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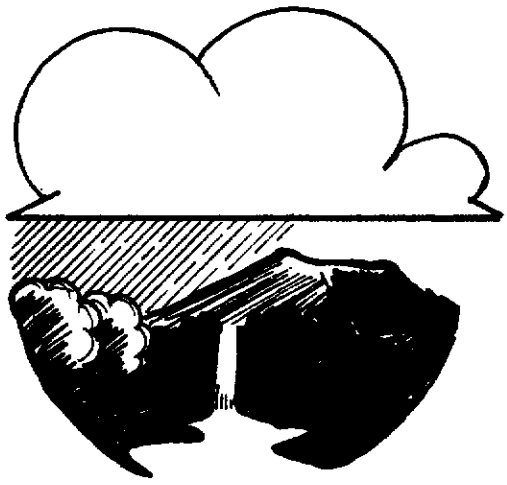
THE COLORADO WATER STUDY

DIRECTIONS For The FUTURE

INTRODUCTION



Office of the Executive Director
Colorado Department of Natural Resources

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You are holding the first publication of the Colorado Water Study. A description of the other volumes of the water study is given in the preface to this Introduction. If you wish to receive succeeding publications, you must return the bottom portion of this page to the Department of Natural Resources. The names of those who do not respond will be purged from the mailing list.

In addition, some publications of the water study (e.g., the legal studies and some technical appendices and special studies) will be printed in limited quantities. It would be helpful if members of agencies, organizations, and commissions try to share those publications. If you are a member of such a group, would you please check to see if it could be arranged to have one or two people receive these limited editions, and send us the appropriate name(s).

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INTRODUCTION

OFFICE OF THE EXECUTIVE DIRECTOR
COLORADO DEPARTMENT OF NATURAL RESOURCES

OCTOBER, 1978

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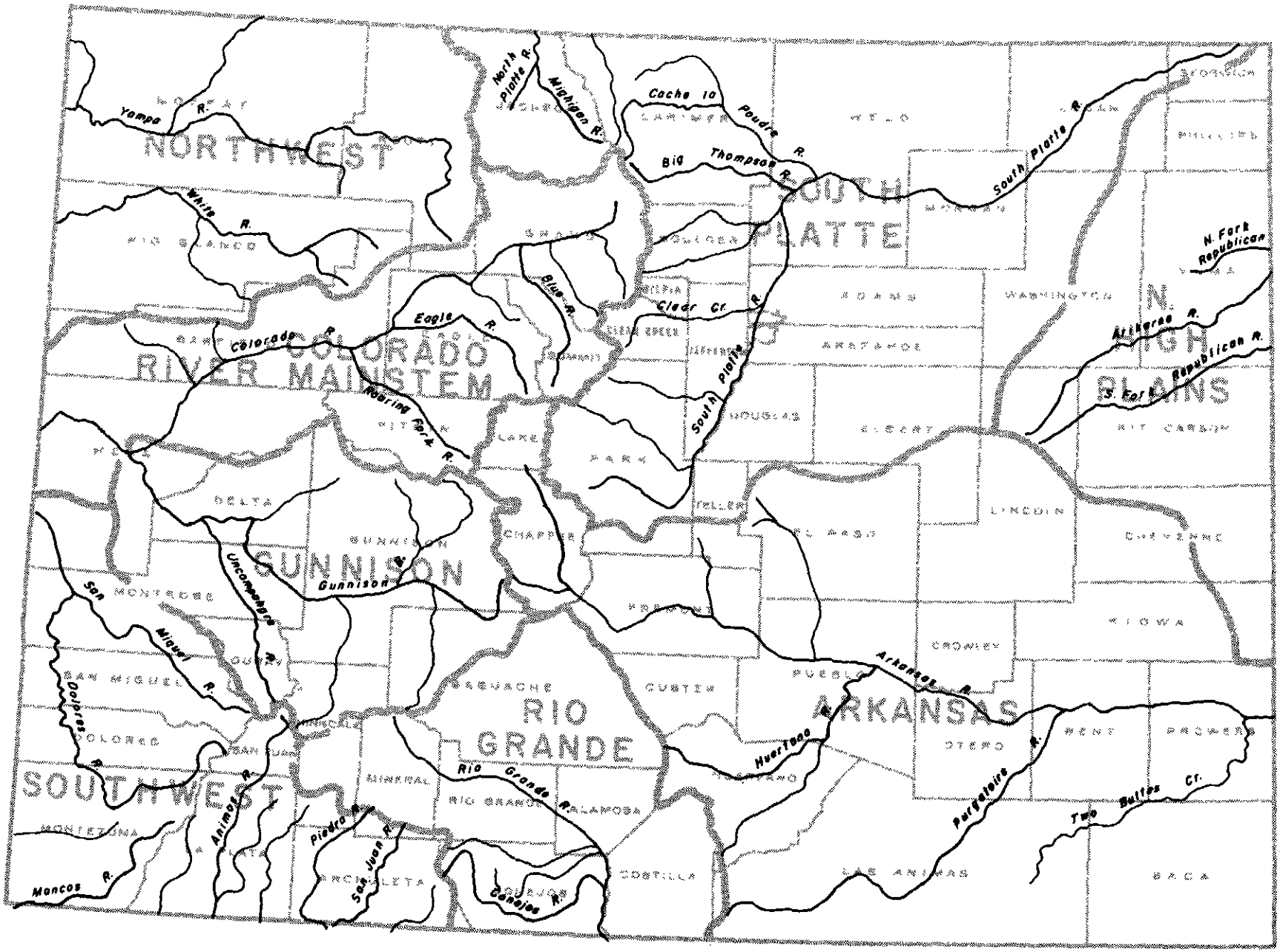

