

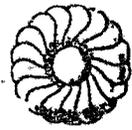
G. E. P. Smith

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Harnessing of the Colorado River

BY
GEORGE E. P. SMITH

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HARNESSING OF THE COLORADO RIVER ¹

By DR. GEORGE E. P. SMITH

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Turning of the now wasted vast potentialities of hydro-electric powers and the irrigation benefits to agriculture of the Colorado River to serve the purposes of man is one of the great conservation projects of our day and of the world. The theme is one with many facets; and therein lies so much of the general misunderstanding on the part of geologists, scientists and the public as to just what Congress and our Government proposes to do with one of the great streams of the continent, why seven great commonwealths are quarrelling over it, and what is an equitable basis for settlement of the Colorado River controversy.

If we may employ the term political in its truest sense, no other political problem in Arizona is fraught with so much potential welfare and so much menace as that of the Colorado River. I shall sketch the various aspects of the problem and shall review the history of the conflict. Also I shall be bold enough to offer a solution, one which is sound from both engineering and political standpoints and which can restore a spirit of amity and co-operation among the states of the Southwest.

We shall first refresh our memory as to the geography of the Colorado basin. The river and its tributaries drain the western slope of the Continental divide from western Wyoming to Silver City, New Mexico, and the intervening lower country down to the head of the Gulf of California. Technically, the river begins at a point about fifty miles northwest of Denver. The largest tributary is the Green River, and the two next in importance are the San Juan and the Gila rivers. The drainage basin includes the south-

¹ Address delivered before the Arizona State Bar Association, December 15, 1928.

western part of Wyoming, the western half of Colorado, the eastern half of Utah, western New Mexico, virtually all of Arizona, the southeast corner of Nevada, and a narrow fringe of California.

The Colorado River, in volume of flow, is sometimes called the third river of the United States. This is not true, however; it is the sixth, standing next after the Sacramento. The longest record of measurement of stream-flow is that at Yuma, where the average annual discharge has been about seventeen million, three hundred thousand acre-feet. A more significant figure, however, is the volume of the reconstructed river; that is, had there been no diversions for irrigation and the water had all reached Yuma, there would have been during the period of measurement an average of approximately twenty-one million acre-feet. That is the volume to be considered, therefore, in discussions of adequacy and of allocation.

Study of irrigable areas and water-demand indicates that the future ultimate requirements for the seven states may practically exhaust the entire supply. For a long time to come, there will be a surplus for Mexico. If, however, Mexico acquires water-rights for all, or even half of her irrigable area, it will cause a serious depletion in the supply and the burden of the deficit is bound to fall on Arizona. The real contest for the last four million acre-feet is between Arizona and Mexico.

Sixty per cent of the total volume of water is gathered above the junction of the Green River with the main river; forty per cent of the supply originates south of that point. Arizona contributes about four million acre-feet. The Gila River, reconstructed, accounts for two million, seven hundred thousand acre-feet.

The annual flood, due to melting snows, occurs in May and June. During the late summer, through September, in many years, the flow is below the present requirements for irrigation. In 1924, the Imperial valley was practically out of water for two months, and the crop losses were estimated at five million dollars. If the rainfall and run-off should get as low again as they were in 1902, there would be complete failure in the Imperial valley and

the Yuma valley would experience water shortage. Therefore, the necessity for storage.

There is no dearth of reservoir sites on the Colorado River and its tributaries. Of good dam-sites, there are many score, but many of these sites do not have wide basins just above them. There has been much argument as to which sites are best, and also as to which should be developed first. Referring only to those sites which figure in the day's news, and beginning down-stream, there are: The Parker site, the Topock site and the Bulls Head site, these three being adapted to dams of perhaps one hundred feet height, but all three with discouragingly great depth to bed-rock; next in order, the Black Canyon site and the Boulder Canyon site, where bed-rock is deep, but where a very high dam, if feasible, would utilize an enormous storage capacity; next the Bridge Canyon site and the Diamond Creek site, excellent as power dam-sites, the height of a dam at the Diamond Creek site being limited by topography, while the Bridge Canyon possibilities are almost limitless; then two sites near Lees Ferry, the Marble Gorge and the Glen Canyon, comparable to the Black and Boulder sites as to storage capacities but farther from the best present power-market; and finally, in Utah, the Dewey site on the main stream, the Ouray, Split Mountain, and Flaming Gorge sites on the Green River, and the Juniper Mountain site in Colorado, on the Yampa.

Inasmuch as the San Juan River, the Little Colorado, and other tributaries between the mouth of the Green and the mouth of the Gila, never produce floods which seriously menace the lower river, the problem of flood control may be divided into two parts: First, the control of the Gila; and second, the control of the upper river, which may be effected wherever the storage can be most wisely and cheaply secured, and just as well in Utah as in Arizona.

River development has usually been effected by building dams on the head-waters first. It is an engineering principle that a stream should be controlled by beginning at the head. Thus Arizona has brought the Salt River under control. And thus the United States Reclamation Service set out to do on the Colorado. Between 1914 and 1919 the reservoir sites of the upper river were studied, and the plan was advanced to regulate the main stream by dams at Kremmling and Dewey, with two million acre-feet capacity at each,

and to regulate the Green River separately, either at the Ouray site, or at Flaming Gorge. The Juniper Mountain project, to regulate the Yampa, was included also but that project is a small one.

However, subsequent to the development of those plans, consideration of the Kremmling site was abandoned, and yet the Dewey reservoir was still considered as of two million, three hundred thousand acre-feet capacity, while the capacity needed for river regulation is four million acre-feet. It was an unfortunate oversight — a blunder. In the published reports of the Reclamation Service the possible capacity is stated to be two million, three hundred thousand acre-feet and the reports have wailed that the reservoir was too small. I have mistrusted for several years that an injustice was being done to the Dewey project. Through interviews with the engineer who had charge of the original surveys and through information from the chief engineer of the Denver and Rio Grande Western railway, which runs through the upper edge of the reservoir, through these sources I have verified a conclusion based on study of plans and maps, that the Dewey dam can be built to a height of two hundred and seventy-five feet, equal to that of the Horse Mesa dam, and will then hold back four million acre-feet, and thus thoroughly equate the main river down to the mouth of the Green. A short stretch of the railway must be moved to higher ground, but the cost will be less than half the cost of rebuilding the Bowie-Globe railway around the San Carlos reservoir. The total cost of the Dewey dam, including the moving of the railway, would be about one-twelfth of the cost of the Boulder project, and because of the shallow foundations at the Dewey site, the dam can be started any year, wet or dry, and can be completed in two and a half years.

What would be accomplished? Let us see. First, flood-crests of the annual floods at Yuma would be reduced about fifty per cent. Last year, which was an average year, there were two peaks, seventy-four thousand and seventy-seven thousand second-feet. They would have been reduced to thirty-five thousand and forty thousand. The maximum recorded flood occurred in June, 1921, when the flow reached one hundred and eighty-six thousand second-feet. The Dewey dam would have reduced that flow to less than ninety thousand second-feet. Is that worth while? Levees

must be maintained along the lower river anyway, because of the occasional floods from the Gila River, and if the extreme floods in the main stem of the river can be brought below ninety thousand second-feet, the control will be equal to that on any other big river in this country. But the Dewey dam would be followed by others. In a few years there would be a dam on the Green River and a dam for power in the Canyon region in Arizona. Which is better: River regulation in fifteen or twenty years, or fifty per cent regulation in three years and complete regulation in six years?

What other inducements? The flood-water stored in Dewey reservoir in May and June would be released gradually through the succeeding months, and the low-season late-summer flow would be more than doubled, making the power dam-sites in the Canyon region of great value, while at present, and until there is stream regulation above, neither the Diamond Creek site nor any other of the power-sites above Boulder Canyon is "worth a continental."

Furthermore, the augmented late-summer supply would prevent another disastrous shortage in Imperial valley like that of 1924, and would permit of normal gradual increase in irrigated area throughout the entire Colorado basin. Let us emphasize this. The four million acre-feet held back from early summer to late summer would permit the irrigation of all projects in California and Arizona up to a time when the so-called high-line project may become economically feasible, and would release the normal late-summer flow for use in the upper basin.

