Appendix C

Institutions

Note: The information in this appendix further elaborates on material presented in chapter V.

State Initiatives in Water-Resources Planning

Early State involvement with water rights in the Western States related to allocating water rights to individuals as property rights, As discussed in chapter V, the "distributive" character of early water resources projects required local consent. A number of economic benefits accrued to States; there were also some less obvious disadvantages. The impetus for development of specific water-resource projects usually came from the Federal agencies which had expertise and planning capacity and was triggered by demand or crises.

In the early days of reclamation projects, States generally deferred to Federal agency initiatives in large-scale water-resources development, These agencies, staffed largely by engineers, were expert in large dam and related construction projects. Decisions on project development were essentially political and rarely involved difficult technical benefit-cost evaluations (e.g., esthetics, noneconomic impacts), realistic repayment plans, or consideration of potential alternatives, such as changing patterns of settlement or behavior, to meet development goals. In 1964, the Executive Secretary of the Upper Colorado River Basin, speaking generally about the States, observed:

> Many States have poor organizations for long-range planning and their water resource agencies lack financial support. Some States even appear to lack the proper agencies that can do their share of the overall planning job. In many instances, initiatives in planning rests with Federal agencies. State and local governments are often in a position to approve or disapprove plans without having made adequate studies for major decisions needed in the field of water resources. (U.S. Senate, 1964, in ref. 18)

In the 1960's and 1970's a number of events combined to begin a gradual shift to more active State roles. local perceptions began to change about environmental values associated with water, and these views were voiced by local groups to local politicians. Environmental impact statements and water-quality standards brought more expertise to the State level as State agencies became more aware and involved with local impacts of development. Federal funding for capital-intensive water projects showed signs of diminishing, Federal funds and planning assistance became available through such mechanisms as the Water Resources Planning Act of 1965 and the Office of Water Research and Technology (OWRT) within the Department of the Interior to help States build their own water research capabilities.

The result has been a growing and increasingly visible level of State interest, awareness, and involvement in water-resources planning and management. For example, in November 1982 the National Conference of State Legislatures (NCSL) issued a detailed and well-documented report, Water *Resources Management: Issues and Policy Options,* to assist State legislatures formulate water-related policies and programs (17). Though State efforts have varied, three kinds of activities help illustrate this shift:

1. protecting instream uses,
2. dealing with conflicting uses of water, and
3. water-resource planning and regulation.

Water for Instream Uses

Multiple use of a State's water resources is advocated by most States. Within the last 10 to 15 years, this concept has taken on a new dimension in the form of minimum stream flows to protect and preserve instream values for fish, wildlife, and recreational purposes. While it is true that some of these programs are modest in nature, they reflect a shift in traditional State policy. It is somewhat ironic that efforts to preserve instream flows come at a time when most States are experiencing even greater demands for additional diversions from the streams for other uses. This has and will make the task of protecting instream values much more difficult. Nevertheless, considerable amount of activity is occurring with respect to nonconsumptive uses such as minimum streamflow protection with potential important implications for sustaining and advancing agricultural uses of water at the State level.

The type, scope, and strength of the various State programs in this field vary greatly, For example, California has adopted, among other strategies, a State version of a wild and scenic rivers act. Colorado, Idaho, and Montana have enacted legislation that allows administrative agencies to protect certain instream values by reserving water for this purpose. Oregon, one of the first States to recognize instream values, created a Water Policy Review Board in 1955 with powers to set minimum perennial streamflows sufficient to support aquatic life and minimize pollution. Utah allows the State Engineer to consider the natural stream environment when evaluating new applications to appropriate water. Other States have charted different courses.

In application, protecting instream flows involves tradeoffs with existing water uses. As such, decisionmaking to protect such flows has been difficult and complicated even where authority exists. For example, while the Oregon Water Board has had the authority to classify and allocate water for instream flow purposes, instream rights are a lower class than the water rights granted prior to the 1955 enactment and thus are junior to most of the water rights in the State. Taking administrative action to protect instream flows would involve changing actual or allocated offstream uses. Consequently, according to one policy expert, minimum instream flow protection in Oregon has not been guaranteed under the 1955 legislative authorization (19).