HYDROLOGIC REGIONS

PREFACE

The 1976 state legislature, acting on its own initiative, appropriated $50,000 to the executive director's office of the Colorado Department of Natural Resources for a "water study." The study was funded in an equal amount for a second year at the request of the department. Both appropriations were matched by the U.S. Bureau of Reclamation. Additional funds have been provided by the state's water quality management program.

The Colorado Water Study is being coordinated with two related efforts. At the invitation of the U.S. Water Resources Council, the Department of Natural Resources is managing a five-state assessment of the impacts of potential energy development on the water resources of the Upper Colorado River Basin. Secondly, the state legislature has provided funds to the Colorado Energy Research Institute for a broad-based study of the effects of future energy development in Colorado. Taken together, these studies should provide a reasonably comprehensive and coordinated analysis of Colorado water issues.

The purpose of this report is to introduce the Colorado Water Study and review its scope and content. Subsequent reports will provide complete documentation of the information developed by, and the results of, the study. These reports will be, in order of publication:

1. A volume of background information and data on present and projected water uses.

2. A volume on alternatives for the future use and distribution of water in Colorado, on the impacts of such alternatives, and on the possible means for achieving the alternatives.

3. A volume of legal studies.

4. Multiple volumes of technical appendices and miscellaneous special studies.

It should be emphasized that none of the above reports will make recommendations regarding the future use and distribution of water, nor will they recommend changes in existing laws and policies. Rather, the distribution of the reports will be accompanied by a citizen participation program designed to provide the public with an opportunity to:

1. review and comment on all the information developed by the study and

2. express its preferences with respect to the alternatives examined and analyzed in the second volume.

In short, these publications are intended to provide a foundation for public consideration and discussion of "directions for the future."

After distribution of the reports and completion of the citizen participation program, the Department of Natural Resources will submit a final report to the governor concerning Colorado's future water policies and the need for changes, if any, in state water laws and the state constitution. It should be noted that any significant change in the way Colorado's water resources are used and distributed will require legislative action.

Questions and comments regarding this report, or the study in general, should be addressed to:

Colorado Water Study
Colorado Department of Natural Resources
1313 Sherman Street, #718
Denver, Colorado 80203

Telephone: 839-3311

Setting for the Study

SETTING FOR THE STUDY

As Coloradans have long recognized, water is a scarce and precious resource in our semi-arid climate. Its use and distribution have always been a matter of concern and, on occasion, a source of intense conflict. The future will be no different. Complex and difficult issues lie ahead, each of which raises fundamental questions about the ends to be served by the use of Colorado's water resources. In order to understand these issues, and the approach which this study has taken in examining them, one must first be aware of:

1. Physical and compact limitations on the supply of water available for use in Colorado.

2. The operation of the present water rights system, which determines the legal and institutional procedures for the appropriation, use, and transfer of water.

3. Potential demands for various uses of water in the future.

Each of these is considered below.

PHYSICAL AND COMPACT LIMITATIONS

Water supplies are, of course, finite. However, unlike resources such as oil, natural gas, and minerals, the supply of surface waters and hydrologically connected ground water is renewed annually, although in amounts which vary from year to year. Furthermore, these water supplies fluctuate from season to season. In addition to this variability, there is a scarcity of precipitation as compared with more humid climates, and the natural distribution of supplies does not coincide with the areas of greatest demand.

