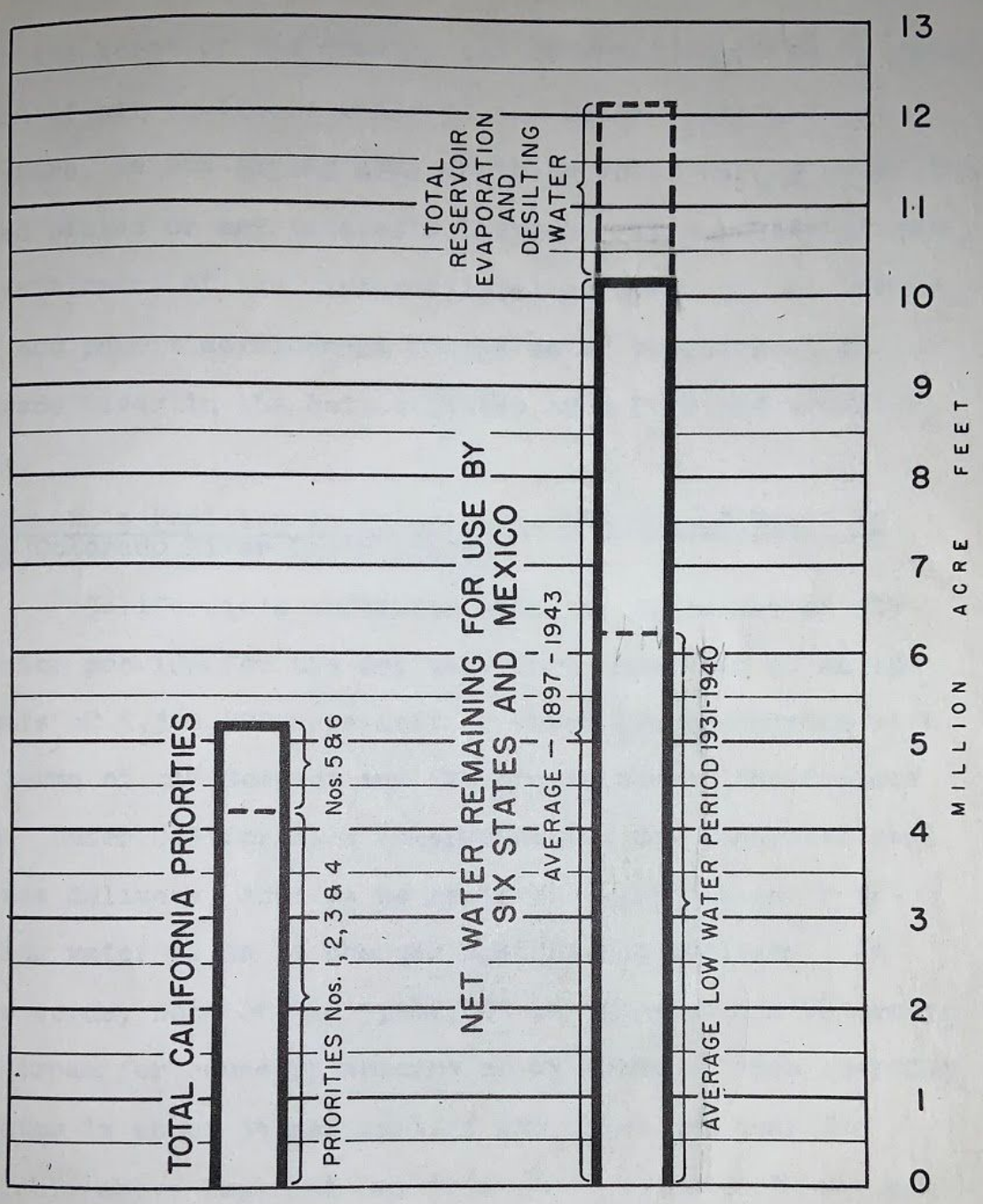
to arrive at an equitable settlement with Mexico.

10. The treaty at least should have made allocation of water in excess of 750,000 acre-feet junior to the California so-called junior priorities.

The state of California, when she became a signatory to the Colorado River Compact, agreed that any water allocated to Mexico should be senior to what now are called the junior priorities of California. As heretofore made plain, Articles III (a) and (b) apportioned certain quantities of water to the Upper and Lower basins. The Compact under Article III (c) provides for water for Mexico over and above the amounts apportioned under Articles III (a) and (b) if a treaty is negotiated with Mexico. It then provides further that if the water over and above that allocated by Articles III (a) and (b) is insufficient to satisfy the allocation, each basin shall make up equally parts of the deficiency out of water allocated by Articles III (a) and III (b). The treaty provides for additional apportionment of water not apportioned by Articles III (a), (b) and (c) at such time as either of the basins is using all the water apportioned to it under Articles III (a) and (b) after October 1, 1963. It is out of this type of water that the California junior priorities must be satisfied, and California agreed to this when she ratified the Compact.

11. The treaty gives away a great vital resource of the southwest.

The treaty merely fixes Mexico's equitable apportionment of the use of the waters of the Colorado River. It is probable that a board of arbitration would award to Mexico at least as much, and probably more, water than she will receive



