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GROUNDWATER PROJECTIONS FOR 11 BASINS

"Senate Bill 1391 of the 1977 Legislative session charges the Groundwater Management Study Commission to 'Make findings and recommendations and prepare legislation to provide for the best development, utilization and conservation of groundwater in the State.' To aid in this mission the Study Commission requested that the Arizona Water Commission undertake a '... study of the impacts of future growth on groundwater resources in the major basins of the State, assuming official projections of the Department of Economic Security of population and economic growth and no change in existing law and institutions as they relate to water and its use.'"

So begins the introductory chapter to the Arizona Water Commission draft report "Projected Water Uses, Supplies and Groundwater Conditions in Selected Basins in Arizona: A Baseline Conditions Report to the Groundwater Management Study Commission."

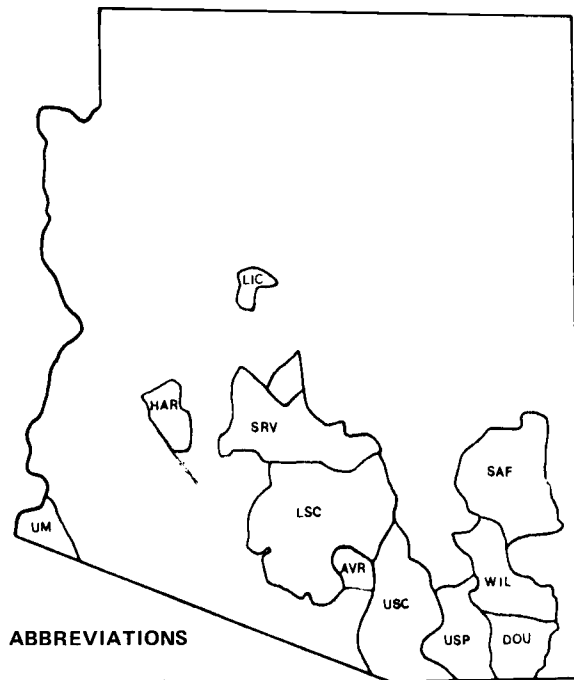
Eleven basins were selected for the study: Avra Valley, Douglas, Harquahala Plains, Little Chino Valley, Lower Santa Cruz, Safford, Salt River Valley, Upper San Pedro, Upper Santa Cruz, Willcox and Yuma. About 80 percent of the State's water depletion occurs in these 11 basins. Basins studied are shown in the figure at right.

The report is intended to provide an informational base with which to evaluate the various groundwater management strategies which may be considered by the Groundwater Management Study Commission. It is further the intent of the study to provide information that will aid members of the Commission in discharging their responsibilities as described in the first paragraph and to inform interested persons of potential groundwater problems and solutions.

Synopses of summary evaluations of the 11 basins addressed by the study follow.

Avra Valley Basin

Overdraft in the Avra Valley Basin amounts to about 87 percent of groundwater in-basin depletions. The 129,000 acre-feet overdrafted in 1975 represents slightly more than 1 percent of the groundwater in storage above 700 feet. Annual



ABBREVIATIONS

AVR	Avra Valley	SRV	Salt River Valley
DOU	Douglas	USP	Upper San Pedro
HAR	Harquahala Plains	USC	Upper Santa Cruz
LIC	Little Chino Valley	WIL	Willcox
LSC	Lower Santa Cruz	YUM	Yuma
SAF	Safford		

overdraft in the Basin is expected to decline by approximately 24 percent in the future.

Competing users of Avra Valley groundwater complicate the situation in the Basin. Basin agricultural users account for about 92 percent of the depletion. Competing with agricultural users is the City of Tucson. Its exports from the Basin represent about 7 percent of the total overdraft. Others contributing to Basin overdraft are mining, a small percentage; and local urban users, also a small percentage.

Pumping depths and costs will approach levels where economic pressures probably will reduce agricultural demands, leaving substantial groundwater to support the small, non-agricultural uses within the Basin. However, consideration should be given to limiting groundwater pumping to preserve

the supply for the Tucson urban area. The various options which would promote this objective should be evaluated.