In addition to physical limitations, the amount of water available for consumption in Colorado is controlled by interstate compacts, U.S. Supreme Court decisions, and an international treaty. These apportion the flow of Colorado rivers among this state, nine downstream states, and the Republic of Mexico. Since 1922, Colorado has become a party to nine such compacts, and it is subject to two Supreme Court decrees. Except for some unresolved questions about the Colorado River Compact, which covers all the surface water arising west of the Continental Divide, most uncertainties about the allocation of water among Colorado and its neighboring states have been settled.

On the western slope, favorable interpretation of the Colorado

River Compact, coupled with estimates of virgin flows dating from 1906, indicate that up to one million acre-feet of water per year, on the average, may remain for consumption in Colorado. However, an unfavorable interpretation of the compact, or downward revisions of virgin flow estimates, could result in a substantial reduction in that figure. In addition, ongoing litigation concerning salinity standards under the Federal Water Pollution Control Act could result in restrictions on future consumption of water from the Colorado River.

East of the Continental Divide, it is clear that there is little additional water left to consume, given physical and legal limitations and present consumptive uses. The surface water supplies of the Laramie, Arkansas, and Rio Grande river basins are, for all practical purposes, fully utilized. On the North Platte River, additional water could be devoted to irrigation on only a specified amount of land, but unlimited amounts could apparently be devoted to any other use.* In the South Platte River basin, only about 300,000 acre-feet of water per year remain, on the average, for Colorado to consume. However, it is unlikely that more than about two-thirds of that amount can be consumed since significant amounts of return flows from irrigated agriculture enter the river too far downstream to be recaptured. Finally, while significant ground water reserves underlie the Northern High Plains region, they are being pumped at rates which probably will exhaust this source over the next 25 to 50 years.

Even though legally available to Colorado, the amount of water which can actually be developed for additional future consumption in any basin may be limited by recurring droughts. This is because low priority conditional decrees, which would receive relatively little or no water during times of low flow, may never be developed due to the risks of reliance on such uncertain water supplies.

In short, Colorado water supplies are limited, and their availability is subject to fluctuation and uncertainty. In light of these facts, Colorado has developed a system for the distribution and use of water, which recognizes water rights as property rights that can be severed from the land and freely transferred to other uses or locations. This water rights system, as embodied in the Colorado Constitution, statutes, and case law, is described below.

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*Under the terms of the U.S. Supreme Court decree in Nebraska v. Wyoming, 325 U.S. 589 (1945), as amended by subsequent order of the court (345 U.S. 981) in 1953, Colorado may irrigate 145,000 acres in Jackson County. Estimates of acreage currently irrigated range from 110,000 to 125,000 acres. The decree also limits the amount of transbasin diversions. However, domestic and municipal uses are not limited, and the decree is silent on all other uses.

THE PRESENT WATER RIGHTS SYSTEM

The doctrine of prior appropriation is the cornerstone of Colorado's water rights system. It has been the basis for the distribution and use of water since before statehood. Although several aspects of Colorado's water rights system have changed substantially since 1876, the essential elements have not been altered. The salient feature of this system is that water users themselves decide upon the uses to which water will be put and the geographical location of use, with the "first in time" being the "first in right." Thus, within the limits of the definition of "beneficial use" and of the requirement that there be a "taking of water," one making an initial appropriation is free to apply water to such uses and at such locations and times as he or she alone see fit, provided only that senior (i.e., earlier priority) water rights are not injured. By the same token, a purchaser of previously appropriated water may transfer the water, in an amount not exceeding the seller's historic consumptive use, to such uses and places as desired, provided only that other vested water rights (both those junior and senior to the right being transferred) are not injured.

In the context of this system, state government has three primary functions. The first and foremost of these is to insure that private property rights in water are protected and that the necessary elements of an appropriation are satisfied. This function is carried out by the state engineer's office and the courts, which are responsible for policing the system. Decisions about the use, transfer, and distribution of water remain, however, with the water users themselves. The second function is to regulate the use of certain ground water resources. Depending on the physical and legal circumstances, this function is carried out by the state engineer, the Ground Water Commission, or local ground water management districts. In this instance, government can directly influence the location, rate, and amount of water use, but it still has a very limited role in specifying the uses of water. The third function of state government is an informal one, consisting of expressions of support for, or reservation about, water use and development proposals by private parties, local governments, or the Federal Government. Although the state normally has no final authority to approve or disapprove such proposals, this function is an important one. In fact, it constitutes the primary role of the state in water policy matters. While this role is typically carried out by the executive branch, the legislature may become involved from time to time through the actions of individual legislators or through the passage of resolutions or memorials which express the formal opinion of one or both houses of the legislature.