COLORADO WATER CONSERVATION BOARD

CLIFFORD H. STONE, Director

C. L. PATTERSON, Chief Engineer R. J. TIPTON, Consulting Engineer

CALIFORNIA PRIORITIES Nos. 1 to 6 VERSUS NET WATER SUPPLY ABOVE IMPERIAL DAM REMAINING

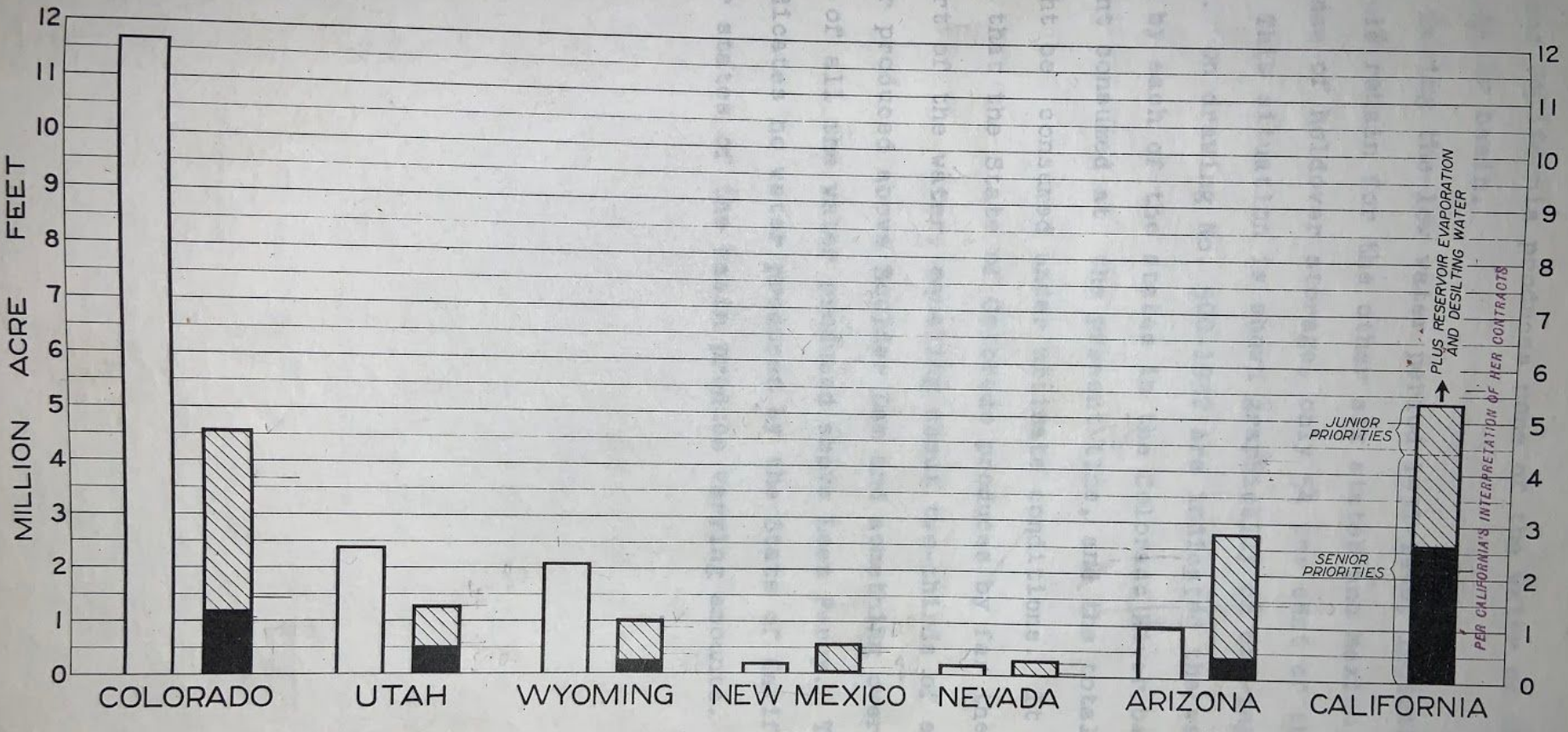
Drawn by G.H.F. March, 1944 500-1934

under the terms of the treaty, all of which would be in recognition of her equitable share of the water. The treaty, therefore, is not giving away anything which was owned by the United States or any interests therein. As a matter of fact, the settlement of the international question by the treaty will now permit development of the water supplies of the Colorado River in the United States on a firm and sound basis.

California's Position in Relation to the Use of Water by Other Colorado River Basin States.

California's contracts with the Secretary of the Interior provide for the delivery from Lake Mead of an aggregate of 5,362,000 acre-feet of water ½ in accordance with the terms of the Compact and the provisions of the Project Act½. Under California's interpretation the contracts call for net delivery; that is no reservoir evaporation or desilting water is to be changed against the delivery. In other words, none of the 5,362,000 acre-feet would return to the stream for reuse by Arizona or by Mexico. This quantity of water is about 34 per cent of the total net quantity available above Imperial Dam from the Colorado River and all of its tributaries to take care of present and future uses in all of the states of the Colorado River Basin. In other words, if California's contracts are satisfied under her interpretation, there will remain only 66 per cent of the total net water supply above Imperial Dam for use by the other six states of the Colorado River basin and by

COLORADO RIVER
ABOVE IMPERIAL DAM
WATER PRODUCTION AND CONSUMPTION BY STATES



-LEGEND-

WATER PRODUCTION

ESTIMATED FUTURE CONSUMPTION

PRESENT CONSUMPTION

COLORADO WATER CONSERVATION BOARD
CLIFFORD H. STONE, Director
C. L. PATTERSON, Chief Engineer R. J. TIPTON, Consulting Engineer
March 1944 500-1932

Mexico, and California produces none of the water of the Colorado River basin.

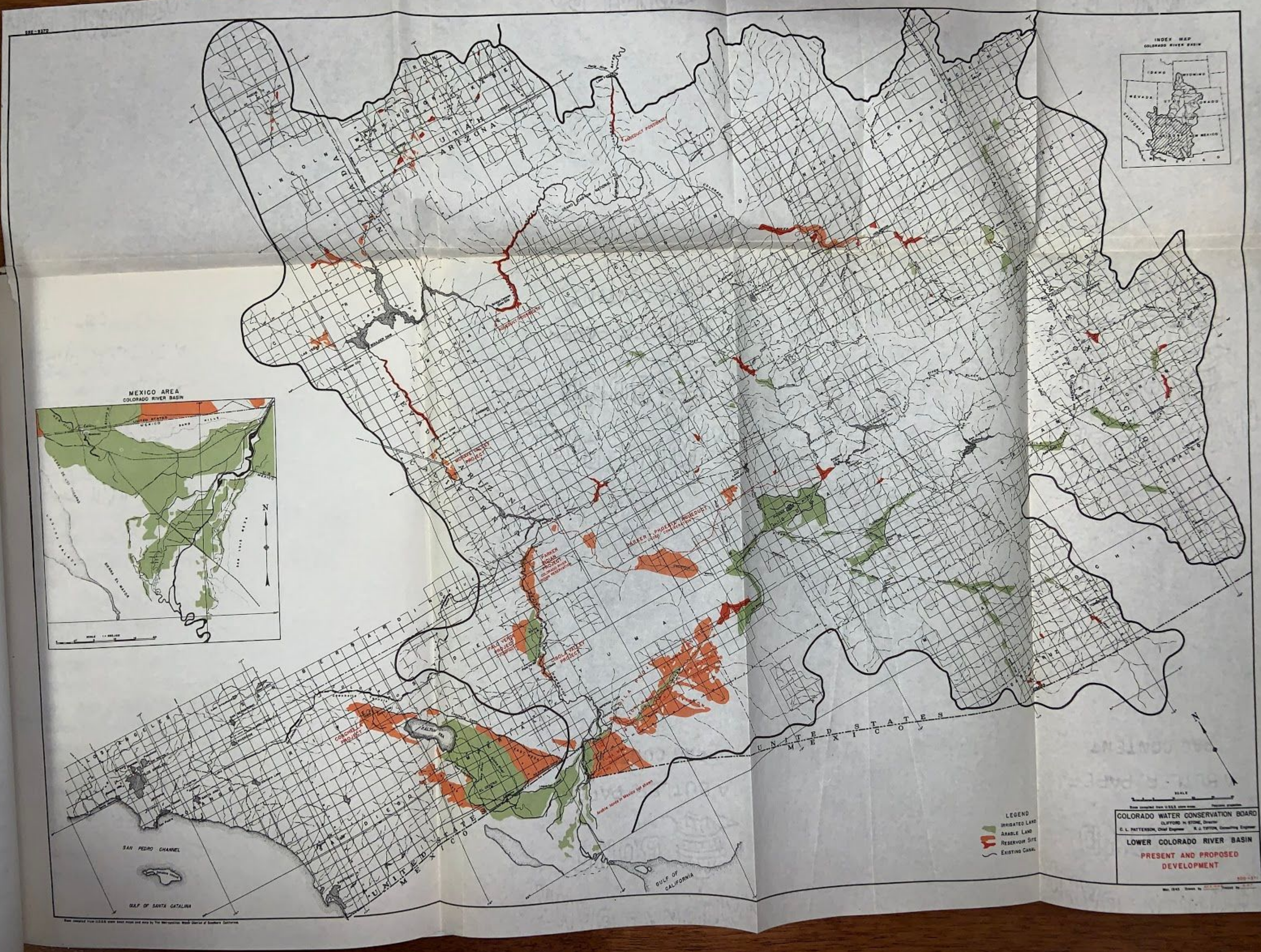
During the low water period 1931-1940, inclusive, there would remain for the other six states and Mexico, in the absence of holdover storage, only 54 per cent of the net supply. This situation is shown graphically on drawing No. 500-1934. On drawing No. 500-1932 are indicated the water produced by each of the states in the Colorado River basin, the amount consumed at the present time, and the total amount that might be consumed under ultimate conditions. It may be noted that the State of Colorado produces by far the major part of the water, equaling about two-thirds of all the water produced above Boulder Dam and something over 70 per cent of all the water produced above Lees Ferry. The graph indicates no water produced by the State of California. The other states of the basin produce varying amounts.