Douglas Basin

Approximately 56 percent of the groundwater pumped in the Douglas Basin is mined. Total overdraft amounts to about 67,000 acre-feet annually and will continue at that approximate level through the year 2020. By that time, an aggregate of 3.6 million acre-feet will be depleted, of 15 percent of the 23.6 million acre-feet currently in storage above 700 feet.

No major conflicts between groundwater uses exist. There is little potential for conflicts to arise in the future or that an unreasonable groundwater supply depletion will occur. A critical groundwater area embraces most of the Basin and no further action seems warranted now other than imposing optimal conservation techniques.

It is recommended that additional studies of the Basin be limited to the impacts of an intensive conservation effort, according to the Report.

Harquahala Plains Basin

Irrigated agriculture is consuming all of the annual, renewable water supply of 1,000 acre-feet as well as depleting less than 1 percent of the stored supply each year. No serious conflicts exist between potential water users because agriculture is the only significant activity in the Basin. Should significant municipal or industrial developments occur, net increase in water demands would be minimal because such developments probably would be sited on lands used for irrigated agriculture, displacing irrigation requirements.

Pumping depths and costs are approaching levels where economic pressures are likely to reduce agricultural groundwater demands long before water stored above 700 feet is depleted significantly. Additionally, use of Central Arizona Project water to fill part of the Basin's agricultural requirements will lower the rate and magnitude of future depletions.

Conditions in this Basin do not appear to warrant severe adjustments in groundwater law or management practices. Groundwater Management Study Commission efforts can be limited to deliberate consideration of the data in the Report, evaluation of conservation alternatives and designation of the Basin under existing law as a critical groundwater area.

Little Chino Valley Basin

The water supply and use situation in the Little Chino Valley Basin is complicated by groundwater occurring in a confined artesian aquifer, by an existing critical groundwater area which does not cover the entire Basin, and by the City of Prescott depending on groundwater supplies imported from the Granite Creek critical groundwater area. And there are conflicts and disputes between groundwater users in the critical area and the City of Prescott. Without water law modification, continued groundwater overdraft is expected to continue in the Basin.

Total Prescott urban water use will not exceed Basin dependable supplies with the implementation of projected Verde River waters importation to the area. However, because agricultural users have prior rights to surface water in the Little Chino area, Chino Valley urban water users must depend on

groundwater supplies thus creating an annual overdraft of 8,000 acre-feet.

It is suggested in the Report that future Groundwater Management Study Commission research address two groundwater management options. Both options incorporate more efficient use of water through conservation. The first option would combine conservation with wastewater use and improved watershed management to augment existing supplies and would constitute an approach to extend Basin life without interfering with existing uses. The second option would be designed to create a balance between depletion and recharge and would add purchase and retirement of undeveloped water rights as a device to curtail demand.

Lower Santa Cruz Basin

The Lower Santa Cruz Basin is the largest basin discussed in the Report. Groundwater withdrawals in the Basin represent about 25 percent of all water pumped in the State. Some 552,000 acre-feet of groundwater were overdrafted in the Basin in 1975.

As Central Arizona Project water becomes available Basin groundwater overdrafts will be reduced substantially. However, unless groundwater law is changed, the annual overdraft by the year 2020 once again will exceed 0.5 million acre-feet, or somewhat less than 2 percent per year of the total groundwater in storage above 700 feet.

Predominant groundwater use in the Basin is for agriculture. Current and projected urban groundwater use in the Basin is less than 0.5 percent of the total use. Even assuming increased groundwater use by mines in the Basin, total non-agricultural uses will represent only about 5 percent of the total depletions.

Little conflict is expected between agricultural and non-agricultural water users in the Basin. If necessary, the small non-agricultural water demands can be satisfied by purchase

and retirement of irrigated farmlands. Quantification of Indian rights to Gila River waters and to Basin groundwater poses the greatest potential for user conflicts.