Resolving Problems of Conflicting Uses

States are becoming increasingly involved in resolving conflicting uses of water. Water scarcity plus rising water demands have brought forth a variety of attempts at the State level to reallocate or transfer private water rights, A few State experiences illustrate some of the approaches being taken:

1. Arizona, where a comprehensive legislative framework is being used to allocate and reallocate water rights;
2. a subbasin in New Mexico, where a local water district is expanding its traditional functions; and
3. Colorado where economic, market-oriented procedures are used to resolve water conflicts,

Arizona relies on ground water supplies and since the 1930's has been "mining" this resource, In the 1970's, as use conflicts grew and competitors turned increasingly to the courts to protect their interests, legislation was passed mandating the development of a Groundwater Management Study Commission composed of legislators and representatives from mining, municipal, and agricultural interests to rewrite the ground water code. Pressure also came from the Secretary of the Interior, who indicated that his recommendations on the Central Arizona Project water allocations would be positively influenced by strong ground-water law reforms.

The Arizona Groundwater Management Act was passed on June 12, 1980, " creating the first comprehensive legislative framework for management of ground water resources in Arizona. It established active management areas (AMAs) in parts of the State, where, owing to the magnitude of ground water pumping, active ground water management was necessary to ensure long-term supplies. Management plans detailing water duties and approved water-use practices are required for each AMA, The act allowed all legal ground water pumping that had existed at the time the act was passed to continue, It called for validation of such grandfathered rights, the issuance of permits under certain criteria for new rights, and restriction on new irrigated acreage. Because the goal of the act is to eventually balance ground water withdrawals with the safe yield of aquifers, new uses will depend on the willingness of existing uses (in other words, irrigated agriculture) to sell their water rights. This will have significant ramifications on land use in Arizona and the future of agriculture in the State (3).

The *middle Rio Grande basin of New Mexico* has been the setting for growing conflict between the historical, rural character of the State and the modern demand for transfer of water rights to industrial and municipal uses. Originally, this basin was almost exclusively devoted to agriculture. Now it has become the largest urban center in the State. Thus, the principal agricultural institution in the area—the Middle Rio Grande Conservancy District—has come under increasing pressure to accommodate these new uses (3),

Because of competing uses, a market for water rights has developed in the basin. Since water rights were originally attached to agriculture, any reduction or diminution of these rights threatens the traditional role of the basin's Conservancy District, The district became involved with litigation as it tried to protect agricultural water rights and prevent transfers from within the district's boundaries to a new owner and use outside the boundaries. It has considered the prospect of leasing its water to other uses of higher economic value in the urban area. The district might become more involved with use of its existing agricultural rights to offer recreational and related amenities to the urban population through more active management of its lands and water as "greenbelt" areas in the urban vicinity, Whether such a shift to multiple-use management is possible depends on the speed with which the district can assume a new role as regional water

•Ariz.Rev Stat Ann sees, 45-401 to 636 (Supp. 1981-62).

Photo credit: *Ted Spiegel, 1982*

A suburb in Tucson, Ariz., an area of extensive ground water overdraft, with a major interest in domestic, urban, and industrial water use, where agriculture may become a lower priority.

manager to provide the new kinds of services required,

Colorado has had some of the most extensive experience with water transfers as a means of dealing with conflicting uses. Colorado water law allows the free transfer of private water rights as long as third- party rights are protected. This provision has resulted in the development of largely economic, market-oriented procedures. Over the last 20 years large transfers of water from the agricultural sector to municipal and industrial uses have been made. Purchases of agricultural rights have been particularly active for the Colorado communities along the eastern side of' the Rocky Mountains (the "Front Range"). Shifts are even more evident in the use of water from the Bureau of Reclamation Colorado-Big Thompson (CBT) project, In 1957, 15 percent of the project water was owned by municipalities; by 1978, municipalities owned 34 percent (3).

At the same time, Colorado is a Western State that recognizes environmental interests. In 1973 changes were made in the State's constitution and water laws recognizing instream use of water as a beneficial use and allowing the State to appropriate or purchase water rights for such use. The large shifts in water use plus these emerging social values resulted in the commissioning in 1976 of a Colorado Water Study to analyze "future water allocations . . . in terms of their impacts upon values of fundamental concern to broad segments of society" (4).

