Report on

Conference on WESTERN WATER ISSUES

17-18 May 1979

Edited by

MORTON S. ISAACSON

THERESA C. FALL

EQL MEMORANDUM NO. 22

September 1979

Environmental Quality Laboratory
CALIFORNIA INSTITUTE OF TECHNOLOGY
Pasadena, California 91125

REPORT ON

CONFERENCE ON WESTERN WATER ISSUES

held at the

CALIFORNIA INSTITUTE OF TECHNOLOGY

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Edited by

Morton S. Isaacson
Theresa C. Fall

Conference Committee:

E. John List (Chairman)
James P. Quirk
Norman H. Brooks

ENVIRONMENTAL QUALITY LABORATORY
California Institute of Technology
Pasadena, California

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Partial support for the conference and preparation of this report was provided by a grant from the Office of Environment of the United States Department of Energy and by gifts to EQL from the Bechtel Corporation and the General Services Foundation, St. Paul. The conference was co-sponsored by EQL and the Industrial Associates of Caltech.

ABSTRACT

Over the last few years several potential conflicts have emerged over the manner in which water is put to beneficial use in the western United States. These potential problems have been further heightened by the western drought of 1976-77 and by the recent upsurge of interest in developing western coal and oil-shale resources. The conference on Western Water Issues, held at the California Institute of Technology, 17-18 May 1979, provided a forum for representatives of industry, agriculture, government, environmental groups, research establishments and universities to exchange ideas on the subject.

Most of the discussions centered on California and the Colorado River Basin. Specific items discussed included climatic fluctuations and predictability of the basic water supply; existing water law and needed changes; economics of water and the lack of real water markets; pending California state legislation (on the Peripheral Canal in the Sacramento-San Joaquin Delta area, and on limits to pumping overdrafted ground water basins); water availability for energy resources development; and competing needs by municipalities, industry, and agriculture. As a summary of the conference, this report should be regarded as a source book to clarify the issues and direct the reader to relevant individuals and references.

ACKNOWLEDGMENTS

Both the conference and this report were made possible by a grant from the Office of Environment of the United States Department of Energy and by gifts to EQL from the Bechtel Corporation and the General Services Foundation, St. Paul. Additional funding for the conference was provided by the Industrial Associates of Caltech.

The enthusiastic participation of the speakers and session chairmen has resulted in a clear statement of the water problems and issues confronting the state. We will all benefit from their contributions.

Members of the EQL staff deserve special recognition for their efforts toward making the conference a success. Dr. Morton Isaacson and Debra Polsky did an excellent job of organizing and coordinating the conference program and travel arrangements. Dr. Isaacson and Theresa Fall compiled the conference report (i.e., prepared the individual summaries which were then sent to the speakers for review) and expedited its production. The help of Partricia Rankin, Jeri Lucas and Suzanne Bond is also much appreciated.

Thanks also go to Thomas Walters, Gail Hodgdon, Kermit Jacobson and Richard Schuster (whose untimely death is mourned by us all) of the Industrial Associates Office; James Black, Nancy Hopkins and Denise Ovrum of the Caltech Alumni Association; Jerry Willis, Thomas Lehman, Kitty Macdonnell, Don Delson and Charles Seagrave of the Public Events Office; and Dennis Meredith of the Caltech News Bureau.

Finally, the assistance of the Director's Office of the California Department of Water Resources in transcribing and editing Governor Brown's address is gratefully acknowledged.

E. John List
Conference Chairman

CONTENTS

CHAPTER 1

EXECUTIVE SUMMARY

Over the last few years several potential conflicts have emerged over the manner in which water is put to beneficial use in the western United States. These potential problems have been further heightened by the western drought of 1976-77 and by the recent upsurge of interest in developing western coal and oil-shale resources. When considering water availability for one type of development -- that of energy resources, for example -- it is necessary to consider the relationships among all types of water supply and use, because all development in the west is, to a large extent, water limited. For this reason the conference was organized as a forum for exchange of ideas among representatives of all interest groups, including industry, agriculture, government, environmental groups, research establishments and universities. As a summary of the conference, this report should be regarded as a source book to clarify the issues and direct the reader to relevant individuals and references.

Some of the discussions at the conference were relevant to the entire western United States, while others were chiefly important to the Upper or Lower Colorado River Basins or to California. Maps of the Colorado River System and of California have been included in this report as Figures 1-1 and 1-2, respectively. For the complete conference program, see Chapter 2.

The first session of the conference (summarized in Chapter 3), discussed the current knowledge of climatic fluctuations and predictability and their implications for water supplies in the west. The topics covered included the question of climate stability, the effect of climatic change on water resources, methods of extending temperature and precipitation records beyond the historical period, and techniques for forecasting regional, seasonal precipitation patterns.

COLORADO RIVER BASIN

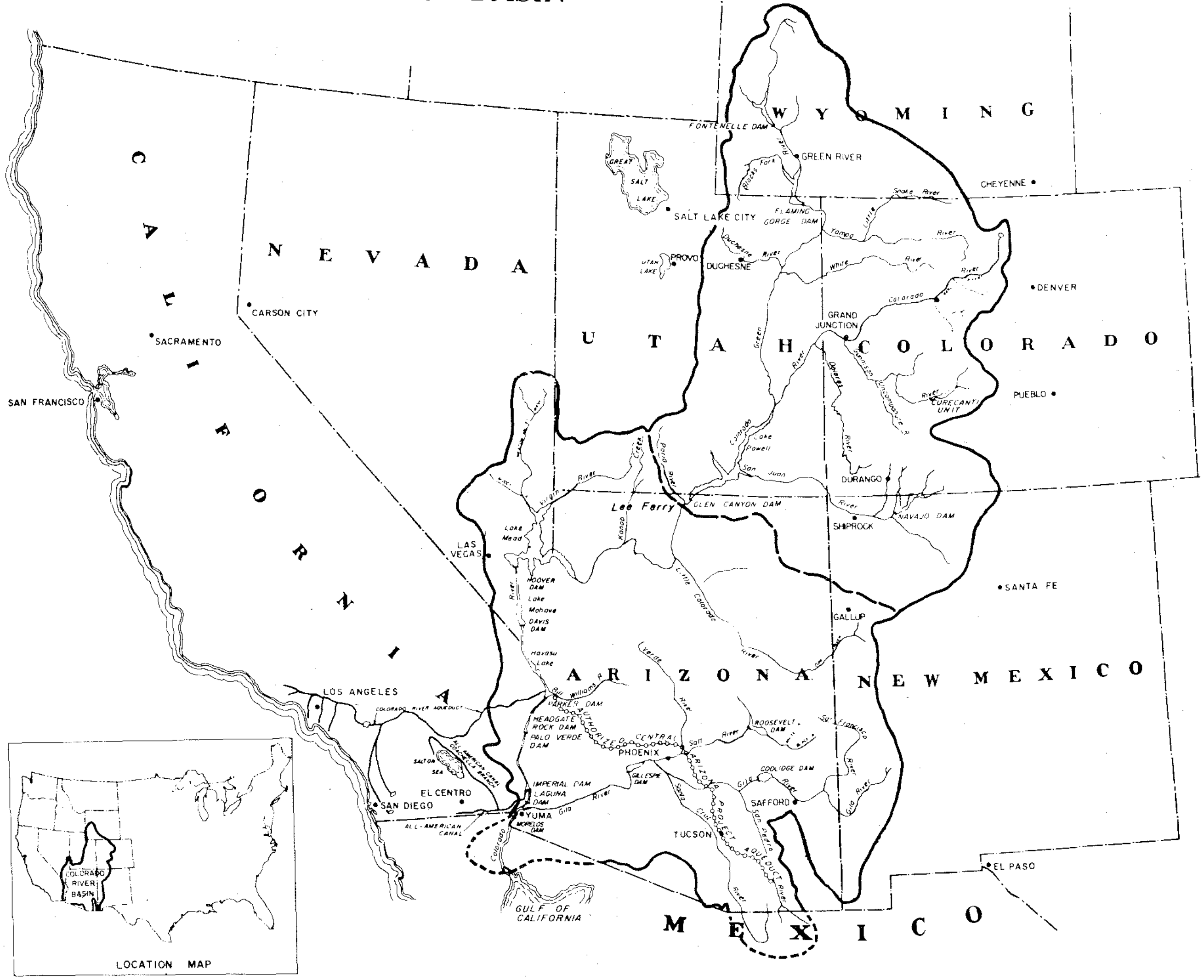

Figure 1-1. Map of the Colorado River Basin showing the Upper and Lower Basins and major water development projects. (Source: "Annual Report for the Calendar Year 1971," Colorado River Board of California, Los Angeles, California.)

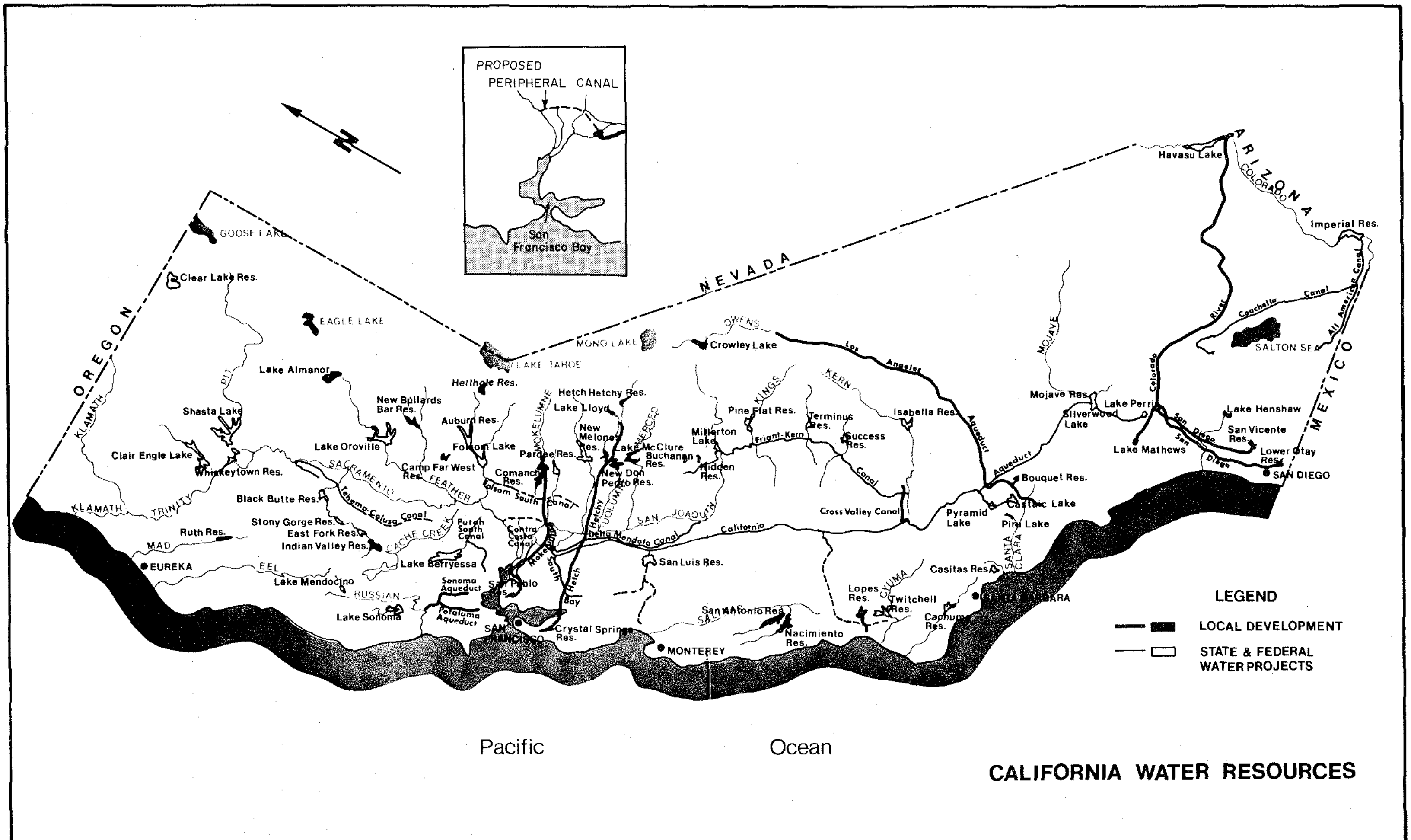

Figure 1-2. Map of California showing rivers and water development projects. (Adapted from Hobbs, C.D., "The Water Districts of California," Association of California Water Agencies, Sacramento, California, April 1979.)

The second session (summarized in Chapter 4), considered economics and the law as they relate to western water supply issues. The main focus of the discussion of the law was possible changes in California water rights law. Topics covered included state versus local control of ground water management, instream uses, rigidity in the law, public trust doctrine and clarification of "reasonable beneficial use." The main focus of the economics discussion was the present lack of well developed water markets (where water can be readily bought or sold at market clearing prices). The century-old system of appropriative water rights (first in time, first in right) may be an impediment to the economic efficiency of water distribution and use (including the supply to new energy resources developments).

In the third session (summarized in Chapter 5), current management issues were highlighted. For California, these included such current state water policy issues as economic subsidies to irrigated agriculture, sensitivity to environmental concerns, water conservation and reclamation, and the Peripheral Canal. For the Colorado River Basins, the topics included the outstripping of supply by demand; the lack of predictability of runoff or of the long-term demand due to new energy industries; the uncertain impact of Indian water rights claims; and such institutional issues as remote management from Washington, clarification of the "Law of the River," and a general distrust of the reliability of agreements between political entities.

The fourth session (summarized in Chapter 6) gave an opportunity to various user groups and public representatives to express their views on what they consider to be the important current water supply related issues. Some of the topics discussed related to pending California state legislation: the Peripheral Canal in the Sacramento-San Joaquin Delta area, the irrigation of "new lands," state regulation of ground water rights and overdrafts, the proposed San Luis Drain in the San Joaquin Valley, and studies of increasing the height of Shasta Dam. Other topics discussed were: United States agricultural policy as it affects energy and water use, the loss of water from the Metropolitan

Water District of Southern California to the Central Arizona Project, water related constraints on the siting of new electrical generating plants, hydroelectric power development, and the relationship between the development of western energy resources and water resources. Included in this last topic were the water dependent relationship between irrigated agriculture and energy resources development, the effect of water availability on the siting of fuel conversion industries, the effect of energy resources development in the Upper Colorado River Basin on water supply in the Lower Basin, and the effect of environmental regulations on energy resources development.

In addition to the regular sessions at the conference, there was also a panel discussion (summarized in Chapter 7) and an evening address by Governor Edmund G. Brown Jr. of California concerning his views on water supply issues (transcribed in Chapter 8). (Written comments submitted to the conference chairman with reference to the Owens Valley and Mono Lake controversies are included as an appendix.)

In summary, the overall impression gained from the conference was that the basic water supply is adequate, except in periods of extreme drought, to serve a wide variety of societal needs for domestic and industrial water, for irrigated agriculture, and for energy projects. However, the elaborate network of institutions regulating water use and protecting water rights (along with significant subsidies to irrigation) may be interfering significantly with efficient planning for, and allocation of, water for future uses. In effect, there are currently no comprehensive water markets in which water prices can help to establish the uses of water that are most valuable for society. Furthermore, it is clear that there is no coherent water policy that is agreed to by federal, state, and local government agencies. The available evidence suggests that proceeding with construction of more water project facilities in the absence of clarification of water policy will not solve the water management problems.

CHAPTER 2

CONFERENCE PROGRAM

CONFERENCE ON WESTERN WATER ISSUES

Sponsored by
ENVIRONMENTAL QUALITY LABORATORY
and
INDUSTRIAL ASSOCIATES
CALIFORNIA INSTITUTE OF TECHNOLOGY
Pasadena, California

Ramo Auditorium -- Caltech Campus
17-18 May 1979

THURSDAY, MAY 17

8:00 a.m.

Registration

9:00 a.m.

Welcoming Remarks

Marvin L. Goldberger, *President, Caltech*

Norman H. Brooks, *Director, Environmental Quality Laboratory; James Irvine Professor of Environmental and Civil Engineering, Caltech*

SESSION I: DEFINING THE BASIC WATER SUPPLY

Chairman: Norman H. Brooks

9:20 a.m.

Potential of Long Term Forecasting Methods -- Isotopic Techniques

Samuel Epstein, *Professor of Geochemistry, Caltech*

9:50 a.m.

Potential of Long Term Forecasting Methods -- Dendrochronology

Charles W. Stockton, *Associate Professor of Dendrochronology; Laboratory of Tree Ring Research, University of Arizona, Tucson*

10:20 a.m.

Coffee

10:45 a.m.

Short Term Forecasts Based on Seasonal Weather Patterns and Ocean Influences

Robert M. Born, *Senior Programmer, Climate Research Group, Scripps Institution of Oceanography*

11:15 a.m.

Climate in the Western United States

George I. Smith, *Coordinator, Climate Program, U.S. Geological Survey*

11:45 a.m.

Climate in the Western United States -- Effects of Global Trends and Variance

Stephen H. Schneider, *Acting Leader, Climate Sensitivity Group, National Center for Atmospheric Research*

12:15 p.m.

Comments on Long-Range Forecasting and Cloud Seeding

Irving P. Krick, *President, Irving P. Krick Associates, Inc.*

12:30 p.m.

Luncheon, Athenaeum

SESSION II: ECONOMICS, THE LAW, AND INSTITUTIONAL CONTROLS OF WATER

Chairman: James E. Krier, *Professor of Law, Stanford Law School*

1:30 p.m.

The Law as It Relates to California Water Supply, Allocation and Use

Harrison C. Dunning, *Professor of Law, University of California at Davis; Former Staff Director, Governor's Commission to Review California Water Rights Law*

2:00 p.m.

The Law as it Relates to California Water Supply, Allocation and Use -- Comment

Don Stark, *Attorney-at-Law, Irvine, California*

2:15 p.m.

The Economics of Western Water as it Relates to Metropolitan, Industrial, and Agricultural Use

James P. Quirk, *Professor of Economics, Caltech*

2:45 p.m.

The Economics of Western Water -- Comments on Indian Water Rights

Ronald G. Cummings, *Professor of Economics, University of New Mexico, Albuquerque*

3:00 p.m.

Coffee

SESSION III: CURRENT AND FUTURE MANAGEMENT ISSUES

Chairman: Thayer Scudder, *Professor of Anthropology, Caltech*

3:30 p.m.

Current Water Policy in the State of California

Ronald B. Robie, *Director, California Department of Water Resources*

4:00 p.m.

The Colorado River and Current Water Policy

Manuel Lopez, Jr., *Consultant; Former Lower Colorado River Basin Regional Director, Bureau of Reclamation*

4:30 p.m.

Conservationist/Environmentalist Position on Water Policy

Larry E. Moss, *Executive Secretary, Citizens' Committee on U.S. Forest Service Management Practices in California; Former Director, California Planning and Conservation League*

5:00 p.m.

Reconsideration of Water Conveyance, Construction, and Are There Alternatives?

Dorothy Green, *Coordinator, Working Alliance to Equalize Rates*

5:15 p.m.

Break

5:30 p.m.

No Host Bar, Athenaeum

6:30 p.m.

Dinner, Athenaeum

8:00 p.m.

Address

Edmund G. Brown Jr., *Governor of California*

FRIDAY, MAY 18

SESSION IV: USERS' PERSPECTIVES ON THE ISSUES

Chairman: Harvey O. Banks, *President, Water Resources Division, Camp Dresser & McKee Inc.; Former Director, California Department of Water Resources*

8:00 a.m.