The Groundwater Management Study Commission should devote considerable effort to the situation in the Lower Santa Cruz Basin, according to the Report. Because the economy of the Basin is supported predominantly by agriculture, groundwater management options which would reduce agricultural production rapidly should be viewed cautiously.

It appears that in much, if not all, of the Basin pumping depths and costs in the future will approach levels where economic pressures will reduce groundwater overdraft, thus preserving extensive quantities of water for uses having higher economic values. The Report states that more direct groundwater management schemes may be warranted in other portions of the Basin because of the potential for subsidence and because other demands which may develop after economic pressures have curtailed agricultural withdrawals.

Safford Basin

Water use in the Safford Basin has been confined for the most part to a narrow developed area along the Gila River.

During the last 43 years surface water has been diverted under the provisions of the Gila Decree; groundwater has been used conjunctively with surface water. Little conflict exists among the various users for available groundwater supplies in the Basin because water use has been limited to annual availability.

Classifying water pumped in the Basin has posed some problems. Is it truly groundwater subject only to reasonable use limitations or is it actually surface water subject to the provisions of the Gila Decree? Further litigation is expected with respect to this issue but no changes between established groundwater-surface water relationships within the Basin are included in the Report: Cutbacks resulting from court decisions adverse to Basin pumpers would be relatively small and would not have major impacts on supply or use.

Minor overdrafts are occurring in aquifers not hydraulically connected to the Gila River. These overdrafts are expected to become larger as mining operations in the Basin mature and demand increasing water supplies. However, only 8.5 percent of the groundwater stored above 700 feet would be depleted by mining by the end of the year 2020. If mining demands for water are not fulfilled by aquifers in outlying areas, competition for water along the Gila River will occur and mining activities could displace projected agricultural activities.

The Groundwater Management Study Commission should consider designating the major water-use area along the Gila River as a critical groundwater area and making it a "safe yield" region within a very short time, according to the Report. The potential of watershed management programs to increase water supplies in the area should be considered as well as the potential impacts of water conservation efforts. No consideration is recommended for areas away from the Gila River because significant impacts in the future appear to be minimal.

Salt River Valley Basin

The Salt River Valley Basin is a complex water supply and use area with large competing water users proximate to one another. Relative magnitudes of water use by agriculture and urban areas are expected to change drastically by the year 2020. Agriculture is depleting about three times as much groundwater as are urban users but these depletions are expected to be nearly equal by the year 2020. Although areal population will increase by more than two million people by 2020, total water depletion in the Basin should be somewhat less than it is now. Increased urban water depletions will be offset by significant reductions in irrigated agriculture in the Basin.

Basin overdraft exceeds one million acre-feet annually, an amount which will be reduced by 60 percent when Central Arizona Project water is brought into the Basin. Overdraft is expected to increase again to about 650,000 acre-feet annually by the year 2020.

During 1975-2020, groundwater stored above 700 feet will be reduced some 20 percent. Approximately 80 million acre-feet will remain stored in the first 700 feet under the Basin. But a depletion-recharge balance should be effected within a reasonable amount of time to minimize the effects of subsidence and of costs in terms of dollars and energy to pump "safe yield" supplies in the future.

Each of the different water-use areas in the Basin has problems peculiar to it and solutions to these problems probably

will have to be tailored to fit. The Report recommends that the Groundwater Management Study Commission assess several management options and that all options include achieving safe-yield conditions in Basin problem areas within a medium-term period of time. Management devices might include conservation, watershed management, groundwater recharge, reduction of uses by category and/or priority, and restrictive taxes.

Upper San Pedro Basin

Water supply and use is complex in the Upper San Pedro Basin. This complexity is magnified within the context of the Report by data deficiencies relevant to a large portion of the Basin.

The modest agricultural economy developed along the San Pedro River apparently has sufficient water supplies to support minor expansion in the future. The non-agricultural economy in the Basin is dominated by the Fort Huachuca-Sierra Vista urban area. In terms of employment and economic output, it is considerably larger than the agricultural sector and faces potentially severe water supply problems. The Fort Huachuca-Sierra Vista urban area water use creates an overdraft situation which could effectively exhaust the nearby aquifer by the year 2020.