In summary, the present Colorado water rights system constitutes a private market approach to the allocation of a scarce resource, with government having very little formal authority over the use of water. In principle, this market system weighs the relative importance to

society of various water uses through the investment which appropriators are willing to make in order to develop a water right, or through the prices agreed upon by buyers and sellers of water rights. Put another way, the market "allocates" water to those most willing to pay for its use. Thus, individual water users, each acting to promote his or her own welfare, decide how water in Colorado will be used.

While the market system is a commonly employed means for allocating water, as well as many other resources, it is not without its shortcomings. One significant difficulty arises when a resource cannot be privately owned. The problem stems from the fact that when property rights to a resource are not, or cannot (as in the case of air), be defined by the legal system, then the values associated with the use of that resource will not be taken into account by the market since one cannot express his or her preferences through the purchase of the resource.*

For example, so long as water is physically removed from a stream, it is possible to identify it as the property of someone in particular. In turn, that person can use the water as desired and can also exclude all others from benefiting from its use. Thus, if someone else wants to put the same water to a different use, they have to buy the water. The price at which the water is sold will then be an expression of the relative importance of two different uses of the water.

On the other hand, it is difficult, perhaps even impossible, to define privately owned rights to water that is to be used in a stream. This stems primarily from the fact that water in a natural stream (like air) is a "fugitive" resource which cannot be claimed by one person to the exclusion of all others. Thus, until 1973, instream uses of water, and the recreational, ecological, and aesthetic values associated with such uses, were not accounted for because the water rights system did not provide people with an opportunity to make their preferences known through the operation of the marketplace.

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*It is a common misconception that only economic values (e.g., the production of income) are taken into account by a market system. On the contrary, a market system recognizes any of the values which people place in a resource (be they economic, ecological, aesthetic, social, cultural, or recreational) so long as property rights to the resource in question can be defined by the legal system. A good example is the use of water to irrigate lawns and gardens. The values associated with this use are essentially non-economic, yet the water rights system clearly affords the opportunity to preserve these aesthetic values to the extent desired, as measured by people's willingness to pay for municipal water service.

In recognition of this situation, the legislature passed S.B. 97 in 1973.* This law authorizes the state, acting through the Colorado Water Conservation Board, to appropriate or purchase water rights for "such minimum flows . . . as are required to preserve the natural environment to a reasonable degree. . . ." To date, the state has filed for minimum flow appropriations on over 2,400 miles of stream and on about 460 lakes in order to protect coldwater fisheries. All of these appropriations carry a 1973 or later priority date. To the extent that they are on the upper reaches of streams and rivers above existing diversions, they will effectively reserve minimum flows, even though they are relatively junior water rights. However, on streams where pre-1973 rights are already depleting flows below minimum levels, senior rights would have to be purchased if the public desired to provide for various instream uses of water.**

FUTURE DEMANDS FOR WATER

The final element in the setting for the water study is potential future demand for water. The demand will be for uses which fall into two broad categories: (1) consumptive uses, and (2) non-consumptive, or instream, uses. The consumptive uses with which this study is concerned include irrigated agriculture, energy conversion processes (oil shale, coal gasification and liquefaction, and steam electric power generation), coal slurry pipelines, and municipal uses (the consumptive portion of which is attributable primarily to lawn and garden watering).*** The instream uses which this study is examining include fishing, kayaking, and rafting.

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*The constitutional validity of S.B. 97 is currently being tested. The statute has been upheld in state district court, and the decision is now on appeal to the Colorado Supreme Court.

**A minimum flow appropriation, like any other water right, gives the state the right to object to changes by other water users in the time of use, type of use, point of use, or point of diversion, if that change will injure the minimum flow right.

***While various industrial uses other than energy conversion processes consume water, the anticipated demand for increases above present levels is so small relative to the overall amount of consumption in Colorado that such uses are not being considered in this study.

Consumptive Uses

With respect to municipal uses, the largest demand for additional supplies will undoubtedly come from Front Range communities. However, neither the magnitude of those demands, nor the specific sources of water to be used, are known with certainty. The demand for water will depend upon population growth and the extent to which water conservation practices are employed. The sources of new supplies will depend upon their cost and availability. The two primary sources for Front Range municipalities will most likely be transbasin diversions and purchases of agricultural water rights. In addition, there may be some opportunity for municipal-agricultural successive use arrangements and for new reservoir facilities on the eastern slope to capture very high spring runoffs or flood waters.

