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WATER RESOURCES AND NEEDS IN AREAS OF ABUNDANCE
UPPER COLORADO RIVER BASIN
WESTERN INTERSTATE WATER CONFERENCE

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Introduction

Because this Conference represents eleven or more Western States instead of only the States of the Colorado River Basin there may be a number of interested people here who are not familiar with the Upper Basin of the Colorado River. In order that we may become better oriented, let us spend a few moments briefly reviewing the setting, geographically and politically, Fig. 1.

The Colorado River rises among mountains more than 14,000 feet in altitude in the Rocky Mountain National Park, about 70 miles northwest of Denver. It meanders southwest 640 miles through the Upper Basin to Lee Ferry, Arizona, the division point between the Upper and Lower Basins.

The Green River, its major tributary, rises in western Wyoming and discharges into the Colorado River in southeastern Utah, 730 miles south of its origin and 220 miles by river above Lee Ferry. The Green River drains 70% more area than the Colorado River above their junction, but it produces only about three-fourths as much water.

With a drainage area of 110,000 square miles, the Upper Colorado River Basin is larger than New York, Pennsylvania, and New Jersey combined. It is bordered on the east and north by mountains forming the Continental Divide and on the west by other Rocky Mountain ranges. On the south it opens to the Lower Basin through which the river continues to the Gulf of California. Politically the Upper Colorado River Basin is considered a separate entity created by the Colorado River Compact of 1922. This Compact defined the Upper Basin to include not only those parts of the States of Arizona, Colorado, New Mexico, Utah, and Wyoming whose waters naturally drain into the Colorado River system above Lee Ferry, but also those parts of these States outside the natural basin which can be beneficially served by waters diverted above Lee Ferry. Likewise the
Lower Basin includes the natural drainage areas of Arizona, California, Nevada, New Mexico and Utah below Lee Ferry, and all parts of those States outside the physical basin that can be beneficially served by diverting waters below Lee Ferry.

**The Upper Colorado River Basin As An Area Of Abundance**

A rapid perusal of the tentative program for this Conference almost threw me into a tailspin. The revelation that I was to discuss "Water Resources and Needs in Areas of Abundance" coupled with the fact that Professor Todd tended to restrict me to the Upper Colorado River Basin, caused me no little consternation at first. Why? Although admittedly I do like to wander beyond the limits of the Upper Basin, both physically and philosophically, my feeling of inadequacy was not caused by Professor Todd's restriction, but by the fact that I felt that perhaps my accidental and scholastic exposures to the world's knowledge had failed to impress me with the proper meaning of the word "abundance". I always thought that "abundance" meant something similar to "a great plenty". Next I became worried that perhaps the program committee had misplaced or improperly classified the subject, me, the program heading, or some combination thereof.

In order to relieve my frustration and enhance my knowledge it seemed that a visit to Mr. Webster's publication was in order. An examination of this tome revealed that "abundance" means "a great quantity or amount" or "a plentiful supply". At this point I felt vindicated in my limited knowledge, but upset about trying to apply the term to the Upper Colorado River Basin, because everyone knows that in large areas of the Upper Basin it is so dry that the rattlesnakes spit dust. Luckily, my eyes strayed further down the page, and it was noted that "abundance" could also mean a "relative quantity or amount". At this point my spirits revived. Here was a definition that vindicated our program chairman. If "abundance" is a relative term the next problem was to determine the objects to which the Upper Colorado River was to be compared as an area of abundance of water.

Let us not allow our today's program to fool us on this point. You will note on the program that the Upper Basin of the Colorado River is listed as an area of abundance with Northern California and the Columbia River Basin. Relative to the other two areas the water supply of the Upper Basin ranks about the same as a thimble of water in a large bathtub. To illustrate: average virgin flow of the Colorado River at Lee Ferry, which can be regarded as the thirsty throat of the Lower Basin, annually amounts to about 12 to 17 maf depending upon the period of records used. One tributary of the Columbia River, the Snake, from 103,200 sq mi (smaller than the Upper Colorado River
watershed) discharges near its mouth an annual average of 35-1/2 maf of water after having irrigated almost three million acres and furnishing domestic and industrial water to the bulk of the population of the State of Idaho, or more than twice as much as the Colorado River as it leaves the Upper Basin. The Columbia River at The Dalles, Oregon, after meeting all upstream demands on it, flows about 142 maf per year from a watershed of 237,000 sq mi, which is approximately the same as the area of the Colorado River Basin. In the future the Colorado River will pass only about one and one-half maf per year to Mexico under an international treaty.