Some improvement in managing Basin water resources is in order to meet future needs of the non-agricultural sector. According to the Report, it would appear that a balance between depletion and supply could be effected without significant dislocation of the economy and should be undertaken before Basin water supplies and use become irreparably out of balance.

Upper Santa Cruz Basin

Water supply and use in the Upper Santa Cruz Basin is a complex problem. Competition for the limited water resources available in the Basin is intense. The Basin is one of the most critically overdrafted basins in the State. About 236,000 acre-feet of water were depleted in 1975 while dependable groundwater supplies and water imports totaled only 74,000 acre-feet which amounts to a depletion-to-supply ration of 3.3 to 1.

Urban, agricultural and mining users accounted for 29, 41 and 27 percent, respectively, of total depletions in the Basin during 1975. Projections show urban and mining water uses increasing and agricultural use decreasing. This Basin is the only one of the 11 basins discussed in the Report in which non-agricultural water use exceeds dependable supplies. Central Arizona Project water will counter urban and mining depletions and for a brief period of time there will be a dependable water supply in the Basin. However, by the year 2005 an estimated dependable supply of 191,000 acre-feet will be exceeded by non-agricultural demands for 237,000 acre-feet annually.

The Basin supply-use picture could be further clouded if the Department of Justice and Indians resident on the San Xavier Reservation are successful in their lawsuit which seeks to enjoin pumpers whose withdrawals affect groundwater levels under the Reservation. The potentials for increased subsidence in the City of Tucson and for decreased yields from wells in the area also complicate charting a management course for the Basin.

The Upper Santa Cruz Basin warrants high priority for management option studies. Specific problems vary with use area, thus it is possible that remedies will have to be tailored to fit each area in the Basin. It is recommended in the Report that several management options be evaluated by the Groundwater Management Study Commission and that all options considered include achieving "safe yield" conditions in all Basin problem areas within a medium-term time period. Management tools might include conservation, groundwater recharge, reducing uses by category and/or priority, restrictive taxes, inter-basin transfers, reducing use by purchasing and retiring irrigated farmlands, and controlling growth.

Willcox Basin

The Willcox Basin water situation is relatively uncomplicated. Irrigated agriculture accounts for more than 99 percent of the total water depletions in the Basin. No conflicting use demands exist. And total overdraft amounts to about 250,000 acre-feet annually, about 0.6 percent of the groundwater estimated to be in storage above the 700-foot level. Projected large increases in water demands by mining and steam-electric powerplant operations will create some user conflicts in the Basin. However, these future uses combined will represent less than 20 percent of all depletions in the Basin by the year 2020.

The most significant projected new water use in the Basin is for copper mining, but this projection is very speculative and may not come to pass. Because total water depletion by mining over the period necessary to extract the ore body would be small compared to the amount of water in storage, there appears to be no need to consider seriously the development of controls because of mining.

Total non-agricultural water depletions, excluding copper mining, are expected to be 18,000 acre-feet annually by the year 2020, about 4,000 acre-feet more than the average annual dependable supply. Large quantities of groundwater are stored in the Basin. When pumping depths and costs approach levels where economic pressures will curtail agricultural demands, extensive amounts of groundwater will remain in storage for retrieval by the limited non-agricultural users in the Basin.

The Report concludes that it appears to be of no advantage for the Groundwater Management Study Commission to develop management options to balance supplies and uses in the Basin. It does suggest that it would appear reasonable to consider designating the Basin a critical groundwater area to limit new users, thus affording some protection for the current users and extending economic life in the Basin.

Yuma Area Basin

The Yuma Area Basin presents a very complex water supply-use system. Fortunately, its complexity is not associated with water scarcity. Basin problems are related to drainage and water quality rather than to overdraft or excessive pumping costs.