Agriculture, Water, and the San Joaquin Valley

Stanley M. Barnes, *Manager of Water Resources, J. G. Boswell Company*

8:25 a.m.

Salinity and Ground Water Supplies in the San Joaquin Valley

Steward T. Pyle, *Engineer-Manager, Kern County Water Agency*

8:50 a.m.

Natural Resources and Agriculture

W. R. Z. Willey, *Staff Economist, Environmental Defense Fund*

9:15 a.m.

Coffee

9:45 a.m.

Water and the Legislature

Clyde Macdonald, *Consultant, Committee on Water, Parks and Wildlife, California State Assembly*

10:10 a.m.

Agriculture and the Colorado River

Donald A. Twogood, *General Manager, Imperial Irrigation District*

10:35 a.m.

Metropolitan Water District

David N. Kennedy, *Assistant General Manager, Metropolitan Water District of Southern California*

11:00 a.m.

Water and Electric Utilities

James H. Drake, *Vice President, Engineering and Construction, Southern California Edison Company*

11:25 a.m.

Engineering for Energy and Water

Paul D. Terrell, Jr., *Project Manager, Hydro and Community Facilities Division, Bechtel Corporation*

11:50 a.m.

Luncheon, Athenaeum

1:15 p.m.

Energy Development in the West and Water Use

George H. Davis, *Assistant Director, Mineral and Water Resources, U.S. Geological Survey*

1:40 p.m.

Energy Development in the Upper Colorado River Basin and Water Use

J. William McDonald, *Program Administrator for Water Resources, Colorado Department of Natural Resources*

2:05 p.m.

Activities of the Navajo Water Commission

M. Eliza Scudder, *Staff Attorney, Navajo Tribal Legal Department*

2:15 p.m.

PANEL DISCUSSION

Chairman: E. John List, *Professor of Environmental Engineering Science, Caltech*

Panel: Stanley M. Barnes; H. Stuart Burness, *Associate Professor of Economics, University of New Mexico, Albuquerque;* James H. Drake; Harrison C. Dunning; Larry E. Moss; Donald A. Twogood

3:30 p.m.

Adjourn

CHAPTER 3

DEFINING THE BASIC WATER SUPPLY -- SUMMARIES OF PRESENTATIONS FROM SESSION I

3.1 POTENTIAL OF LONG-TERM FORECASTING METHODS -- ISOTOPIC TECHNIQUES

Samuel Epstein

Professor of Geochemistry
California Institute of Technology
Pasadena, California

Isotopic techniques for developing historic temperature and humidity records rely on three factors. The first is that water in nature is actually a mixture of nine isotopic species having similar chemical properties, but differing in weight. The hydrogen (H) in water has two stable isotopes (i.e., atoms with the same number of electrons, but different numbers of neutrons and, therefore, weight); while the oxygen (^{16}O) in water has three stable isotopes. Relative differences in isotope ratios between a given sample and sea water are readily measurable. These changes are given in terms of delta (δ) values. For deuterium (D, one of the stable isotopes of hydrogen), such a value would be defined by:

$$\delta D = \left[\frac{D/H\ (sample) - D/H\ (sea\ water)}{D/H\ (sea\ water)} \right] \times 1000.$$

The accuracy of these measurements is $\pm 1\delta$-unit.

The second factor of importance is that the vapor pressure of water depends on its isotopic composition. Roughly speaking the meteoric cycle consists of water evaporating from the warm parts of the ocean and then cooling adiabatically. As a vapor mass evaporated from the ocean cools, the water containing deuterium will rain out preferentially to the water containing only normal hydrogen atoms. Therefore, the lower the temperature of the rain formation region, the lower the D/H radio or the more negative the δD-value. δD-values vary with both latitude (e.g., $\delta D \simeq 0$ in Florida, ~ -50 in Illinois, and ~ -160 in Alaska) and season. The δD is more negative in winter precipitation.

The third factor that allows this phenomenon to be used to reconstruct temperature records is that certain hydrogen atoms in the cellulose of plants remain unchanged from the time the cellulose is first synthesized by the plant from the water in its environment. These atoms can be isolated and their δD values determined. This has been done with currently growing plants and the δD values from both the plants and the environmental water near them correlate well. Therefore, cellulose from old plants can be used as proxies for the water that precipitated at the time the plants grew.

Using the above methods, Professor Epstein and his collegues have analyzed the historical δD (and, therefore, temperature) records from bristlecone pines in California's White Mountains. The records show pronounced 22-year cycle (approximately) in the fluctuation of temperature. Furthermore, this 22-year cycle is not as strong in samples from the period 1532 A.D. to 1718 A.D., which was also a period of minimum sunspot activity, indicating that there may be a connection between the cycle of sunspot activity and the cycle of temperature fluctuations.

Further evidence for a 22-year temperature cycle has come from δD analysis of a cedar tree growing in Sequoia National Park, indicating it is not a phenomenon associated with bristlecone pines, only. On the other hand, analyses of samples from a pine tree grown in an area of Scotland has failed to find a 22-year recurrence in δD fluctuations, indicating the basis for this phenomenon might be more complicated.

The δD analysis permits a reconstruction of past temperature records. It is hoped that the $\delta^{18}O$ analysis may lead to a reconstruction of ambient humidity records. It has been found that when plants grow in an aquatic environment, the results of δD and $\delta^{18}O$ analyses are similar; but for terrestrial plants, the cellulose is enriched in ^{18}O compared to D. Water contained in the leaves of terrestrial plants is also enriched in ^{18}O compared to D, when compared to the environmental water near the plant. Since this is what happens when evaporation is rapid and equilibrium is not established, Professor Epstein believes this might be a method to distinguish between periods of high and low ambient moisture. It is a technique currently under development.

QUESTIONS

Questions to Professor Epstein were postponed until after Professor Stockton's talk. Please see the end of the following section for his responses.

REFERENCES

Epstein, Samuel, Thompson, Peter, and Yapp, C. J., 1977, "Oxygen and Hydrogen Isotopic Ratios in Plant Cellulose," Science, v. 198, no. 4323, pp. 1209-1215.

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Yapp, C. J. and Epstein, Samuel, 1977, "Climatic Implications of D/H Ratios of Meteoric Waters over North America (9,500-22,000 B.P.) as inferred from Ancient Wood Cellulose C-H Hydrogen," Earth and Planetary Science Letters, v. 34, no. 3, pp. 333-350.

3.2 POTENTIAL OF LONG-TERM FORECASTING METHODS -- DENDROCHRONOLOGY

Charles W. Stockton

Associate Professor of Dendrochronology
Laboratory of Tree Ring Research
University of Arizona
Tucson, Arizona

As a preface to his talk, Dr. Stockton cautioned the audience that when supply and requirements for water are essentially equal, a slight climatic change that reduces the supply can have serious economic and social impacts.

The research reported consisted of three parts: (1) the present national water supply and requirement picture, (2) projected effects of climate variability on water resources management, and (3) a drought frequency study using tree ring data to extend the historical record.

Present National Water Supply and Demand Picture

Basing his analysis on the Second National Assessment of the Water Supply Situation by the Water Resources Council, 1978, and assuming that supply can be considered as precipitation minus evaporation and transpiration, Dr. Stockton came to the following conclusions: The lowest amount of precipitation is in the west, the highest amount of consumptive use is in the west (the east has high withdrawal but low consumption) and supply and requirements are currently nearly equal in the southwest. Therefore, the greatest impact of climate variability should be in the southwest.

Projected Effects of Climate Variability on Water Management

In a research project recently completed for the Corps of Engineers, requirement/supply ratios were developed for the different regions of the country for the year 2000 based on four climate scenarios: (1) 10 percent decrease in precipitation and 2°C increase in temperature; (2) 10 percent increase in precipitation and 2°C decrease in temperature; (3) and (4) the two permutations of the above. In cases (3) and (4) the effects of temperature and precipitation balanced out and the situation was left unchanged. In case (2) the eastern U.S. would be subjected to much excess runoff with accompanying flooding problems. In case (1) the east would be little affected, but the west would be significantly affected. The requirement/supply ratio would increase to 1.2 for the Missouri Basin, 4.0 for the Rio Grande Basin, 1.2 for the Upper Colorado Basin, and 2.75 for the Lower Colorado Basin, even when allocations from the Upper Basin are counted.

Dr. Stockton concluded this part of his talk by showing evidence that there has been significant climatic change in the last fifty to sixty years, such as a definite trend in decreasing annual runoff for selected watersheds in the southern intermountain region of the Rocky Mountains. This trend was strongest in the southwest. To see such trends, sampling periods must be longer than thirty years.

Drought Frequency Study Based on Tree Ring Analysis

In studies of drought recurrence frequency, tree ring data can be used to formulate proxy series to replace precipitation and runoff records that do not extend back beyond fifty years. In order to prove this point, Dr. Stockton showed a comparison between tree ring data and the Palmer Drought Severity Index (PDSI, based on soil moisture measurement) for a given location in the Oklahoma Panhandle for the period 1930-1970. The comparison showed very good convariance.

In a recent study of drought recurrence frequency, the western U.S. was divided into forty "climatic homogeneous" subregions and the PDSI was determined from tree ring data for each subregion for every year between 1700 and 1965. Figure 3.2-1 shows the results of the study in terms of the number of subregions with a PDSI greater than 1 (wet) or less than -1 (drought). One important observation is the frequency of multiyear droughts lasting 3 or 4 years, which can seriously effect reservoir reserves. A second important observation is the presence of a 22-year periodicity in the amount of area affected by drought in the west.

This 22-year periodicity means that the area of the west affected by drought waxes and wanes in 22-year periods. It should be noted, however, that only about 20 percent of the variance in affected areas is included in this 22-year cycle, so most of the variance is random. Nevertheless, society should still be more wary at the peaks of the 22-year cycle.

Professor Stockton concluded his talk by emphasizing that climate variability should be taken into account in the design of water management programs. There is evidence that climate has changed in the past in both time and space and it might be to society's advantage to build resilience into its water resources system to anticipate this, at least suspected, climate variation.

QUESTIONS

Q: Since there was a drought in 1976 and 1977, does the 22-year cycle mean that there will not be another one for 22-years?

A: C.W. Stockton: The 22-year cycle only accounts for about 20 percent of the variability. To have real predictive capability the causes of droughts must be better understood.

Q: Does the 22-year period show up in other parts of the world?

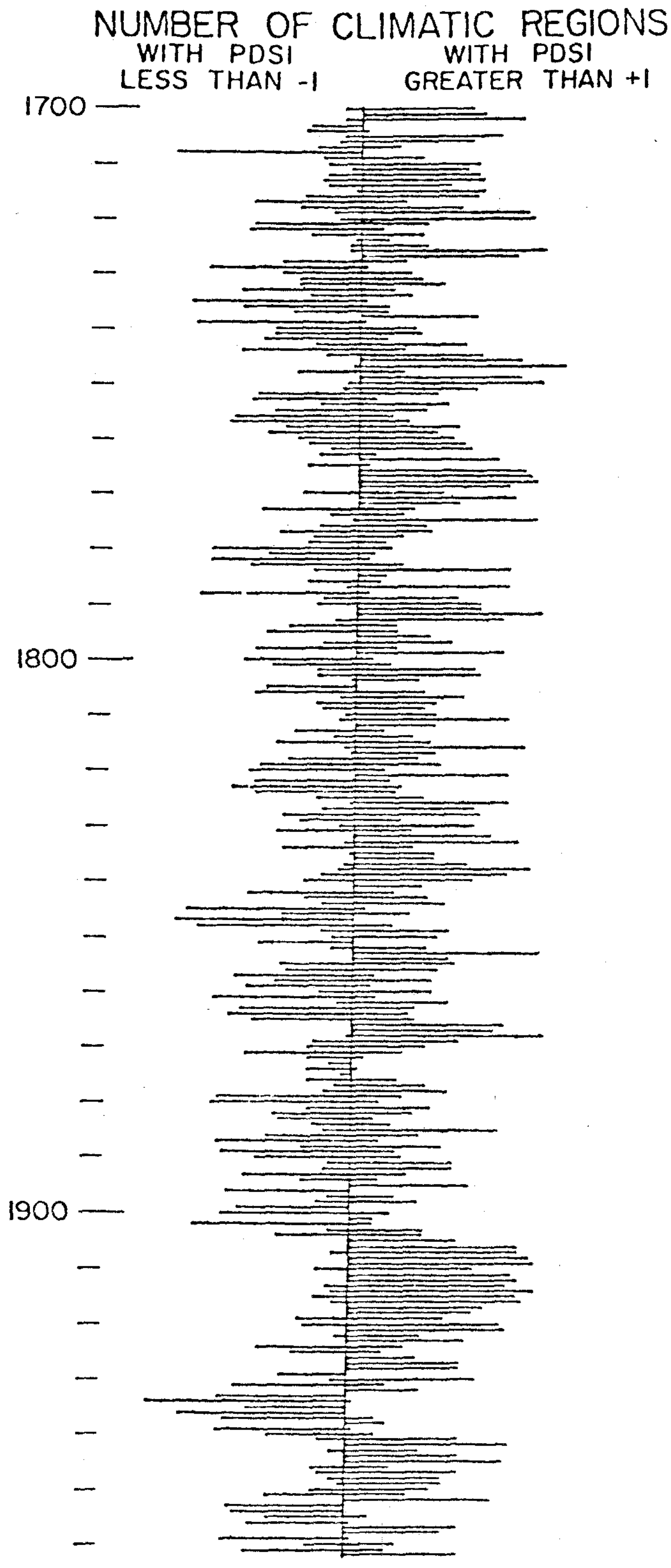

Figure 3.2-1 Long-term reconstructed drought-area index for drier than normal (Palmer Index ≤ -1.0) and wetter than normal (Palmer Index $\geq +1.0$) categories, A.D. 1700 to A.D. 1962. Source: Stockton and Boggess, 1979.

A: C.W. Stockton: It is most important to look for this in the Soviet Union because of the way our weather patterns are formed. So far, the Soviets have been approached, but have not responded.
S. Epstein: It is very difficult to obtain even small wood samples from around the world.
S.H. Schneider: There is some evidence of a 20-year cycle found in Greenland. There is little evidence for periodic temperature variation. It is mainly summer precipitation which displays a 22-year cycle.

Q: If the sunspot cycle is 11 years, why is the 22-year drought cycle attributed to the sunspot cycle?

A: S. Epstein: The answer is not known for certain, but the magnetic field of the sun varies in a 22-year cycle.

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Stockton, C.W., and Fritts, H.C., 1973, "Long-Term Reconstruction of Water Level Changes for Lake Athabasca by Analysis of Tree Rings." Water Resources Bulletin, v. 9, pp. 1006-1027.

3.3 SHORT-TERM FORECASTS BASED ON SEASONAL WEATHER PATTERNS AND OCEAN INFLUENCES

Robert M. Born

Senior Programmer
Climate Research Group
Scripps Institution of Oceanography
La Jolla, California

The state of the art of conventional weather forecasting, particularly precipitation forecasting, is at a point where specific forecasts can be made only three or four days in advance. The theoretical limit for daily forecasts is two to three weeks in advance. The Climate Research Group at Scripps Institution of Oceanography has been studying large scale oceanic-atmospheric interactions as a means of improving forecasts of generalized seasonal precipitation patterns. In his talk, Mr. Born reviewed the progress of that research.

A tremendous amount of moisture and heat energy is extracted from the oceans by the atmosphere in the temperate latitudes. The heat capacity and viscosity of the ocean are about 1,000 times greater than those of the atmosphere and as much heat is contained in the upper 10 meters of the oceans as in the entire atmosphere. Thermal changes in the ocean often extend down as deep as 300 meters and indicate the ability of the surface layers of the ocean to act as a source or sink for large amounts of heat energy. Mapping of sea-surface temperatures, for example, in the north Pacific, shows large areas of cooler than normal and warmer than normal sea surface temperatures, with the difference in temperature between the two of 1°C or more. The heat exchanges taking place with the passage of air over regions of anomalously cool and warm sea surfaces is beginning to be understood, as is the momentum transfer from atmosphere to ocean.

In dealing with oceanic atmospheric interactions, a mapping of current monthly and seasonal conditions, such as sea-surface temperatures and elevation contours of the 700 millibar (mb) atmospheric pressure surface is done. In the Northern Hemisphere, a plot of the mean elevation height of the 700 millibar atmospheric pressure surface for a given season will usually show a 3-6 lobed circulation pattern. The waves in this circulation pattern are referred to as planetary waves or Rossby Waves. The area of closest spacing of the 700 mb elevation contours (area of steepest rise in the height of the 700 mb pressure surface) for a season indicates the mean position of the jet stream, which is often used to trace the high-speed core of planetary circulation.

To produce a seasonal precipitation forecast, the forecaster must be able to forecast the amplitude, wavelength, and phasing (or longitudinal positioning) of the prevailing seasonal planetary wave. It is observed that the jet stream, a west-to-east movement of air, usually dips south over the anomalously cool water regions in the ocean, and ridges north over the anomalously warm water. The decending (heading south) limb of the planetary wave trough brings relatively cold, dry air southward over the already cool sea-surface and the ascending limb (heading north) of the ridge draws warm, moist air northward over the warm sea-surface. Mr. Born commented that it is this positive feedback between the ocean and the atmosphere that tends to self-perpetuate and stabilize the mean position, amplitude and wave number of the planetary wave and, therefore, allows the forecaster to derive seasonal precipitation forecasts for the western United States.

Observed seasonal weather patterns are readily explained by planetary wave circulation, which is partially controlled by oceanic-atmospheric interaction. For example, during the drought of 1976-77, north Pacific storm tracts were channeled in a narrow path across the Pacific Ocean and then turned abruptly north into Alaska following a strong north-south sea-surface temperature gradient, rather than continuing on their normal course into the western United States.

Using oceanic-atmospheric interaction principles, predictions were made for the winter seasons of 1975-76 through 1978-79. The predicted and observed values of precipitation for the western United States are shown in Figure 3.3-1. Gross features of precipitation are fairly well represented, but individual watersheds could be only poorly predicted. These forecasts are indicative of the present state of the art in seasonal precipitation forecasting.

QUESTIONS

Q: Disregarding all boundary influences, what is the time persistence of a Rossby Wave? How long does a given pattern persist?

A: A Rossby Wave tends to migrate from west to east, on the average, at about 10° per day. The monthly or seasonal mean maps indicate the dominant Rossby Wave configuration.

Q: Is it possible to predict abnormally dry years or abnormally wet years for water management purposes?

A: Researchers are getting close to that, if it is a very abnormal year. If it is only a little above or below normal, there is less chance the prediction will be correct. We are looking at a very low signal-to-noise ratio system and extreme years have the strongest signal.

One thing researchers are attempting to do is to extend the time period of their forecasts from three months up to six months. The six-month period from summer to winter may show some positive results.