APPENDIX A

DESCRIPTION OF THE LOWER COLORADO RIVER BASIN

The Lower Colorado River basin is defined by Article II (g) of the Colorado River Compact as "those parts of the states of Arizona, California, Nevada, New Mexico, and Utah within and from which water naturally drain into the Colorado River system below Lee Ferry, and also all parts of said states located without the drainage area of the Colorado River system which are now, or shall hereafter be, beneficially served by waters diverting from the stream below Lees Ferry". The natural drainage area of the Colorado River system below Lees Ferry includes practically all the state of Arizona, parts of Nevada, Utah and New Mexico, and a very small part of the state of California.

The main stream of the drainage basin is the Colorado River proper extending from Lees Ferry to the Gulf of Lower California. The principal tributaries are the Gila River, most of whose drainage area is in Arizona; the Williams River which is all in Arizona; the Little Colorado, the extreme headwaters of which rise in New Mexico - the main portion of the drainage area, however, being in Arizona; and the Virgin River which rises in Utah and flows through the extreme northwest corner of Arizona into Nevada and thence into the Colorado River by way of an arm of Lake Mead. The Muddy River is a tributary of the Virgin River which also enters an arm of Lake Mead. No live tributaries enter the stream from the California side.


MEXICO AREA
COLORADO RIVER BASIN
INDEX MAP
COLORADO RIVER BASIN
SAN PEDRO CHANNEL
GULF OF SANTA CATALINA
GULF OF CALIFORNIA
UNITED STATES
MEXICO
ARIZONA
NEVADA
CALIFORNIA
LEGEND
IRRIGATED LAND
ARABLE LAND
RESERVOIR SITE
EXISTING CANAL
SCALE
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R. J. TIPTON, Consulting Engineer
LOWER COLORADO RIVER BASIN
PRESENT AND PROPOSED
DEVELOPMENT

The attached map shows the Lower Colorado River basin as defined by the Compact. The drainage area of the Colorado River system is bounded by the black irregular line. That portion of the Lower Basin lying outside the drainage basin of the Colorado River system which now receives water and which will receive additional quantities from the Colorado River lying all in the state of California, is shown on the map. Present irrigated areas are shown in green, and the arable areas some of which may be irrigated in the future are shown in orange. The present principal reservioirs in the Lower basin are shown by closely stippled areas, the principal one of which is Lake Mead.

Parker Dam which forms Lake Havasu on the boundary between Arizona and California is located about 150 miles below Boulder Dam. Davis damsite is shown on the map between Boulder and Parker Dams. ~~Davis~~ Bullshead reservoir, To be created by Davis Dam with a capacity of 1,600,000 acre-feet, will extend to Boulder Dam. Davis reservoir will be used to regulate ~~power re-~~ the water released for the ~~leases~~ generation of hydro-electric energy from Lake Mead and make the water so released parallel with the irrigation and municipal demand below Davis Dam, including the water to be delivered to the international boundary line for use by Mexico.

The Colorado River aqueduct which furnishes water to the Southern California Metropolitan Water District diverts from Lake Havasu by means of pumps. The line of the aqueduct extending from Lake Havasu to its western

terminus at Lake Mathews may be noted on the map.

Future proposed reservoirs are shown in red. In addition to Davis reservoir two other proposed reservoirs on the main stream may be noted on the map - Bridge Canyon, the dam of which will be a short distance above the high water of Lake Mead and Marble Canyon, the dam of which will be above the boundary of Grand Canyon National Park. Various reservoir sites exist on the tributaries and some ultimately will be constructed. The one on the Little Colorado, indicated on the map, will be largely for the control of silt. The one shown on Williams River will be for ~~the control of~~ silt and ~~f~~ flood control. The reservoir shown on the middle reaches of the Gila River below the town of Gila Bend will be constructed for flood control and the regulation of return flow and flood flows which reach the reservoir site from the upper portion of the Gila River.

The present and some of the potentially irrigable areas in both California and Arizona are listed in the following tables. The area designations are the same as those appearing on the map.

CALIFORNIA

Project or Area	Arable but not Irrigated	Irrigated 1932-42	Total
All-American Canal			
I. I. D.	122,160	400,840	523,000
Coachella	113,730	15,000	128,730
West Mesa	125,790		125,790
East Mesa	169,740		169,740
Pilot Knob Mesa	20,580		20,580
Total All-American	552,000	415,840	967,840
Yuma Project			
Reservation	5,340	2,400	7,740
Bard	1,550	4,770	6,320
Total Yuma	6,890	7,170	14,060
Palo Verde			
P.V.I.D.	37,570	35,430	73,000
Mesa	16,000		16,000
Total Palo Verde	53,570	35,430	89,000
Grand Total	612,460	458,440	1,070,900

ARIZONA

Project or Area	Arable but not Irrigated	Irrigated	Total
Williams River	5,950	2,380	8,330
Little Colorado	96,100	24,760	120,860
Kanab-Johnson		1,090	1,090
Sub total tribs. above Gila	102,050	28,230	130,280
Ft. Mohave	21,940	140	22,080
Colo. R. I. Reservation (Parker)	69,140	5,380	74,520
Sub total main stream below Boulder and above Imperial Dam	91,080	5,520	96,600
Central Arizona	1,500,000		1,500,000
Gila Project			
North Gila Valley	2,380	4,420	6,800
South Gila Valley	5,300	4,540	9,840
Yuma Mesa	172,430	100	172,530
Welton-Mohawk Palomas and San Cristobal	464,800	7,800	472,600
Total Gila Project	644,910	16,860	661,770
Yuma	6,820	47,610	54,430
Grand totals	2,344,860	98,220	2,443,080

The total available irrigable lands are in excess of the available water supply.

It is assumed that most of Arizona's water will be used below Boulder Dam and that the areas irrigated above the dam in the Little Colorado River, Kanab Creek, Virgin River, and other small tributary basins will not exceed some 50,000 acres. Twenty thousand acres may be irrigated in the Mohave Valley below Boulder along the main stream if there is not greater need for this water some place else. It is estimated that about 60,000 acres will be irrigated in the Colorado River-Indian Reservation. The Yuma project is practically fully irrigated.