This Basin presents an interesting challenge in terms of potential water savings stemming from conservation practices, according to the Report. Chances that groundwater law changes would benefit the Basin are remote, the Report states.

The Report recommends that an assessment of potential water savings through conservation be included in management

options developed by the Groundwater Management Study Commission.

CONDENSATION

State's Water Rights

State's water policy rights in the U.S. West were strengthened by recent U.S. Supreme Court rulings which involved New Mexico and California. The rulings addressed state versus federal control of federally financed water projects.

Associate Justice William H. Rehnquist wrote majority opinions in both cases, enhancing states' powers to determine how these waters are used.

New Mexico has primary control of the Rio Timbres, Rehnquist wrote, although the river headwaters are within the Gila National Forest. The federal government exceeded its authority when it attempted to divert Rio Timbres waters for federal uses, Rehnquist wrote.

In the California case, state officials had sought to protect a nine-mile reach of white waters above the federally financed New Melones Dam in Central Valley and were given the right to impose conditions on use of the Dam. The Supreme Court ruling involved an interpretation of the 1902 Reclamation Act under which the federal government is developing the \$800 million Central Valley project.

National Water Supplies

Overall water supplies for the nation have remained remarkably constant during the past 57 years despite notable variations in the last five years, according to Walter Langbein, U.S. Geological Survey, National Center, Reston, Virginia.

Langbein studied streamflow charts covering the past 57 water years and concluded that in the long-term view "there is no general or persistent downward trend in our surface-water supplies, although recent floods and droughts have produced some rather prominent year-to-year variations.

"The total supply of water in the Nation's stream is derived from rainfall and averages about 1,200 billion gallons per day—several times the current or even prospective withdrawals of water," Langbein said.

". . . despite this overall abundance, parts of the country, particularly in the arid West, are actually consuming or eliminating from reuse more water than is naturally available as stream discharge," Langbein noted.

"Furthermore, some local areas of the country that appear to have adequate quantities of water are beset by water-quality problems that effectively limit the available supply," he added.

"Over the long term, however, the Nation's overall water supply has been and will probably remain both dependable and adequate," Langbein concluded. He noted that "What remains to be solved are the short-term and local management and engineering problems of inadequate quantity and quality."

Antitranspirant

Some 25 million acre-feet of water are lost to the atmosphere annually through transpiration by certain kinds of vegetation. For instance, phreatophytic vegetation such as salt cedar consumes vast amounts of water but have practically no economic value.

A study at the Colorado Environmental Resources Center, Colorado State University, Fort Collins, aims to determine whether transpiration rates can be reduced in these plants without destroying them. An antitranspirant chemical applied to leaf surfaces to interfere with the transpiration process appears to be a viable solution.

With the increasingly high cost of water, the possibility of using antitranspirants as a practical treatment to conserve water could be an attractive alternative to destruction of the vegetation.

PUBLICATIONS

"Water Conservation," Part I of Phase III of the State Water Plan, points out the existing imbalance between water supplies and demands in Arizona and outlines a State-level water conservation program.

The report includes descriptions of water conservation techniques applicable to urban, agricultural, mining and steam-electric power generation water use. Domestic water use conservation recommendations also are offered.

Tables, figures and photographs are presented in the 36-page publication which is available at no cost from the Arizona Water Commission, 222 N. Central Ave., Suite 800, Phoenix, Arizona 85004.



A publication illustrating groundwater conditions in approximately 1,500 square miles of the House Rock area in north-central Arizona has been released as U.S. Geological Survey (USGS) Water-Resources Investigations 78-15, "Map showing ground-water conditions in the House Rock area, Coconino County, Arizona—1976."

Prepared by the USGS in cooperation with the Arizona Water Commission (AWC), the map presents information about principal aquifer, aquifer from which spring issues, discharge of spring, depth to water, altitude of water level and water chemical quality. The map is part of a series that eventually will describe groundwater conditions throughout Arizona.