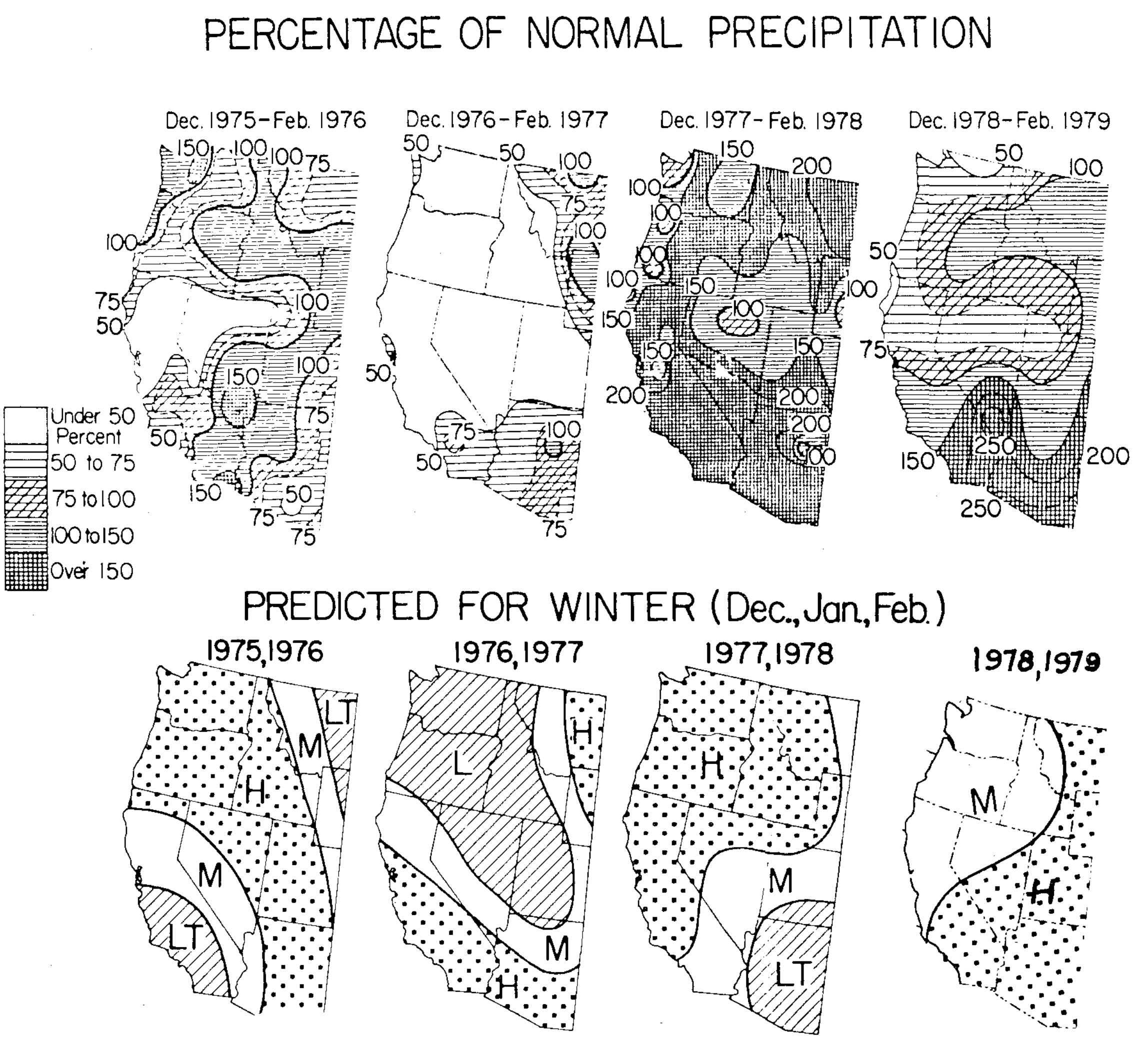

Figure 3.3-1 Percentage of normal precipitation observed (top) and predicted (bottom) for three equally probable classes of heavier than normal (H), moderate (M) and lighter than normal (L or LT).

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3.4 CLIMATE IN THE WESTERN UNITED STATES

George I. Smith

Coordinator, Climate Program
United States Geological Survey
Menlo Park, California

Three topics were covered by Dr. Smith in his well illustrated presentation: (1) the influence of topography on climatic patterns and the response of the landscape to the climate; (2) the measurement of, and man's impact on, the secondary consequences of climate -- e.g., stream character, erosion, and lake size; and (3) the stability of the climate.

Climate and Topography

In the west, most precipitation comes from storms that originate in the Pacific and then move eastward. A large part of the moisture they contain is intercepted by the Coastal Ranges and by the Sierra Nevada in the south and the Cascade Mountains in the north, creating rain shadow deserts to the east. Snowfall is determined by the elevations of mountain systems in the west, whereas it is determined primarily by latitude in the east. In addition, evaporation is most intense in the southwest.

From west to east, the effect of this climate pattern on the landscape of the far west is as follows. The Coastal Ranges display Mediterranean type vegetation of sparse trees on grassy slopes. The San Joaquin Valley would be a desert except for human management of the water resources. The foothills of the Sierra Nevada are characterized by grasslands with scattered large trees; while the high Sierra is characterized by hardy conifers that can withstand cold and snow. East of the Sierra, the low valleys and adjoining slopes are nearly treeless deserts of exposed rocks, alluvial fans, and playa lakes that support only plants that can survive eight to ten months without moisture.

Secondary Consequences of Climate

Stream gaging, along with snow core surveys, is used to determine the runoff available as a secondary consequence of winter precipitation. The United States Geological Survey also uses orbiting satellites to transmit information from remote, umanned gaging stations.

In addition, photo-reconnaissance satellites can aid in determining the extent of dust storms -- a secondary consequence of drought when followed by strong, damaging winds. The secondary effects of drought, therefore, can be more severe than the primary affects, and the penalties for poor management of resources during and after a drought can be greater than first perceived.

In considering man's impact on the secondary consequences of climate, Dr. Smith said, "Anytime man disturbs something, he is upsetting a balance that has taken a long, long time to establish, and once that balance is upset, it is very hard to predict what kinds of chain reactions will follow." In addition to the damage due to dust storms mentioned above, Dr. Smith also gave some examples of this related to desert lakes. Numerous desert lakes have fallen several to tens of meters or dried up completely due to upstream human diversions. One important example is Mono Lake whose surface dropped 8 meters between 1940 and 1965 and, if the present diversions continue, is expected to dry up by early next century. On the other hand, some desert lakes have been created by human diversions of ground water. The resulting increased evaporation has upset the ground water balance.

Stability of the Climate

The climate is quite variable from year to year, and also over longer periods. Evidence gained from the germination and burial in alluvium of juniper trees in one area of the southwest indicates a high water table (wet period) in 1350 A.D. and 1750 A.D. and a low water table during the intervening period and at present. Over longer periods of time, the climate has been even more variable -- e.g., the ice ages. Information on the climate during these long past periods comes from dry lake beds in desert regions; cores from fresh water lake beds -- pollen grains trapped in the sediment indicate local flora while diatom remains indicate lake salinity and temperature; and deep sea cores -- pebbles trapped in the sediment indicate iceberg activity and foraminifera remains yield sea-surface temperature information.

In conclusion, Dr. Smith stressed that the rule of thumb for normal annual variation in climate is that precipitation can be more than 250 percent above average or 50 percent below average. Furthermore, on a decade and century basis, there can be mean temperature changes on the order of a degree or two.

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3.5 CLIMATE IN THE WESTERN UNITED STATES -- EFFECTS OF GLOBAL TRENDS AND VARIANCE

Stephen H. Schneider

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Dr. Schneider's talk covered three main topics: (1) how the atmospheric heat engine works that drives the weather, (2) the possible dire consequences of even modest changes in the climate, and (3) the possible effect of CO_2 buildup in the atmosphere. He began his talk, however, with two caveats. The first was that the climate changes he is talking about are ones that would become apparent over a period of several decades to a century in length. The second was that "global" trends must be viewed with care because (a) there is much regional variation and (b) most sampling is done in the mid-to-high north latitudes rather than on a true global basis.

The Climate System

In very simple terms, the climate system works as follows: Solar radiation falls on the earth. The amount, kind and distribution of gases and particles in the atmosphere largely control the amount of solar energy reflected and the infrared radiation that is reradiated. The balance among these determines the temperature of the earth. The tropics absorb more energy than they reradiate to space, while the polar regions reradiate more to space than they absorb. This causes the flow of warm air from the tropics to the poles and cool air from the poles to the tropics. In the northern hemisphere, the warm air moves eastward as it moves northward, due to the spin of the earth. This is what forms the jet stream. These flows form very long waves, called Rossby waves, which tend to be unstable and break down to form the high and low pressure regions that determine the daily atmospheric condition we call weather. The Rossby waves and their breakdown usually occur over one- to four-week periods. The details of the flow patterns after breakdown are largely unpredictable so that weather predictions will never be good for more than two to four weeks.

On the other hand, climate predictability does not rest on the details of individual storms as does daily weather forecasting, but on the long-term averaging of many storms. Weather is unpredictable beyond two- to four-week periods, but the climate may be predictable over longer periods. Unfortunately, a large fraction -- 50 to 75 percent -- of climate variability on seasonal time scales is believed to be due to daily weather, so it is only the remaining 25 to 50 percent of the climate variability that the climatologists are looking for. However, for climate variability due to factors outside of the climatic system (e.g., a change in the solar output) it is possible that all of the climatic signals could be predicted.

Consequences of Climatic Change

Having reviewed the basis of weather and climate, Dr. Schneider went on to look at possible consequences of climatic change. He explained that not just the absolute values of supply and demand, but the difference between them can cause climate-related trouble for society. As an example, he pointed to the prehistoric Mesa Verde culture in southwestern Colorado, which, some believe, was destroyed by drought. Too many preceding wet years allowed the population level to increase beyond the point where the society had the resilience to survive a series of drought years. Its demand was too close to its supply. In Dr. Schneider's view, even a modest decrease in supply, say 20 percent, can be catastrophic even today if society is operating too near its limits.

Possible Effects of the Atmospheric CO_2 Buildup

There is clear evidence that the concentration of CO_2 in the atmosphere is increasing. According to the atmospheric model that Dr. Schneider is using, if this buildup continues, by the year 2000, it could result in a noticeable change in the global temperature. Furthermore, the temperature change would be larger at the poles than at the tropics, possibly leading to major changes in the variance of the climate as well as in its mean. Sea levels could also be altered if a polar warming melted glacial ice.

Dr. Schneider cautioned the audience that beyond ten to twenty years from now, the variance in the climate could change, as well as its mean, and this could have major consequences for a society without sufficient resilience.

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3.6 COMMENTS ON LONG-RANGE FORECASTING AND CLOUD SEEDING

Irving P. Krick

Irving P. Krick Associates, Inc.
Palm Springs, California

Dr. Krick began his talk by noting that, by the late 1930's, he and the Caltech Meteorology Department, which he chaired at that time, had found recurrent six-day meso-scale barometric pressure patterns from a study of weather maps. This information was used during World War II by Col. Krick and other Air Force meteorologists for weather forecasting in all theaters, including the Normandy invasion. After the war, he claims to have developed methods for determining how the six-day weather patterns fit together in a sequence to form the longer period climate.

Dr. Krick continued his presentation by showing some slides of weather maps that were typical of the weather pattern dominant during the recent drought of 1976-1977. These had formed the basis for yearly forecasts issued to the California Department of Water Resources and other agencies. He also provided weather maps that were typical of the wetter years that followed. He showed one slide that he said summarized the results of a computer prediction started from a take-off point in 1960. It predicted high rainfall this past year in the Ohio and lower Mississippi River basins which, he said, actually did occur and caused serious flooding.

To finish his talk, Dr. Krick commented on the possible importance of cloud seeding operations to power generation. During a low precipitation period in the Columbia River Basin in 1951, he managed a cloud seeding program for the Bonneville Power Administration on the U.S. side of the border. Comparing U.S. and Canadian runoff figures, the U.S. had

83 percent greater runoff than it would have had without the cloud seeding. Subsequently, many such programs have been initiated throughout the world. This is significant for energy interests because it can increase hydroelectric power production from present facilities and cut down on the need to use fossil fuel.

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CHAPTER 4

ECONOMICS, THE LAW AND INSTITUTIONAL CONTROLS OF WATER -- SUMMARIES OF PRESENTATIONS FROM SESSION II

4.1 THE LAW AS IT RELATES TO CALIFORNIA WATER SUPPLY, ALLOCATION, AND USE

Harrison C. Dunning

Professor of Law
University of California
Davis, California

Professor Dunning, who recently served as Staff Director of the Governor's Commission to Review California Water Rights Law, stressed intrastate rather than interstate issues in his talk. He focused on the history of California water rights law and some current issues in California, in particular issues discussed in the Final Report of the Governor's Commission to Review California Water Rights Law (December 1978).

History

An important regime of water law -- the riparian system -- developed as part of English common law. Rights to water use belong to those owning lands along the borders of surface sources (riparian lands). Water rights, then, were tied to land rights -- water could only be used on the riparian lands, rather than being treated independently.

In contrast to riparian doctrine, all the western states developed a system of appropriative rights. One obtains appropriative water rights not by owning land adjacent to the water, but by putting water to beneficial use. This system originated during the Gold Rush; behind it lies the notion of "first in time, first in right." The person who first puts water to beneficial use is preferred. Beneficial use is the origin, the measure, and the limit of the right. The right exists for only as long as the water is put to beneficial use.

The appropriative system is the exclusive system for establishing new uses in most western states, but California has a dual system that gives full recognition to the riparian doctrine first developed in England, even though the appropriative system is the dominant one. This is known as the "California Doctrine."

One might think that the appropriative system broke the tie between land and water so characteristic of riparian rights, but this is not entirely so. For example, junior appropriators have a right to the return flow from upstream users, and this tends to freeze the original pattern of allocation. Moreover, water districts have been established to service given areas, and once an allocation is made by the district it tends to be preserved. Also, appropriation in most states requires physical control of water, as opposed to mere reservations of water for such purposes as instream use, suggesting that water is to be used primarily out of stream to service particular parcels.

At the end of the 19th century, state permit and licensing systems developed in the western states. California instituted such a system in 1914, primarily as a result of fears that power companies were hoarding water. The purpose of permits and licensing is to impose order and certainty -- establish beneficial uses, process appropriations, and protect existing rights. In California, in contrast to most western states, this system applies only to surface (not ground) waters.

In 1928, California adopted a constitutional provision subjecting riparian rights to limits of reasonableness in disputes with appropriative rights, the purpose being to promote conservation (i.e., water impoundment).

<u>Current Issues</u>

Professor Dunning identified five issues currently at the center of water rights debates in California:

(1) As mentioned above, California's permit system does not apply to ground water. There have, however, been some ground water ajudications, and local districts have plans for ground water management. The Governor's Commission has recommended a state policy to eliminate ground water overdrafting (reducing the size of ground water reservoirs by pumping out more than flows in). The idea is a controversial one. Some interests want additional water imported for development; others want such new sources only to remedy the present overdraft problem; still others want improved ground water management independent of any new water sources.

(2) The Governor's Commission has recommended creation of a state authority to develop standards for instream uses -- protecting fisheries, for example -- uses not presently protected under California law (see discussion above).

(3) Professor Dunning believes an important issue lies in the meaning of California's constitutional provision regarding "reasonable beneficial use" (see above). The Governor's Commission has recommended continued judicial definition on a case-by-case basis rather than by systematic legislative action.

(4) As Professor Dunning's historical discussion indicated, there is considerable rigidity (land-water ties) in California water rights law, and this generates pressure for new water projects because they are the only practical means to get water for new development. Rigidity is to some degree a product of water district structure and powers; the Governor's Commission has recommended some changes, especially with regard to water districts and ground water management that might promote flexibility through transferability.

(5) A final area of development mentioned by Professor Dunning concerns public trust doctrine. Traditionally limited to coastal waters, its application to inland waters (e.g., Mono Lake) is now being investigated.

QUESTIONS

Q: Is treated sewage effluent subject to appropriation?

A: It would be if there were no other claim on the return flow. The Governor's Commission has looked into the question of rights to reclaimed water and found it murky.

Q: Many water districts have been very creative in finding solutions to water problems, so what is meant by their rigidity?

A: The districts serve small areas and exist to service those areas, resulting in a somewhat restricted view from the standpoint of resource allocation. There were some district transfers during the drought, but much more could be done to improve the efficiency of such transfers.

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Both items are available from: General Services
Documents Section
P.O. Box 1015
North Highlands, CA 95660

4.2 THE LAW AS IT RELATES TO CALIFORNIA WATER SUPPLY, ALLOCATION, AND USE -- COMMENT

Don Stark

Attorney-at-Law
Irvine, California

Mr. Stark prefaced his comments by noting that water law is the law of property. Its function is to provide rules for allocating resources. Through evolution, the particular rules in the water law area have become quite complex. In an attempt to clarify these rules, the Governor's Commission to Review California Water Rights Law appears, he suggested, to answer many questions -- questions that perhaps will never, and should never, be asked.

The California system, for all its complexities, functions well. It takes into account the differing circumstances of different local areas. It is a dynamic system and, although it developed out of lawsuits between individuals, it now applies equally well to public entities in the present era of water resource planning.

The Governor's Commission has called for more state policy and control at a time when localities have, for the most part, been doing fine. He stressed that people will resolve, on a local level, how to handle their affairs. Local control, however, is not the answer to all problems. For example, if the local people controlled Owens Valley water that serves southern California, there would be problems in developing the allocation of that resource.

QUESTIONS

Q: As shown by the climatologists in an earlier session, the water supply is quite variable. What are the legal precedents for maintaing minimum quantities in ground water storage as reserve capacity to meet these climate fluctuations?

A: As interpreted in the so-called "San Fernando Case" 1975, the law permits long-term storage in ground water basins by allowing the ground water level to fluctuate over periods longer than a year. Previously, the law was interpreted as allowing the water level to fluctuate only within annual periods. But this is only good for fluctuations in supply around some long-term average. For a long-term change in climate, society must go back and reallocate the entire resource to reflect the new annual average situation.

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4.3 THE ECONOMICS OF WESTERN WATER AS IT RELATES TO METROPOLITAN, INDUSTRIAL, AND AGRICULTURAL USE

James P. Quirk

Professor of Economics
California Institute of Technology
Pasadena, California

Professor Quirk began his talk by pointing out that both lawyers and economists are concerned about the allocation of water and about the rights to water. But lawyers are primarily concerned with the equity aspects of the allocation of water -- is the allocation fair? -- while economists are concerned about the efficiency aspects of water allocation -- does the allocation lead to maximizing the value of output for the society? The issue that Prof. Quirk addressed specifically was the appropriate role of markets in water supply relative to the role of government agencies and other outside influences.

One of the basic theorems of economics (with roots as far in the past as Adam Smith) is that, under certain conditions, a system of competitive markets achieves an efficient allocation of resources. So, according to Prof. Quirk, the first reaction of an economist to the problem of growing water scarcity is to say: "Let markets operate, with water being allocated according to the law of supply and demand, and with price acting to direct the allocation of water to its highest value uses." According to this view, there will be no future shortage of water in the west, simply more expensive water. And there is only a minimal role for the government to play in the allocation of water, restricted mainly to laying down and enforcing the rules of the game so far as property rights to water are concerned.

But it is argued by some that there are special attributes of water as a commodity that justifies bypassing market solutions to allocation problems and substituting governmentally imposed allocations.

For example, water is an essential for human survival, so equity considerations are more important than efficiency considerations. However, this argument ignores the fact that at the margin, water is not at all an essential for survival; instead, the marginal (least valuable) units of water are used for growing alfalfa, for washing cars, and other such mundane activities. Moreover, at the margin, there are good substitutes for traditional water use, even in agriculture, as the recent drought illustrated. In 1977, with cutbacks of up to 75 percent in deliveries of aqueduct water to Central Valley farmers, the value of farm output fell by only 3 percent from its 1976 levels, which were the highest in history. Farmers substituted ground water, better irrigation techniques, crop substitution and other devices to conserve on water use during the drought.

The inefficiency of our present method of water allocation can be illustrated by the following facts. Colorado River water sells today for about $5.50 per acre-foot in the Imperial Valley, and for about $230 per acre-foot in Beverly Hills ($130 net, after treatment and pumping costs). It is clear that both groups of citizens can benefit from the institution of markets in water; at present prices, too much water is employed in Imperial Valley farming and too little in Beverly Hills. An even more extreme example of inefficiency arises in connection with the proposed desalting plant along the Colorado, which will produce water for delivery to Mexico at a cost ranging upwards from $300 per acre-foot, while even better quality water is available a few miles away at $5.50 per acre-foot.