Trends over the past 15 to 20 years substantiate the tendency to rely on the purchase of agricultural water and on transbasin diversions as a means of acquiring new municipal water supplies. For example, in the South Platte Basin, it is estimated that Front Range communities have purchased agricultural rights totaling 5 to 10 percent of all the water presently consumed by irrigated agriculture. Furthermore, several water condemnation actions have been filed by municipalities, and many communities pursue an active water acquisition program. At the same time, other cities have completed transbasin diversions and have plans to further develop their remaining conditional decrees on the western slope.

As for energy conversion facilities, it is clear that at least some industries, primarily on the western slope, are apt to grow during the next 15 to 20 years. However, their demands for water are very uncertain. National and international energy supply factors, economic considerations, environmental concerns, and unresolved technological questions make both the size of these industries and their water consumption requirements difficult to determine. Equally unclear are the sources of water upon which such energy conversion facilities may draw. On the one hand, many conditional decrees exist for industrial (including energy) purposes which could be developed in the future. Whether those rights are used will probably depend upon how senior they are and upon the cost of developing them into reliable water supplies. On the other hand, senior agricultural rights could be purchased from willing sellers. However, the current extent of such purchases, if any, is unknown since there is no legal requirement that water sales or options to purchase be publicly recorded. For example, there would be no public record if water were purchased and leased back to an irrigator, until the time it was needed by the energy conversion industry. Thus, all that can be documented to date is that a very small amount of water has actually been transferred from agricultural to energy uses.

The third major water-consuming use is irrigated agriculture. In contrast to municipal and energy conversion demands, which are a function of the willingness of cities and energy companies to develop or acquire the necessary water supplies, the demand for water in order to increase irrigated acreage will be almost entirely a function of the state's long-standing policy of support for Federal irrigation projects. The reason for this is that irrigated agriculture cannot finance the development of significant amounts of additional water except in the High Plains areas, where ground water is being mined. Therefore, Federal reclamation projects represent the best way of maintaining or significantly increasing the amount of irrigated acreage in the state. However, the future of such projects has been clouded by possible changes in Federal water policies, such as the proposed state cost-sharing requirement for states. Thus, the extent to which additional water will be made available for irrigated agriculture is unclear.

The concerns and objectives which underlie the state's policy of support for irrigation projects are many and diverse. First, the state desires to strengthen and sustain the irrigated agriculture component of its economy. There is concern that any significant reduction in the contribution which irrigated agriculture makes to the state's economy will have adverse effects. In contrast to other states, in which one or two sectors account for most economic activity, each of five sectors in Colorado (agriculture, tourism, manufacturing, mining, and commerce) contribute more than $1 billion annually to the state's gross product. The maintenance of such a diverse and "balanced" state economy is seen as an important goal, with the preservation of irrigated agriculture being viewed as one way to achieve that goal. Second, many people have a strong interest in the maintenance and enhancement of irrigated agriculture due to the social values which they associate with a rural agriculture lifestyle. Many view the maintenance of irrigated agriculture as a primary means of strengthening rural communities and providing opportunities in many of the non-metropolitan areas of the state. Finally, others value the open space and scenic qualities of irrigated farmland.

Instream Uses

Another factor which will influence the future demands placed on the state's water resources is the rapidly growing interest in non-consumptive, or instream, uses of water. Recent trends, projected population growth, and anticipated increases in leisure time and disposable income strongly suggest that the demand for non-consumptive uses will continue to grow for the foreseeable future and will constitute an important future demand on the state's water resources.

While the present water rights system does not, as discussed above, account for the values which non-consumptive uses reflect

(except to the extent that S.B. 97 may do so), it is clear that these values are important to a broad segment of Coloradans. Among these values are the recreational satisfaction which instream uses yield, the aesthetic attributes of flowing streams, and the concern for maintenance of ecological integrity in aquatic environments. Furthermore, non-consumptive uses also reflect economic values since recreation and tourism generate significant amounts of income for many Colorado businesses.

SUMMARY: ISSUES CONFRONTING COLORADO

From the setting described above emerge a wide range of familiar conflicts and controversies. They include concern for the preservation and enhancement of irrigated agriculture, conflicts over transbasin diversions, questions about the use of weather modification as a means of augmenting scarce water resources, conflicts over provision of water supplies to Front Range municipalities, concern for the maintenance of stream flows, controversy over the use of water by energy conversion developments, and many, many more. While these conflicts and controversies are frequently stated as if they were separate and independent, they are, in fact, components of two underlying issues.