In addition the Dewey dam, by giving fifty per cent stream regulation, would thereby reduce the difficulties and the hazards of building foundations later on for a great dam in the main stream below the Canyon region.

The Dewey project is a simple, easy one, of small cost but large in dividends, and it is a burning shame that this first project has not been authorized by Congress, and built during the past six years, thereby giving to Yuma and Imperial valleys the degree of flood protection which they have a right to expect, and obviating the apparent emergency which threatens to embroil the National Government in the hydro-electric-power business.

It is noteworthy, too, that the State of Utah desires the Dewey dam, and would join with Arizona in advocating its construction.

About 1920, the Reclamation Service began to advocate a great project in Boulder Canyon. The new plans provided also for the irrigation of eight hundred and fifteen thousand acres in Mexico, and it is probable that the plans had the approval of the owners of the rich alluvial Mexican delta lands. Then the cupidity of Los Angeles boosters was aroused by pointing out the possibility of flooding the Los Angeles industrial market with cheap power, and later they discovered that Los Angeles water supply would make a good talking point. The Reclamation Service in 1920 was "broke," and therefore Los Angeles, Pasadena, and the Imperial valley raised several hundred thousand dollars, with which the Reclamation Service carried on extensive test-drilling and other engineering studies of the Boulder project. The result of the test-drilling was sadly disappointing; the bed-rock was found to be three times as deep as had been expected, and dangerous earth-faults were revealed at the narrow sections of the canyon. No satisfactory dam-site was found in Boulder Canyon. So the test-drilling was moved into Black Canyon, the next canyon below Boulder. Conditions there were not much better as regards the depth of foundations, and much of the rock is spongy and inferior to the rock at Boulder Canyon, but after a period of indecision, it was concluded that in spite of the great hazards, foundations for a dam probably could be built at one place in Black Canyon, though at great cost.

Meanwhile, the hydro-electric-power companies of California, realizing the menace to their investments by this proposed competition, made extensive engineering studies on the Colorado. Their engineers, however, had the good sense to see the impracticability of building a high dam immediately on the lower river, and so their efforts were directed toward first securing a fair degree of river regulation above the Grand Canyon region, to be followed by a power project somewhere on the lower river within reach of the California market for power. Regardless of whether the development is made by public or private agencies, that plan is the only sound and sensible one. Based on reconnaissance investigations, the power companies considered a very high rock-fill dam at Glen Canyon for river control, and when that proposal was ridiculed by the engineering profession, they considered a medium-height dam

at the same location, a proposal that indeed might be meritorious if the same objects could not be secured with less risk and at far less cost by smaller dams still farther up-stream.

Last February, I challenged the ability of engineers to design a dam seven hundred feet high from foundation to high-water line. Engineering is not a pure science but applied science. I had just listened to an address by Prof. Charles B. Wing, Professor of Structural Engineering at Stanford University, in which he explained how engineering progress is made by the trial and error method. The Quebec bridge was an example of advancing too fast; engineers built before they had studied compression in large members. Col. Goethals testified that there will be stresses in high dams of which we do not know. The design of high gravity dams is based on theory, and the theory may be right or may be wrong. It is only within a year that engineers have come to realize that long dangerous cooling cracks are inherent to massive concrete, and assumptions are made as to upward pressure which after all are only assumptions. The compression stresses at the toe, allowed in the design of the Boulder dam are higher than have been used heretofore. And the hazards of building foundations in a constricted high-walled canyon, at a depth of one hundred and thirty-six feet below the river-bed, with the possibility of floods of two hundred thousand second-feet during the annual flood season, and of eighty thousand second-feet at other times, with huge quantities of drift to choke the entrance to by-pass tunnels, such hazards are unjustifiable. Failures of dams have been common, but the Boulder dam simply must not fail, by earthquake or otherwise, for the sudden losing of twenty-six million acre-feet of water would be devastating.

If the Boulder dam were built to a height of three hundred and fifty feet instead of seven hundred feet, another dam could be built at the Grand Wash site to utilize the rest of the fall. It would stand wholly on Arizona soil, and the power would be under Arizona's control.

If Congress sees fit to make a huge appropriation for the Boulder dam, it should provide by amendment that, while by-pass tunnels are being driven at the Boulder site, a part of the appropriation shall be spent in building Dewey dam, to reduce the

flood-crests. Its cost would be saved in conserving life and property and time at the lower site.

The Dewey dam should be built at Federal expense as the nation's contribution to flood-control on the Colorado River, and no further call should be made on Congress. The Southwest could then continue its development alone.

Some opponents of the Boulder project have concentrated their propaganda in favor of a flood-control dam at the Topock site, near Needles. I have felt that that propaganda was not in good faith, but merely a stop-gap, for the principal objection to the Boulder dam as a first project applies to the Topock site with equal force. The bed-rock at Topock is certainly over one hundred feet below the river-bed and may be over two hundred feet. No boring has been done at the site, but we have the evidence obtained at the Santa Fe Railway bridge site two miles up-stream. And a short distance down-stream, at the mouth of Bill Williams Fork, a test-hole of two hundred and thirty feet depth was still in gravel. The difficulties and the risks are so great that neither the Boulder nor the Topock dam should be undertaken until river-control is secured farther up-stream at points where bed-rock lies at shallow depths. At the Marble Gorge site, also, the depth to bed-rock is too great.

Had Los Angeles not developed its thirst for cheap power, to be developed on somebody else's soil, Imperial valley would have worked in harness with Arizona for a project which would be to their mutual advantage. Los Angeles plotters realized that, if they were to obtain power, free from that public duty of property which we call taxation, it must be accomplished through the agency of the National Government. The National Government and the State cannot tax each other, each being a sovereignty. It was not the magnitude of the cost; indeed, Los Angeles asserts that she will build an aqueduct from Blythe to Los Angeles at a cost much greater than the cost of the entire Boulder project, including its power features and the All-American Canal. It was not the cost; it was the scheme of getting Arizona power without paying taxes to Arizona. If Los Angeles wins at Boulder Canyon, she will win likewise at Bridge Canyon when that power is needed, for that dam also will be undertaken as a National project. (So will Flam-

ing Gorge and Split Mountain). Our greatest natural resource will be alienated from State control.

Among the fallacious arguments that have figured in California propaganda is the statement that the storage capacity required on the Colorado is twenty-six million acre-feet, and that the Boulder project is the only one which provides so much storage. Twenty-six million acre-feet! That is just ten times as much as the capacity of the largest reservoir in the world! Well, it will be needed in eighty or one hundred years, when all of the water supply of the river, including all of the flow of years of exceptionally high run-off like 1909, when all of the water is utilized and applied to irrigation. But today only one-fifth of that capacity is needed, and for a generation less than one-half will be needed. And besides, the total storage finally required should be distributed among several reservoirs, some of which should be situated above the Canyon region.

Just what are the needs?

First, a reasonable degree of flood-protection for the lower river. And time is the essential factor, for the flood which menaces Imperial valley may occur in 1933 quite as likely as in 1943.

Second, additional water for irrigation in late summer. A few million acre-feet will meet that need for twenty-five years, maybe fifty years.

Third, power, after a while. Los Angeles has enough power in sight for twelve to fifteen years, and Arizona power needs will be supplied by further developments of the Salt and Verde rivers. The logical answer is a dam somewhere in northwestern Arizona, at Black or at Bridge Canyon, after storage in the upper river.