Assuming the above areas to be fully irrigated, a substantial amount of water, for which Arizona has contracts with the Secretary of the Interior for delivery from Lake Mead, will remain for use in other areas. Two major possibilities exist for the use of this water. One possibility is the Gila project extending, as shown on the map, from the mouth of the Gila River up to the proposed flood control and conservation reservoir on the Gila. This area includes the Yuma Mesa which lies immediately east of the present Yuma project and south of the Gila River. A canal has been constructed from Imperial Dam to serve a part of the Yuma Mesa division of the first unit of the project. This division embraces a gross area of 172,430 acres, about 120,000 acres of which are irrigable. The balance of the Gila project comprises a gross of about 465,000 acres. It is reported that

the lands of the Gila project are not of good quality and that if all were irrigated they would require the application of relatively large amounts of water, to keep the land in good condition. A part of the area, particularly the Yuma Mesa addition, also is very gravelly.

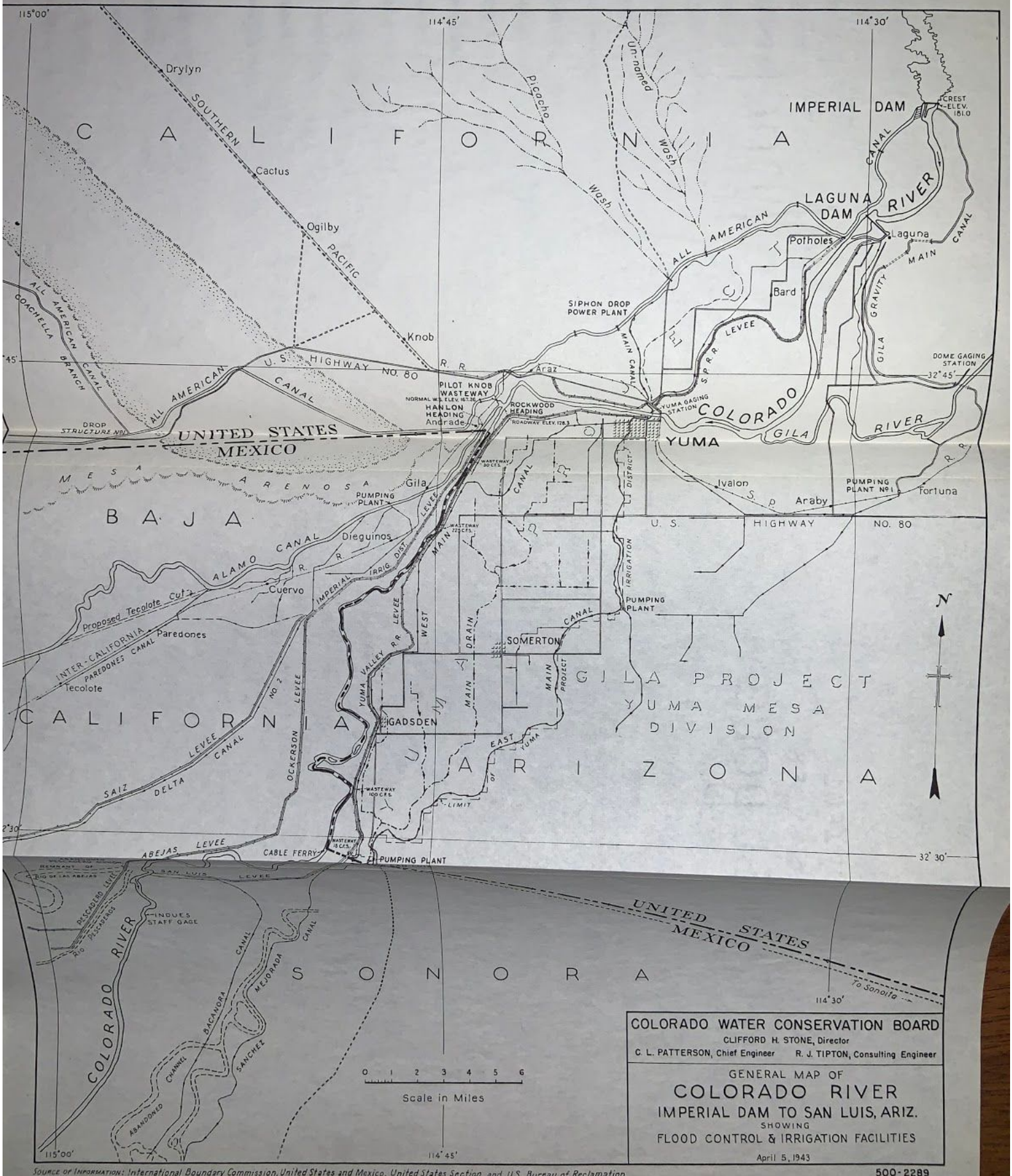
It may be that Arizona will choose to use a major portion of her share of the Colorado River in central Arizona, largely in the Gila River basin. A number of projects have been proposed to accomplish this, and investigations of some of these proposed plans are actively underway. One plan contemplates diverting water by a pumping plant from Lake Havasu and transporting the water in a canal across country in a generally southerly and then easterly direction, the line to terminate in Salt River at or near the Granite Reef diversion dam which diverts water to the Salt River project. The line of the canal is indicated by the dashed ~~orange~~ red line on the map. Several irrigable areas are indicated on the map along this line. The indicated areas are diagrammatic, because more good land exists along the proposed route of the canal than there will be water successfully to irrigate.

Two other aqueduct possibilities are under investigation, either of which would cover essentially the same area as would be covered by the Parker-Phoenix aqueduct. One plan would involve a diversion at Bridge Canyon reservoir to a long tunnel, and thence to a canal which would join the proposed Parker-Phoenix aqueduct where it takes out

of the Williams River. This line would be an all gravity line. The other possibility is a tunnel extending from Marble Canyon reservoir to the headwaters of the Verde River. This line would involve no canal. Considerable power could be generated on the Verde River.

In California on the main stream the Palo Verde project may be extended. The largest potential areas are in the Imperial and Coachella Valleys which would be served by the All-American canal. Among such lands are the East and West Mesas, both outlined on the map, and the Coachella Valley in the vicinity of Indio. A portion of the Coachella canal has been constructed and contracts have been let for the construction of the balance of the line. The West Mesa would be served by pumping.

The lands at present irrigated in Mexico from Colorado River waters in both Lower California and Sonora are shown in green on the map. They are shown to a larger scale on the insert on the left side of the map. The upper contiguous area is irrigated from the Alamo canal while most of the lower area on the Lower California side of the river has been irrigated by pumps. Some of the area on the Sonora side has been irrigated by pumps from the main stream, while another area just below the San Luis mesa has been irrigated by drainage and waste water from the Yuma project which is pumped from the main Yuma drain to the Sanchez Mejorado Mexican canal, the Mexican interests paying a portion of the pumping costs. It is reported that approximately 900,000 acres of



COLORADO WATER CONSERVATION BOARD

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GENERAL MAP OF

COLORADO RIVER

IMPERIAL DAM TO SAN LUIS, ARIZ.