In northern California are found a number of prolific water producing streams. Confining our comparison to only five, the Klamath, Mattole, Mad, Russian, and Eel Rivers, we note that the water wasted into the ocean from combined watersheds of roughly 17,500 sq mi amounts to about 25 maf per year.

When compared to the areas represented by my two good friends, Mr. Steiner of California and Mr. Lane of Oregon, the Upper Colorado River Basin water supply quantitatively fades into insignificance.

The planners of this Conference may have classified the Upper Basin as an area of abundance because it produces about 90% of the total water for both the Lower and Upper Basins. On the basis of water production, the Upper Basin, when compared with the Lower Basin, could be called an area of abundance. Or was our Conference planner's premise resting upon the fact that the Upper Basin is not depleting the river by more than a fraction of the use of water apportioned to it by the Colorado River Compact? Presently, and in terms of water remaining to be put to use under the Compact, the Upper Basin appears to have an abundance when compared with the Lower Basin.

Relative To Other Natural Resources Water Supply Is Not Abundant

Rationale dictates that the capacity to produce water does not necessarily guarantee a plentiful supply. Residual supplies under a Compact cannot be regarded as synonymous with adequacy of water. In this case the evidence substantiates the conclusion that the residuals are insufficient for full development of related natural resources in both the Upper and Lower Basins of the Colorado River under present and reasonably predictable technology and social trends.

House Document 419, 80th Congress, a Report by the Bureau of Reclamation in 1946 on "The Colorado River" contains statement after statement expressing the thought that because of the limited water supply, it will not be possible for all potential water projects to be constructed in either the Upper Basin or the Lower Basin. This report shows that with full development of
existing and potential projects contemplated 20 years ago the ultimate average reduction by the Upper Basin from the virgin flow at Lee Ferry could exceed nine maf per year, if there were that much water available. The report further says "... all of the projects are competitive to the extent that the total demand for water exceeds the Colorado River Compact allocation for the Upper Basin."

The fact that there are two major interstate compacts, one smaller compact, numerous agreements, judicial decisions, and operating criteria involving the Upper Basin further quashes the myth that the water supply is truly plentiful. Water compacts, agreements, etc., are almost invariably born in areas of insufficiency as the result of the necessity to protect one area against another in the acquisition of the limited supply which cannot fully satisfy the needs of both. Insufficiency of water was the underlying stimulus that produced the Colorado River Compact that divided the physical basin into two political subbasins and apportioned the use of water between them. Insufficiency was the causative factor behind the Upper Colorado River Basin Compact that apportioned the Upper Basin’s use of water among the five states and created an administrative agency for four of them. Lack of enough water for all potential uses in the Lower Basin was the real cause of that notorious and expensive litigation Arizona v. California, recently decreed by the U. S. Supreme Court.

Confusion Regarding True Water Supply

The virgin flow of the Colorado River at Lee Ferry may be taken as an indicator of the water supply available in the Upper Basin. Confusion runs riot, however, when two engineers get together and try to state in mathematical terms the number of acre-feet either physically or legally available for use in the Upper Basin. Part of this confusion has its basis in the statement I made a few moments ago--namely, that the average virgin flow at Lee Ferry can be stated in round numbers as anything between about 12 and 17 maf depending upon the period of records used.

Additional confusion is added to the question of water available to the Upper Basin by conflicting interpretations of the basic law of the river. Contrary to the beliefs of many people, the Supreme Court in Arizona v. California did not interpret the Colorado River Compact by defining the rights of the Upper Basin and Lower Basin each against the other. I, too, am going to avoid trying to interpret this Compact, even with regard to the effect of any particular meaning on the amount of water resources available to the Upper Basin, except to state that the Compact purports to apportion the exclusive beneficial consumptive use of seven and one-half maf of water.
per year to the Upper Basin and to the Lower Basin respectively, recognizes
that one and one-half maf of water must be delivered to Mexico each year
and requires the Upper Basin to deliver 75 maf to the Lower Basin in any
ten consecutive years.