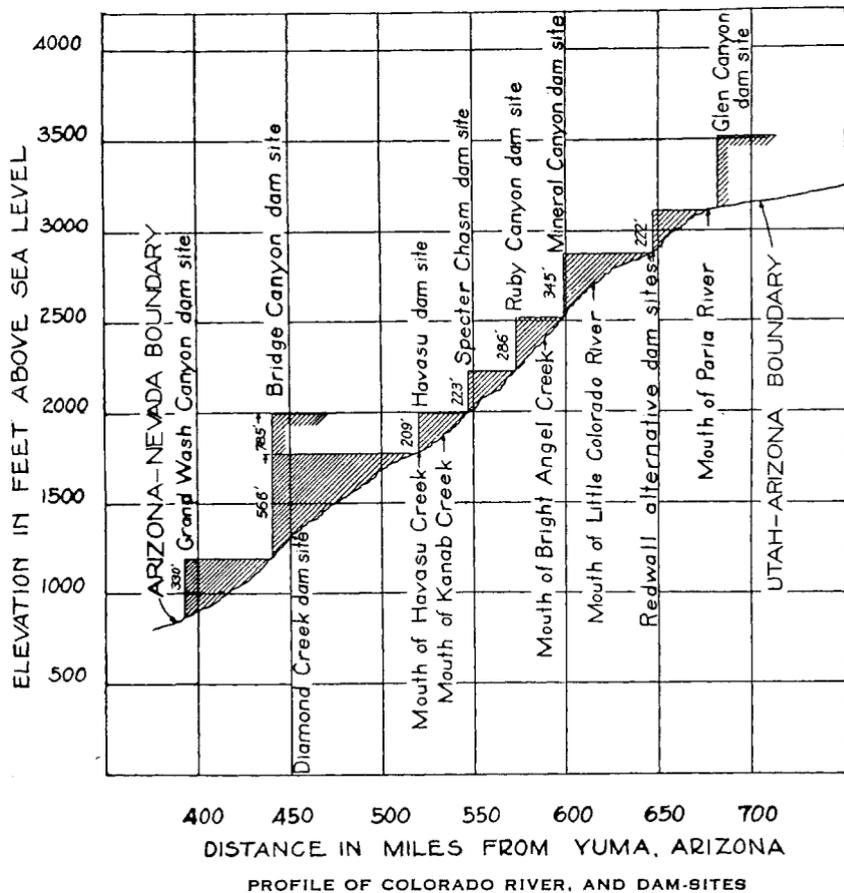
Fourth, silt-storage. This is a fallacious demand. Silt-storage will come incidentally with the building of dams; however, the total silt-storage in the Colorado River reservoirs will suffice for less than two hundred years, and then what shall be done? Silt-storage has always been considered a curse. During the next decades, before the water has been put to use and while most of the water will run to the sea, the effort should be to make it carry its load of silt with it, so as to conserve the storage space. If the Dewey dam and a dam on the Green are built, the Colorado River can be canalized below Yuma and some of the silt can be passed

through the reservoirs at times and carried away to the sea. Imperial Irrigation district is put to great expense to handle the silt in its canal system, and the farmers object to so much silt on their land, but those troubles would be obviated largely if the District would, first, connect their canal to the Laguna dam as they long ago contracted to do, and second, if the District would build its canals on proper grades. At the Laguna dam the water could be settled and skimmed in the same manner as the water supply for the Yuma valley, or even better. The Imperial Canal never has had adequate head-works. As already stated, the river water will be de-silted, in part, in reservoirs, wherever they are built, but for fifty years silt will be picked up again below the reservoirs so that de-silting will be required at every head-works.

Fifth, water supply for Los Angeles. This is another Los Angeles bugaboo. There have been gross, exaggerated and deceptive misstatements as to Los Angeles' dependence on Colorado River for water supply. What are the facts?

In order to get at the true picture, I have studied the engineering reports, particularly the one made by three eminent consulting engineers, a report made primarily, to win support of the city voters for a bond issue for investigations, plans and estimates of the Colorado River aqueduct. This report, if it erred, erred in the direction of minimizing the extent and value of the Owens Valley supply and magnifying the necessity for bringing Colorado River water to Los Angeles.

The report shows that the two proposed storage regulating reservoirs in Owens Valley, one in the upper end and one near the intake of the aqueduct, have not as yet been built; that the program of buying irrigation water-rights for municipal use, a superior use and, therefore, a justifiable procedure, has been carried out but partially; that the quantity obtained through the aqueduct has been only about two hundred and sixty second-feet; and that when the program is completed, the supply, during the years of lowest rain-fall will be five hundred and forty-five second-feet; that the adjacent Mono basin will furnish an additional one hundred and eighty second-feet, to be conveyed through the same aqueduct; that this supply will be adequate for the city, within its present limits including San Fernando valley, until 1960; but if



PROFILE OF COLORADO RIVER, AND DAM-SITES

the entire county from Pomona to San Pedro is considered and complete irrigation development and tremendous rate of population growth are premised, then the Owens-Mono supply will be exhausted by 1933. It is, therefore, the extension of irrigation supply for Pomona and San Gabriel valleys and the coastal plain, and not the needs of the city and San Fernando valley, that inspires Los Angeles to undertake the bringing of Colorado River water across the state, two hundred and sixty miles, and to lift it to a height of one-third of a mile, thence to flow through a long tunnel beneath San Gorgonio Pass. Costly water for irrigation use!

The present Owens Valley supply, therefore, can be approximately tripled in quantity, some California engineers say quadrupled, and since that water is far superior to Colorado River water in quality and since it will flow down hill all the way to Los Angeles, generating power, it is inevitable that it will be developed first. When the Swing-Johnson bill becomes a law, and the absurd Mulholland-Eaton feud is settled, Los Angeles could at once begin work on the further development of the Owens Valley supply. The Los Angeles need for water is not an emergency; it is a monumental bluff. Arizona admits that Los Angeles has a legal right to appropriate the water; but she objects to the use of that bugaboo as an argument for the Boulder power project.

We have now discussed the needs. The legitimate needs of flood-control and water for irrigation can be met best by head-water storage, and the need for power, by a dam at Bridge Canyon, where, as compared with the Boulder project, the canyon is narrower, bed-rock is only one-third as deep, and the character of the rock is better. Los Angeles, even, would be served better by this program, for that city could have power more quickly and at lower cost, from Bridge Canyon than from the Boulder project. The transmission distance, presumably via Shaver's summit, would be no greater. The two dams, Dewey and Bridge, can be built at much less cost than Boulder dam, and more quickly, and with less risk. The problems of silt and of Los Angeles water supply will be solved incidentally. Boulder dam should come later when additional power is needed and when the stream-flow has been equalized.

What interest has Arizona in the Boulder project? Five years

ago I told a prominent political leader of this state that head-water storage would make our power sites valuable. His reply was, "Yes, but we want the Government to build the dam in Arizona, to spend the money here; it will make times good." Short-sightedness! He expected that the Government would build a railway from Kingman to Boulder Canyon and that Kingman would become a real city, for ten years at least, while the dam was under construction. By 1924, it had become apparent that the Boulder dam was a California-Nevada project, with Arizona left out entirely. Las Vegas, Nevada, would become a city temporarily, and Nevada might hope to derive revenue from the power generation, the power house being on the Nevada side, but for Arizona — not a smitch of revenue, though the power "head," that is, the fall in the river, most of it, is a natural resource of this State, and several good dam-sites in Arizona would be submerged. The power would go to Los Angeles and most of the water to California and Mexico. Even today it is difficult to get Arizona people away from the proposition that the first dam should be built in Arizona "to make times good."

Due to the pressure exerted in 1927 at the Denver conference by the Pittman resolution, California appeared to yield the principle that Arizona and Nevada should be compensated, in lieu of taxes. However, the eighteenth and three-fourths per cent amendment to the Swing-Johnson bill will be totally ineffective, for the sale of power will be so slow and the sale price so low that there will be no surplus revenue. California will plead for a bargain price, and will get it.

The story of the Colorado River imbroglio is a depressing one. If the whole narrative of the plotting, the political chicanery, the fallacious propaganda, the blunders, and the reprehensible coercion shall ever be written, it will read like a succession of chapters of *Les Miserables*. Bedeviled scheming and pressure from without and bewildered faintheartedness within have forced Arizona backward by steps, till she fights "with back against the wall."

Seven years ago this little state was happy working out her own destiny, engrossed in development of the Salt and other tributary streams. But the Colorado, the greatest natural resource of the state, excited the cupidity of our affluent neighbors, and in their

The accompanying views are presented by courtesy of the Arizona Bureau of Mines.

machinations they have capitalized even our weakness and unsophistication.

First, it was the great land-holders to the south of the international boundary. There is good evidence that as far back as 1915 they were planning that the opulent government of the United States should create storage on the river so that the regulated, equalized flow could be diverted onto the vast areas of rich alluvial delta land in Mexico. That each additional acre in Mexico meant the dedication of an acre in Arizona to the desert did not deter them. The extent of their direct and indirect influence on American officials will never be fully known.