Professor Quirk concluded his talk by stating that he did not want to claim that markets in water will solve all of the problems of water in the west. The "unitized field problem" in ground water management, in which many people pump from a common field, is one example of an area where the market system does not work properly. Furthermore, flood control, recreational uses of water, and other "public good" aspects of water use and storage are problems that are not efficiently handled within a system of private markets; and there are externality problems with return flows and with water pollution that require intervention into markets if efficiency is to be achieved. However, the problem is that as the system of water allocation currently operates, intervention in markets to handle these problems has led to a cure that is worse than the original disease, and reform of our present system should be directed toward expanding the role that markets in water rights play in allocation.

QUESTIONS

Q: Montana currently has a moratorium on large-scale water transfers to industrial users because ranching interests fear large court costs in proving they are being harmed by not receiving return flows as junior appropriators. Is the cost of litigation included in the argument for letting markets operate?

A: It should be noted that industry also faces these costs, and it usually must also bear the burden of proof. There are important transaction costs involved. This is the return flow externality problem mentioned above, which will become much more critical over the next 25 years as the rivers become fully utilized. To make the market system work these external costs must somehow be internalized.

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4.4 THE ECONOMICS OF WESTERN WATER -- COMMENTS ON INDIAN WATER RIGHTS

Ronald G. Cummings

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Central to a market system for water use is the existence of established water rights. The questin that Professor Cummings addressed was what happens when the established rights have been established in error? In the southwest, water rights have historically been established without regard to possible Indian claims. However, in Arizona vs. California, 373 U.S. 546(1963), it was decided that reservations have the rights to enough water to serve their "practicably irrigable acreage." But what is meant by "practicably irrigable acerage?" Should it be based on engineering feasibility or on economic feasibility? The trouble with basing it on economic feasibility is that most present holders of water rights have received implicit subsidies from the federal government through its reclamation policy. Typically, irrigated agriculture in the west pays only about 15 percent of its allocated cost for the water it uses. This issue as well as several others will be crucial in court determinations of the legal status of Indian claims, and is a matter of intense interest to all rights holders along the Colorado.

QUESTIONS

Q: How much water is involved?

A: As an example of the magnitude of the problem, one tribe in New Mexico is claiming the entire flow in the San Juan River, which is presently already heavily used and is also claimed, in part, by two other tribes.

CHAPTER 5

CURRENT AND FUTURE MANAGEMENT ISSUES -- SUMMARIES OF PRESENTATIONS FROM SESSION III

5.1 CURRENT WATER POLICY IN THE STATE OF CALIFORNIA

Ronald B. Robie

Director, Department of Water Resources
The Resource Agency
State of California
Sacramento, California

The water policy that California follows today is derived from a broad variety of sources. The most basic policy followed, according to Mr. Robie, comes from the California Constitution, Article X, Section 2, and has two specific charges: (1) that "the water resources of the state be put to beneficial use to the fullest extent to which they are capable," and (2) that "the waste or unreasonable use or unreasonable method of use of water be prevented." However, in interpreting the Constitution, the California Supreme Court recognizes that what is reasonable depends on the particular circumstances at a particular time, as seen in changing public attitudes in the fifty years since the Constitutional provision was written. By the late 1950's the State Department of Water Resources was at a high point of water development with the completion of construction of the Central Valley Project and construction beginning on the California State Water Project. Starting in the early 1960's, with all the good dam sites virtually exhausted and strong public sentiment toward preservation of the natural environment, legislation turned from construction of water projects to environmental and water quality control acts. During this period such environmental and water quality acts as California's Porter-Cologne Water Quality Control Act, Federal Clean Water Act of 1972, and California's Wild and Scenic Rivers Act of 1972 were put into effect.

Following his review of how California water policy has constantly changed to meet the changing needs of the state, Mr. Robie summarized California water policy as it stands today.

> Policy 1 - "The water resources of California shall be managed in a manner which will result in the greatest long-term benefit to the people of the State."

The emphasis in this basic concept is on long-term effects, not just short-term, immediate results or benefits. This is a key part of the California Environmental Quality Act (CEQA) and, according to Mr. Robie, one of the hardest policies to implement as future impacts seem so far off and ephemeral.

> Policy 2 - "Water resources already developed shall be used to the maximum extent before new sources are developed."

Mr. Robie expressed the belief that this basic concept is the cornerstone of California's water policy and simply means "good stewardship" of what you have before you get more.

> Policy 3 - "All alternative sources of supply, including water exchanges, shall be considered. Conjunctive use of surface and ground water supplies and storage capacity, including planned temporary overdrafting of ground water, shall be utilized to maximize yield and improve water quality."

The essence of this policy is to try to stop the tendency of looking at only one "solution," the traditional dam and aqueduct. For example, Mr. Robie stated that during the drought in California, by exchanging water between northern California/southern California agencies, the agencies were able to maximize the available water supply and make it cost effective. In regards to the conjunctive use of surface and ground water supplies, Mr. Robie expressed the opinion that far better use of water can be obtained through improved ground water management. The Governor's Commission to Review California Water Rights Law has placed before the California Legislature a comprehensive program for local ground water management.

According to Mr. Robie, the Department of Water Resources sees a major future role for ground water storage just as we now utilize surface storage. Under present plans, for example, the State Water Project will use ground water storage for 400,000 acre-feet of the project yield, nearly 10 percent of the contracted supply of the project.

Policy 4 - "Optimum application techniques and processes for water conservation shall be implemented and waste shall be avoided."

Conservation today means two consistent concepts, the traditional conservation of water behind a dam or under ground <u>and</u> the reduction of demand and minimization of use, which also conserves existing supplies so that they can be stretched or used at a later time.

Urban water conservation is possible, as demonstrated during the 1976-77 drought when 35 major urban areas throughout California showed a 21 percent reduction of water use from 1976 to 1977. However, what is more important is that the conservation in these 35 communities has continued, although not at as high a level as during the drought.

Because agriculture is the largest single user of water in the state, the Department of Water Resources is very interested in encouraging agricultural water conservation. The Department has sponsored research into specific agricultural water conservation techniques and has seen progress in bringing more California farms under sprinkler and drip irrigation.

Policy 5 - "Water shall be reused to the maximum extent feasible."

In October 1977, Governor Brown issued an executive order creating the Office of Water Recycling in the State Water Resource Control Board. This office promotes water reclamation and takes the lead in setting priorities for reclamation projects receiving grants from the state and federal governments. Mr. Robie believes that reclaimed water can provide a source of new supplies for the State Water Project with reduced energy demands for the additional yield from reclaimed effluent. The Department of Water Resources has proposed the recycling of agricultural waste water by construction of two 25,000 acre-feet per year reverse osmosis plants to reclaim brackish water in the San Joaquin Valley and in southern California.

The State Water Project has contractual commitments to deliver 4.23 million acre-feet of water, but, after allowing for water conservation and water reclamation, this estimated demand in the year 2000 can be reduced to 3.2 million acre-feet. With current facilities, and allowing for increased use in the areas of origin, they will be able to deliver 65 percent of that amount. During the next 20 years the State Water Project, according to Mr. Robie, is proposing to construct two major reservoirs: The Glenn Reservoir Complex, an offstream storage reservoir north of the Sacramento Delta, and the Los Vaqueros Project, a major reservoir south of the Delta. Furthermore, the Department of Water Resources is strongly supporting the construction of the $600 million Peripheral Canal. In Mr. Robie's eyes, the canal is necessary and is the only environmentally sound alternative that will provide both efficient water transfer and Bay-Delta protection.

Policy 6 - "Water quality objectives and beneficial uses adopted by the State Water Resources Control Board shall be the basis for water quality management."

This policy simply means that the water projects must be planned to meet the water quality requirements of the State Water Resources Control Board. A new California water plan produced jointly by the Water Resources Department and the State Water Resources Control Board will be available for public comment soon.

The last two policies Mr. Robie mentioned briefly. One policy places a strong emphasis on flood plain management, particularly nonstructural forms of flood damage prevention. This is an area related to the current sediment management work of the Environmental Quality Laboratory at Caltech and Scripps Institution of Oceanography.

The other policy, in recognition of social, energy and environmental impacts, concludes that "the least expensive alternative will not necessarily be selected." This means that quality of life sometimes costs a little more and mitigation and avoidance of social and environmental harm is a legitimate cost.

QUESTIONS

Q: What is the Department's position on placing the north coast rivers in the Federal Wild and Scenic River System?

A: The Department believes they should be protected, but has reservations about the federal system. Included in these reservations, shared by many environmental groups, are federal management practices and the lack of adherence to state standards.

Q: Referring to the extension of the State Water Project, have transferability of water rights been considered and when will a cost/benefit analysis of the extension be issued?

A: Water transfers must be on a voluntary basis, and are encouraged by the Department. Each facility in the project will go through a cost/benefit analysis prior to its construction. (Personally, Mr. Robie doubted that the established cost/benefit formulae are effective when considering the broad social issues that are important.)

Q: How does the push towards energy conservation square with the building of the Peripheral Canal, which will require pumping plants to operate?

A: The Peripheral Canal's energy requirements would be offset by pumping less water over the Tehachapi Mountains into southern California. The present plan for the State Water Project calls for 700,000 acre-feet of water to come from conservation and reclamation by the year 2000, mostly in southern California. This is water that would not have to be pumped over the mountains.

Q: Has the Department set the frequency and amount of flood waters on the Sacramento River that would be released to flood the south bay rather than be used by the Peripheral Canal?

A: The State Department of Water Resources has not established any numbers, but does recognize this as a problem worth studying. The State Water Resources Control Board has control over how much can be diverted, and in the agreements that have been worked out it is clear that this is to be covered.

Q: Can you clarify the status of contracts for water in excess of the State Water Project's capacity?

A: The aqueduct was designed to carry 4.23 million acre-feet (maf), which was forecast as the demand in 1990. Demand has since slowed down and only 3.2 maf is forecast as the demand by 2000, which includes the conservation and reclamation mentioned above. We do not now have enough supplies to meet even this reduced figure. The Department does not view its commitments necessarily as water to be brought into southern California over the mountains, but includes possible local supply options, too.

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5.2 THE COLORADO RIVER AND CURRENT WATER POLICY

Manuel Lopez, Jr.*

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Boise, Idaho

Mr. Lopez divided his presentation into four parts: (1) physical facts about the Colorado River, (2) what the "Law of the River" is and how it has evolved, (3) major issues with regard to the river today, and (4) possible solutions to the problems. In a preface to his talk, Mr. Lopez stressed that these are his own opinions and not those of his former employer, the U.S. Bureau of Reclamation.

Physical Facts About the Colorado River

The Colorado River is 1,400 miles long and drains all or part of seven states. It is divided into two administrative "basins," the Upper Basin (Colorado, New Mexico, Utah, and Wyoming) and the Lower Basin (Arizona, California, and Nevada) with the dividing line at Lee Ferry, Arizona, just below the Utah border. Ninety percent of the runoff originates in the Upper Basin. Measured flows at Lee Ferry have varied from as high as 24 million acre-feet per year (maf/yr) in 1917 to as low as 6 maf/yr in 1934. The average flow at Lee Ferry is between 14 and 15 maf/yr. (The uncertainty is due to whether the very wet years that occurred in the early 1900's were included.) An additional 1 maf/yr enters the river between Lee Ferry and Lake Mead. Two-thirds of the runoff occurs in one-third of the year, April through July.

The river has 60 maf storage capacity, mostly in Lake Mead in the Lower Basin and Lake Powell in the Upper Basin. Approximately 52 maf of water will be in storage by October 1, 1979. It is

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being stored at a rate of 2 maf/yr. Current use is about 13 maf/yr (including losses). Demand will probably equal supply by the year 2000.

The "Law of the River"

The Law of the River consists of the various treaties, compacts, acts of Congress, and pronouncements of the Secretary of the Interior that determine how the river is managed. The Colorado River Compact of 1922 gave 7.5 maf/yr to each basin for "beneficial use," with the Lower Basin allowed to use up to 1 maf/yr more if water were available, provided that any water guaranteed to Mexico would come equally from both basins. The Compact also specified that the flow at Lee Ferry must be greater than 75 maf over any consecutive 10-year period, and it set use priorities, in decending order -- agricultural and domestic, power production, and navigation. This was all done at a time when the average flow was believed to be 17 maf/yr. The Boulder Canyon Project Act of 1928 gave Congressional recognition of the Compact, authorized the building of Hoover Dam and the All American Canal, and divided the waters of the Lower Basin, giving 4.4 maf/yr to California, 2.8 maf/yr (exclusive of the Gila River) to Arizona, and 300,000 acre-feet/yr to Nevada. The Palo Verde Irrigation District contract of 1933 set priorities for Colorado River water use among California users: (1) Palo Verde (for use on no more than 104,500 acres), (2) Yuma (for use on no more than 25,000 acres), (3) Imperial and Coachella, and (4) MWD and/or City of Los Angeles (for 550,000 acre-feet/yr). The total water use by the first three priorities (primarily agricultural use) was limited to 3.85 maf/yr.

In 1944, a treaty was signed with Mexico that guaranteed that country 1.5 maf/yr. However, this flow could come from all sources, including agricultural return flows.

More recently, in 1956, a number of storage works in the Upper Basin were authorized, including Lake Powell. In 1962, rules were set to govern reservoir operation during the filling of Lake Powell.

In 1964 the U.S. Supreme Court settled the Arizona vs. California dispute by apportioning the water as specified in the Boulder Canyon Project Act if 7.5 maf/yr were available to the Lower Basin, and, if not, by protecting present perfected rights but granting no more than 4.4 maf/yr to California. It also gave some water rights to Indian reservations. Finally, the Colorado River Basin Project Act of 1968 authorized the Central Arizona Project (CAP), placed a moratorium on studies of importing water into the Colorado River Basin until after 1978 (since extended to 1988), allowed California to use more than 4.4 maf/yr until CAP is finished, and specified that enough water must be stored in Lake Powell to meet supply needs in critical years. This last provision, Section 602a, has caused much controversy.

Major Issues

In reviewing the major issues related to the Colorado River today Mr. Lopez said, "Not only is the Colorado River the most over-allocated river in the United States, it probably also is the most institutionalized river in the United States." He divided the issues into two groups -- physical and institutional. The physical issues include:

1. Below Lake Mead, the supply is 7.5 maf/yr, which is enough to cover demand at present, but when CAP comes on line the demand will increase to 9 maf/yr.
2. The yearly supply of water is not known until June, which is too late for planning. The ability to predict what the supply will be would be very helpful.
3. Long-range demand is not known. This will depend on the development of the fossil fuel resources in the Upper Basin, on population increase in the region, on the settlement of Indian claims, and on future instream uses for environmental reasons.

4. The salinity is increasing with time. The Upper Basin contributes the most salt, while the Lower Basin is hurt the most.

The institutional issues can also be viewed as psychological issues. These include:

1. The river is over-institutionalized and is controlled from Washington, which is too far away. These constraints limit the flexibility of management.

2. Decisions on present use are constrained by future concerns that are not of importance at present. To illustrate this, Mr. Lopez gave the example of power production at Hoover Dam, which is lower than it could be due to restrictions on present releases from Lake Powell, even though both Lake Powell and Lake Mead will probably soon be filled to capacity.

3. There is great distrust between states within basins, between the basins, and with the federal government.

4. The distribution of Mexican water obligations between the basins is being contested and will probably go to the Supreme Court.

5. Although they are important in determining management policy, the terms "surplus" and "deficity" are not clearly defined.

6. Multipurpose use of reservoirs implies compromise on the part of single-purpose users.

Possible Solutions

Mr. Lopez concluded his talk with some suggestions for solutions to some of the problems mentioned above.

1. The management of the river could be simplified by moving the center of management from Washington, D.C., to a site near the river and directly involving the state and federal governments in decisions.

2. Detailed overall operating criteria for the future should be developed. To do this, the simpler, less controversial issues -- such as determining unmeasured return flows and losses, and what to do with surpluses -- should be tackled first. Then the more difficult issues -- such as shortage criteria and Mexican water obligations -- will have to be solved. In addition, unnecessary irritants should be avoided. The Lake Powell filling criterion is an example of this last item, since the reservoir is almost full now.

3. Improve forecasting techniques to improve planning and operations by knowing the water supply available earlier in the year.

4. The water rights system should be designed to encourage, not discourage water conservation, and to discourage future uneconomic uses of this water. Water banking should also be encouraged so that if, for example, Colorado leaves water in the river for "in stream" uses, it will receive remuneration from downstream beneficiaries.

5. Weather modification to increase runoff should be seriously considered.

QUESTIONS

Q: Are evaporative losses from reservoirs charged to anyone under the Compact?

A: They are not mentioned in the Compact, but in the Upper Basin they are charged to each state. In the Lower Basin, it is believed the unallocated water that enters the river between Lee Ferry and Lake Mead (approximately 800,000 acre ft/yr) balances the evaporation from Lake Mead. This needs checking.

Q: What would be the effect on new projects if water were priced at its full cost?

A: It would probably preclude new agricultural development.

Q: Would it be a good idea to avoid the expense of the Yuma desalting plant by buying out the farmers in the Welton-Mohawk Irrigation District?

A: It would not be a good idea, since the social costs must also be considered. It would effectively shut down southern Arizona and throw 8,000 people out of work. This would burden one section of the country for the political benefit of all the country. It would also probably cost almost as much to buy out the farmers as to build and operate the plant.

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5.3 CONSERVATIONIST/ENVIRONMENTALIST POSITION ON WATER POLICY

Larry E. Moss*

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Management Practices in California
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Mr. Moss's talk centered on water development in California, its problems and its future. The primary theme of the talk was that, due to environmental as well as other reasons, many more people are interested in water development decisions today than have been in the past. As a result, water developers will have to learn to share their authority as well as to make decisions based on broader considerations than in the past. Under this theme, there were two main sub-themes: the economic subsidy granted to irrigated agriculture and sensitivity to environmental issues.

To illustrate his theme, Mr. Moss chose as an example the Central Valley Project (CVP) of the U.S. Bureau of Reclamation. A few years ago he was a member of the San Luis Task Force, which studied the Westland Water District in the Central Valley. They found that the Bureau of Reclamation was selling water to the farmers for less than it cost to transport it there, even exclusive of capital costs. This, in effect, is a government subsidy to irrigated agriculture. He believes the rising concern over environmental perservation will force the government to drop this subsidy. He later noted that actual cost pricing of water would not destroy irrigated agriculture, but it would probably change agricultural practices and the nature of the crops raised.

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*Former Executive Director of the California Planning and Conservation League.

With respect to the issue of environmental sensitivity, Mr. Moss stated that, until very recently, the Bureau of Reclamation has had a very noncooperative attitude toward solving the ecological problems created in the San Francisco Bay-Sacramento Delta Estuary by the operation of the CVP. He later stressed that these types of environmental issues should not be thought of in terms of "people vs. fish," but in terms of true economic trade-offs. To demonstrate this, one only needs to consider real estate values in environmentally desirable areas. In fact, the agricultural, industrial, and recreational productivity of the Bay-Delta area is important for the economy of that part of the state.

Recently, judging by the pronouncements of Secretary Andrus concerning the Bay-Delta Estuary, it appears Washington may be coming to similar conclusions. Furthermore, Mr. Moss believes that the federal government will no longer pay most of the bill for new water development for agriculture.