To prevent my being misunderstood, I want to say that there are other
parts of the Colorado River Compact that may have some effects upon this
problem, because a Compact to be correctly interpreted must be studied in
its entirety. In the Colorado River Basin we have spent too much time in
the past bickering over meanings of the Compact. Undoubtedly it is true
that, to a large degree, Compacts serve the purpose of assuring the develop­
ment of a limited water resource in one water-deficient area by protecting
that resource from being confiscated by use in another area. Thus, the
Colorado River Compact has served to limit the Lower Basin's more rapid
development and to permit the Upper Basin to utilize its share of the water
resources at a later date. This is another way of saying that a Compact's
primary purpose is to insure the orderly development of the water resources
of the entire Basin. That is why I think we should stay as far away as
possible from legalistic compact interpretations. They do not represent
the real problem facing either the Upper or Lower Basins.

Ground Water Supply

There is a dearth of data concerning ground water supplies in the
Upper Basin. The results of studies of certain small areas have been deter­
mined, but these are not necessarily representative of the Basin as a whole.
From the information that is available it can be generally stated that there is
not sufficient ground water in the Upper Basin to make large-scale develop­
ments. The supply is so limited that it has only insignificant effect on the
total resource. With judicious choice, locations may be found where ground
water would support municipal or industrial enterprises but not large-scale
irrigation.

Water Use In The Upper Basin

There is only general information concerning the use of water in the
Upper Basin. The Engineering Advisory Committee to the Upper Colorado
River Compact Commission made a detailed investigation of water uses in
the Basin in 1946-1947 for the guidance of the Upper Basin Compact
Commissioners. An Upper Basin-wide inventory has not been made since
that time. It is estimated that about two to two and one-half maf of water
are used annually in the Upper Basin. On the basis of this early survey and
our general knowledge of the Basin, the preponderance of consumptive use
of water is for irrigation. Both Colorado and Utah have made extensive use
of transmountain diversions for getting water from where it is produced to
where it is used. We estimate that, as an average, transmountain diversions account for 20%-25% of the total water used, or about one-half maf per year.

The Upper Basin is now undergoing a transformation from a long period of slow growth to an era of rapidly accelerating expansion. This more rapid development is related to the nation-wide population explosion and more directly to the immigration of hundreds of thousands of people into the area in search of space, jobs, and homes in the last 20 years. The population growth of the Upper Basin from 1940 to 1960 was considerably above the national average. The need for an enlarged water program resulted in the construction of the Colorado River Storage Project and participating projects. It is anticipated that when the presently authorized storage units and participating projects are fully developed there will be an additional one and one-half maf of stream depletion in the Upper Basin.

Effects Of Population Growth On Water Use

As the Basin continues to grow the thirst of more and more people and likewise the thirst of more and more acres of land must be satisfied. According to population estimates made by Resources for the Future for the Senate Select Committee on Water Resources the number of people in the entire Colorado River Basin was 1.2 millions in 1950, and is expected to reach 2.5 millions in 1970, 3.3 millions in 1980, and about 5 million by the year 2000. The States of the Upper Basin in the drainage area had about 311,000 in 1950, would have about 425,000 in 1970, 510,000 in 1980, and 676,000 in year 2000. In considering the anticipated use of water, however, we must remember the Compact's definition of the Upper Basin, which includes all areas in the Upper Basin States that can be served by Colorado River water. Thus we must consider the larger metropolitan areas of the four Upper Division States, cities such as Denver, Salt Lake City, Albuquerque, Casper, and others which would bring the population to be served directly or indirectly by Colorado River water to about 60% of the expected population or approximately 5 million persons by the year 2000.

With this great influx of people larger and larger proportions of water in the Upper Basin will be consumed for domestic, municipal and industrial purposes. Agriculture will continue to be a major consumer for many years. Projected estimates of future uses of water have been made by various agencies, principally to rationalize assumptions for studies in other aspects of resource problems, such as power production project repayment, project planning, etc. For instance, one Federal agency has started with two and one-half maf as the present stream depletion in the Upper Basin and has projected this to 5.4 maf in year 2020 and 6.2 maf by
year 2062, or a century from now. For a different purpose this same agency, starting from the same base, arrived at a depletion of 5.4 maf by the year 2000. One interested State agency has projected its figures to show a depletion of 5.7 maf by the end of the century.