Computer printouts of the hydrologic data used to prepare the map are available for perusal at the AWC office, 222 N. Central Ave., Suite 800, Phoenix. Additional copies are available for reference and for copying at one's own expense at the following USGS offices: Federal Building, 301 W. Congress St., Tucson; Valley Center, Suite 1180, Phoenix; and 2255 N. Gemini Drive, Building 3, Flagstaff.

"Basic Data for Selected Wells and Springs in the Pine-Payson-Kohl's Ranch Area" presents basic data on selected wells, springs and water quality. The data were collected and compiled by the U.S. Geological Survey (USGS) and were published by the Arizona Water Commission (AWC) as AWC Report No. 9.

Increasing population and consequent increasing demand for water in the Payson vicinity creates the need for an appraisal of groundwater resources in the region. For this reason, the AWC is cooperating with the USGS to conduct a geologic

and hydrologic study aimed at understanding and evaluating groundwater resources in the Pine-Payson-Kohl's Ranch area.

Following completion of the study a final report will be published. AWC Report No. 9 will supplement the final report. Report No. 9 is available without charge from the Arizona Water Commission, 222 N. Central Ave., Suite 800, Phoenix, Arizona 85004.



Construction, assembly and operation of a water-pumping windmill is described in "The Arusha Windmill: A Construction Manual," by Dick Stanley and edited by Ken Darrow.

The windmill can be fabricated with commonly available metal and pipes. No sophisticated metal-working skills or equipment are needed. It is a lightweight and highly responsive device which costs one-sixth to one-tenth of imported windmills with equivalent pumping capacities.

Copies of the manual are available from the Appropriate Technology Project, Volunteers in Asia, Box 4543, Stanford, California 94305.



Methods used in analyzing pollutants in air, water, rain, sediment, soil, vegetation and fish are discussed in "Environmental Pollution Analysis," a comprehensive volume by P.D. Goulden. Chapter subjects include determination of metals; classification of metal compound species; analysis of inorganic materials; radionuclides; determination and identification of organic materials; and micro-organisms and continuous monitoring. Copies of the 248-page publication cost \$16.50 and are available from Heyden & Son, Inc., 247 S. 41st St., Philadelphia, Pennsylvania 19104.



Proceedings of the 1978 Irrigation Association Annual Technical Conference held in Cincinnati, Ohio, Feb. 26-28, have been published under the title "Efficiency in Irrigation."

Topics discussed in the proceedings include a solar-powered pump, energy, effects of 208 areawide planning, solid-state control systems, selection of control valves, electrical loads and management, economics, water conservation, surface-irrigation system efficiency measurement, solar-cell irrigation, trickle-irrigation system design, legislation and Environmental Protection Agency guidance for land treatment, wastewater, and sludge disposal on land.

Proceedings copies are available from the Irrigation Association, 13975 Connecticut Ave., Silver Spring, Maryland 20906.



Proceedings of a national conference on "Irrigation Return Flow Quality Management," cosponsored by the Environmental Protection Agency and Colorado State University, addresses a variety of topics including nitrogen in return flows, management, modeling, case studies and implementation of possible solutions.

Forty-eight papers presented at the conference held May 16-19, 1977, at Fort Collins, Colorado, are included in the 450-

page proceedings. Copies cost \$20 and are available from the Agricultural and Chemical Engineering Department, B-13 Engineering Research Center, Colorado State University, Fort Collins, Colorado 80523.

MEETINGS

Governor's Commission on Arizona Environment

The Governor's Commission on Arizona Environment and Mexican representatives will co-sponsor a joint environmental workshop in Douglas, Arizona, Dec. 7-8, 1978, to continue an exchange of information and cooperation between Arizona and Mexico.

Commission member Carlos Nagel, Coordinator of the Arizona-Sonora Desert Museum Mexico Program, will arrange

and develop the workshop in cooperation with persons from both sides of the border.

The next meeting of the Commission is scheduled to be held Jan. 12, 1979, at the Sheraton Pueblo Inn, Tucson.

Please address your news items or comments on the News Bulletin to any of the three editors:

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