Mr. Moss said that his theme could also be applied to many local authorities. One example he cited was the present conflict over the Los Angeles Department of Water and Power's diversions from Mono Lake and the environmental results. Furthermore, many water districts have the same attitude today that they did twenty years ago, before the recent upswing in environmental awareness. In some places, a water subsidy is financed in part from local property taxes.

While on the subject of local authorities, Mr. Moss added that it is difficult to control population growth through water availability. Air pollution or water shortage crises are poor mechanisms for good decision making. A better mechanism should be found at the local level.

Mr. Moss continued his talk by pointing to one example of what he considers to be relatively enlightened water planning, the California State Water Project (CSWP). He maintained that the state, since 1975, has attempted to work within the present environmental laws, including a planning effort related to future demand and how best to meet that demand. It has also respected the laws related to Bay-Delta water quality and those preventing exports of water from the northern California coastal area. He believes the California Department of Water Resources has been fair in balancing the various needs, so that the CSWP contains elements of conservation, reclamation and protection for the Delta's ecology, as well as plans for new storage facilities.

In conjunction with the CSWP, Mr. Moss reviewed the recommendations of the Delta Environmental Advisory Committee, of which he was a member, to the Director of the State Department of Water Resources. Those recommendations were:

1. Respect the State's wild rivers.
2. Provide adequate guarantees of water quality and water rights in the source areas of exported water.
3. Realize there will be a ceiling on exports.
4. Establish water conservation and water reclamation programs.
5. Construct and operate the Peripheral Canal in accordance with the previous recommendations, in order to protect the ecology of the Delta.

In his concluding remarks, Mr. Moss noted that the principle of paying the full cost of water must be worked into present supplies if we are to determine the true economics of water conservation and supply. This is not a suggestion that California should be economically destroyed in order to prevent water exports from the north to the south, but that the system must be tightened up. He believes that municipal and industrial demand could be reduced by one-third and agricultural demand by one-tenth without hardship.

QUESTIONS

Q: If agriculture paid the full cost of water, what would happen to U.S. food exports and the resulting foreign exchange that comes from them?

A: Most export crops are not grown using subsidized water. Removing the subsidy would lead to a more efficient use of the water. Agricultural products that are valuable enough for people to pay the true cost of water for irrigation will still be grown. This way true costs will be paid up front, rather than through tax-supported subsidies.

Q: What is the projected true cost of State Water Project water delivered through the Peripheral Canal?

A: The cost would be about $35 per acre-ft. The Peripheral Canal is not needed in order to have increased water delivery -- the projects currently have the capacity to carry 1.5 maf/yr more than they do -- but in order to protect the Bay-Delta estuary ecology

Q: What is the actual cost of the project and who will pay?

A: R.B. Robie: The cost of the Peripheral Canal is estimated to be $600 million, but will, no doubt, be more by the time it is built. If the federal government does not share the cost, the yield to the State Water Project will be larger.

L. Moss: The canal would be financed by state bonds to be repaid by the canal's users (i.e., the MWD and San Joaquin Valley agricultural interests). Only the Peripheral Canal is being recommended, not the development facilities included in SB 200. About 5 maf/yr are withdrawn from the Delta now, and, without the Peripheral Canal, this would have to be reduced to no more than about 1.5 maf/yr to stop the damage being done to the Delta.

Q: In SB 200, $50 million are earmarked for agricultural water conservation while $3 billion are earmarked for new construction. Is this a reasonable balance?

A: No, it is not a good balance, but it shows California is moving in the right direction.

Q: If a facility were built only to protect the Delta and not to transport water across it, what would it be and what would it cost?

A: The only way to bring the currently used water across the Delta and protect it is to build something like the Peripheral Canal. Shutting down the present projects would be very costly. Agricultural interests in the Delta have proposed a dam across the western end of the Delta. This would protect the water quality in the Delta, but not its ecology.

Q: Does the Peripheral Canal need to be as large as it is planned -- 400 feet wide and 30 feet deep?

A: Unfortunately, yes. The canal must be able to be operated in a flexible manner, i.e., sometimes carry more than the average flow so that at other times it can be shut down. Otherwise, it could damage the estuary of the Sacramento River, e.g., interfering with salmon and striped bass runs.

5.4 RECONSIDERATION OF WATER CONVEYANCE CONSTRUCTION, AND ARE THERE ALTERNATIVES?

Dorothy Green

Coordinator
Working Alliance to Equalize Rates (WATER)
Los Angeles, California

Ms. Green stated that there is growing concern among the people of WATER that new water conveyance facilities, like the Peripheral Canal, are not needed. They feel that better ground water management, along with water conservation and reclamation, enabling better use of present water supplies, will decrease the demand for imported water and make the construction of new water conveyance structures on the State Water Project unnecessary.

Estimates of the costs to bring water to Los Angeles from the north start at $160/acre-foot. With costs such as these, a lot of questions should first be answered -- questions such as: Who pays and who benefits? Who in the Central Valley is going to pay $160/acre-foot? Should people in the urban areas be required to continue to subsidize agri-business in the state? Can enough water be sold at a price high enough to cover the revenue bonds that are now being contemplated to cover the building of the Peripheral Canal?

The main point Ms. Green made was that the people of California should ask if there are cheaper ways of obtaining water than going through with the construction of new conveyance systems in the State.

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CHAPTER 6

USERS' PERSPECTIVES ON THE ISSUES -- SUMMARIES OF PRESENTATIONS FROM SESSION IV

6.1 AGRICULTURE, WATER, AND THE SAN JOAQUIN VALLEY

Stanley M. Barnes

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Irrigated agriculture in the southern San Joaquin Valley is highly dependent upon imported water supplies and overdraft of the ground water supplies. Mr. Barnes stated that ground water resources will continue to be mined until substantial quantities of additional imported water can be brought into the area to help support the $3 billion agricultural industry in the southern San Joaquin Valley.

Agriculture is California's number one industry. Irrigated acreage has grown from 60,000 acres in 1870 to 9 million acres in all of California. More than 3 million acres of irrigated land lie in the southern San Joaquin Valley area. In some areas of the state, precipitation is sufficient for successful farming of a limited number of crops, but in the southern San Joaquin Valley, where annual precipitation averages 5 to 10 inches, agriculture is dependent on irrigation.

The southern San Joaquin Valley, the valley portions of Fresno, Kings, Tulare and Kern counties, is a closed basin, sometimes referred to as the Tulare Lake Basin. All streams south of the Kings River and north of the Tehachapis, principally the Kaweah, Tule and Kern rivers, terminate in Tulare Lake.

Irrigation prior to 1860 was crude and limited in extent; but, in the period from 1860-1880, substantial diversion structures and irrigation canals were constructed on each of the major streams in the area. These streams were unregulated until the construction of federal flood control reservoirs from 1954 to 1962, authorized by the Flood Control Act of 1944.

As the need arose to supplement the water supply from surface diversions, the first use of a pump on a well was reported in the 1880's near Porterville. However, extensive use of ground water pumping awaited development of more efficient pumps and economical power after the beginning of the twentieth century.

Today, 75 percent of California's average annual river runoff of 70,000,000 acre-feet occurs north of Sacramento, while 75 percent of the water demands, for irrigation and other uses, are south of Sacramento. Ninety percent of the precipitation occurs during the months of November through April, either as rainfall or snow, the latter within the Sierra Nevada's watersheds. As a consequence, reservoirs are needed to regulate runoff for summer irrigation. Reservoirs are also needed due to the substantial variation in river runoffs from year to year. On the Kings River, for example, the lower quantile of the years produce 65 percent or less of the mean annual runoff and the upper quantile produce 126 percent or more of the mean.

Table 6.1-1 shows the summary of present water requirements and water supplies within the southern San Joaquin Valley. The table shows the dependence of the southern San Joaquin Valley on imported water. Irrigated agriculture requires 94 percent of the total water supply, or 6.9 million acre-feet per year.

Table 6.1-1
PRESENT WATER REQUIREMENTS AND WATER SUPPLIES WITHIN THE SOUTHERN SAN JOAQUIN VALLEY, CALIFORNIA*

Water supply from:	Acre-feet per Annum	% of Total Requirement
Runoff from local rivers	2,460,000	33.7%
Safe yield of ground water	510,000	7.0%
Waste water reclamation	45,000	0.6%
Subtotal (local supplies)	3,015,000	41.3%
Imported water (federal and state)	2,975,000	40.7%
Overdraft of ground water	1,310,000	18.0%
Subtotal (imported and overdraft)	4,285,000	58.7%
Total Supplies	7,300,000	100.0%
Total Net Water Requirement	7,300,000	100.0%

*Data from 1972. Source: California Department of Water Resources 1974, The California Water Plan -- Outlook in 1974, Bulletin no. 160-74, November 1974.

QUESTIONS

Q: What has been done or what can be done about the contamination of ground water by the saline, perched agricultural waste water?

A: The only on-going program is in the Tulare Lake Drainage District (comprised of lands in Tulare Lake Basin, a little over 200,000 acres). The program is still in the construction phase, but it will use solar evaporation of the agricultural waste water and is planned to be in operation by the end of summer 1979.

The land where the evaporation ponds will be situated is near the Kings/Kern county line and is nonagricultural. There is no ground water under the land and there is negligible vertical percolation.

The program may later be coordinated with the U.S. Fish and Wildlife Service's Kern National Wildlife Refuge. The area may be planted with salt-tolerant marsh grasses and will be a refuge for wildlife such as ducks. Provisions are also made to allow for disposal in the San Joaquin Master Drain, when and if that proposed facility is constructed and made available for use on an economical basis.

Q: Is the 18 percent of the water that is overdrafted commensurate with the additional water you plan to get from the State Water Project when it is completed?

A: The water from the completed State Water Project will not be sufficient to cover the overdrafted water. After the water from the project is delivered there will still be a residual overdraft of about 1.0 million acre-feet (a 33 percent drop from the present overdraft).

Q: Is J.G. Boswell Company (the company Mr. Barnes represents) for the Peripheral Canal, and if not, why and what are the alternatives?

A: The Boswell Company is for the efficient conveyence of water across the Delta, without imposing additional burdens on the State Water Project. Currently, the company is for a non-isolated facility, which will get water across the Delta, at less cost and with less hazard of having excessive quantities of water taken away from the Delta at times of need.

Q: What facilities, other than the Peripheral Canal, are necessary for the completion of the California Water Project.

A: The California Water Project is not specific. Additional imported water from the north, either from the north coast or Sacramento River Basin, is needed. This could be achieved by enlarging Shasta Dam or putting facilities on the Cottonwood and Eel rivers.

Q: What are the major features of the ground water legislation and what are your views?

A: The main features of the legislation should be elaborated on by Professor Dunning.

The only places in California where there is sound ground water management are in basins with balanced total water supply. The issue then becomes how to fairly allocate the cost of a total water supply.

What the people of the San Joaquin Valley are fearful of is that once there is state controlled ground water management, there will be no additional supplementary water supplies. Instead, political mandates will put 20 percent of the agricultural lands out of business, due to lack of water.

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6.2 SALINITY AND GROUND WATER SUPPLIES IN THE SAN JOAQUIN VALLEY

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Mr. Pyle covered three topics in his talk: ground water use and the overdraft issue, water districts and ground water management, and salinity control. He began his talk by urging the audience to read the recent summary report on water usage in the southern San Joaquin Valley by Bookman-Edmonston Engineering, Inc. (see reference list below).

Ground Water Use and the Overdraft Issue

There are currently around 3.8 million acres under irrigation in the five-county (Fresno, Kern, Kings, Madera, Tulare) southern San Joaquin Valley area. In 1966, an estimated 8.25 million acre-feet (maf) were pumped from ground water. There is no current estimate of total ground water pumped, but it probably exceeds the earlier estimate and may be in the range of 8.5 to 9 maf. Even though more land is irrigated, additional supplies of imported water have prevented the valley-wide overdraft from increasing. The current estimate of the overdraft in the San Joaquin Valley is about 1.4 maf. When the California State Water Project was planned in 1957, there was a statewide overdraft of about 4 maf/yr, which has been reduced to the present 1.4 maf/yr through the development of reservoirs and water supply projects. The users of the water, Mr. Pyle said, do not find the overdraft alarming, but consider it a use of resources economically rewarding to the state.

It was Mr. Pyle's opinion that the amount of irrigated acreage in the southern San Joaquin Valley would not be increased very much in the near future and that the overdraft would not be increased either. In the entire area, there are only about 160,000 acres subject to future development, and only 80,000 to 90,000 of those are in Kern County (in which 950,000 acres are now irrigated).

Water Districts and Ground Water Management

In Kern County, individual water districts have instituted ground water management schemes tailored to their individual needs. Some districts spread excess runoff during wet years to recharge the ground water. Some, like Arvin-Edison, spread Class II water during wet years so that more ground water is available in dry years when only Class I water is available. Some districts percolate their entire imported supply and let farmers pump it out from the ground water. In some urban areas, ground water use is being replaced by imported surface water.

The farmers in the southern San Joaquin Valley, according to Mr. Pyle, oppose the new ground water-related laws recently proposed by the Governor's Commission to Review California Water Rights Law. They agree with the majority on the Senate's Committee on Agriculture and Water, who could find no useful purpose in moving control of ground water from the local level to the state level.

Salinity Control

On the west side of the southern San Joaquin Valley, there is what is known as a "perched water condition." This means that a clay layer near the surface causes salty drainage water to pond near the surface, interfering with crop root functioning and reducing productivity. In the Tulare Basin, local drainage works have been built to control the problem. In the Westlands area, the U.S. Bureau of Reclamation built a regional drain, which terminates in Kesterson Reservoir. A drain is currently needed north of the Westlands District to isolate the drainage water from the San Joaquin River.

Some perched water is also found in Kern County. Currently, 40,000 acres are in trouble, but this could grow to 160,000 acres in the future. The State Department of Water Resources and the U.S. Bureau of Reclamation have studied the problem and recommended a master drain to carry the drainage north and introduce it into the Suisun Bay area of the San Francisco Bay-Sacramento Delta Estuary. There is much opposition to this plan on ecological grounds, but Mr. Pyle insisted that people with technical information on the subject do not consider that the introduction of the drainage water would cause problems, if it were managed properly. Because of the time and cost involved in overcoming this opposition, however, local solutions, such as evaporation ponds, will probably be instituted in Kern County.

QUESTIONS

Q: How will the overdraft problem be solved if more water is not imported?

A: In Kern County, in the 1990's, after all present contracts for State Water Project water have been met, there will still be a residual overdraft of about 500,000 acre-ft/yr. Only a new water supply project will completely solve the problem. Farmers in the San Joaquin Valley feel that the legislature, when adopting the California Water Plan, promised to meet all needs as they developed.

Q: What is the potential for more efficient irrigation to cut the overdraft without cutting production?

A: In Kern County, most irrigation is done by modern methods (see the reference list below). For example, approximately 65 percent of the water used in areas receiving State Water Project water is applied by sprinklers. The overall district efficiency (i.e., the water delivered to irrigation districts as related to the total use) in Kern County is 68 percent. Counting the water that escapes and percolates to ground water too salty for further use, efficiency is 96 percent.

Q: Can the perched water problem be solved by installing tile drains if subsidence from continued pumping, which would ruin the drain lines, is occurring?

A: This is not a problem since the perched water problem and subsidence occur in different geologic areas.

Q: Is there a market for agricultural waste water -- e.g., for power plant cooling?

A: If all other conditions for acceptability (e.g., air pollution considerations for fossil plants or popular acceptance for nuclear plants) are met, there is plenty of water available for cooling purposes. For other uses, the reclamation cost would be quite high, approximately $300/acre-foot.

Q: How many more years can the basin handle the overdraft?

A: In Kern County, the water table is already down to between 200 and 250 ft in many places and pumping costs are up as high as $30/acre-foot. For many low-value crops, such as alfalfa, the break-even point is $25/acre-foot. Further exploitation may soon be stopped by economic forces. With the introduction of State Water Project water, the decline of the water table appears to be leveling off, but data from a few more years will be necessary to know for sure.

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6.3 NATURAL RESOURCES AND AGRICULTURE

W.R.Z. Willey

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Dr. Willey began his presentation by noting that the effects of agriculture on the land, water and energy resource sectors are controlled, to a large extent, by government policy. Furthermore, it is the federal government, through the United States Department of Agriculture (USDA), that has, by far, the greatest control. Single objective federal agricultural policy can have serious consequences in exacerbating agricultural impacts on other resource sectors. Dr. Willey's primary conclusion was that U.S. agricultural policy needs updating along integrated or holistic lines in order to eliminate these unwanted negative impacts. His talk was divided into three parts: (1) interactions of agriculture with the resource sectors, (2) new developments affecting these interactions, and (3) the role played by U.S. agricultural policy.

Interactions of Agriculture with the Resource Sectors

Today there is a growing reliance on energy intensive crops. Such crops have a reduced genetic base, which leads to increased disease susceptibility. Furthermore, their cultivation depends on increased use of artificial fertilizers (usually made from fossil fuels), pesticides and irrigation. Although agricultural energy use is only 2-4 percent of the national energy use, it has been growing at an annual rate of 5 percent [Steinhart and Steinhart, 1975; Buffington and Zar, 1977].

The use of large amounts of synthetic organic pesticides leads to what is known as the "pesticide treadmill." The target pests develop an increased resistance to the pesticide; while the pesticide kills the target pests' natural predators. This leads to an increased need for pesticide [Apple and Smith, 1976]. The use of pesticides has been increasing at a rate of 7 percent per year [U.S.D.A., 1970, 1977]. In addition, indiscriminately increased irrigation can lead to increased pest problems.

The increased use of irrigation, based on present pricing policies, will probably lead to an agricultural water shortage in many western basins by the year 2000, even if the energy resources in the west were not developed [U.S.W.R.C., 1978]. It also leads to over-drafting problems and an aggravation of the already intolerable soil erosion problem [Willey, 1977; Willis and Evans, 1977]. In addition, the sediment resulting from erosion, combined with the excess runoff of pesticides and fertilizers, has led to agricultural waste water quality problems. According to Dr. Willey, the inability to control such nonpoint sources of water pollution has been the greatest failing of the Federal Water Pollution Control Act Amendments of 1972 [U.S.E.P.A., 1976]. To many people, the proposed San Joaquin Drain is seen as a way to relieve the farmers in the Central Valley from the problems associated with their pollution by dumping pollutants into the San Francisco Bay-Sacramento Delta.

New Developments Affecting Agriculture Resource Use

The traditional belief has been that the way to increase agricultural productivity is to increase the resource base -- more water supply such as interbasin transfers and more land use such as the "reclamation" of wetlands, ranges and forests. This was certainly the intent of the Reclamation Act. But experience has shown that this leads to an increased use of nonrenewable resources and an increase in pollution. Dr. Willey believes that with the recent advent of energy constraints and increased environmental awareness this is not likely to continue in the future.

The United States must develop new agricultural techniques that keep pollution and energy use down [Wittwer, 1975]. There have been some promising developments in the area of pest management with the advent of Integrated Pest Management and irrigation manipulation. In the latter technique, soil moisture is managed in a way that inhibits the development of certain pest life stages and/or encourages beneficial species. Other new techniques that should be developed include more efficient methods of irrigation, reductions in conveyance losses in distribution systems, and methods to minimize leaching. Drought resistant, salt resistant and nutrient efficient crop strains should also be developed [Browning, 1972; N.A.S.N.R.C., 1977]. These would lead to energy conservation through reduction of energy needs for water transport, construction of new supply systems, and fertilizer production. They would also reduce erosion losses. Such techniques may also be exportable to the Lesser Developed Countries (LDC's) to facilitate the development of sustainable agricultural production in these countries.