A major purpose of the Colorado Water Study was to look at the State's water-allocation practices in the context of water scarcity and the growing pressures of economic growth, energy development, and increased population. Of particular concern was the loss of the economic base which irrigated agriculture represented and the "rural lifestyle" associated with the agricultural way of life. The concern focused on whether unrestricted water transfers for solely economic values are also adequately serving other important values such as the rural lifestyle and environmental preservation (4).

Many new demands for water are being placed on Colorado's water supply. As transfers continue to be proposed, some may be found detrimental to the present instream flow values when they involve a change in use or change in point of diversion. The instream flow classification as a beneficial use may provide a mechanism whereby noneconomic considerations could be incorporated into a basically market-oriented water-allocation process.

Water-Resource Planning and Regulation

State water-resource management programs have never been more in need as traditional water uses grow and compete with rapidly accelerating demands for water for energy development and instream flows. Opportunities to stretch available water resources in the foreseeable future are going to come primarily from better water resources management programs at the local level.

The development of a State water plan is an important step in minimizing friction between competing interests for available water while advancing overall public interest. Some Western States have begun to develop water-planning mechanisms, The preparation of water plans can be expensive and requires a good deal of time and the input of many people representing different disciplines and interests. For any plan to be effective, competing interests must perceive a full and fair opportunity to advance their views. Moreover, the resulting management decision must reflect a balanced approach that adequately takes into account differing views and local interests. According to some Western law experts, a planning process should proceed under State guidelines that are mandated by law and become part of the state regulatory program (7).

Utah is one of the States actively debating the development of a comprehensive approach to water-resources planning and management. Since 1975 it has been considering possibilities for a statewide water plan (6). The proposed plan is a combined system of planning and regulation through integrated management of water within hydrologic units. The elements of the 1975 proposed plan noted here are illustrative of the kinds of considerations likely to be faced by many Western States as they attempt to manage their limited water resources among competing uses.

In the 1975 proposal, the Utah statewide water plan would emerge through the preparation of separate unit plans for hydrologic units in the State. The unit plans would involve a substantial amount of local participation and would be under State supervision, with general guidelines and criteria applicable on a statewide basis. Once completed and approved at the State level, the various unit plans would have a regulatory status and would guide water management in their respective areas until modified. The plan would cover all uses, including agriculture.

The Utah proposed plan has several key elements for managing water resources. It incorporates water-quality considerations into the development of the plan, using the expertise of water-quality officials. The hydrologic unit plans, once adopted would serve as a regulatory as well as a planning tool. In addition, any prospective appropriator (whether an irrigator, municipality, or industry) could examine the unit plan for the particular hydrologic unit of interest and immediately determine whether there were any unappropriated water or rights available for purchase or transfer.

The Utah Legislature did not adopt the plan in 1975 because of concern by many—principally those owning irrigation water rights—that there might be some impairment or adverse impact on their water rights if they were brought within the hydrologic unit plans and a statewide plan, According to the drafters of the plan, however, any vested water rights would be entitled to the protection of constitutional due process and would not be impaired or taken without payment of just compensation (7). The position of those who advocate the plan has been that an integrated hydrologic/regulatory approach may be one of the best prospects for protecting, sustaining, and perhaps expanding the use of water for irrigated agriculture in the arid and semiarid States (7).

Studies of the Economic Values of Western Water*

The Economic Value of Water for Irrigation

The direct value of water in irrigation is measured in terms of the increment of profit to the producer with irrigation as compared to profits without irrigation. Several methods may be employed to make this calculation. One is an "ex ante" (before the fact) approach, which computes the change in net income from assumptions about crop prices, yields, production technology, and production costs, An alternative technique maybe labeled "ex post" (after the fact), which relies on statistical analysis of actual production data. The ex ante method is often most convenient for planning in specific cases, and is generally used by the Bureau of Reclamation and other Government agencies that deal with water. Various statistical approaches serve to validate the analytic measures, and are regarded by many analysts as more reliable owing to their base in "real, observable data. " Any analytic measures—ex ante or ex post—can be abused by improper assumptions about prices, yields, and/or input requirements, or some cost items that may be ignored, Experience has shown, however, that when properly performed, the methods yield similar results.