Present Predictions Are Too Low For Several Reasons

Time will prove that all of these prognostications are too low for several reasons. First, it is true that it has taken a century to cause a stream depletion of two and one-half maf, but the start on the second two and one-half maf is under entirely different economic and social conditions than existed in the days of the pioneers. Population growth, economic development, scientific and industrial enterprises are forging ahead at velocities that are not only more rapid but that are also accelerating at greater rates each year. I am sure that we lack imagination if we cannot conceive that there are new methods, processes, enterprises, products, desires, and new demands in the future that do not exist today, and that some of these will require supplies of water that are not even contemplated today. Second, barring some man-made or natural catastrophe that would destroy millions of people, if we base the future on the past, we can only conclude that today's estimates of future populations will prove to be too low. When we were in college we were told that by 1980 the population of the United States would be 180 million people, and that it would become stabilized at about that figure. Many predictions have been made during the past 30 years, and each has had to be revised upward.

Third, there are those of us who believe that projections of future stream depletions do not include sufficient water for the industrial expansion and the immigrants to man it. We are only beginning to realize that the Upper Colorado River Basin is the energy basin of the World. Reliable agencies have estimated that the four States contain about 1,510 billion barrels of oil in shale deposits, or about 90% of the world's supply in this form; about 150 billion tons of recoverable reserves of coal; and more than 23 trillion cubic feet of proved recoverable reserves of natural gas. When these energy potentials, combined with radioactive elements, petroleum, gilsonite, phosphates, etc., are considered together with other assets of the Upper Basin, such as space, recreational opportunities, and other natural resources, it becomes apparent that there is a great imbalance in the energy - population - water resources potentials relationship. The population deficiency will be eliminated by population pressures in other areas. As the population increases more and more energy industries and related service enterprises will spring into existence, which, in turn, will result in greatly increasing needs for development of water resources.
Experience has taught us that in a dynamic society with a constantly growing economy this relationship operates in an endless expanding cycle.

According to authorities in the field, an oil shale industry is imminent in the Upper Basin. A recent study made for the State of Colorado reveals that if prototype plants are started during the 1960-1965 period, water needs by 1975 for oil shale and related activities in three western Colorado counties and one eastern Utah county would amount to about one-fourthmaf annually.

A fourth reason why predictions of the future water needs may be too low, is that in the event of another national emergency the energy potentials will have to be exploited at a greatly accelerated rate, a rate much greater than any presently conceived. After surviving two world holocaus ts in one generation the United States must surely have learned that it is better to be prepared ahead than to try to prepare behind.

A fifth reason, although admittedly not a very scientific one, for believing that current predictions of water use may be low originates from the fact that on every river system where I have had the experience of close observation short-sightedness has proved to be the rule.

**Several Major Problems**

It is extremely difficult to differentiate the water problems of the Upper Colorado River Basin into those that are endemic to the area and problems that are interrelated hydrologically or operationally to those of the Lower Basin.

As a political subbasin created by the Colorado River Compact, the Upper Basin probably has several important water problems to face. First, the Upper Basin must protect its presently unused water supply until it can be used in the Upper Basin States. The Upper Basin is an area of origin of water. Its remaining potential must not be destroyed or limited. As new projects are proposed for authorization the Upper Basin must take the necessary steps to insure that there is no possible encroachment, either physically or legally, upon its future water supply. Protection of the future of the Upper Basin will require the highest degree of cooperation and understanding by representatives of all seven Basin States and the Federal Government. The Upper Basin cannot forget that cooperation has been sadly lacking in the past. The Colorado will probably be the first major river system in America to have its water completely consumptively consumed. The point of complete usage is imminent in the Lower Basin, and it is coming more rapidly in the Upper Basin than most people realize.
Second, is the problem of obtaining the best possible development of the remaining water resources that are physically and legally available.