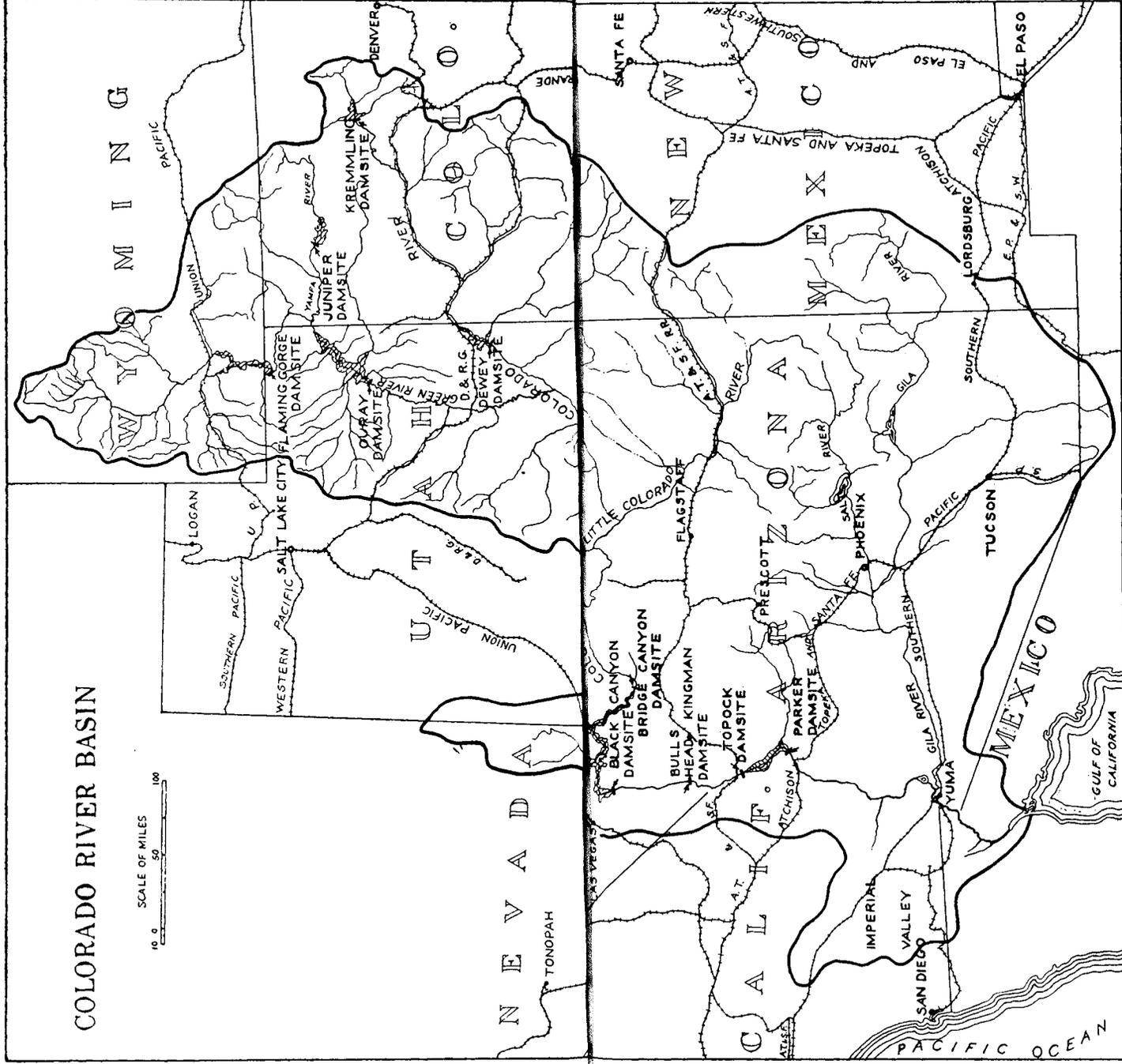
Then came Los Angeles and Imperial valley. Los Angeles wanted hydro power; Imperial valley needed a reasonable degree of flood protection, and it needed more water for late summer. That Valley should have worked hand-in-hand with Arizona for a rational development of the river, but it espoused the grandiose scheme of Los Angeles real estaters, which was based on the scheme of the owners of Mexican land. To cheapen the hydro power, it must escape taxation, and so it was desired that the Federal Government should own and control the development, even though in defiance of established law. Certain interests in southern California, not all, have labored, in season and out of season, craftily oft-times, indefatigably, laying the foundation for the undertaking by Congress of the indefensible Boulder project, buying votes with votes and with figs, almonds, and grape-fruit, propagandizing the country with fallacies, and dramatizing even the bigness of the project. At first the appeal to Arizona was that we would shine in the reflected prosperity of Los Angeles; and many Arizonans were duped. Later, in 1924, it became apparent that the Boulder project was a two-state, California-Nevada, enterprise, with Arizona left out, because the power-house would be on the Nevada side; and when sentiment in Arizona crystallized against the monumental steal, then strong-arm methods were employed to crush the opposition of a puerile state.

Nor was that all. New foes arose, a new attack from the rear! When the Los Angeles plan to reservoir and utilize all the waters of the river took shape in 1921, then the states of Colorado and

Wyoming became alarmed. Those states are on the roof of the continent and already they had had long hard battles with the lower states on other water-courses. If the Boulder project should once utilize all the water for power, then under the doctrine of priority of appropriation, would development in the upper states of the basin be forced to cease? Few people, probably, believe that the Supreme Court would so decide, but it might! The logical thing to do was to settle the matter by a test-case; but affairs of state normally do not take the direct route. The inter-state water commissioner of Colorado, Mr. Delph E. Carpenter, devised the ingenious plan of protecting his state and incidentally the three other upper basin states, through an interstate compact, which would reserve for the upper basin states all and more than enough water for future needs. He should have included Arizona, for our utilization of water from the main river will come after that of California, while our irrigable lands for the most part are at higher elevations than the tail-race of a Boulder power-plant. Authorization for a compact was obtained from Congress, though this was not necessary, and an egregious blunder was made by Congress in limiting the time of study and negotiation to one year!

Mr. Carpenter has recently stated in a masterly discussion of the compact method, as follows: "The 'do it now' fad prevalent in the business world has no place . . . in interstate river commissions. . . . A good compact is a blessing. A poor compact is worse than none. . . . Compacts hastily drawn . . . should not have been conceived. Although interstate river compacts were but recently adopted as a method of dealing with acute river situations, already there are signs of a disposition to hastily negotiate them. . . . We must proceed with caution. Undue haste is worse than no action at all. . . . Compacts fix the destinies of millions of people yet unborn. . . . They are the basis of titles which will be of fabulous ultimate values." In the same discussion, Carpenter said, "To fully marshal all the facts and to clearly and tersely present them to the court in a manner demanded by the importance of the issues, usually is a herculean task requiring a decade." Equal assiduity and deliberation should attend the negotiation of an important river compact.