The Role of Federal Agricultural Policy

The problems of American agriculture can not be solved under the present federal agricultural policy. As an example of the contradictory nature of present federal policy, Dr. Willey briefly reviewed the major laws passed by Congress in 1977 that related to agriculture:

(1) Food and Agriculture Act -- which raised price supports to stablize farm income for present day large scale agribusiness as it did for small farmers in the depression.

(2) International Development Food Assistance Act -- whose contradictory intent was to both increase agricultural output in the LDC's and enhance domestic farm exports through price supports and water subsidies. These allow domestic crops to be cheap enough to undermine indigenous agriculture in the LDC's.

(3) Soil and Water Conservation Act.

(4) Clean Water Act.

(5) Public Works Authorization Act.

Subsidized water and subsidized markets have produced crop cultivation on marginal lands, increased erosion, increased pollution and increased energy demand. In addition, the agricultural extension program of the Department of Agriculture has, until recently, focused on pesticide use rather than on Integrated Pest Management, which minimizes the use of pesticides.

Dr. Willey concluded by stating that the ultimate solutions to agriculture's problems are not clear, but that an important first step is a movement toward unsubsidized production at both market and resource levels.

QUESTIONS

Q: Who are the true beneficiaries of the low cost crops produced in California, the farmers or the consumers?

A: For an answer, consider rice production. There are two subsidies: a crop support system, featuring a price floor, and a water subsidy. The beneficiaries are rice producers and people who eat a lot of rice. There is a redistribution of income from the general tax-paying public to those who produce rice and, to some degree, to those who consume rice. Rice growers have received large amounts of revenue due to both subsidies.

Q: Without the use of pesticides the cost of food will rise by at least 50 percent. Can you comment on this?

A: Integrated Pest Management (IPM) does not mean going without pesticides. What it does mean is using pesticides in a rational manner along with other controls. Using IPM, pesticide use could be reduced by 50 percent [Metcalf, 1977]. Although pesticide use has been increasing at a compounded annual rate of 7 percent, pest damage has stayed constant at about 35 percent [Pimentel, 1978]. Therefore, present pesticide use methods are decreasingly effective. Furthermore, pesticide costs are based on highly subsidized fossil fuel costs.

Q: Integrated Pest Management demands careful timing and an extensive knowledge of the life cycles of pests and predators. It is very complicated and difficult for farmers to handle. How should it be brought to the farmers?

A: Today, independent consultants are the primary source of IPM information. They are, however, at a competitive disadvantage to pesticide salesmen because of the large numbers of the latter -- 2,000-3,000 field men for agricultural pesticide companies. The Agricultural Extension Service is another possible route, but it has been slow to adopt IPM.

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6.4 WATER AND THE LEGISLATURE

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Mr. Macdonald's discussion of the water-related legislation currently facing the California State Legislature was divided into three parts. The first was the socio-psychological realities the legislature is confronted with when dealing with water legislation. The second was the differences between the present State Senate bill dealing with the Peripheral Canal, Senate Bill 200 (SB 200), and the previous Senate bill of two years ago, SB 346. Finally, he discussed the three major differences between the Assembly's Peripheral Canal bill, AB 442, and the Senate's Peripheral Canal bill, SB 200, with respect to (1) issues of fisheries, (2) water conservation, and (3) the irrigation of new lands.

Socio-Psychological Realities of Water-Related Legislation

According to Mr. Macdonald, the people of California deal with water in an ideological, philosophical or symbolic manner, rather than in a rational manner. For example, the Peripheral Canal is perceived by the people in the San Joaquin Valley as the transfusion needed for one of the members of their family, while the people of the San Francisco Bay-Sacramento Delta view it as the rape of northern California. Not only is it difficult for the State Legislature to deal with the public's attitude toward the subject of water, but the Legislature must also contend with the public's distrust of both state and federal governments.

*Mr. Macdonald attended the conference on behalf of Lawrence Kapiloff, Chairman of the Committee on Water, Parks and Wildlife of the California State Assembly, who was unable to attend the conference.

Mr. Macdonald presented several examples of governmental water policies that have led to this distrust by the public. In 1933, California authorized the State Central Valley Project, which included, as an official project purpose, the protection of water quality in the Sacramento-San Joaquin Delta. Favorable public interest was aroused by the Project's salinity control aspects within the Delta, but due to a lack of state funds, federal funds were made available to finance a federal Central Valley Project instead. The federal Central Valley Project, however, did not provide salinity control as an official project purpose. Nevertheless, federal officials repeatedly promised that Delta water quality would be protected. Then, in 1957, in a letter that has come to be known as the Spencer Letter, the federal government formally informed the State of California that it would not provide Delta salinity control protection. This incident, plus several others, spurred the public's distrust in the federal government, particularly in matters dealing with water.

This feeling of distrust by the people of California is not limited to just northern Californians, nor to a distrust of only the federal government. Farmers in the Central Valley have been promised several projects by the Bureau of Reclamation that were never actually built. As for mistrust of the state, 20 years after the State Water Project was first authorized, its contracted commitments with 31 public water agencies in the San Joaquin Valley and southern California have not been met and probably will not be met, at least in the short run. Furthermore, the question of what constitutes the "surplus" water that can be exported from the Delta by the State Water Project has not been resolved, which produces much mistrust in the Delta.

Mr. Macdonald concluded this section of his talk by stating that this lack of trust is one of the most difficult issues with which the legislature must deal.

State Senate Bill SB 200 Related to the Peripheral Canal

Currently, the Peripheral Canal bill before the State Senate is Senate Bill 200 (SB 200), Senator Rubin's bill. It is similar in many ways to Senator Ayala's bill of two years ago, SB 346. There are two major differences between the two bills. The first is that SB 346 was supported primarily by a Los Angeles-environmentalist coalition, the environmentalists being able to swing northern California urban voters; while SB 200 is supported by a San Joaquin Valley-Los Angeles coalition. It appears to Mr. Macdonald that the environmentalists will not support SB 200, leaving the northern California vote in question. The second difference is that SB 346 was a two-thirds vote bill because it included appropriations, while SB 200 is a simple majority vote bill because it does not include appropriations.

Mr. Macdonald stated that he foresees SB 200, which is basically a Rubin-Ayala-Administration bill, coming out of the Senate relatively easily, but bogging down once it reaches the Assembly. A similar "bogging down" in the Assembly occurred two years ago with SB 346. This delay of the Senate's Peripheral Canal bill within the Assembly is related to Assembly Speaker McCarthy's objection to passing the bill by a simple majority vote when so much money is involved ($4 to $7 billion). The delay is also related to the fact that the water interests have been concentrating their attention on the Senate and ignoring the Assembly, as well as to substantive differences of interests between the Senate and Assembly.

State Assembly Bill AB 442 Related to the Peripheral Canal

With respect to the Peripheral Canal itself, the Assembly Peripheral Canal bill, AB 442, and the Senate Peripheral Canal bill, SB 200, are quite similar. There are, however, three substantive differences between the two bills with respect to related issues:

(1) fisheries, (2) water conservation, and (3) the irrigation of new lands. Based on historical fisheries records, only 40 percent of the State's fisheries are left. Mr. Macdonald maintained this was primarily the result of devastating water developments on major rivers. AB 442 will provide fisheries protection, while SB 200 does not provide such protection directly. AB 442 provides conservation requirements for urban areas that are importing water from other basins in the state, SB 200 has no such provisions. Finally, since Mr. Macdonald believed the new lands question would be the focus of differences between AB 442 and SB 200, he elaborated on it at greater length.

The problem with bringing new lands into production in the San Joaquin Valley is that more water must be found to irrigate them. This means that either more water sources will have to be tapped in the north, or water will have to be mined in the south. Already the San Joaquin Valley has a 1.7 million acre-feet per year (maf/yr) overdraft. The State Water Project currently has an obligation to make up only 0.6 maf/yr of this overdraft. This means that even without expanding into new lands, the San Joaquin Valley will still have a 1.1 maf/yr overdraft after the State Water Project is completed. Mr. Macdonald predicted that the state will be able to take care of the rest of the present overdraft by constructing such new facilities as Glenn Reservoir or one of the alternatives to it -- e.g., enlarging Shasta or Berryessa. But, where will the water come from to irrigate the new lands?

One possibility would be to export more water from northern California, but from where in northern California? If from the Delta, its water quality as well as that of the Bay would have to suffer. If from the north coast rivers, very substantial opposition would have to be overcome. If from the Sacramento River system, it would be in direct competition with northern California water interests, who are already at a disadvantage because the southern water exporters have used all the good dam sites.

The other possible source of water for new lands is continued overdrafting, but overdrafting cannot continue indefinitely. As with any mined commodity, water will become more expensive to mine as it is used up. There will possibly be a big bulge in production, but then it will fall off; and a net benefit-cost analysis for the entire region would probably be less than unity over the long run. This is a consideration the state must deal with because the ground water is treated as a common pool and, due to the "tragedy of the commons" nature of the problem, the diseconomies of overdrafting to irrigate new lands will not be perceived by the individuals who do it.

Because of the importance of this "new lands" issue it will be included in AB 442. During the question period following his presentation, Mr. Macdonald said that AB 442 will identify the critically overdrafted areas in the San Joaquin Valley where new lands will not be allowed to come into production until more supplemental water is available.

Mr. Macdonald concluded his talk by predicting relatively easy passage of SB 200 in the Senate, but trouble for it in the Assembly where it has only three "yes" votes out of nine in the Committee on Water, Parks and Wildlife. He believes that to expedite passage, the water development interests will have to negotiate with the Assemblymen who want local areas to recognize that secure economies must be built on secure water supplies. He also believes that the Los Angeles water agencies, depending on how they view their own interests, will be the deciding factor in determining the future of the water legislation.

QUESTIONS

Q: Can you summarize how AB 442 deals with the question of new lands?

A: AB 442 will provide for the identification of all critically overdrafted areas in the San Joaquin Valley. The Governor's Commission on Water Rights recommended that the administration identify areas that were overdrafted. However, since the water industry likes certainty, rather than leave it to the administration, it was put into the bill. The bill also prohibits new lands from coming into production until supplemental water is available.

Q: Can you explain why the two-thirds vote is needed for the bills dealing with the Peripheral Canal? The department has the authorization for the revenue. It seems to imply that the public is being asked to pay for these projects, while that is not the case at all.

A: The answer is political in nature. The cost of the facilities in SB 200 is about $7 billion. After the passage of the Jarvis-Gann Initiative, a legislator does not want to stand up and say "I'm voting for such and such a bill, which involves a lot of money. Let's have a simple majority vote on whether we want it and then put the money in later." Yes, the money is there, but the question is one of policy.

Q: How do the bills you presented today treat the Wild and Scenic Rivers Act, especially with regards to construction on the Eel River?

A: Neither of the bills tamper with the existing Wild and Scenic Rivers Act as far as the Eel River is concerned. AB 442 will place one additional river into the Wild and Scenic Rivers Act, that being the South Fork of the American River. But there are no changes in the Wild and Scenic Rivers Act itself.

Q: Certain areas of the San Joaquin Valley are to be labeled "critically overdrafted" with respect to ground water. Can you define critically overdrafted?

A: The Department of Water Resources developed the concept of "critically overdrafted." They define it as that level of ground water use which, if current practices continue, will result in a threat to the economy of the area. Obviously there is a lot of discretion involved.

Q: If mining water were allowed in the development of new lands, would you expect that when the ground water levels fall to such low levels as to make mining uneconomical, the farmers would argue that they are a viable economic power, and that the Department of Water Resources is obligated to supply them with water?

A: That scenario has been the history of the San Joaquin Valley. Many areas in the state have developed their economies on ground water supplies, and when it became uneconomical for them to continue mining the ground water, they were supplied with supplemental water. AB 442 will allow sufficient water to be brought into the San Joaquin Valley to take care of the existing overdraft. The bill takes care of the existing economy and attempts to discourage expanding the economy on the basis of overdraft.

Q: You stated before that economies should be built on secure water supplies. Many of us are concerned with what is occurring in southern California. If we bring in more water we will be creating a greater dependence on importation. If we get a drought, and less water in northern California is available to be shipped down here, we will not have a secure water economy. This is especially true in San Diego, your Assemblyman's home town, where the ground water supply is negligible and the importation of the Colorado River water will probably soon be cut back. There is concern, when we see water restrictions used to control growth in other California communities, that we in southern California will be bringing water down for a growth our airshed cannot handle, or a growth that our services cannot handle after the Jarvis-Gann Initiative. Based on your statement about stable economies, I wondered how you felt the bill might deal with this.

A: Southern California is going to lose some 662,000 acre-feet of its entitlement to the Colorado, which is 1,212,000 acre-feet. That loss is roughly 17 percent of the total water use in the South Coast Air Basin, the Los Angeles-San Diego complex. There is a need to replace that water. The Peripheral Canal is to provide a replacement for some of the water that was lost. There are also substantial opportunities for conservation and reclamation within the urban areas.

As far as Los Angeles is concerned, there are really two important elements: (1) the replacement of the water lost to Arizona and (2) reliability. Los Angeles does not need that much additional water from the north in an average year. What Los Angeles needs is protection against drought periods. It needs reliability in its water supply. Los Angeles has a tremendous economy and when suddenly its industries are cut back substantially it hurts the economy.

Q: During the recent drought, water supplies in southern California were not fully secure because water was not allowed to be imported from the north through the California Aqueduct. Why was this so if the State Water Project is supposed to increase water security?

A: During the drought, Los Angeles voluntarily, under pressure, gave up the water it normally imports from the north through the California Aqueduct. There were important political reasons for this. The drought was not as severe in Los Angeles as it was in northern California. The real problem was in northern California. Los Angeles was also not taking its total entitlement from the Colorado River, so Los Angeles could take less water from the north and more water from the Colorado River to replace it. The feeling in the legislature was that there ought to be a sharing of the shortage. Los Angeles wants to build projects like the Peripheral Canal and other water supply and conveyance facilities in northern California, so goodwill with the north is extremely important. Therefore, in its own interest, Los Angeles made the political decision that goodwill with the north was more important than getting the water from the California Aqueduct, which it had paid for, since it had the alternative of an increased supply from the Colorado River.

6.5 AGRICULTURE AND THE COLORADO RIVER

Donald A. Twogood

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The major users of Colorado River water for agriculture in California are the Palo Verde Irrigation District near Blythe, the Reservation Division of the Yuma Project in and around Winterhaven and Bard, the Imperial Irrigation District in the Imperial Valley and the Coachella Valley County Water District in the Coachella Valley. The Colorado River is the main, if not the only, source for these agricultural areas. In addition, minor irrigation use is derived from the supply diverted from the Colorado River by the Metropolitan Water District.

Today, the Imperial Irrigation District is the largest single diverter in the entire Colorado River system, annually diverting 2.9 million acre-feet of water from the River at Imperial Dam and delivering that water to farmers, cities and all others for it is the sole water source for the Imperial Valley. In some years over 600,000 acres of crops are grown on 450,000 net acres. Due to the heavy, silty soils and water salinity, field crops predominate -- cotton, sugar beets, over 150,000 acres of alfalfa, and wheat -- but because of the mild winters, vegetable crops such as lettuce, broccoli, asparagus, and carrots are grown during winter to supply a major portion of the country's needs at that time of year. Cattle fed lots provide Imperial County with its most significant gross revenue -- over 100 million dollars. Imperial County's agri-business had a gross value of over one-half billion dollars in 1978 -- about twenty crops each grossed over one million dollars.

Mr. Twogood presented the development of diversion and storage structures from the late 1800's to the present in the Lower Colorado River and discussed the ways in which the Imperial Irrigation District has improved its methods of drainage, water distribution and application. The earliest irrigation development on the Colorado River system took place in the upper basin as early as 1860, followed by irrigation in the Gila Basin tributary to the Colorado River around 1875. Shortly after 1877 the first diversion works were constructed along the mainstem in the lower basin in the Palo Verde area, followed by irrigation development in the Winterhaven-Bard area about 1884, and in 1901 Colorado River water was delivered to Imperial Valley by an unlined canal running through Mexico. These dates are significant because they establish relative priorities to Colorado River water among California agricultural users.

Palo Verde and Bard are adjacent to the river, their rights being primarily riparian, but Imperial's water right was developed from a series of individual filings in the 1890's. Notices were posted of the appropriation of 10,000 cfs from the river to be used on "New River Country." Subsequently, all of the individual filings were assigned to the California Development Company and finally to Imperial Irrigation District in 1916. Shortly after the formation of the District in 1911, efforts began toward planning for construction of an "All-American" Canal, since the Alamo Canal ran through Mexico for nearly fifty miles and gave the Valley little security in its water supply. After many years of struggle, initiated by Imperial Irrigation District but having support of all southern California, the Boulder Canyon Project Act was passed by Congress in 1928, authorizing Hoover Dam and the All-American Canal. Imperial Dam was completed by the Bureau of Reclamation in 1938.

The desilting works at Imperial Dam are unique and absolutely necessary to prevent the type of problem that led to the invention of the Ruth Dredge, not to mention the silt buildup on farm lands. From Imperial Dam, the All-American Canal, with a capacity of 15,000 cfs, follows the river for some 20 miles to the first check at Pilot Knob near Yuma. Here the District owns a hydroelectric power plant, which is operated when Mexican Treaty water is run through the Canal to be returned to the river. The All-American Canal from Imperial Dam to its terminus at the Westside Main Canal is about 80 miles long. It took six years to construct. The Coachella Branch was constructed later -- being completed in 1949. The water surface in the All-American Canal drops from about 180 feet above sea level at Imperial Dam to sea level near Calexico. This difference in water level has led to the construction of hydroelectric power plants at 3 of the 5 drop structures along the canal, to date.

Most of the District's agricultural lands lie below sea level, so nearly all deliveries are made by gravity, certainly a blessing in these days of increased energy costs.

From the East Highline Check, the All-American Canal drops for the last time at Drop 5, the site of the next hydro plant planned for completion in a few years. West of Calexico, the canal crosses the New River in a double-barrel, 15.5-foot diameter steel siphon.

Imperial Irrigation District operates and maintains over 1650 miles of canals and laterals and more than 5500 farm deliveries, and provides water service to the Valley's seven cities and towns. On the average, there is a lateral paralleling a county road every one-half mile.

The original canal and lateral system was unlined. Seepage losses from the canal system were not unusually great, but in this vast network, even 10 percent represents about 250,000 acre-feet of water loss. Therefore, in 1954, the District initiated a concrete lining program, and over 600 miles of laterals have been lined, to date. This year over $1.3 million will be spent collectively by the District and landowners in this cooperative program. The Imperial Irrigation District lines from 1/2 to 1-1/2 miles of laterals in four days -- partly by District forces, but mainly by contract. This has been the District's main conservation program, but not the only one. Instead of lining the East Highline Canal, the Imperial Irrigation District has installed seepage recover tile drain lines in several reaches and pumps return the salvaged water to the Canal.

The Imperial Irrigation District's most recent conservation program has been to construct regulating reservoirs -- to capture water rejected by water users -- as well as formerly operational spills. It now has two such reservoirs, one on the East Highline Canal and the other on the Westside Main Canal, each storing approximately 500 acre-feet and costing about $800,000 each. The District plans to construct many more, as time and money permit.

Water orders must be placed with the Bureau by the District Watermaster each Wednesday for the coming Monday through Sunday. It takes five days for water released from Hoover to reach Imperial Dam, where there is some off-stream storage, and six hours more to reach the East Highline. Finally, the last diversion in the system is made six days after release from Hoover. The District accepts orders one day in advance, but reserves the right to carry over for three days.