Third, the problem of economics is an important one to the Upper Basin, and one that has many facets. Presently the Basin is faced with the problem of paying for expensive dams, reservoirs, and irrigation projects by the use of power revenues from a Basin Fund that is dependent upon a diminishing water supply. The amount of revenues that are supposed to accrue to the Basin Fund may also be adversely affected by a reduction in power rates.

Fourth, the Upper Basin has always been an exploited region. Its resources have been transported from the Basin. This situation can be expected to continue so long as there are masses of population to be served elsewhere, and transportation technology makes it possible. For this reason, if industrial expansion and population do not come to the Upper Basin as rapidly as it is hoped, the Upper Basin may be forced to make a choice that would tend to commit large water supplies to recreational enterprises that will attract people and money.

Fifth, because the potential Upper Colorado River water supply is a limited one relative to the other undeveloped resources waiting to be exploited, the Upper Basin must combine its efforts with those of the Lower Basin in order to provide supplies of water from other sources, whether those sources be water savings, improved management, desalination of sea water, or other river systems. Interbasin cooperation is mandatory in order to generate basin-wide support for legislative action.

Crisis In The Lower Basin -- Impending Crisis In The Upper Basin

There is a serious water deficiency in the Pacific Southwest. This deficiency exists only because there is an imbalance in the supply of water relative to the other resources, including people, land, and climate. If we are cognizant of the laws of nature we will acknowledge that a crisis exists in the areas to be served from the Lower Colorado River, and that this same crisis year after year is creeping stealthily upon the Upper Basin. During the first half of this century the Upper Basin stood in the wings and watched the staging of large-scale water developments in the Lower Basin. It was not until about 1950 that the Upper Basin found itself ready to actively participate in major water programs.

From 1952 to 1954 the Upper Division States were faced with the choice of whether they should become parties in the lawsuit Arizona v. California, in which case their much-needed and long-sought water
resources program would surely have been delayed for another 10-20 years, or resisting the lawsuit and pursuing the Congressional authorization of the Colorado River Storage Project and participating projects. They chose the latter course and, in spite of all-out opposition from certain quarters in the Lower Basin, Glen Canyon, Flaming Gorge, Navajo, and Curecanti Dams and reservoirs and several irrigation projects are realities, or are about to be. Although satiated with its embryonic success the Upper Basin is not so naive as to believe that the construction of the first phases of the Storage Project will resolve all of its water problems.

**Action By A United Basin Is Preferred**

You will have noted that I have given a high priority to the problem of protection to the future development of the water resources apportioned by Compact to the Upper Basin and without regard to what magnitude those resources might be under various interpretations of the Law of the River or of the basic hydrologic data. Perhaps the belief in need for this protection is predicated in part on past experience and in part on the fact that the decree in *Arizona v. California* offers no solace in this respect, because it has not defined the issues between the two subbasins with respect to what is included in the water supply of the Colorado River system and what is to be accounted for as consumptive uses under the Compact. These are fundamental issues involving the water supply left for the Upper Basin. They could be the causes of serious differences unless through prudent statesmanship they can be resolved by agreement, or unless they can be eliminated by cooperative constructive action. Although we would be willing to try in the interest of expediting progress, I have serious reservations about the ability of the most astute and reasonable diplomats in the Upper and Lower Basins to reach complete agreement on these points. Therefore, action by a united Basin with the objective of increasing the total water supply would contribute a constructive approach that would eliminate controversial issues and aid both subbasins.

**The Real Colorado River Basin Problem**

The total water supply of the entire Basin is the real problem of both the Lower and Upper Basins. It seems almost platitudinous to say that if a supplemental water supply could be injected into the water-deficient area served by the Lower Colorado River, the potential resource development of the Upper Basin could be guaranteed at the same time. In fact, the importation of water into the Colorado River Basin in quantities sufficient to guarantee present uses, relieve the deficiencies in the Lower Basin, and meet future needs would cause most of the problems and fears of the Upper Basin to vanish. With plenty of water available the controversial questions pertaining
to interpretations of the Compact with regard to supplies of water and measurements of consumptive use as between Basins would become relatively immaterial. It is conceivable and within the realm of probability that the time may arrive when sufficient water can be brought into the Basin to make possible the exchange of imported water to the Lower Basin for part of its share of Colorado River water to be used up the river.