SHOWING

FLOOD CONTROL & IRRIGATION FACILITIES

April 5, 1943

SOURCE OF INFORMATION: International Boundary Commission, United States and Mexico, United States Section, and U.S. Bureau of Reclamation.

500-2289

irrigated and irrigable land are available in Mexico to use Colorado River water without excessive pumping.

The attached map, No. 500-2289, is a larger scale map showing the Colorado River and various diversion, drainage, and protection facilities in the boundary region. The boundary between the United States and Mexico is shown on the map. Within the limits of the map the boundary starts on the left side as a land boundary between California and Lower California, extending in a slightly north by east direction to the Colorado River a short distance below Rockwood heading. From that point the Colorado River forms the boundary for a distance, including the meanderings of the river, of about twenty miles. The portion of the river which forms the boundary is called the limitrophe section of the river. From the lowest point on the limitrophe section about two miles west of the town of San Luis, Sonora, the boundary extends in a southeasterly direction between the state of Arizona in the United States and the state of Sonora in Mexico. The boundary between California and Lower California is commonly called the upper boundary and the boundary between Sonora and Arizona is called the lower boundary.

The United States Bureau of Reclamation-Yuma project, indicated on the map, extends from the Laguna dam on the Colorado River to the lower boundary. This project is one of the early Bureau of Reclamation projects and serves lands both in California and Arizona, most of the land lying in

Arizona. The project was formerly served by a canal diverting from the river at Laguna Dam and running along the upper side of the California portion of the Yuma project and thence across the river through a siphon to the Arizona side.

The All-American canal is indicated as diverting at the Imperial Dam, in the upper right hand corner of the map, and extending in a generally southwesterly direction to a point near the upper boundary, where it runs parallel to the boundary for some distance and thence northwesterly to skirt some high sand hills and again southwesterly to Drop Structure No. 1 where the Coachella branch of the canal takes out in a northwesterly direction. The All-American canal proper extends on westward connecting with the old Imperial canal near Calexico.

Most of Yuma project water is now furnished through the All-American canal, the diversion from the canal being at Siphon Drop which is shown on the map. The All-American canal down to this point was constructed to a capacity of 15,000 cubic feet per second, it being contemplated that 2,000 cubic feet per second would be discharged through the Siphon Drop power plant and thence to the main canal of the Yuma project. About 1200 cubic feet per second of the 2,000 cubic feet per second is returned to the river at a wasteway above the Yuma siphon and the balance is carried across the river through the siphon for use on the Arizona portion of the project. The All-American canal from Siphon Drop down to the Pilot Knob wasteway shown on the map is

constructed to a capacity of 13,000 cubic feet per second and from that point to Drop Structure No. 1 is constructed to a capacity of 10,000 cubic feet per second. It probably was contemplated that a power plant would be constructed at the Pilot Knob wasteway and surplus water would be discharged up to a rate of 3,000 cubic feet per second through the All-American canal down to Pilot Knob wasteway and discharged at that point through the power plant back to the river or to the Alamo canal to serve Mexico.

The Alamo Canal is shown on the map diverting from the river at Rockwood heading a short distance above the upper boundary, from which point the canal extends in a southwesterly direction crossing the upper land boundary about 1-1/2 miles below the Rockwood heading, and running therefrom in a generally southwesterly direction in Lower California skirting the sand hills. The canal turns and runs in a somewhat northwesterly direction, entering the United States near Calexico. The full length of the canal is shown on the map of the Lower Colorado River basin, Dwg. No. 500-371.

Various protective works consisting mainly of levees have been constructed along the lower reaches of the river to protect existing irrigated lands and irrigation facilities immediately contiguous to the river, and to prevent the river from again breaking through into the old Alamo and New Rivers and flowing thereby through the Mexicali and Imperial Valleys to the Salton Sea. These various levees

are indicated on the map.

The canal recently constructed to serve the first unit of the Gila project is shown as diverting from the river at Imperial Dam and running in a generally southern direction crossing the Gila River through a siphon and terminating at pumping plant number 1. A portion of the Yuma Mesa division of the Gila project is shown on the map.

The pumping plant near San Luis Sonora which serves the Sanchez Mejorado canal in Sonora is indicated on the map. This is the plant used to pump drain and waste water from the Yuma Main Drain.

APPENDIX B

Virgin Flow of Colorado River at Lees Ferry

	Combined Flow of Main Upper Tributaries	Adopted Flow at Lees Ferry			Normal Past Depletions		Past Depletions above Lees Ferry	Virgin Flow	10 Year Progressive Mean
		Lees Ferry	Paria	Total	Irr.	T.M. Div.			
1897	18,721	19,797		19,797	650	5	734	20,531	
98	12,206	12,948		12,948	711	5	652	13,600	
99	16,925	17,899		17,899	772	5	824	18,723	
1900	11,996	12,686		12,686	834	5	755	13,441	
01	12,925	13,668		13,668	896	5	847	14,515	
02	8,245	8,454		8,454	957	6	751	9,205	
03	12,550	12,346		12,346	1,036	6	938	13,284	
04	12,505	11,675		11,675	1,118	11	994	12,669	
05	13,800	15,290		15,290	1,197	21	1,206	16,496	
06	18,131	18,656		18,656	1,276	21	1,427	20,083	15,250
07	20,755	21,179		21,179	1,358	21	1,641	22,820	15,480
08	10,852	12,065		12,065	1,437	21	1,312	13,377	15,460
09	20,543	23,295		23,295	1,516	21	1,937	25,232	16,110
1910	12,392	13,583		13,583	1,568	21	1,509	15,092	16,280
11	14,688	16,473		16,473	1,620	22	1,708	18,181	16,650
12	17,666	18,393		18,393	1,671	22	1,879	20,272	17,760
13	12,394	12,581		12,581	1,724	30	1,631	14,212	17,850
14	18,206	19,868		19,868	1,774	35	2,098	21,966	18,780
15	10,964	12,396		12,396	1,826	55	1,740	14,136	18,540
16	16,865	18,380		18,380	1,878	85	2,199	20,579	18,590
17	19,918	20,436		20,436	1,929	105	2,420	22,856	18,600
18	13,373	13,775		13,775	1,982	105	2,035	15,810	18,840
19	9,980	10,611		10,611	2,032	115	1,868	12,479	17,570
1920	18,764	20,387		20,387	2,080	115	2,613	23,000	18,360
21	18,728	19,572		19,572	2,127	115	2,633	22,205	18,760
22		16,070	E30	16,100	2,175	115	2,427	18,527	18,580
23		16,940	E30	16,970	2,175	115	2,473	19,443	19,100
24		11,700	18	11,718	2,175	115	2,084	13,802	18,280
25		12,400	46	12,446	2,175	115	2,153	14,599	18,330
26		13,100	16	13,116	2,175	115	2,198	15,314	17,800
27		17,500	45	17,545	2,175	117	2,521	20,066	17,520
28		14,700	16	14,716	2,175	120	2,318	17,034	17,640
29		19,600	34	19,634			2,685	22,319	18,620
1930		12,400	21	12,421			2,157	14,578	17,780
31		6,220	10	6,230			1,698	7,928	16,350
32		15,100	38	15,138			2,364	17,502	16,250
33		9,730	18	9,748			1,951	11,699	15,480
34		3,948	18	3,966			1,520	5,486	14,650
35		10,266	17	10,283			2,020	12,303	14,420
36		12,108	37	12,145			2,185	14,330	14,320
37		11,980	26	12,006			2,230	14,236	13,730
38		15,640	26	15,666			2,570	18,236	13,850
39		8,839	33	8,872			2,075	10,947	12,710
1940		7,589	28	7,617			2,015	9,632	12,210
41		17,846	E30	17,876			2,760	20,636	13,480
42		14,738	E30	14,768			2,650	17,418	13,470
43		9,405	E30	9,435			2,240	11,675	13,470
Avge.		14,345		14,358			1,865	16,223	