The first and overriding issue is that of competition for a scarce resource. The question is whether there will be enough water to go around, and, if not, which uses should prevail. This issue has a geographic component as well, in that regions which are water short are looking toward other areas of the state for future water supplies. The second issue relates to the operation of the present water rights system. As long as a market-based system is the exclusive means for the distribution of water, it is clear that only certain values and water uses can be taken into account, and that other uses and values will be only partially accommodated, or ignored altogether.

Resolution of these two underlying issues, and the myriad controversies which they encompass, will involve difficult and complex choices about basic social values. For, in the end, it is not the various water uses themselves that are in competition, but the basic values served by those uses. Thus, the important question is not which uses should prevail, but which values and which goals should be promoted. In other words, one must ultimately ask which combination of water uses will result in the highest "quality of life" for Coloradans.

Since all values can seldom be fully satisfied at the same time, trade-offs will have to be made and a balance of interests sought. In order to foster an understanding of what choices are available to Coloradans and what the consequences of those choices are likely to be, the water study will analyze:

1. Several future water allocation alternatives (each of which is a mixture of the water uses and future demands discussed earlier*) in terms of their impacts upon values of fundamental concern to broad segments of society.

2. The need for changes, if any, in the state's constitution, statutes, and administrative policies in order to achieve any particular alternatives.

The next two chapters describe the way in which these tasks will be accomplished.

*The reader will recall that these uses include irrigated agriculture, steam electric power generation, oil shale, coal gasification, coal liquefaction, coal slurry pipelines, municipal uses, and instream uses (fishing, rafting, and kayaking).

Analysis of Impacts

ANALYSIS OF IMPACTS

Water-using activities have direct and demonstrable impacts on several basic social values. In particular, the water study will examine the impact of water allocation alternatives on:

1. economic well-being;
2. employment opportunities;
3. the aesthetic quality of urban surroundings;
4. opportunities for a rural agricultural lifestyle; and
5. water-based recreational opportunities.

For each of these values, impacts will be expressed in terms of an indicator, or "yardstick," which empirically measures the effect of an alternative on that value. For example, personal income will be used as the measure of economic well-being. Such indicators are necessary in order to give concrete meaning to abstractly stated values, although they can sometimes substantially restrict the range of meaning associated with a value.

The rationale for choosing each of the above values is discussed below, and the "yardstick" associated with each is also illustrated.

ECONOMIC WELL-BEING

Needless to say, everyone is concerned about his or her economic welfare. The water study will measure economic impacts by estimating changes in the total personal income of Coloradans which would result if various water-using activities were either to increase or decrease. These estimates will be derived from an input-output model of the Colorado economy which has been developed at Colorado State University. They will include the "ripple" effects which occur throughout the state's economy when an activity takes place.

EMPLOYMENT OPPORTUNITIES

The opportunity to be employed necessarily goes hand in hand with the concern for one's economic well-being. In order to measure the

impact which various future water uses would have on employment opportunities, the water study will provide estimates of the number of jobs which would be created or lost if various water uses were either expanded or reduced. These estimates will be derived from the model mentioned above and will also include "ripple" effects throughout the state's economy.

AESTHETIC QUALITY OF URBAN SURROUNDINGS

The physical environment of our cities and towns is an important aspect of the overall "quality of life" in Colorado. This fact is reflected in the attention given to, and concern expressed for, such things as the design of buildings, the layout of roads and parkways, the provision of recreational areas, the upkeep of homes and neighborhoods, the quality of the air, and many other factors. Insofar as the use of water may have an effect on this value, such impacts will be measured in terms of the acres of irrigated urban land (lawns, gardens, and parks) per capita.

OPPORTUNITIES FOR A RURAL AGRICULTURAL LIFESTYLE

While difficult to capture in words, the opportunity to live in a rural atmosphere and to labor on the land is a deep-seated value embraced by many Coloradans. Other elements of this broadly stated value include preservation of family farms and maintaining the vitality of rural towns. Intangible though it may be, there can be no doubt that this is a social and cultural value of importance to many.

The impact of water allocation alternatives on this value will be measured in terms of the acres of irrigated cropland in Colorado. However, since water allocation decisions are only one of many factors which will have an impact on this value in the future, this measure, by itself, is apt to provide an incomplete indication of the attainment of this value. For example, even if all of the acreage currently under irrigation were to remain so in the future, it is highly probable that the number of family farms will continue its historic decline for some time to come due to economic and technological forces which are beyond the control of water allocation decisions. Nonetheless, acres of irrigated cropland appears to be the best possible measure of this value, given the constraints of available information.