Need To Broaden Scope Of Water Resource Planning

We cannot meet the future water needs in either the Upper or Lower Colorado River Basins or in other arid and semi-arid western states unless we raise our sights and broaden our horizons in approaching water resources planning. Our planning has been too narrow in scope. It has been fragmentary, not actually so comprehensive as we try to convince ourselves that it is. Our grandfathers and our fathers did a good job of local planning. They did not have occasion to step on each other's toes very much. Our generation, in some instances, has progressed through state-wide planning and, in certain instances, has utilized limited inter-state planning and development. We are now entering an era of expanded interstate planning that will involve regional transfers and exchanges of water supplies from one river system to another.

With respect to geography we must think in terms of regions of our nation and their interstate and international relationships. With respect to time, we must try to project ourselves 50 - 100 years into the future instead of 10 - 20 - 40 years.

Our water resource planning must be in terms of people who need water. This concept must include planning for potential populations, as well as for present concentrations of human beings. As illustrated by the energy resources of the Upper Colorado River Basin millions of units of undeveloped resources often exist in water-short basins. These resources can and will be utilized only if water is made accessible. The presence of water for human consumption and industries will lead to new jobs, homes, and new tax bases to support future populations. This will tend to bring into balance the population - other resources - water relationship.

Proposals To Increase Water Supply Of Colorado River Basin

Within the last year we have heard several proposals to increase the water supply of the Pacific Southwest. Among other things, the Pacific Southwest Water Plan proposed the importation of water from Northern California to the Lower Colorado River System and to Arizona and California. There have been suggestions to tap the Snake River in Idaho, the Columbia River,
the Yellowstone, and the great international scheme known as the North American Water and Power Alliance, a proposal to import water from Canadian and Alaskan rivers to benefit areas in Canada, 33 states of the United States, and Mexico. All of these suggestions are good examples of the broad-horizon type of interstate, regional, and international thinking, cooperation, and planning that will be necessary if this generation meets its social and economic responsibilities to the next by providing for the rising standards of living of an increasing population.

The storm of political protests that arose when most of these suggestions were made public is strong evidence that before proposals to transfer water inter-regionally can become realities, education of the public with regard to the consequences with and without the projects involved will be necessary. Furthermore, it is apparent that areas of origin of water to be exported must have their necessary potential water development and future economies protected by some reasonable pre-arrangement. The Upper Basin of the Colorado River can sympathize with this position -- yet, as explained above, it would be good engineering and political judgment to effectuate the principle of developing new supplies of water for the Basin simultaneously with the authorizations and construction of new large water projects in order to meet the pressing needs of the Pacific Southwest, and, at the same time, relieve the pressure on the Upper Basin. If, through legislative processes, the principle of increasing the water supply can be established, badly-needed projects now pending should be constructed at once. If it is desirable they can be integrated into a master plan.

The magnitude and complexities of this task should act as a challenge - not a deterrent. If we can explore space, we can meet our water requirements. Outside of perfecting the economics of desalting sea water not one new technique involved in the resolution of our western water problems needs to be invented. The time has arrived when we must get started on this job in the west, and specifically for the Colorado River Basin. We need the exercise of good judgment in negotiating arrangements between and among areas of export and import of water. We need better communications among the various divisions of the region involved in order to foster correct understanding of the problem, dissemination of information, and rapid, efficient planning. With respect to the problems of the Colorado River Basin the seven states need a task force of their own consisting of persons with the necessary skills and time to develop and perfect a plan and initiate action in conjunction with representatives of the Federal Government. Action by seven states can accomplish the job. If it is decided that it might be more feasible to go beyond the boundaries of these states for a supplemental water supply, then other states in the expanded region will need representation in such an organization.

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The importance of the responsibility facing every one of us here today was ably expressed by Mr. John C. Calhoun, Jr. of the Office of Water Resources Research when he told the Senate Appropriations Committee, "for approximately one-fifth of the United States . . . water supply will limit economic and population growth by 1980 unless some new and improved methods are developed to increase the usefulness of available water resources." We cannot afford to continue to allow our available resources to fail to contribute the highest degree of benefits to mankind. Conquering the frontiers of the Colorado River Basin and other western rivers has produced an exciting chapter in American history. The book is still open. It is our duty to write the next chapter.