Sources of Information: U.S.B.R. 1935 Hydrology Report and Supplemental memorandum from Mr. Riter revising and bringing data up to 1942. 1943 supplied from records at U.S.B.R. office.

VIRGIN FLOW INTO LAKE MEAD

Table B3 which follows indicates the past estimated discharge of the Colorado River at Boulder Canyon, and the estimated inflow to Lake Mead under present and assumed 1988 conditions each year from 1897 to 1943, inclusive. The quantities in the table for the period 1897-1940, inclusive, were taken from a United States Bureau of Reclamation table having serial number 45-D-10472. The table was brought up-to-date by the same methods that were used by the United States Bureau of Reclamation in making its estimates. The United States Bureau of Reclamation assumed normal depletions as of 1938 equal to 2,644,000 acre-feet and that the increased depletion between 1938 and 1988 would be 3,949,000 acre-feet. This represents a total estimated depletion above Lake Mead in 1988 of 6,593,000 acre-feet.

To arrive at the estimated virgin flow for any period which does not depart greatly from the long-time average, there should be added to the average of the estimated inflow to Lake Mead under 1988 conditions for the particular period in question the above depletion. For example, the estimated virgin inflow to Lake Mead for the period 1897-1940 equals 10,740,000 acre-feet (the average estimated inflow to Lake Mead under 1988 conditions for such a period) plus the total estimated depletion of 6,593,000 acre-feet, or 17,333,000 acre-feet. The estimated virgin inflow to Lake Mead for the period 1897-1943 equals 10,807,000 acre-feet (the average of the last column of Table B3) plus 6,593,000 acre-feet, or 17,397,000 acre-feet.

Table B3

ESTIMATE OF INFLOW TO LAKE MEAD AND CORRECTIONS TO REFLECT RUN-OFF CONDITIONS AS OF PRESENT AND 1988

Units - 1000 Acre - Feet

	Estimated Past Discharge At Boulder Canyon	Increased Depletions Between Past Conditions And Present	Estimated Inflow To Lake Mead With Present Conditions	Increased Depletions Between Present And 1988 Conditions	Estimated Inflow To Lake Mead With 1988 Conditions
1897	21,061	2,191	18,870	4,423	14,447
98	13,732	1,721	12,011	3,594	8,417
99	19,041	1,934	17,107	4,186	12,921
1900	13,496	1,582	11,914	3,554	8,360
01	14,540	1,590	12,950	3,712	9,238
02	8,699	1,268	7,431	3,080	4,351
03	12,107	1,390	10,717	3,554	7,163
04	10,701	1,281	9,420	3,475	5,945
05	17,038	1,352	15,686	3,910	11,776
06	19,272	1,415	17,857	4,344	13,513
07	21,677	1,420	20,257	4,660	15,597
08	13,490	1,010	12,480	3,554	8,926
09	26,525	1,313	25,212	4,975	20,237
1910	14,981	939	14,042	3,752	10,290
11	18,569	978	17,591	4,107	13,484
12	19,224	972	18,252	4,384	13,868
13	12,800	755	12,045	3,672	8,373
14	21,819	875	20,944	4,580	16,364
15	14,078	625	13,453	3,633	9,820
16	20,158	665	19,493	4,423	15,070
17	21,045	618	20,427	4,700	15,727
18	14,247	449	13,798	3,830	9,968
19	11,353	348	11,005	3,435	7,570
1920	22,293	422	21,871	4,700	17,171
21	20,562	362	20,200	4,620	15,580
22	17,960	279	17,681	4,186	13,495
23	19,506	285	19,221	4,265	14,956
24	12,971	240	12,731	3,594	9,137
25	12,920	249	12,671	3,712	8,959
26	13,629	255	13,374	3,791	9,583
27	18,406	291	18,115	4,344	13,771
28	14,889	262	14,627	3,988	10,639
29	19,732	308	19,424	4,620	14,804
1930	12,905	247	12,658	3,712	8,946
31	6,816	195	6,621	2,924	3,697
32	16,310	271	16,039	4,068	11,971
33	10,166	224	9,942	3,357	6,585
34	4,373	100	4,273	2,007	2,266
35	10,965	0	10,965	3,435	7,530
36	12,819	0	12,819	3,673	9,146
37	12,890	0	12,890	3,673	9,217
38	16,211	0	16,211	4,068	12,143
39	9,760	0	9,760	3,357	6,403
1940	8,411	0	8,411	3,280	5,131
41	19,524	0	19,524	4,486	15,038
42	15,618	0	15,618	4,095	11,523
43	12,073	0	12,073	3,396	8,677
AVGE. 47 Years	15,348	653	14,695	3,891	10,804

APPENDIX B

Table B4

Consumptive Uses above Imperial Dam, Diversions for use below Imperial Dam and Return Flow and Waste if Arizona uses no Colorado River Water in Central Portion.

Consumptive Uses above Imperial Dam:

By Arizona areas above Boulder Dam in Little Colorado River, Kanab Creek, Virgin River, and other basins - - - - - - - - - - - - - - - -	150,000 A.F.
Mohave Valley, 20,000 acres at 3.0 acre-feet - - -	60,000 A.F.
Parker Valley, 60,000 acres at 3 acre-feet - - -	180,000 A.F.

Diversions for use below Imperial Dam:

Yuma Project - - - - - - - - - - - -	280,000 A.F.	
North and South Gila Valleys - - -	50,000 A.F.	
Gila Project, First Unit - - - - -	720,000 A.F.	1,050,000 A.F.
		1,440,000 A.F.
Balance for remainder of Gila Project or Central Arizona Project (Exclusive of Gila River waters used) - - - - - - - - -		1,360,000 A.F.
TOTAL ARIZONA CONTRACT -		2,800,000 A.F.(1)

(1) BASED ON THE ASSUMPTION THAT THE 2,800,000 ACRE-FEET IS NET AND THAT NO RESERVOIR EVAPORATION OR DESILTING WATER IS CHARGED AGAINST IT.

Return flows and wastes from:

North Gila Valley - - - - - - - - -	20,000 A.F.	
Yuma Project (entire) - - - - - - -	180,000 A.F.	
Gila Project, First Unit - - - - -	360,000 A.F.	
SUBTOTAL - - - -		560,000 A.F.
Gila Project, Balance - - - - - - - - - - - - - - -		620,000 A.F.
GRAND TOTAL - -		1,180,000 A.F.