What is the value of irrigation water? The value of the marginal unit of water may reflect water scarcity as well as the cost of supplying the marginal unit. Local production conditions such as rainfall, temperature, length of growing season, and market situations will also have an impact, so considerable variation in water value across the West can be expected, Highly productive areas such as the Imperial Valley or the San Joaquin Valley in California will have high values for water. Marginal production areas such as the high meadows of Wyoming will show low values.

* Excerpted from: R. Young, "Allocating the Water Resource: Market Systems and the Economic Value of Water," OTA commissioned paper, 1982,

Beattie and Frank (2) used 1974 census data as the basis for a statistical analysis of agricultural output. One of their purposes was to learn how agricultural output is influenced by resource inputs, including land, labor, machinery, chemicals, and irrigation water. The results yielded water values (expressed in current 1982 dollars) of $10 to $15/acre-ft in the intermountain valleys of the Upper Colorado and Snake River basins; $20 to $25/acre-ft in the desert Southwest and central California; and $40 to $45/acre-ft in the Ogallala ground water region of the High Plains.

Hewitt, et al. (12), reported similar results using a much different technique. Their interregional supply-demand model for California yielded prices at the margin of $23 to $35/acre-ft in the Central Valley and southern California and $7 in the Imperial Valley, Gollehon, et al. (10), show estimated prices for irrigation water in 11 Rocky Mountain subregions. This study is somewhat atypical since it studies the value of water that might be lost to the region or transferred to other uses. When the water supply is reduced by 20 percent, two regions showed water valued in excess of $20/acre-ft, four were between $10 and $20/acre-ft, and six were below $10/acre-ft.

The Department of Commerce recently sponsored a study of water value in the Ogallala region of the High Plains, The study showed a value of $60 to $80/acre-ft for water used in irrigation. These values move upwards wit h the passage of time, reflecting (assumed) increases in crop prices and yields through the year 2000.

The estimates of the value of water used to produce certain specialty crops (e. g., flowers, spices, berries) may be somewhat higher than the figures cited above. However, such uses will account for less than 10 percent of total irrigation water use in the foreseeable future. These crops are not, and probably will not be, of much significance for the formation of national water policy. This being the case, a rough estimate suggests that 90 percent of all irrigation demand is probably for water that costs no more than $40/acre-ft.

The Value of Water in Industry

Energy production is the major consumer of water used for industrial purposes in the arid West. Most of this water is used for cooling thermal-electric powerplants. Several processes can be used for cooling, depending on water scarcity and price.

Young and Gray (23) use an alternative cost approach to show that it is economical to convert existing plants from a pass-through cooling system to an evaporative cooling tower when water costs rise above $5/acre-ft (1982 price levels). Methods designed to conserve cooling water are much more expensive. Gold, et al. (9), in a study for the U.S. Environmental Protection Agency, report that the break-even points for combination wet-dry cooling systems run around $600/acre-ft, while the shift to a completely dry, water-free cooling system would be economical only if water were extremely expensive—perhaps as much as $1,400/acre-ft. Abbey's (1) comprehensive analysis of water and energy problems in the Colorado River Basin provides similar estimates. Hence, the large-scale stem plants proposed for several areas in the West could, if necessary, be willing to pay an amount many times the value of water in neighboring and competing agricultural uses.

Recent experience suggests, however, that even the large 'water requirements of huge powerplants can be met with relatively little loss of water to agriculture in the surrounding area. Much of the 45,000 acre-ft required by the Intermountain Power Project (IPP) in Utah will be met by using conveyance losses or water used on saline soils that have little or no present agricultural value.

Leigh (14) has studied the value of water for coal slurry pipelines. His values are based on cost savings that accrue from not having to rely on rail transportation to move the coal (the alternative cost method of measurement). The value of water in a Colorado-to-Texas pipeline system is estimated to exceed $1,600/acre-ft. This estimate of value is, however, extremely sensitive to changes in the level of railroad freight rates. Reductions in freight rates could reduce the imputed value of water, although it is not likely to drive the value below willingness to pay for irrigation water. That is, agriculture cannot expect to compete with this use of water.