It should be noted that this indicator--acres of irrigated cropland--will partially measure the impact on values other than the opportunity for a rural agricultural lifestyle. For example, provision of open space and scenic vistas are environmental values of

importance to many people, and one may infer the impact on these values from a change in irrigated acreage.

WATER-BASED RECREATIONAL OPPORTUNITIES

The growing concern for environmental values on the part of a large number of Coloradans is self-evident. Among these values are outdoor recreational opportunities, in general, and water-based recreation, in particular.

In order to measure impacts on this value, two indicators will be utilized. The first indicator will measure impacts in terms of the miles of streams in Colorado which have flows sufficient to maintain a cold-water fishery and/or to support rafting and kayaking on a seasonal basis. This indicator is also taken to measure, as a first approximation, the ecological integrity of a stream and the values associated therewith. The second indicator will measure impacts by estimating the number of activity days of fishing, rafting, and kayaking that would be gained or lost as a function of different levels of future water consumption. The reason for employing this indicator is that it will, in contrast to the first one, provide at least a crude measure of the satisfaction which people derive from various levels of instream flows.

SUMMARY

As the above discussion has pointed out, the water study will depict the effects of water allocation alternatives in terms of their impacts on several social values of concern to broad segments of society. Having done so, the study will then go on to examine the ways in which any particular alternative can be brought about. In other words, the tools to bring about specified uses of water must by analyzed. The scope and content of this analysis is discussed in the next chapter.

Means to Influence
the Use and Distribution of Water

MEANS TO INFLUENCE THE USE AND DISTRIBUTION OF WATER

The water study will inventory and analyze the technological, institutional, statutory, and constitutional means (i.e., tools) which may be available to influence the future use and allocation of water in Colorado. The tools to be considered fall into three general categories. The first category is tools which tend to increase the supply of water available for use. This includes such things as weather modification and construction of water storage projects. The second category covers tools which tend to reduce the demand for water, such as successive use arrangements, metering and pricing of municipal water, and various techniques for conserving water in irrigation. The third and final category encompasses a broad range of tools which may affect the legal and institutional availability of water for various uses. Included in this category are, for example, proposals to zone water rights; establishment of a "state water bank"; various state, Federal, and local agreements concerning the use of water, such as the agreement now in effect between the state and the U.S. Department of Interior; and use of "public interest" criteria in water court proceedings.

In determining the efficacy of any given tool, several questions had to be addressed. Although the specifics of each question as applied to any given tool vary, the general outlines of the pertinent inquiries are as follows:

1. Is use of the tool technically feasible?

2. How much water will it yield? Where? When? At what cost?

3. What authority exists to implement the tool? If no authority exists, what would be required?

4. What statutory and constitutional problems, if any, are raised by the use of the tool?

5. What changes in the distribution and use of water are likely to result from use of the tool?

It should be emphasized that the examination and analysis of a tool does not imply approval or suggest that the tool, in fact, be adopted. Whether the use of any given tool is appropriate will depend on the projected consequences of its use, on the public perceptions as to the desirability of those consequences, on the trade-offs between different water uses, and on the magnitude of the legal or constitutional problems, if any, which occur with its use. Thus, the purpose of the

analysis of tools is not to suggest change for the sake of change alone, but rather to identify for public discussion the means available to achieve specified ends.

The study's analysis of tools has involved the examination of numerous possibilities. Insofar as legal (i.e., statutory and constitutional) tools are concerned, only a few were eliminated from consideration at the outset:

a. The water study does not consider or analyze the possibility of a constitutional amendment that would abrogate the right to appropriate water. The reason for this exclusion is that most of the surface water in the state is already covered by final or conditional appropriations, and such a change would be largely irrelevant. However, while the study does not consider abrogation or elimination of the right to appropriate, numerous other changes are examined, some of which would limit or condition appropriative rights.

b. Similarly, the water study does not consider shifting to an administrative permit system for the initial appropriation of water. The reason for this is the long-standing tradition of a judicially based system. However, the study does consider various changes which would apply to applications for changes in water rights. Some of these changes would give greater authority to state or local government, or would give greater latitude to the water court. An example would be the establishment of new criteria which water courts could use in reaching their decisions.

c. The water study does not consider "forced" reallocations of water by government edict, condemnation, or order; and no wholesale reallocations of existing water rights are considered. The study does look at ways to encourage or discourage certain types of reallocations or transfers. Because of current water use patterns, and the realities of market economics, it is assumed that most, if not all, future water transfers out of existing uses will come from irrigated agriculture; and the tools considered tend to be those that might slow, accelerate, or otherwise modify such transfers.