APPENDIX B (Cont'd)

Table B5

Consumptive Uses above Imperial Dam, Diversions for use below Imperial Dam and Return Flow and Waste Assuming Major Portion of Arizona's share of Colorado River water to be used in Central Arizona.

Consumptive Use above Imperial Dam:

By Arizona areas along Colorado River and tributaries above Boulder Dam - - - - - - - -	150,000 A.F.
Parker Valley, 60,000 acres at 3.0 - - - - - - - -	180,000 A.F.

Diversions for use below Imperial Dam:

Yuma Project (canals lined to reduce diversions)	235,000 A.F.
North Gila Valley - - - - - - - - - - - - - - - -	50,000 A.F.
Gila Project, minimum development - - - - - - - -	480,000 A.F.
Total - - - - - - - - - - -	1,095,000 A.F.
Balance available for diversion to Central Arizona - - -	1,705,000 A.F.
Total Arizona Contract - -	2,800,000 A.F.(1)

(1) BASED ON THE ASSUMPTION THAT THE 2,800,000 ACRE-FEET IS NET AND THAT NO RESERVOIR EVAPORATION OR DESILTING WATER IS CHARGED AGAINST IT.

Return flow and waste from:

North Gila Valley - - - - - - - - - - - - - - - -	20,000 A.F.
Yuma Project - - - - - - - - - - - - - - - - - - -	120,000 A.F.
Gila Project (minimum development) - - - - - - - -	240,000 A.F.
Central Arizona (returns to Gila subject to regulation in proposed reservoir) - - -	426,000 A.F.
Total - - - - - - - - - - -	806,000 A.F.

APPENDIX B (Cont'd)

Table B6

Draft on Water above Imperial Dam to make Deliveries to Mexico under Conditions Assumed under Table B5

Units in Acre-feet

Month	Ultimate return flow	Assumed (1) Mexican requirements	Make up water required from above	Surplus
January	48,000	55,000	7,000	
February	48,000	52,000	4,000	
March	56,000	120,000	64,000	
April	64,000	136,000	72,000	
May	73,000	78,000	5,000	
June	81,000	118,000	37,000	
July	89,000	169,000	80,000	
August	81,000	144,000	63,000	
September	73,000	96,000	23,000	
October	73,000	43,000	-	30,000
November	64,000	31,000	-	33,000
December	56,000	83,000	27,000	
Total	806,000	1,125,000	382,000	63,000

Net required from above Imperial with storage control on Gila River	319,000

	Acre-feet
All-American Canal delivery to Mexico	375,000
Make up water from above Imperial from above table	319,000
Total	694,000
Desilting water (minimum)	100,000
Net demand on water above Imperial Dam for Mexico	594,000

(1) Seasonal distribution per 1938-1941 use modified by minimum schedule provisions of treaty.

APPENDIX B (Continued)

Table B7

Releases from Lake Mead and Requirements for Consumptive Uses below Boulder Dam.
Present Conditions (Average water supply 1897-1940)
Treaty assumed to be in operation
Units - 1000 Acre-feet

Month	All American Canal, Yuma & North Gila(1)	River Projects (Cons.Use)	Los Angeles Aqueduct	Channel Losses	Sub-Total	To Mexico(2)	Parker & Imperial Res. Evap.	Total	Average Releases from Lake Mead	Dif-fer-ence	Return to River by Syphon Drop Power Plant	Sur-plus Goin to Mexi
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13
Jan.	266	9	3	34	312	25	2	339	1121	782	96	87
Feb.	274	9	0	42	325	23	3	351	1191	840	84	92
Mar.	359	12	2	54	427	54	4	485	1004	519	92	61
Apr.	365	13	3	69	450	60	6	516	1285	769	86	85
May	352	14	6	104	476	34	9	519	1196	677	89	76
June	360	15	6	123	504	53	12	569	1189	620	84	70
July	362	14	1	123	500	75	11	586	1201	615	91	70
Aug.	322	13	1	109	445	64	9	518	1145	627	89	71
Sept.	340	12	1	90	443	42	7	492	1116	624	79	70
Oct.	393	13	7	69	482	19	5	506	1104	598	79	67
Nov.	327	11	5	48	391	14	3	408	1135	727	84	81
Dec.	280	9	0	35	324	37	2	363	1138	775	97	872
Total	4000	144	35	900	5079	500	73	5652	13,825	8173	1050	9223

(1) Includes power water at Siphon Drop, but not water for Mexico.

(2) From All-American Canal.

APPENDIX B (Continued)

Table B8

Releases from Lake Mead and Requirements for Consumptive Uses from Boulder Dam.
Present Conditions (Average Low Water Period 1931-1940)
Treaty assumed to be in operation
Units - 1000 acre-feet

Month	All American Canal, Yuma & North Gila(1)	River Projects (Cons.Use)	Los Angeles Aqueduct	Channel Losses	Sub-Total	To Mexico(2)	Parker & Imperial Res. Evap.	Total	Average Releases from Lake Mead	Dif-fer-ence	Return to River by Syphon Drop Power Plant	Sur-plus Going to Mexico
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Jan.	266	9	3	34	312	25	2	339	892	553	96	649
Feb.	274	9	0	42	325	23	3	351	843	492	84	576
Mar.	359	12	2	54	427	54	4	485	847	362	92	454
Apr.	365	13	3	69	450	60	6	516	905	389	86	475
May	352	14	6	104	476	34	9	519	890	371	89	460
June	360	15	6	123	504	53	12	569	876	307	84	391
July	362	14	1	123	500	75	11	586	836	250	91	341
Aug.	322	13	1	109	445	64	9	518	864	346	89	435
Sept.	340	12	1	90	443	42	7	492	849	357	79	436
Oct.	393	13	7	69	482	19	5	506	845	339	79	418
Nov.	327	11	5	48	391	14	3	408	846	438	84	522
Dec.	280	9	0	35	324	37	2	363	853	490	97	587
Total	4000	144	35	900	5079	500	73	5652	10,346	4694	1050	5744

(1) Includes power water at Siphon Drop, but not water for Mexico.

(2) From All-American Canal.

APPENDIX B (Continued)

Table B9

NET WATER SUPPLY ABOVE IMPERIAL DAM

(Average 1897-1943)

Units in Acre-feet

Virgin inflow Lake Mead		17,400,000
Inflow Boulder Dam to Imperial Dam		195,000
Total gross water supply		17,595,000
Reservoir evaporation Upper Basin	400,000	
Reservoir evaporation Lower Basin	800,000	
Desilting Water	100,000	
Channel Losses Boulder Dam to Imperial Dam	600,000	
Total Losses		1,900,000
Net water supply above Imperial Dam		15,695,000

APPENDIX C

THE CONSUMPTION BY ARIZONA OF GILA RIVER WATER

This question has been in controversy for many years. In the opinion of the writer the best estimates are those that have been made by the United States Bureau of Reclamation. The following table is quoted from page 25 of the report by the United States Bureau of Reclamation, dated December, 1934, entitled "Stream flow of Lower Colorado River and its tributaries."