When talking about the Imperial Valley, drainage must be mentioned. In early years, the water table was 15 to 50 feet below ground, but in the early 1920's crop production declined and some land went out of production due to high ground water and increasing soil salinity. Realizing this, a 2.5 million-dollar bond issue was authorized by the people, and construction of open drains begun -- with landowners contributing $800 per mile, and the District paying costs over that amount. In 1929, the District began laying farm tile drains for farmers at their request and cost. It took several years to develop adequate methods and materials. Today, plastic tile is widely accepted as the best, with concrete tile used for collectors.

Today the District maintains a 1,400 mile drainage system serving an area of over 400,000 acres and containing subsurface tile drains aggregating over 24,000 miles in length. This system functions to remove four million tons of salt from the soil each year, resulting in the net removal of 1/2 million tons annually to maintain a favorable salt balance in the Valley. Drainage effluent -- ranging in quality between 2,000 and 15,000 mg/l -- is conveyed through the New and Alamo rivers to the Salton Sea, which functions as a repository for drainage waters from the Mexicali, Imperial, and Coachella valleys.

According to Mr. Twogood, farmers in the Lower Colorado Desert are among the best in the world. They know the value of their water right and have been steadily increasing their efforts to use this resource beneficially -- as required by the California Water Code.

In conclusion, both the agricultural water users and their public districts in the Colorado Desert are very aware of their responsibilities for efficient use of their water supply. The Imperial Irrigation District intends to continue, even accelerate, its efforts to improve methods of water distribution and application.

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6.6 METROPOLITAN WATER DISTRICT

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Mr. Kennedy began his review of current issues of interest to the Metropolitan Water District of Southern California (MWD) with two prefatory remarks. The first was that the views expressed in his talk were not necessarily those of the Metropolitan Water District or the municipal water districts it serves. The second was that the MWD does not operate solely for the County of Los Angeles. Within the MWD there are 126 cities in six counties. The MWD acts as a supplemental water supplier, supplying water to those cities and water districts that cannot get enough water from their own sources. The City of Los Angeles, the member city with the largest population, gets about 5 percent of its total water supply from the MWD. The City of Pasadena gets about 50 percent of its water from the MWD and the County of San Diego gets about 95 percent of its water from the MWD.

At present, there are two sources of supply for the MWD: the Colorado River Aqueduct, which the MWD owns and operates, and the California State Water Project, with which the MWD has a contract for slightly less than half of the state's total entitlement. By the mid-1980's, however, the MWD will lose 60 percent of its present Colorado River water supply to Arizona. The MWD will have to make up this loss from within the State of California -- thus its present interest in current California state water legislation.

One of the current bills that has caused much uproar in the state legislature, but which is desperately needed by the state, according to Mr. Kennedy, is SB 200. This is the authorization bill for the construction of the Peripheral Canal. It was thought that SB 200 would quickly be passed by the State Senate, but it has now been blocked by a coalition of southern California Republicans and northern Senators. When the Assembly met in January 1979, it decided to try to deal with many controversial water issues in one bill: overdraft in the San Joaquin Valley, fisheries problems, and new land development problems. The Assembly decided that comprehensive legislation was the best way to handle all these issues. There were eight hearings of the Assembly's water committee, and at present no new bill has been written by the committee.

One Assembly bill that is essentially in opposition to SB 200 is AB 442. One problem that is dealt with in AB 442 and not dealt with in SB 200 is that of statewide fisheries protection. However, according to Mr. Kennedy, the Peripheral Canal basically is a fisheries protection project. In fact, the strongest supporter for the Peripheral Canal has been the State Department of Fish and Game.

With respect to the San Joaquin Valley overdraft, Mr. Kennedy wondered whether it is such a critical problem that it must be solved immediately while the "Peripheral Canal is being held hostage."

In concluding, Mr. Kennedy emphasized that without the construction of the Peripheral Canal, every indication points to water shortages by the mid- to late 1980's.

QUESTIONS

Q: Why, in the planning of municipal water supply, must we plan to meet 100 percent of the expected demand? Why cannot municipal water supply planning be based on some degree of risk of shortage?

A: To some degree, municipal water systems do plan some risk. The days of planning for an absolute quantity of water are in the past. In all of the studies done by the Metropolitan Water District (MWD) the probability of supply and demand are both looked at. Unfortunately, supply and demand work at cross purposes; in years when supply is down, there is increased demand.

Q: Why did MWD support the Central Arizona Project, since the MWD knew it would lose 60 percent of its water supply?

A: The Metropolitan Water District fought the Central Arizona Project through the Supreme Court for 14 years and in Congress for four years. It tried every way possible to stop the project. Finally, federal and state officials encouraged the MWD to accept and support the Central Arizona Project, since in every court where the case was presented, it was decided in favor of the Central Arizona Project.

Q: Mr. Barnes indicated the possibility of building the Yellow Jacket Reservoir on the Eel River, while Mr. Macdonald indicated that the Wild and Scenic Rivers Act would be respected in regards to the Eel River. Where is the water going to come from to run through the Peripheral Canal?

A: The Peripheral Canal, through more efficient operation in the Delta, will conserve a minimum of 600,000 acre-feet, up to 1,000,000 acre-feet/year. Beyond that, more water sources in the Sacramento Valley will have to be developed. Some suggestions have been the enlargement of Shasta Lake and the building of Glenn Reservoir. The MWD does not support the development of the Eel River in the near future.

Q: Is the demand for MWD water responsive to pricing?

A: The demand is not very responsive to the District increasing prices. The MWD charges about $100 per acre-foot for municipal and industrial water. By the time the customer receives it, the water is about $200 per acre-foot.

There is a continuing debate within the MWD board of directors about water pricing. One issue is deciding how much should be collected from taxes versus how much from water sales revenues. Another issue is the relative pricing of the interruptible supply, the municipal and industrial supply, and agricultural supply. Some on the board believe all supplies should be priced at the same rate.

Q: By increasing the water supply to meet the increasing demand of a growing population, further population growth is encouraged with a resulting increase in vulnerability during droughts and shortages. Water companies are in the same position as the electric utilities during the post-Arab oil embargo era, in which it became clear that there were other ways in which to deal with people's electric needs than by continually expanding supply. Could you comment on this, please?

A: There is a strong argument that the urban areas in southern California have reached the point where water is not the limiting factor for population growth. The present population in southern California is 11 million, with a growth of 100,000 people per year; meanwhile MWD is going to lose over 600,000 acre-feet per year to Arizona. Under the current state water system, whether the population growth rate continues in southern California or decreases, within 10 years we will be faced with the problem of not having enough water.

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6.7 WATER AND ELECTRIC UTILITIES

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Mr. Drake's presentation began with a series of slides illustrating the different kinds of cooling systems used in electric power generation that are consumptive users of water. For each type of system, he indicated the average amount of water consumed. He then summarized some of the major constraints on the siting of power generating facilities, both within the State of California and outside the state.

Power Plant Cooling Systems and Water Consumption

The three most commonly used power generating cooling systems are: (1) once-through cooling, which in California has involved mostly Pacific Ocean waters; (2) recirculating cooling ponds; and (3) recirculating evaporative cooling towers. The last two are commonly used inland where water supplies are limited. In addition, two new systems are dry cooling towers and wet/dry cooling towers.

The use of once-through cooling with ocean water involves no consumption of high quality water. The Salton Sea, Colorado River, and Colorado River aqueduct have been suggested as sources of once-through cooling water. However, Mr. Drakes sees insurmountable legal and institutional roadblocks to the use of these for once-through cooling. Furthermore, use of the Colorado River for once-through cooling would involve some consumption of the water, although only about one-third of that used for an equivalent evaporative cooling tower.

The amount of water consumed by evaporative cooling towers is dependent on four factors: (1) plant type; (2) plant efficiency, related to the amount of heat transfer from the plant to the environment; (3) plant capacity factor, the average plant loading during the year; and (4) the quality of water used for cooling -- the higher the salinity of the cooling water the more consumptive use.

Mr. Drake illustrated the effect of the type of power plant on the average water consumed, assuming fresh water as the cooling medium, a plant capacity of 1,000,000 kilowatts, and a plant capacity factor of 75 percent. The usage was as follows:

gas turbine	2,700 acre-feet/year
combined cycle	9,000 acre-feet/year
oil, gas, and nuclear	15,000 to 20,000 acre-feet/year
geothermal	75,000 acre-feet/year

Water sources that are being used for cooling in cooling towers include fresh water, agricultural drainage water, reclaimed sewage effluent and brackish ground water.

Power Plant Siting Constraints

The state and federal governments have placed constraints on the use and disposal of power plant cooling water. The Federal Clean Water Act of 1977 and Sections 316(a) and 316(b) of the Federal Water Pollution Control Act Amendments of 1972, as administered by the United States Environmental Protection Agency, place constraints on the intake and discharge of cooling water and the resulting environmental impact. The State Ocean and Thermal Plans also address thermal and chemical discharges into the ocean. While it is possible to engineer plants to meet the regulations specified in the plan, increased costs are involved due to the use of long diffuser-type discharge systems in order to meet the thermal criteria. In mid-1975, the State Water Resource Control Board adopted water control use and disposal regulations for inland water used for power plant cooling.

There are, according to Mr. Drake, more severe constraints to power plant siting than those related to cooling water use. One such constraint put on power plants by the Fuel Use Act of 1978 restricts the use of oil or natural gas to a maximum of 1,500 hours per year, and thus forces more emphasis on coal or nuclear power generation. The stricter air quality regulations in California make it extremely difficult, if not impossible, to site a coal-fired power plant in California, even in the desert. Both emission limitations and ambient air quality standards must be met. The latter lead to the kind of emission off-set problems that the SOHIO project faced. Furthermore, the uncertainty of the constitutionality of state laws dealing with the certification of nuclear power plants makes the construction of any new nuclear power facility in this state imprudent.

With regards to other siting restrictions, the California Coastal Commission restricts power plant siting on 75 percent of the coastline, while the remaining 25 percent of the coastline is not suitable due to land use or terrain problems. In addition, the Bureau of Land Management has designated 138 parcels of desert land, covering 5.5 million acres, as Wilderness Study Areas, restricting not only the siting of power plant facilities in the desert, but also restricting the siting of transmission corridors from a power facility. A similar situation exists with regards to the United States Forest Service and hydropower projects in forest areas.

Currently, 40 percent of California's power is imported from facilities in neighboring states -- Nevada, Arizona and New Mexico. These states are attempting to stop the exportation of water in the form of electric power from their states to California. Thus, out-of-state power generation, in the opinion of Mr. Drake, is not going to be as viable an alternative in the future as it has been in the past.

Currently, fresh water consumption in California due to power plant cooling is only one-tenth of 1 percent of the available water.

Southern California Edison estimates that electrical demand will double by the year 2000. If by then all plants use evaporative cooling towers that consume fresh water, power generation would consume about 2 percent of the then available water supply. Mr. Drake believes that some fresh water will have to be used in the future to meet the increasing demands for electricity. Poorer quality water could be used when economically and technically feasible to do so and if it is available. The problem with the use of sewage effluent is that the large sewage treatment plants are located close to urban areas with burdened air sheds, where power plants are restricted.

Mr. Drake summarized by stating that water is only one of the problems with which Southern California Edison must contend in order to meet further electrical energy demand.

QUESTIONS

Q: The dry cooling tower now being completed in Wyoming does not use any water. What penalty will be incurred in operating it?

A: I can only give you a rough estimate. First, the turbines are designed to operate at a higher than normal back pressure. The turbines can operate as high as 15 inches of back pressure, whereas normal commercial steam turbines can operate at a maximum back pressure of only five inches. When operating at a higher back pressure, however, there is a less efficient steam cycle.

I am unable to give you the economics of the plant. It was designed by Stone and Webster. Studies done by Southern California Edison (SCE) for the desert areas of California indicate that the differential capital cost, in 1979 dollars, for a completely dry-type system, with a generation capacity of 1 million kilowatts, would run about $100,000,000 over that for evaporative cooling towers.

Q: Has Southern California Edison done any studies on using brackish ground water for cooling?

A: Yes, we have done studies and it certainly is feasible.

Q: Do you think that SCE will be able to buy fresh water for new plants where it is needed.

A: Let me give a real example, one in which the company is now involved. Southern California Edison is currently in litigation with the Mojave Water Agency (MWA). SCE feels the company has a valid and binding contract with the water agency for around 30,000 acre-feet of water to use for a new combined cycle plant, an efficient user of water. Assuming the California Energy Commission finds the site suitable, we would use about 13,000 acre-feet of water. The contract was approved by a previous MWA board, but the present board wants to break the contract because they believe all their water will be needed for future growth in the Lucerne Valley.

Q: The differential capital cost for a 1 million kilowatt dry-type system, as you stated earlier, would be $100,000,000 over that for an evaporative cooling tower. Without considering discount rates, this means make-up water for an equivalently expensive evaporative cooling system would have to cost $130 per acre-foot. Does it make sense to invest the capital for the dry-type towers when the cost for make-up water is far less than $130 per acre-foot?

A: The annual carrying charge on a $100 million investment would be about $21 to $22 million per year. A crude calculation for a 1,000 megawatt coal generating plant using 15,000 acre-feet of water per year would be $1,300 per acre-foot. Thus the cost of water for an evaporative cooling tower system would have to approach $1,000 per acre-foot before a dry-type cooling tower would be economically warranted. This is a question that often comes up -- should water seek and find its highest and best use from an economic standpoint?

Q: When are the lights going to dim?

A: With the lack of siting approval for new power generating plants in this state, and the 10 to 14 years of lead time for coal and nuclear plants, something must be done quickly or there will be severe energy shortages in the mid-1980s.

The consequences of decisions, not only from an environmental standpoint, but also from an industrial and economic standpoint, are so far reaching and long in the future that those responsible for the decisions will not have to be accountable for them when problems due to them arise in the future. "When you divorce decision making from the resposibility for the accountability of the decisions, that is, when you are no longer in a regulatory agency or no longer in power in office, this spells trouble and expedience."

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6.8 ENGINEERING FOR ENERGY & WATER

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Mr. Terrell began his talk by stating that Bechtel's interest in EQL and the water conference was one of furthering the opportunity to expose, discuss, and resolve western water issues. Although Bechtel has "no axe to grind" in the resolution of issues, it does have a sincere interest in them in that there is hardly a single western project in which Bechtel is involved that is not affected, to a greater or lesser extent, by water and its availability in quantity and quality.

Engineer's Role and Concerns

In assisting a broad cross-section of clients with diverse projects and purposes, the engineer's role is to meet the test of economic feasibility and the test of environmental acceptability. When these two tests are met, water development projects provide us with the best that nature and man have to offer in the utilization of a renewable resource.

The planning process is one of the important steps in any project. There are certain engineering basics involved in planning that do not change. The engineer must have a valid data base upon which to build; this includes an inventory of resources and an identification of the demands upon those resources. The socio-political process enters the planning through deciding priorities of use and of implementation when the inventory is mated with the demands.

Mr. Terrell noted that in preparing for this talk, he came across Bulletin No. 4 of the State of California, Department of Public Works entitled "Water Resources of California, A Report to the Legislature of 1923." In this document, the resource inventory is presented, beneficial uses are identified and recommendations are made to the political process for further action. Fifty-six years later Bulletin 160-74, "The California Water Plan, Outlook in 1974" also introduced water issues, but of a much broader impact than those discussed in 1923. Fundamentals stay the same; the balance of socio-economic factors change with time.

Clients' Concerns

Clients, whether private or public, expect a consistency in certain basic parameters when a water project is formulated. Obviously the major concern is with the availability of water. Development of a hydro-project commonly takes many years and the completed project is expected to serve for 30 to 50 more years. Heavy investments are made and the economic viability of the project affects the community for years to come. Like other prudent men, water resource development investors do not want to face surprises. The vagaries of nature and the uncertainties of construction combine to provide more than enough risk to make hydro work challenging without imposing policy uncertainties.

Engineers' Perspective on the Issues

Engineers participating in water resource development projects, particularly at the planning levels, are proxy users of water. The thinking process becomes that of the water user, and the development of project concepts becomes one of fitting the project to constraints of water availability, water policy, and industry norms as well as to the constraints of geology, topography, and environment.

In this context, Mr. Terrell referred to the statement on water policy adopted in March 1979 by the California State Council of the

American Society of Civil Engineers (ASCE). In short, the statement reflects engineers' commitments to the philosophy that water supplies be developed with input from the entire community with recognition of all interests and beneficial uses. These include those whose economics are difficult to quantify such as aesthetics, fish, wildlife, air quality, and public interest goals in general. The ASCE Statement also refers to the possibility that preferred projects may not be those that have the least cost or highest benefit/cost ratio. Mr. Terrell commented that it was important to realize that the costs and benefits referred to here are the conventional ones, which are familiar and quantifiable.

Today, engineers routinely include in projects measures to mitigate the impacts of the projects and to enhance the environment. They can evaluate the costs of environmental enhancement and mitigation of project impacts, but they do not have a basis for quantifying the benefits. Engineers need assistance from others involved in water projects in arriving at universally acceptable means of evaluating the benefits of such features.

Water Issues and Project Concepts

The first issue discussed was the case of hydroelectric power plants. Although hydropower utilizes a renewable resource, the development of any specific site can be more or less efficient in terms of harnessing the potential energy of the watershed. However, efficient harnessing may be in competition with other uses such as recreation, fish and wildlife, and aesthetically pleasing streamflows. The trade-offs between energy development and these other uses are difficult to evaluate in objective terms, and the subjective evaluations become quite tortuous and intermixed with many aspects of the general subject of "in the public interest." Some of the economic and environmental benefits of hydropower are related to the economic and environmental impacts of alternative thermal power generation. These are: balance of payment problems, air pollution, transportation requirements, oil spills, strip mining, tailings disposal, and radioactive waste disposal. These elements must be balanced against the hydro project impacts, which may typically include: exchange of white water for flat water, reduced and leveled streamflows in natural channels, habitat changes, and scenic changes. Certainly, the choice is not easy to make and gaining compromises requires informational programs that are themselves subject to the pushes and pulls of special interest groups.

In hydropower, furthermore, it is possible to store energy above that which is inherent in the watershed. For example, pumped-storage is a process whereby energy is taken from base-loaded thermal stations during periods of off-peak demand and used to pump water to a high elevation. Such high storage represents potential energy which can be recovered when needed to meet demand peaks by releasing it through a hydroelectric powerhouse. This is one form of the recycling concept in the use of water.

The second issue briefly looked at was thermal power plant developments. Mr. Terrell includes all sorts of fossil fuel-burning and nuclear power in this category. Cooling water needs of these plants are a major issue. Coastal siting constraints have virtually removed the opportunity for the once-through cooling of thermal power plants using ocean water. Thus thermal power plants have to rely on cooling towers. Cooling water losses to evaporation, drift, and blowdown will average about 18,000 acre-feet per year for fossil fuel plants and about 24,300 acre-feet per year for nuclear plants per 1,000 megawatts of installed capacity.

Cooling water requirements are an obvious target for application of recycled water. At present fossil-fired plants at Las Vegas and Burbank and a nuclear power plant soon to be operating near Phoenix will depend on the effluent of second-stage sewage treatment plants for cooling water. Use of this water for cooling benefits society by (1) releasing higher quality water for other uses, and (2) concentrating the effluent so that ultimate disposal is efficient.

The third issue involves the use of water in mining development projects. Water is required from extraction to concentration and purification of the metals mined. Typically, water is reused many times.

Slurry pipelines have become a consideration in the transport of vast amounts of coal, due to their economic feasibility. Depending on the commodity moved, slurry pipelines require from 70 to 125 gallon of water per ton of material. When the slurry arrives at its destination, the water is removed and is available, depending on water quality, for recycling as process water, cooling water, or returned to the source for slurry make-up water.