And yet all these tenets were violated in the Colorado River



DAM SITES ON COLORADO RIVER IN ARIZONA



A. BOULDER CANYON DAM-SITE



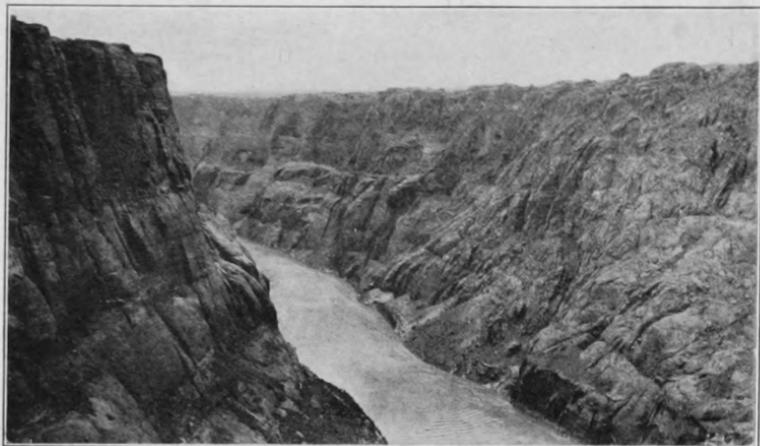
B. BLACK CANYON DAM-SITE
NARROWS ON COLORADO RIVER BELOW GRAND CANYON



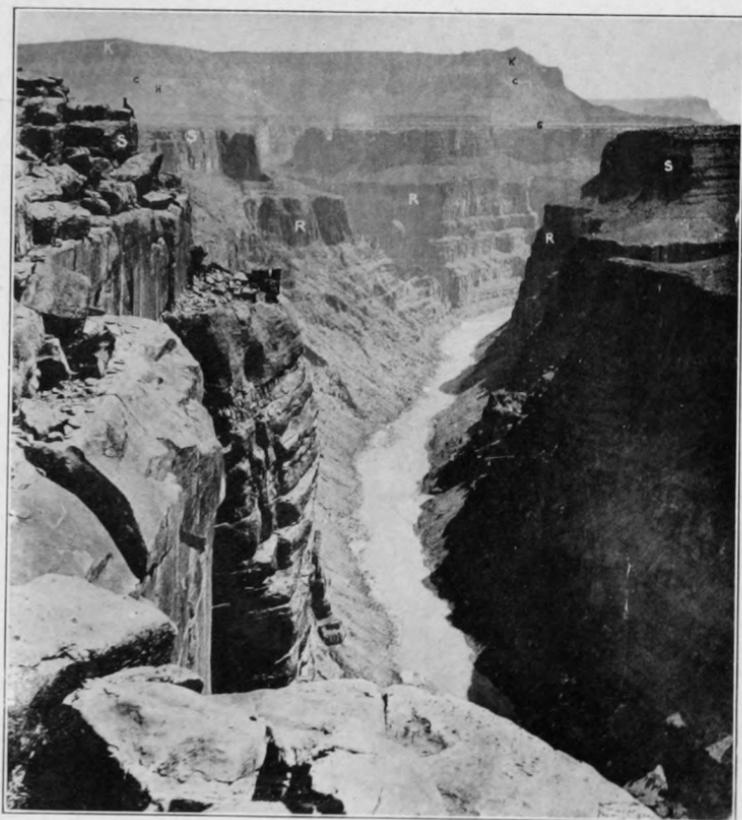
A. NARROWS BELOW DIAMOND CREEK



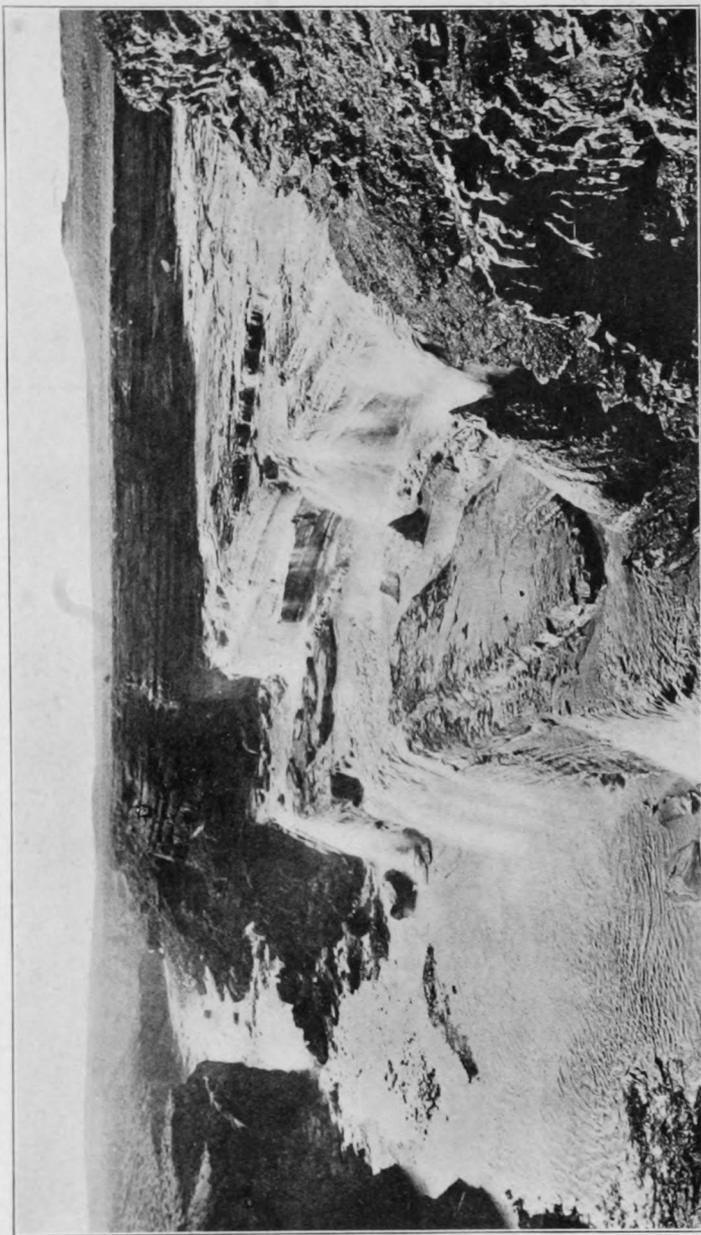
B. MOUTH OF GRAND CANYON
LOWER GORGES ON COLORADO RIVER, BELOW GRAND CANYON



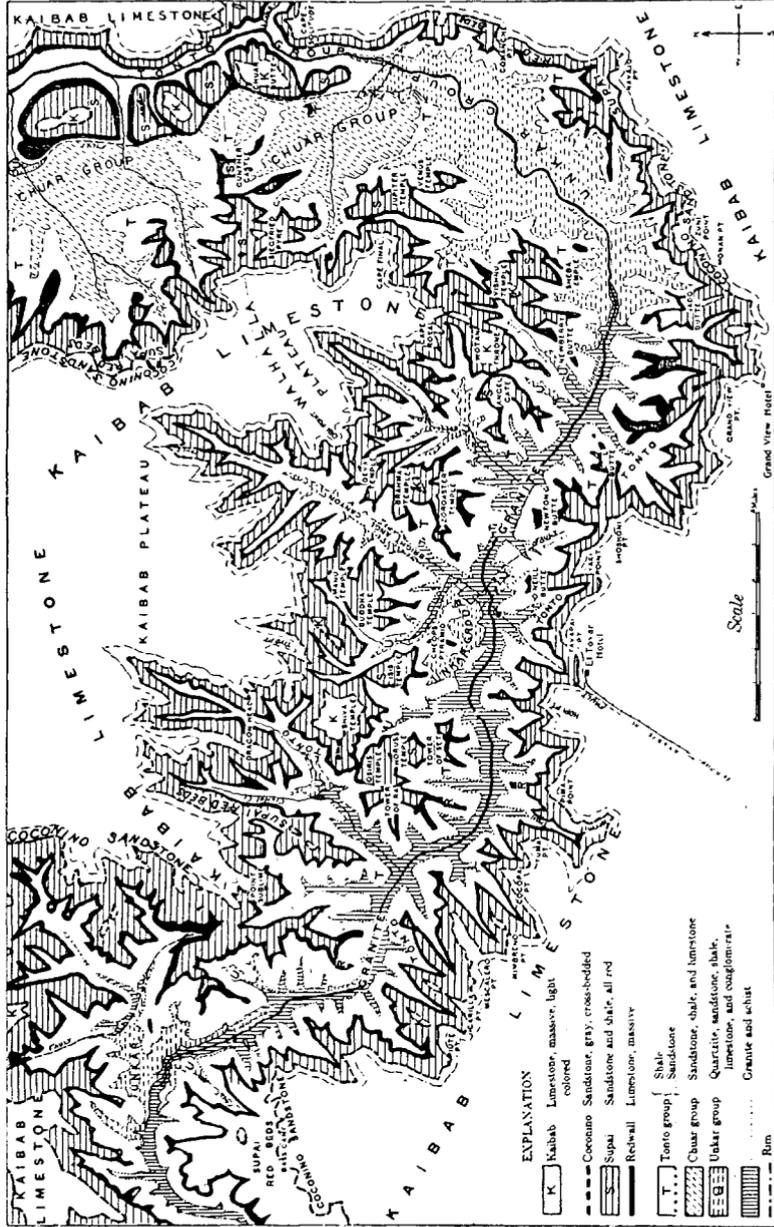
A. LOWER GORGE AT LEES FERRY



B. GRAND CANYON AT TOROWEAP VALLEY
DAM-SITES AT UPPER END OF GRAND CANYON



FALLS ON LITTLE COLORADO RIVER



EXPLANATION

- [K] Kaibab Limestone, massive, light colored
- [---] Coconino Sandstone, gray, cross-bedded
- [---] Supai Sandstone and shale, all red
- [---] Redwall Limestone, massive
- [T] Tonto group { Shale, Sandstone
- [---] Chuar group Sandstone, shale, and limestone
- [---] Ular group Quartzite, sandstone, shale, limestone, and conglomerate
- [---] Granite and schist
- [---] Rim