Units - 1000 A. F.

Feature (based on average annual conditions attained 1895 to 1933 inclusive)	Virgin Condition of River	Present Conditions
Original stream flow in Phoenix vicinity	2,359	2,359
Upstream irrigation depletion	-	91
Evaporation losses upstream reservoirs	-	132
Net inflow to Phoenix area	2,359	2,136
Channel losses in Phoenix area	538	269
Irrigation depletion " "	-	1,223
Net flow at Gillespie dam	1,821	644
Channel losses below Gillespie, including uses below Gillespie dam	490	290
Net flow at mouth	1,331	354
Net effective depletion due to present irrigation development		977

It may be noted that the Bureau of Reclamation estimated that the net effective depletions due to present irrigation development are 977,000 acre-feet. The table indicates that the Bureau estimated, under natural flow conditions, the original water production was 2,359,000 acre-feet per annum of which 1,331,000 acre-feet passed out of

the Basin at the mouth. In other words, prior to irrigation about 1,000,000 acre-feet of the original water produced was being consumed by natural processes. It is believed that this situation is the one which has caused most of the controversy concerning Arizona's consumption of Gila River water. It would not be equitable to charge a basin or a state for waters that are consumed by natural processes. Such policy would involve charging the apportionment to the Lower Basin for the natural losses which occur between Boulder Dam and Imperial Dam estimated under natural conditions to have been practically 1,000,000 acre-feet.

It is the conclusion of the writer that the present beneficial consumption of Gila River water by Arizona approximates 1,000,000 acre-feet. This quantity has been used in the foregoing discussion where Gila River consumption has been an item for consideration.

APPENDIX D

RESERVOIR EVAPORATION - DESILTING WATER - CHANNEL LOSSES BELOW BOULDER - LOWER BASIN RESERVOIR SPILL UNDER ULTIMATE CONDITIONS

Reservoir Evaporation

It is assumed that under ultimate conditions there will be in operation on the main stream of the Colorado River in the Lower basin the following reservoirs: Marble Canon, Bridge Canon, Lake Mead, Bull's Head (Davis Dam), Lake Havasu (Parker Dam), and the Imperial Reservoir formed by the Imperial Diversion Dam.

The total original water and land surfaces in the reservoir areas are estimated at about 25,000 acres and 330,000 acres respectively. The average aggregate water surface of all reservoirs under operating conditions is estimated at about 184,000 acres, and the land surface that will be influenced by the reservoir operation is estimated at about 71,000 acres. It is estimated that the original water and land surface within the reservoir sites under natural conditions consumed about 400,000 acre-feet of water per year by evaporation and transpiration. The total loss from the reservoirs after they are all placed in operation is estimated at 1,200,000 acre-feet per year. Increased loss due to the reservoirs, therefore, is estimated at 800,000 acre-feet. This quantity has been used in the foregoing discussion to represent net main stream reservoir evaporation in the Lower basin under ultimate conditions.

Desilting Water

Various estimates have been made of the amount of water that will be required to remove the silt from the water diverted through the All-American Canal and to be diverted through the Gila Project Canal. These estimates have ranged as high as 400,000 acre-feet per annum.

Prior to the construction of Boulder Dam, the Colorado River carried very large quantities of silt, which over a long period of years formed the delta region of Lower California. Since Boulder Dam was constructed, the major portion of the silt is being stored in Lake Mead.

The origin of a large part of the silt carried by the Colorado River is the San Juan, the Little Colorado and the Williams Rivers. It is probable that Bluff reservoir will be constructed on the San Juan River as a silt storage reservoir. The proposed reservoirs on the Little Colorado and Williams Rivers, if constructed, will intercept silt originating above those reservoirs. These tributary reservoirs, together with other main stream reservoirs constructed in the Upper basin, may prolong the life of the Lower basin main stream reservoirs indefinitely.

The clear water, however, now being released from Lake Mead is causing a degradation of the river channel by eroding the bed of the river below Boulder Dam and carrying the load (silt and sand) to the lower reaches of the river. Since the construction of Parker Dam, this load is being deposited in Lake Havasu. Degradation of the channel is

occurring below Parker Dam, the sand and silt load which is picked up by the river being deposited in the reservoir formed by Imperial Dam. This latter reservoir has now become filled, and the problem of desilting or "desanding" the water diverted by the All-American Canal is an immediate one.

It is believed that as development increases in the Upper basin and the water supplies become more nearly equated by the operation of additional reservoirs, the river channel will become fairly stabilized below Parker Dam so far as the action of water released from Lake Havasu is concerned.

After the Lower basin tributary reservoirs are constructed, very little area will remain that will contribute silt to the river. Such area will consist only of the non-prolific drainage area below Parker Dam. It is believed, therefore, with probable channelization of the river from the Mexican diversion structure to Parker Dam and the small amount of tributary flow which will be available to bring silt to the river, that requirements for desilting water at Imperial Dam may not exceed 100,000 acre-feet per year. This quantity has been used in the foregoing discussion as the estimated requirements for desilting water under ultimate conditions.

Channel Losses below Boulder

Channel losses below Boulder Dam under natural conditions are estimated at about 965,000 acre-feet, 270,000 acre-feet of which occurred between Boulder Dam and Topock and 695,000 acre-feet between Topock and Laguna Dam.

The total length of the river channel between Boulder Dam and Laguna Dam is about 308 miles. After Davis Dam is constructed, about 130 miles of the river channel will be taken up by reservoirs, including Bullshead, Lake Havasu, and Imperial. New lands will be irrigated along the river channel, including the Mohave Valley, the Parker Indian Project, and the Cibola Valley Project. Much of the present and past channel losses under ultimate conditions will have been converted to beneficial consumption. The smaller water supply under ultimate conditions also will cause a reduction in natural losses. A detailed analysis indicates that residual channel losses under ultimate conditions will not exceed 600,000 acre-feet per annum. Such losses may be as low as 300,000 acre-feet per annum, assuming channelization of the river up to Parker Dam.

Lower Basin Reservoir Spill under Ultimate Conditions

To equate fully the virgin flow reaching Lake Mead for such a period as 1897-1943, inclusive, would require a total of about 54,000,000 acre-feet of reservoir capacity. Under ultimate conditions it is estimated that about 20,000,000 acre-feet of capacity will be available in the Lower basin, assuming only 16,000,000 acre-feet of Lake Mead as being available for regulatory purposes, and that about 20,000,000 acre-feet of reservoir capacity will be available in the major main channel and main tributary reservoirs in the Upper basin that will be constructed for the generation of hydroelectric energy. Many smaller reservoirs will be

constructed in the Upper basin as features of projects for the irrigation of new lands in the basin and for the providing of supplemental supplies for present irrigated lands. Other reservoirs will be constructed as parts of large trans-mountain diversion projects. It is estimated that the effect of the operation of all of these reservoirs, trans-mountain diversions and the regulatory effect of irrigation of additional lands will largely equate the flow of the stream so that very little, if any, spill will result under ultimate conditions from a water supply such as is estimated to have been produced from 1897-1943, inclusive.