ADDITIONAL LEGAL ANALYSES

There are important legal issues concerning the benefits and obligations of water rights under Colorado law which are not easily included in the classification of legal tools set forth above. Nonetheless, they are extremely important and of significant interest to a

large number of water users. Therefore, the water study will include a special analysis of several specific water law issues:

1. The plan for augmentation. This special study discusses the origins, impacts, and implications of plans for augmentation, as defined in the 1969 revisions to Colorado water law. The study examines some of the problems of conjunctive management of surface waters and ground water resources. This includes examination of the respective rights of surface diverters and examination of wells in aquifers which are tributary to surface streams.

2. Senate bill 213 wells. A related problem is that of the so-called "S.B. 213" wells, as specified under sec. 37-90-137(4), C.R.S. 1973. The law provides for the issuance of permits for wells in non-tributary ground water sources not included in a designated ground water basin. A number of issues arise:

   a. Whether such ground water is subject to the doctrine of prior appropriation or to a doctrine of limited ownership of water by the overlying landowner.

   b. Whether the statute contemplates a continued regulatory authority over such wells by the state engineer. If so, are such wells to be administered on a priority basis, a non-injury basis, or on some other basis?

   c. Whether the rate of pumping from such aquifers should be limited. If so, what rate of drawdown is best, and how should the drawdown be measured?

   d. Whether owners of existing wells in the same aquifer may enjoin or limit the drilling of new wells or the rate of pumping in other wells.

3. Flow decrees v. volume decrees. From time to time it has been suggested that Colorado adopt a decree system that incorporates volumetric limits on water use, rather than the flow limitations now in use. The water study will briefly discuss the respective merits and liabilities of each system and the practical problems involved in conversion to a volumetric system.

Limitations on the Water Study

LIMITATIONS ON THE WATER STUDY

In authorizing the water study, the legislature did not give any directions as to its scope and content. However, it was clear from the outset of the study that not every topic relating to water and its associated land resources could be examined given the relatively modest budget available to the study. Therefore, some limitations had to be established.

In the first instance, it was decided that the study should be statewide in its geographic coverage, although the state has been divided into hydrologic regions for the sake of analytical convenience (see map at front). Secondly, it was determined that the study should deal with both surface and ground water resources, with one major exception. The exception is that ground water use in the Northern and Southern High Plains has not been examined. The reason for this is that the use of ground water in those areas represents a one-time depletion of a finite resource, and it therefore raises legal, technical, and public policy questions which are different from those pertaining to renewable surface or underground waters. In addition, Colorado is participating in a four-year, federally funded, multi-state study of the High Plains ground water situation, which study will thoroughly address the unique circumstances which those regions confront.

A second limitation on the water study is the omission of a full analysis of water quality issues. Ideally, a comprehensive examination of the state's water resources should include both the quantitative and qualitative aspects of water use since the two are inextricably related. However, the analytical problems of dealing with statewide or regional water quality issues as they affect water uses are immense. First, techniques for examining water quality impacts on a broad geographic basis are, at best, unrefined. Secondly, such an analysis requires data which is difficult to obtain and subject to significant errors. Finally, if reasonable accuracy is to be insured, the analysis must be detailed and site specific. In short, substantial amounts of money would have been required to obtain even a limited understanding of the water quality aspects of one hydrologic basin, let alone the entire state.

While the water study does not deal generally with water quality matters, the Colorado Department of Local Affairs, through the statewide "208" water quality management program, has provided funding for a brief examination of the legal and institutional relationships and conflicts between the existing Colorado water rights system and state and Federal water quality programs. The results of this examination will be published as they become available.

Another question as to the scope of the water study was whether issues relating to water-associated land resources (i.e., flood plains and wetlands) should be examined. It was concluded that they should not, largely because flood plain and wetland issues are more properly viewed as, and arise primarily in the context of, land use concerns.

One final factor as to scope of the study is the future time period considered. While planning efforts have typically made projections 25 or even 50 years into the future, there is growing recognition that no one can accurately forecast events that far in advance. Consequently, it was thought that a 15 to 20 year planning horizon was the most that could be justified in view of the many uncertainties associated with future water uses and developments in Colorado. Thus, this study's projections have been made only to the year 1995.