Scale 0 1 2 Miles Grand View Hotel GEOLOGIC MAP SHOWING DISTRIBUTION OF ROCKS IN THE GRAND CANYON, BY N. K. DARTON

GEOLOGICAL SKETCH MAP OF GRAND CANYON

compact, the first river compact to be negotiated. Little progress was made by the commission until their paltry year of grace was nearly past. When they met at Santa Fe, in November, the Carpenter plan was presented, backed by four votes out of seven, and though the Arizona commissioner fought valiantly for fourteen days, he then capitulated. To the southern California interests the pact was equally distasteful, but they gulped and took the medicine, to prevent a hold-up of the Boulder project in Congress. Anyway, they might hope to get their required water supply out of the allocation to the lower basin through priority of use; the shortage, or deficit in the supply, would then fall on Arizona.

This state, therefore, has been the focal point of three lines of fire: From Mexico, California, and the upper basin. Mexico wants the water, depriving Arizona of the means of development of the western part of the state; California would steal our natural water-power resources without compensation, and deliver our water to us below our land; and the upper basin wants us to sign a death-warrant. Little wonder that the seven years' negotiations have been disheartening!

A compact concerning the South Platte River was consummated in 1926, after ten years of negotiations based on analysis and study. It is advantageous to both states, Colorado and Nebraska, and is an excellent model to be followed. Other excellent compacts have been negotiated. They all are two-way contracts, with definite advantage to both sides. The Colorado River compact is a one-way contract; the upper basin states obtain the reservation of water which they desire, while the lower basin receives nothing in return.

Why did the Colorado River compact prove to be a "dud"? The reason is complex. In part, it was the lightning-like rapidity with which it was "put over." In a similar situation the Columbia River basin states went back to Congress and got an extension of time, in fact, they have done so twice. Second, it was concluded and signed in comparative secrecy, instead of allowing each commissioner to consult with those vitally affected, as has been done with later compacts. Third, and most important, the basic data were incomplete. Wyoming, beginning in 1915, had made thorough studies of its projects, both those feasible today and those which may become

feasible a hundred years hence. Colorado was likewise prepared. California projects had been studied. New Mexico "got wise," and made claims that would cover all future needs, at least. Arizona, on the contrary rested her claims on the findings of the U. S. Reclamation Service, which were based strictly on present economic conditions. Arizona had made no study of projects on the main stem of the river, and the western part of the State was still *terra incognita*. The Arizona Engineering Commission was sent into the field eight months too late; their report was not rendered until the following June.

The division of water, therefore, was most unfortunate for Arizona. Only eight million, five hundred thousand acre-feet were allotted to the lower basin. The three hundred thousand acre-feet desired by Nevada, plus the total use in the Little Colorado and Gila basins, aggregates about three million, two hundred thousand acre-feet, leaving five million, three hundred thousand acre-feet of the allotment to the lower basin to be derived from the main river. This is sufficient to complete existing projects in the lower basin, and also provide one million, eighty thousand acre-feet for Los Angeles and vicinity, and then to provide one-half enough to complete the proposed additional acreage in the Imperial valley. It leaves no water for the Cottonwood, Mojave, or Chemehuevis areas, Cibola valley, Palo Verde mesa, Chuckwalla valley, or for the great Parker-Gila valley project, or for any part thereof.

The irony of the situation lies in the established fact that there is a sufficient water supply for all of the seven states, and if the excess is not allocated, it will flow by and will become, morally at least, by squatters' rights, appurtenant to Mexican irrigable land, the area of which, quoting Dr. C. E. Grunsky, is one million, three hundred thousand acres. Before 1963, when another allocation will become possible, Mexico will have perfected or initiated rights to much or all of the surplus water.

The allocation to the upper basin is much greater than that basin can use. I say that advisedly, after studying technical data and after consulting with those best qualified to know. We do not object to that, however, so much as to the unnecessary restriction of the lower basin to eight million, five hundred thousand, when

the lower basin needs thirteen million acre-feet, not counting the proposed Arizona high-line project.

Behind the conflict over division of the water supply, behind the spectres of silt- and flood-control, those over-worked "talking points," lies the heavy, black shadow of hydro-electric power. As shown in the accompanying profile, the descent of the river is exceedingly steep in Arizona from the Utah line down to the Nevada line, the total fall is two thousand, three hundred and fifteen feet, and after stream regulation is secured in Utah, the development of the water-power will rival the opportunities which made the fame of Cræsus. Fabulous wealth will be created from the utilization of this power. Arizona must not allow this, its greatest natural resource, to be alienated from State control.

During these seven years Arizona has come through many crises. In the Sixth Legislature, and again in the Seventh, the fate of the State hung by a slender thread; but the thread held! We have been called dog-in-the-manger, and anathematized, when in truth our rôle was that of "the man from Jericho who fell among thieves."

The only lifting of the clouds came in 1927, at Denver, when the governors of six states and their advisors adopted the "Pittman Resolution," embodying the principles of Western water-law. That was a great victory for Arizona, and it forces every official of the upper basin, who is not subjected to outside pressure, to support Arizona's contentions, for every principle enunciated in the Pittman Resolution is violated in the Swing-Johnson bill.

The upper basin is in a dilemma. Their future welfare depends on maintaining the principles of the Pittman Resolution, but, they want a seven-state pact before construction is begun on the lower river. Now, using a syllogism, the upper basin desires a seven-state compact; Arizona will not, will never, ratify the Santa Fe compact as it stands. Ergo, the Santa Fe pact must be amended, or a new compact must be written. There is the key that will solve the whole problem; the Santa Fe pact must be revised.

The upper basin leaders realize that the terms of the pact were ill-advised, but they have shrunk from the suggestion that the pact be revised in the light of new evidence which has appeared since

1922. Yet there is nothing sacred about the Santa Fe pact. Does not the Congress of the United States quite often refuse to ratify treaties negotiated by the Department of State? There are treaties now pending which will never be ratified. The upper basin at heart is friendly to Arizona's cause.

How should the compact be written? Let us examine this problem. In the first place, the upper basin should be given *carte blanche* to the beneficial use of water, and likewise the lower tributaries, the Virgin, the Little Colorado, and the Gila, should not be restricted as to the beneficial use. The lower basin should not be restricted as to the remainder, except as to that portion granted to Mexico by international treaty. This is based on the principle of using the waters first in the upper reaches. The ultimate use in the upper basin will not exceed five million acre-feet much, if any. Those states now are using two million, three hundred thousand acre-feet. At least thirteen million acre-feet would then be available to the lower basin, and with this abundance the controversy over water between California and Arizona would automatically disappear. Furthermore, I have it direct from spokesmen of the upper basin recently that this division of water would be entirely satisfactory.