The need for water in recovery of hydrocarbons from oil shale has received considerable attention. Valuing water in this use could be accomplished using the alternative cost method or by estimating the change in net income accruing to oil-producing firms. The alternative cost approach suggests that water could substitute for considerable capital and labor in the refining process and hence be very valuable, The change in net income approach requires that the production process be profitable before positive residual income can be imputed to water. Under current and anticipated petroleum prices, shale oil extraction is not economically feasible, therefore, water has a zero or negative value in this use.

Value of Water in Households

While willingness to pay for water delivered to households is readily observed and has been studied by many analysts, deriving a marginal value of water to households that is comparable and commensurate with estimates of raw water values in streams is, however, quite difficult. Household water that is treated (filtered and chlorinated), stored, and delivered to the user on demand is a much different economic commodity than the raw and untreated river water that is used in irrigation or industry. Hence, a deduction for treatment, storage, and delivery costs must be made to make the prices and values comparable. An estimate may be derived using a method suggested by Young and Gray (23) and based on data developed by Howe and Lineaweaver (12), This approach finds that lawn sprinkling is valued at about $150/acre-ft and in-house uses at $250/acre-ft (in 1982 dollars), A weighted average of water in the two uses would be about $220/acre-ft. In another study Hewitt, et al. (13), do not distinguish between industrial and household demand, Their municipal and household sector estimates for 1980 (in 1982 prices) are about $160 to $200/acre-ft.

An alternative estimate can be derived from market values of water in the Colorado-Big Thompson project (in northeastern Colorado) that can be transferred to urban uses. Gardner and Miller (8) report that the price of water rights—i.e., the price of exclusive rights to water—averaged $2,450/acre-ft in 1981. Converting this figure to an annual acre-foot value requires assumptions regarding the capitalization rate and expectations about future inflation. However, if the interest rate is about 8 to 9 percent (which seems plausible), and the planning horizon is long, the value of water is nearly equivalent to the $240 determined by Young and Gray (23) and Hewitt, et al, (13).

Hydroelectric Power Generation

Because evaluation of hydroelectric projects has usually proceeded on the assumption that falling water is a free good, recorded efforts to value water in this use are rare. In recent years competition for water—even falling water—has intensified, so evaluation methods have had to be developed. The procedure that has emerged centers on the cost of generating electricity using some alternative method of generation (alternative cost method). When this method is used, the value of water is derived by deducting capital and operating costs of the generation and transmission system from the revenue earned by selling the power. The residual, if any, is attributed to the water resource (change in net income method). Specific value estimates vary, depending on the differences in head (the distance the water falls before turning the turbines), distances to load centers, costs of the steam-generating alternative, and the construction costs of the dam and storage facilities behind it. Even given these variables, values are also expressed for one site only or for several sites on a given reach of a river. Young and Gray (23) report single-site values ranging from $3.30 to $10/acre-ft in 1982 prices in the Western States. The higher values are associated with sites that have relatively high heads and can, thus turn larger turbines. Most of these sites are found on the Colorado River. Whittlesey and Gibbs (22) report values for power generation in the Columbia Basin of over $30/acre-ft (1982 prices) for water that goes through all of the dams below Franklin Roosevelt Reservoir, including Grand Coulee, This figure is higher than that reported by Young and Gray because of continued reuse at several generating stations and because of the higher costs associated with alternative energy sources in or near the Columbia River Basin, While single-site values for hydropower are not large relative to the values found in diversionary uses, diversions that are made high in a basin can lead to loss of large cumulative benefits stemming from reuse as the water passes through a number of facilities.

Valuing Water in Water Load Dilution

Water released for dilution of pollutants has value to the extent it reduces damage that the pollutants may impose on subsequent users. Precise estimates are difficult to derive since the detrimental effects depend on the particular pollutant, distance downstream, water temperature, rate of flow, and the quality of the waste-receiving water used for dilution. Most analysts have estimated values by assuming that the value of a unit of "clean" water is equivalent to the cost of treating effluent so that it does not reduce the quality of the water.