Approximate Water Demand and Proposed Allocations — in Acre-Feet

	Future possible use	Allocations		Proposed rational compact
		Colorado River compact	Boulder Canyon act	
Upper basin	5,000,000	7,500,000	7,500,000	No limit
Evaporation (res'rs) ...	1,400,000			
Lower basin		8,500,000		No limit on trib.
Nevada	100,000		300,000	on balance
California	5,700,000		4,400,000	1,000,000
Arizona	6,400,000		2,800,000	
Mexico	5,000,000			

As a matter of fact, the use of water in the upper basin could not be restricted under the Santa Fe compact, for there is a joker in the compact. It is the term "consumptive use." The consumptive use in the Salt River valley can be known because the water is used over and over until it is all consumed. The consumptive use in Imperial valley is known; it is the quantity diverted, for none of

it returns to the river flow. But in the upper basin, no engineer can measure the consumptive use with any degree of accuracy, and on many years the total flow might be diverted and yet it could not be proved that the consumptive use exceeded the quantity allotted. The measurement of the consumptive use of a river never has been attempted. In a few instances it has been estimated, that is, guessed at. Furthermore, who would attempt to measure consumptive use in the upper basin? The states up there would not do it. Could Arizona maintain a river police in Colorado? How could the provision in the compact be enforced? "Highority" rights outrank priority rights sometimes. There is no disadvantage, nothing but gain, in conceding the right of use *ad libitum* in the upper reaches of the river.

The proposed tri-state compact does not offer a solution; it is a false alarm. The upper basin would not be a party to it. It does not strike at the real problem. Of what avail to agree with California as to the division of all the water, including the surplus, and then ratify the Santa Fe pact, the function of which is to limit the right to use in the lower basin? The language of the compact is clear, and, if ratified, then when the use of water in the lower basin, including the Gila, reaches eight million, five hundred thousand acre-feet, we would be stopped from further development. The theory underlying the tri-state compact, as expressed in the Senate Committee hearings, is that, although the Santa Fe pact would not permit us to appropriate and use the surplus water legally, yet "physically" we could take and use it. That assumption ignores a fundamental truth, that before an irrigation project can be financed with either public or private funds, it must show an absolutely clear, clean title to the water. The upper basin claims an equity in the unallocated, or surplus water. The moral aspect is even more compelling. If we sign the Santa Fe compact, and place the State seal upon it, we shall abide by it.

A few years ago it was the custom for certain farmers in the Casa Grande valley to take water from the canal when there was a surplus, and this "theft" was tacitly permitted; these farmers were said to have "slop-water rights." Why now should Arizona be asked to be content with slop-water rights? Why should not

the water rights in Arizona be of the same force and effect as those in the upper basin?

If the upper basin should become a party to the tri-state compact, and should substitute that division of water, including the "surplus," in place of the division of water contained in the Santa Fe pact, the situation would be changed. But it is not contemplated that the tri-state compact would go before the legislatures of the upper states. Therefore the conclusion is inescapable that the Santa Fe compact must be revised; the allocation to the lower basin must be increased.

At the Santa Fe meeting of the Colorado River Commission in 1922, each state presented an estimate of its future water requirements. The allocation of eight million, five hundred thousand acre-feet to the lower basin was based on the claims submitted. California did not ask a reservation for Los Angeles and nearby territory; that demand was made two years later. How could Los Angeles in 1924 obtain water-rights to one million, eighty thousand acre-feet except by establishing a priority over areas for which water had been provided in the allocation, in effect, by robbing Arizona? Clearly, it was the duty of California to ask that the allocation to the lower basin be revised, that it be increased by one million, eighty thousand acre-feet.

In June, 1929, the Los Angeles appropriation of water was increased to three thousand cubic-feet per second, which means slicing off another million acre-feet per year of water originally intended for Arizona lands. This is an attempted wilful theft. Why does not California take the honorable way by obtaining an increase in the allocation to the lower basin.

The pie had been cut. To make California's piece larger, Arizona's slice must be made smaller. Is there no honor among states?

During the past five years, the Swing-Johnson bill has been improved from Arizona's standpoint frequently; that is to say, it has been made more and more unconstitutional, until its chances of being upheld by the Supreme Court are now *nil*.

In general, each state of the Union, Maine and Arizona alike, possesses the power and the attribute of sovereignty possessed by an independent nation, with respect to the waters within its territory, except as surrendered to the Federal Government by the

Constitution. Each state owns and exercises jurisdiction and control over its waters, subject only to the jurisdiction of the Federal Government to regulate interstate navigation and to interstate adjustments of water-rights. Congress has no power to settle interstate controversies, or to equitably apportion waters of an interstate stream. Quoting again from Mr. Carpenter, "For Congress to attempt to expand her jurisdiction over navigable waters beyond the intendment of the Constitution would be an unconscionable Federal encroachment upon State jurisdiction. To attempt to extend Federal jurisdiction over all streams merely because they constitute ultimate tributaries of navigable waters would be unconstitutional and Federal encroachment by subterfuge. Such a policy would lead to complete Federal usurpation of State jurisdiction, within all the States, over that element most vital to the welfare of the States." To build a two hundred million dollar power-project in order to provide an eighteen million dollar flood protection, likewise would be an indefensible subterfuge.

The verbiage of the Constitution, the debates attending its adoption, the classic essays in the *Federalist*, the Tenth amendment, the history of the acquisition of the public lands, and the creation of states, the constitutions of the western states, decisions of state courts and of the United States Supreme Court, and of other Federal courts, the dicta of the best constitutional lawyers, acts of Congress, especially since 1866, the comprehensive water-codes of all the western states except perhaps Montana, the continuous exercise of control and administration by state water-commissions, and even the executive orders of Federal bureaus, all conjoin to force the conclusion that the states are sovereign as to control and utilization of rivers, except as to regulation of interstate commerce, and that the states own the beds of rivers that are navigable and of other important rivers that are meandered. Scores of citations are available, and the evidence is all on one side. The Boulder Dam act is unconstitutional throughout its very framework.

There is no western state more determined to retain sovereignty and exercise control over its own rivers and to develop them to their highest possible limit, than our chief adversary California; her attitude toward Federal bureaus has been that of "hands off." Officials of all western states are so chary and so resentful of

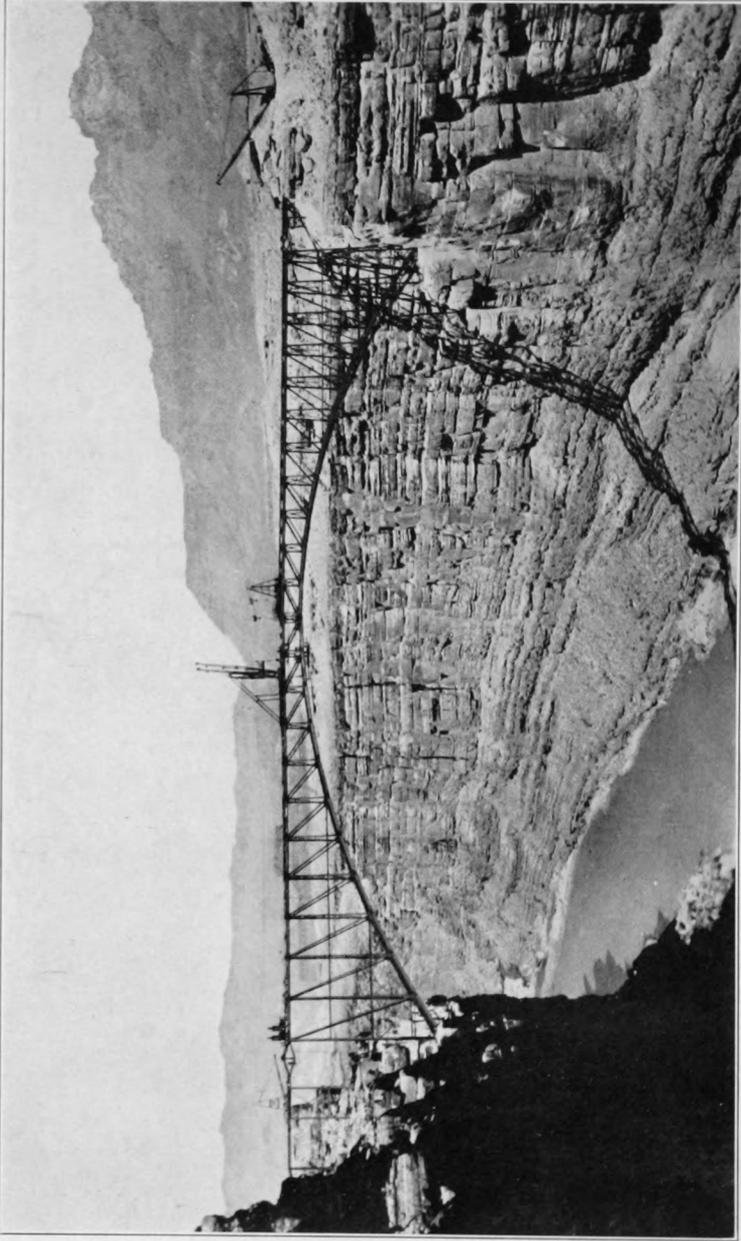
Federal encroachment that the moment one state is subjected to pressure, the officials of other states immediately offer assistance. They see most clearly the dangers of divided authority over water resources. If Arizona does not stand stalwartly for her sovereign rights, she will be ostracized and scorned by other states of the arid West.

I wish at this point to pay tribute to J. L. Gust, for his able and scholarly defense of Arizona before the Senate Committee on Reclamation last January. His argument is concise, clear and convincing, and is the best defense that has been made of Arizona's position. Mr. Gust has the background of familiarity with water-law and should be one of Arizona's chief counsellors.

I must interject here also that the worst thing that can happen to Imperial valley is for the Swing-Johnson bill to become a law. It would result in interminable delay and inaction, while a sane solution would secure to that Valley both flood-control and late-summer water supply in three years.

 It has already been pointed out how Mexico comes into the picture. How much water shall be granted to Mexico? It is essential to settle this problem at once, before the construction of any dam is completed, for whether it be at Boulder Canyon, or at Dewey, as soon as river regulation is effected and the low-season flow is increased, the application of water to Mexican lands will grow apace. On the lower Rio Grande, where the reverse situation exists, the American land-owners are fearful that the increasing development of irrigation along the Salado and the San Juan and the Conchos rivers, in Mexico, will shut off their principal supply. It is conceivable, yes, probable, that Texas will favor selling Colorado River water to Mexico in return for waters of the Salado and Conchos rivers.

Congress provided for a commission of three men to negotiate a treaty, the Mexican Government has appointed three representatives. Of the three Americans, one is a Texan and the other two have homes in California. Arizona is more interested in the result than California inasmuch as the final competition for the last four million acre-feet of water in the Colorado River will be between Arizona and Mexico, after California has secured water for all her irrigable lands. Who is looking after our interests? If



BRIDGING OF INNER GORGE OF GRAND CANYON, NEAR LEES FERRY

Arizona waits until the treaty is negotiated and announced, it will then be too late. Arizona representatives should negotiate with the treaty commission now.

While it may be presumptuous for a layman to suggest what the terms of the treaty should be, still the situation is so clear when stripped of chicanery and sham that I will risk the possible criticism. A treaty is public business and should be subjected to public discussion.

The treaty should first recite that present perfected appropriations and use of water, both in Texas and in Mexico, shall be protected; it should then provide for the abrogation of the fifty-fifty clause in the original concession to the Imperial valley promoters whereby Mexican lands are entitled to fifty per cent of the water diverted through Imperial canal; and third, it should grant to the Imperial irrigation district a wide right-of-way for a new high-line canal running around the south end of the sand-hills, and with no laterals in Mexican territory. I am assured that Mexico would make the grant. This will obviate the necessity for the All-American canal, the proposed deep cut running along the north side of the boundary, and will save the munificent sum of nearly thirty million dollars. The All-American canal would be a great economic waste. A part of its cost would fall on Imperial valley farmers, and the balance would fall indirectly on Nevada and Arizona if it is to be paid out of power revenues, and otherwise it will fall on the National Government. The canal would be justifiable, however, if there were not a better solution.

What have we to give Mexico in return? First, a guaranteed water supply, say for two hundred thousand acres, to be delivered at Andrade, on the boundary line, even on the driest years, such as 1902, out of our stored supply if need be, and second, the right of maintaining head-works in perpetuity at Pilot Knob, on American soil. Without the latter, the project in Mexico would be forced to build new head-works on sand and silt, without a rock wall for control and protection. Such agreement would be fair and advantageous to both sides and co-operative in spirit.

Because of successful strategy of our adversaries and Arizona's mistakes, it must be admitted that the problem, from Arizona's standpoint, is increasingly difficult. The present program of

development, the Swing-Johnson bill, offers us nothing but despair. and yet, it is Arizona that should exhibit leadership instead of always fighting a rear-guard action. None will help him who will not help himself.

Any proposal to extricate Arizona, which at the same time perpetrates an injustice on some other state is doomed to defeat. An interstate agreement must be advantageous to each signatory state.

However, it is not incumbent upon the Colorado basin states, or any one of them, to sacrifice their own future development, for the benefit of the millionaire land-owners of the expansive feudal estates south of the international boundary-line. Most of these land-owners are citizens of our country, but if they ever deserved special consideration, they have forfeited it by their policy of driving out American farmers, and retaining as tenants only men of the yellow race. Not only does their peon-raised cotton compete in the world's market with our own, but their growing colony of the yellow race will be a distinct menace if there shall come a War of the Pacific. If there is an American statesman so ill-advised, so sentimental, or so venal as to grant the unused irrigation water supply to lands in Mexico, instead of to the desert lands on this side of the line, he should go down in history with Benedict Arnold.

A constructive policy for the Colorado basin states should be founded on the following bases:

1. A division of the water supply which will not throttle development in any one of the seven states. Adequate allocation to the seven states can be made, and California will be benefited as well as Arizona, but it will cut deep into the five million acre-feet which under the Santa Fe pact and Swing-Johnson bill is a down-right gift to the Mexico land-owners, (not even accompanied by a request to help pay the cost of storage and regulation).
2. The principles of Western water-law, as expressed in the Pittman Resolution.
3. A rational development program, based on sound engineering principles. No revenue can be derived from an unsound project by any participating interest.

On the above foundation the following program can be evolved:

1. (This is the most important). The Colorado River compact

should be revised in the light of the new evidence as to irrigable land, evidence presented subsequent to the Santa Fe meeting in 1922. Arizona can never assent to a compact which limits us to our present vested rights to water, nor will Arizona be content with "slop-water rights," which would be worthless as security for a great project such as the Parker-Gila Valley project. It is useless to hound California for an increase in water for Arizona; California has an insufficient quantity for her own needs. The compact must be revised, so that the unallocated surplus, now destined to Mexico, may be used on American soil. The fact that Los Angeles entered the lists in 1924 with an appropriation of one million, eighty thousand acre-feet, not provided for by the Compact, that alone justifies a reconsideration of the allocation to the lower basin. If this just claim is denied by the other basin states, Arizona must present its case to the United States Supreme Court, speedily and forcibly.

2. Either a treaty must be secured with Mexico, or the United States should place Mexico on notice that it is our intention to use on our own soil all water made available by storage. The treaty commissioners should take into their confidence the governors and river commissioners of the seven states.

3. As to the engineering program, Congress should provide a commission of eminent engineers and geologists to study and report on the entire river development, not limited as was the commission of the past summer to consideration of the Boulder project, but authorized and directed to weigh and compare all alternative development programs. An unprejudiced, independent commission will favor river regulation in the upper basin, at points where bed-rock is shallow, to be followed by a power-project in northwestern Arizona.

4. Arizona should emulate the example set by her sister states, by making thorough engineering and economic studies to determine the exact extent and feasibility of our projects, with definite plans and cost data, and with drilling of several dam-sites. This obligation cannot be left to the U. S. Bureau of Reclamation which is most unfriendly to this state. It should be remembered that the report of the Arizona Engineering Commission in 1923 was only a reconnaissance report.

The Arizona legislature might well adopt a compact based on the rational plan of allocating the water as outlined above. Such adoption would be in the nature of an offer to the other states and if accepted by them, would supplant the pending Santa Fe pact. This is a recognized method of initiating an interstate compact.

Arizona is at the parting of the ways. If the program of the Swing-Johnson bill prevails, she will become just another Nevada, after her mines are exhausted. If she holds fast to her just rights and is not denied the opportunity to develop and utilize her greatest natural resource, the Colorado River, she will eventually become a rich agricultural state, specialized in subtropical products of the soil, the peer of any state and an asset to the nation.

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