The results of these studies generally imply that dilution values are generally quite low. Merritt and Mar *(16)* showed dilution water in the Willamette Basin (Oregon) to have a value of about $l,30/acre-ft (1982 price levels). Gray and Young (11) applied the aforementioned technique to several regions in the West. Their estimates of value in dilution ranged from $0.08/acre-ft (Colorado Basin) to $3.25/acre-ft in the lower Missouri. Employing data from the Colorado River Board of California, Young and Gray (23), however, derived a value of water for dilution or reduction of salinity in the Colorado Basin at about $15/acre-ft.

The Value of Water in Water-Based Recreation

Water-based recreational services, by tradition and policy, are not often priced by market processes. Indeed, recreation and recreation services are so varied and so abstract that many people scoff at the notion that any reasonable value can be attributed to the resources used to produce them. The normal problems of valuing water are compounded since the value of water for recreation must be derived from a prior, synthetic, and sometimes arbitrary imputation of the value of the recreational services themselves. The problem is further complicated because the recreational uses of water are often complementary to other water uses rather than competitive with them. Water stored for irrigation, hydropower production, or flood control can be enjoyed by swimmers or fishing enthusiasts without diminishing its usefulness in its other uses. In such cases, it is difficult to value the water and only slightly less difficult to ascertain the value of the recreational experience.

However, the growing demand for recreation is creating situations in which recreational uses are beginning to compete with other classes of instream or off stream use. At this time, few analysts are working on measuring water values that are suitable for comparing allocations among alternative uses that include recreation.

Daubert, Young, and Gray (5) formulated a direct interview procedure to elicit hypothetical bids from recreationists on the value of water in flowing streams. Applied to a sample of visitors to the Poudre Canyon in northeastern Colorado, this approach yielded estimates of economic value related to river flow used for fishing, whitewater kayaking, and noncontact streamside recreation such as picnicking, The resulting marginal bid values for typical summer streamflow were converted to dollars per acre-foot and were $9/acre-ft for fishing, $5/acre-ft for whitewater sports, and $7/acre-ft for the noncontact recreational experiences. Walsh, et al. (z I), performed similar analysis on western Colorado streams, reporting $13/acre-ft for fishing, $4/acre-ft for kayaking, and $2/acre-ft for rafting when flows were maintained at 3.5 percent of maximum.

These findings lend support to the notion that nonconsumptive uses, even though they are nonmarketed, have economic value to users. While many are skeptical of the validity of benefit estimates based on responses to questions regarding hypothetical situations, a preferable alternative technique to generate quantitative estimates of instream flow values has not been developed, While recognizing that estimates using this technique are subject to more than the usual error, they appear to be reasonable reflections of user preferences. Since these estimates are for values in a public, nonexclusive use, they must be used with great care, especially when incorporated into water-management policy decisions.

Fish and Wildlife Habitat

Efforts to value habitat directly in economic terms are relatively recent. Many suffer from one or more of the potential difficulties noted earlier, particularly in valuing total product rather than incremental units of water. *

The problem remains of relating physical water requirements to habitat productivity, an issue that appears not to have been addressed in literature that is readily accessible. The estimates made by Lynn, et al. (15), indicate a marshland value of less than $1/acre. Water supplies per acre for the habitat of one crab species would not be highly valued in strict economic terms.

Navigation

provisions of facilities for inland waterways navigation has always been an important part of Federal water policy. Estimates of the value of water for this purpose are almost nonexistent, since the usual approach to benefit-cost analysis of navigation projects implicitly assumes water to be a free good (as with hydropower). A sample approach (23) credited water with the savings from transporting commodities by water rather than by rail, pipeline, or truck. They reported positive values for water used for navigation only on the Mississippi, Ohio, and Tennessee River systems. Elsewhere, such as on the Missouri and the Columbia Rivers, the total cost of building and maintaining a navigation system exceeded the savings: no benefit was creditable to navigation,

*See Lynn (15) for an analysis of the conceptual issues, and some empirical estimates relating to blue crab production on the Florida gulf coast.

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