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6.9 ENERGY DEVELOPMENT IN THE WEST AND WATER USE

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The nation's energy resources that are most suitable for expansion are located in the water deficient west. The nation's major oil-shale reserves, which are equivalent to 418 billion barrels of oil, and strippable coal reserves, which are equal to 103 billion tons out of the nation's total 137 billion tons, lie west of the Mississippi River almost entirely in the Colorado River and Upper Missouri River basins. Interest in these western coal reserves has arisen due to their low sulfur content and the thick coal seams having a minimum amount of overburden.

National energy planning is bogged down in the conflicting water laws of various states. The conflict between water for energy and agriculture is exacerbated by the fact that the economic value of water in industrial use is commonly 10 to 100 times greater than the value of water for agricultural use.

Generally speaking, water is deficient west of the 100th meridian, where water consumption for energy production is great. Consumption, as defined by Mr. Davis, is the permanent removal of water from the naturally circulating terrestrial system by return to the atmosphere as evaporation or transpiration, by placing the water in permanent subsurface storage in rocks, or by altering its structure and incorporating it into some other substance.

Geothermal electric generation is the most water consumptive form of energy production. Nuclear power generation is the next highest consumptive water use, due to reduced efficiency dictated by safety precautions. Coal gasification, coal liquefacation, oil-shale retorting, uranium fuel processing and oil refining are significantly less water consumptive than geothermal and nuclear power.

A major energy consumptive water use includes the chemical processes that use water as a source of hydrogen to raise the hydrogen content of the product stream. High Btu coal gasification, coal gasification, coal liquefacation, in situ shale extraction and petroleum refining consume water for this purpose. This use is essentially irreducible. On the other hand, reductions in consumptive use can be made for such things as dust control, revegetation of mines, and ash disposal when water costs are high or where water supplies are restricted.

Coal-slurry lines can be thought of as another type of water consumptive use. Finely ground coal is mixed with water and pumped through pipelines. At its destination, the coal is separated from the water and this water is used in fuel or chemical processing or is discharged. Relatively little water is consumed in such a system. However, the area of the origin of the pipeline may be deficient in water and, therefore, there may be strong public opinion against the transport. Exportation of electricity out of this same area, according to Mr. Davis, may not meet with the same public opposition even though an on site-electric power generation plant requires six to eight times more water than the exportation of an "energy equivalent" amount of coal through slurry lines

The increased water demands for energy development will have a negative impact on agricultural communities. With the increased value of water, irrigated agriculture may have problems paying the increased "real" price of irrigation water considering its low value in crop production.

The cost of pumping irrigation water becomes critical when looking at irrigation water costs. Whittlesey and Gibbs (1978) pointed out that with an increase in irrigation in the Columbia basin, the energy needed to pump and distribute the new irrigation water may result in a cost of $65 to $100 per acre-foot. Beattie and others (1978) have found that in the high plains of Texas, an increase of $3 per 1,000 cubic feet of natural gas would force the farmers in the area to return to dry farming, because they would be unable to afford the price of water.

On the other hand, large energy developers appear to be more than willing and able to pay the high cost of water. Rio Blanco Oil Shale Company has an option to purchase industrial water rights from the White River in Colorado for $100 per acre-foot. However, this high cost for water would increase the oil-shale product cost by only one cent per barrel.

Mr. Davis noted that, as the water pricing stands today, western irrigated agriculture is not expected to expand further when in competition with energy development due to the fact that energy developers are ready, willing and able to pay the real economic value of water.

The development of oil-shale reserves has been slowed due to the fact that the costs of processing the product, while meeting environmental standards, exceeds the price of foreign imported oil. In addition to this, investment risks are high. To encourage oil-shale development, in light of reduced Iranian oil supplies, negative results in offshore exploratory drilling, and a worsening balance of payments, it has been proposed that the government give about $3 per barrel tax credit to the producers. If oil-shale development becomes economically feasible, the issues of water economy will have to be dealt with between energy development and agriculture.

There are currently two federal prototype oil-shale leases in Colorado, each of about 5,000 acres. It is estimated that by 1987, using in situ extraction, the projects will have top productions of between 57,000 and 76,000 barrels of oil per day.

Gulf and Standard Oil of India, holders of one of the federal leases, expect the initial ten years to be a modular development period and the next 30 years a period of full-scale, in situ operation, in which 80 percent of the ore is retorted in place and 20 percent of the ore is taken to a surface plant for processing. For the commercial scale in situ retorts, a prism of oil shale 100 ft x 300 ft x 700 ft is rubblized and ignited from the top. As the flame front proceeds from top to the bottom of the rubble, the heat generated retorts the hydrocarbon content of the ore. Hydrocarbon gases and liquid are recovered from the base of the chamber. The flame front is regulated by air and steam injection. The steam injection plays an important additional role in the extraction as it produces a higher Btu gas product than air injection alone. The by-products of the retorting are sulfur and gas. The gas by-product is used to supply 86 percent of the energy requirement of the project, which employes gas turbines. The hot air from the gas turbines will be used to produce steam for injection.

According to Mr. Davis, conventional surface extraction of oil-shale requires much more water than modified in situ extraction. Based on a production of 100,000 barrels of oil per day, 12,000 to 18,000 acre-feet per year of water are estimated to be needed by the conventional process. This represents a processed oil-to-water ratio of 1:3. Half of the water supply needed is for surface disposal of spent shale. In contrast, with use of the modified in situ extraction process, the ratio of oil produced to water used approaches 1:1. Furthermore, the water extracted from the subsurface for dewatering the in situ retorts prior to the combustion of oil-shale is more than enough to satisfy the consumptive water demands of the process during operations. The excess water will be reinjected into aquifers off-site.

In concluding his presentation, Mr. Davis stated that the National Energy Policy calls for reducing present dependence on imported oil and declining domestic natural gas supplies by replacing them, when possible, with alternative, plentiful domestic energy sources. This policy, which is to be met without significant degradation of the environment, places emphasis on the utilization of strippable low-sulfur coal, uranium, and oil-shale, which are all abundant in the west. However, water is required for the development of these resources.

The amount of water used in uranium production is small, when the concentrate is exported out of the area for further processing. Conflict has arisen, however, over the disposal of the radioactively contaminated process water. The problem is dealt with by sending the radioactive waste water to evaporative ponds to avoid stream and ground water pollution; however, evaporation of the water represents a consumptive waste.

The development of the large, low-sulfur coal resources for export from the west would require less water for production than on-site methodology. The siting of the energy plants in the west commonly is a compromise between proximity to the power market, environmental acceptability, proximity to cooling water, and location convenient to a coal source.

Most of the large western power generating plants were in operation or committed prior to 1973. Since that time, few new energy projects have been started due to the flattening of the power-demand curve and the uncertainty of the availability of water and federal environmental regulations. The safer course of action has been to enlarge existing plants and rely on rail transport of coal

QUESTIONS

Q: Is there any evidence to indicate that the low-sulfur western coal is lower in Btu value than the eastern coal?

A: Yes, Wyoming coal averages about 8,000 Btu per pound, whereas the high quality eastern coal is 12,000 Btu per pound. However, the sulfur-content-to-Btu ratio is generally lower for the western coal than eastern coal.

Q: What do you know about the Carter Administration trying to encourage the power industry to convert back to natural gas and even making it possible to buy directly from the pipeline?

A: There is a declining supply of natural gas over the long term, so I think that we should be reserving it for future more efficient use, like space heating. But for the short-term, when there is an imported oil crisis, there is a potential for quick switching of petroleum plants to natural gas.

Q: What is your assessment of the water needs for surface rehabilitation of strip mines or oil shale areas?

A: Present strip mine regulations, 1978, provide for only about one year of irrigation -- nothing long term. This amounts to a very small amount of water since you are dealing with only a few hundred acres of land a year.

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6.10 ENERGY DEVELOPMENT IN THE UPPER COLORADO RIVER BASIN AND WATER USE

J. William McDonald

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Mr. McDonald presented some preliminary results from a study concerning the availability of water for potential oil-shale and coal gasification facilities in the Upper Colorado River Basin (see references). The study is one of the Section 13(a) assessments of water availability for non-nuclear, emerging energy technologies required by the legislation that established the Energy Research and Development Administration (ERDA, now part of the Department of Energy, DOE) and was funded by a DOE pass-through of funds to the U.S. Water Resources Council. In his talk, Mr. McDonald defined present water uses and possible future levels of water demand for a variety of energy development scenarios in the Upper Colorado River Basin, and discussed water availability in the Basin.

There have been a number of previous efforts devoted to the same issues in the same geographic area. The present study has tried to build upon these but has gone a step further with respect to (1) clarifying the framework for defining water availability; (2) taking into account, in the study's hydrologic modeling, the ownership of water rights and the administration of state water rights systems; and (3) applying what Mr. McDonald considers the most complete mathematical simulation model available for the Colorado River. (The model is the U.S. Bureau of Reclamation's Colorado River Simulation System Model, the CRSS Model.)

A Brief Sketch of the Upper Colorado River Basin and its Energy Resources

The Upper Colorado River Basin refers to the area drained by the river and its tributaries above Lee Ferry, which is the dividing point on the mainstem between the Lower and Upper basins.* The basin is divided into three sub-basins, each drained by a different river: the Green River originating in Wyoming and flowing south through Utah, the Upper Colorado Mainstem River originating in the mountains of Colorado and flowing through Colorado and Utah, and the San Juan River arising in the mountains of Colorado and New Mexico and flowing directly into Lake Powell. There are in this system five major reservoirs that are important in mainstem regulation.

Coal is broadly distributed throughout the Basin. Oil shale resources are, however, located mainly in the White River Basin (a tributary of the Green River) within the states of Colorado and Utah, in the Upper Colorado Mainstem within the State of Colorado, and, to some extent, in the Green River Basin within the State of Wyoming.

Present and Future Water Demands

To summarize the present (1976) level of development in the Upper Basin, approximately 2/3 of average annual consumption is attributable to irrigated agriculture. The second largest consumer is trans-mountain exports out the basin, with the balance of the water consumption going to municipal and industrial activies such as thermal electric generation.

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*Lee Ferry is the official dividing point on the Colorado River between the Upper and Lower Basins as designated in the Colorado River Compact of 1922. It is located one mile downstream from the mouth of the Paria River. Lees Ferry is a village located at the confluence of the Paria River with the Colorado River and is also the location of the United States Geologic Survey's gaging station for that reach of the Colorado River.

With respect to future oil shale and coal gasification developments, referred to collectively as emerging energy technology (EET) developments, water demand projections were based on two development scenarios provided by the U.S. Department of Energy: A Baseline Case and an Accelerated Synfuel Case, Table 6.10-1. Both projections were to the year 2000. Beyond the end of the century, this level of industrial activity may occur, but capital constraints, technological uncertainties, etc., suggest to Mr. McDonald that this level of development is not apt to happen until after the turn of the century.* Seventy to 80 percent of the oil shale industry in both of these projections is assumed to be sited in the White River Basin in the states of Colorado and Utah, and 70 to 80 percent of the postulated coal gasification industry is assumed to be sited in the San Juan River Basin in the states of Colorado and New Mexico.

Mr. McDonald emphasized that there are large ranges of uncertainty associated with the potential water consumption of these industries. Estimates of water consumption for a unit-sized plant vary by a factor of two or three. Literature estimates of water consumption for oil-shale retorting facilities range from about 2,500 to 9,000 acre-feet/yr per unit-sized plant (i.e., one producing 50,000 barrels per day). The lower figure represents modified in situ technology, while the higher figure represents surface retort technology. For the purpose of this study, the figure of 5,700 acre-feet of consumption per year per 50,000 barrels per day plant was used. With respect to coal gasification, the literature tends to range between 5,000 to 12,000 acre-feet per year per unit-sized plant (i.e., one producing 250 million standard cubic feet per day). For the study, a figure of 7,500 acre-feet per year was used.

Both numbers used are net consumptive use; that takes into account the moisture content of the coal, which can be utilized in the process,

*By the same token, the events of July and August 1979, suggest just how unclear one's crystal ball can be [the speaker].

TABLE 6.10-1

POSTULATED EET DEVELOPMENT, YEAR 2000

EET Projection	Sub-basin	Oil Shale (1,000 bbl/day)	Coal Gasification (MMSCF/DAY)
Baseline Case	Green, Wyo.	25	250
	White, Colo.	625	0
	White, Utah	450	0
	UMS, Colo.	200	0
	San Juan, Colo.	0	375
	San Juan, N. Mex.	0	1,410
	TOTAL	1,300	2,035
Accelerated Synfuel Case	Green, Wyo.	140	250
	Yampa, Colo.	0	250
	White, Colo.	1,200	0
	White, Utah	600	0
	UMS, Colo.	500	250
	San Juan, Colo.	0	340
	San Juan, N. Mex.	0	1,410
	Green, Utah	0	250
	TOTAL	2,440	2,750

Source: U.S. Department of Energy (1978), with additional assumptions made as to the siting pattern.

and a similar water content in oil shale. In terms of water consumption by the year 2000, the Baseline Case would have 148,000 acre-feet/yr of water consumed by oil shale facilities and 69,000 acre-feet/yr for coal gasification for total annual average water consumption of 217,000 acre-feet/yr. The Accelerated Synfuel Case would have 278,000 acre-feet/yr consumed by oil shale processing and 96,000 acre-feet/yr by coal gasification for a total annual average water consumption of 374,000 acre-feet/yr.

Table 6.10-2 presents projections to the year 2000 for non-EET uses, (i.e., uses other than coal gasification and oil shale processing). The labeling convention used is as follows: LWO (low without) are projections for low levels of future development without the existence of the emerging energy technologies. Similarly, MWO (medium without) represents a medium level of development without EET, and HWO (high without) represents a high level of development without EET. Agriculture will continue to dominate and will expand substantially. Transbasin exports will increase by 30 to 60 percent over present levels of development and will continue to account for about 25 percent of total depletions in the year 2000. It should be noted that even though thermal electric use will more than triple, even in the LWO scenario, it will still remain in third place, far behind exports.

Table 6.10-3 combines projected water depletions due to the postulated development of the emerging energy technologies with the projected water depletions of non-EET uses (from Table 6.10-2). In considering the depletions due to EET development, depletions due to associated spin-off growth must be considered. Spin-off growth refers to such items as the additional thermal power generation capacity required to serve the EET industry, the additional coal mining that would be attributable to coal gasification, and the population growth that would be prompted by the industry. As the table shows, consumption of water by the associated spin-off growth would not be inconsequential, it

TABLE 6.10-2

PROJECTED AVERAGE ANNUAL DEPLETIONS[1]
FOR NON-EET USES
UNDER YEAR 2000 CONDITIONS OF DEVELOPMENT

(In Thousand Acre-Feet)

Scenario	Thermal Elec.	Ag.	Fish, WL., & Rec.	Min.	M & I	Exp.	Total
Present	74	2,145	33	55	45	764	3,116
LWO	256	2,548	66	98	67	1,064	4,099
MWO	311	2,736	74	115	97	1,149	4,482
HWO	359	2,895	79	124	117	1,209	4,783

1. Exclusive of evaporation from Fontenelle, Flaming Gorge, Blue Mesa, Morrow Point, Crystal, Navajo, and Lake Powell Reservoirs.

Source: State Data (1978).

TABLE 6.10-3

AVERAGE ANNUAL DEPLETIONS[1]
UNDER YEAR 2000 CONDITIONS OF DEVELOPMENT
FOR ALL SCENARIOS

(In Thousand Acre-Feet)

Scenario[2]	Non-EET Uses	EET	Growth Associated With EET	Total
Present	3,116	---	--	3,116
LWO	4,099	---	--	4,099
LWB	4,099	217	35	4,351
LWA	4,099	374	68	4,541
MWO	4,482	---	--	4,482
MWB	4,482	217	35	4,734
MWA	4,482	374	68	4,924
HWO	4,783	---	--	4,783
HWB	4,783	217	35	5,035
HWA	4,783	374	68	5,225

1. Exclusive of Evaporation from Fontenelle, Flaming Gorge, Blue Mesa, Morrow Point, Crystal, Navajo, and Lake Powell reservoirs.

2. LWO, MWO, and HWO represent the low, medium, and high "without EET" scenarios, respectively.

   LWB, MWB, and HWB represent the low, medium, and high "with Baseline Case" EET scenarios, respectively.

   LWA, MWA, and HWA represent the low, medium, and high "with accelerated Synfuel Case" EET scenarios, respectively.

being estimated to run roughly 15 to 20 percent of the demands of the industry itself.

Water depletions attributable to EET's and the associated growth would account for about 5 to 10 percent of total year 2000 depletions, depending on the scenario.

Defining Water Availability

With the above assumptions in hand, how does one go about determining whether water is available for the postulated levels of oil-shale and coal gasification development and, what does one mean by availability?

Mr. McDonald suggested that there are three different ways to define availability: (1) in terms of the water rights systems of each state; (2) in the sense that no other potential consumptive use will be foregone; and (3) in a broader institutional sense. Mr. McDonald briefly explained availability in each of these senses.

DEFINITION 1. In terms of the water rights system and the ownership and exercise of water rights in each state, in conjunction with the laws and instruments that affect the allocation of water, as between the seven states of the Colorado River System and as between the U.S. and Mexico.

Oil-shale companies already own, in Colorado, numerous surface water rights. The most senior of these rights dates back to 1949 and is owned by Union Oil. Some of these rights may be too junior to yield reliabile water supplies. However, it is clear that the oil-shale industry owns sufficient rights to support a sizable water supply system. It is important to note, however, that new reservoirs will have to be constructed in order to develop surface water supplies.

In addition to the ownership of original appropriations, under the water rights system of each of the Upper Basin states, transfers of water rights from a willing seller to a willing buyer are possible, thus creating a market system (albeit a crude one) for the allocation of this scarce resource. Since the marginal value of an acre-foot of water in irrigated agriculture is one or two orders of magnitude less than the marginal value of water in an energy use, it is the opinion of Mr. McDonald that if there were no other considerations in a "who gets the water" issue, the marketplace would reallocate water out of irrigated agriculture. To date, however, purchases of water rights from irrigated agriculture by oil-shale companies in Colorado are estimated to only about 1 percent of the water consumed by irrigated agriculture on an annual average basis in western Colorado. Furthermore, most all of the water is being leased back to the farmers to present.

Finally, water that is being stored behind existing U.S. Bureau of Reclamation reservoirs is for sale (e.g., Flaming Gorge, Fontenelle, Blue Mesa, Reudi, and Navajo reservoirs).

In short, from the point of view of the first definition, water is available for EET development with essentially no constraints at all on the amount involved.

DEFINITION 2. In the sense that no other potential consumptive use will be foregone.

This definition is important because of the historical posture of the western states in support of irrigated agriculture. If there were no particular importance associated with irrigated agriculture in an economic and social context, there would be no perception of a scarcity of water supplies in the Upper Colorado River Basin, or for that matter, in the Lower Colorado River Basin. But given social, cultural and economic preferences over the years, there is now that perception.

To illustrate some of the issues, Mr. McDonald presented some preliminary results of the hydrologic modeling being done for the study.

In the Upper Basin, the most critical area is expected to be in the White River Basin and, perhaps, the Colorado Mainstem River Basin in the state of Colorado. This is because oil shale reserves are concentrated in these two basins, but the yield of the White River is relatively small. A number of unresolved questions have arisen concerning the trade-off of using the White River as a source of supply versus the Colorado Mainstem River as a source of supply. Within the White River Basin, there are a number of unresolved questions about the potential of using ground water due to its generally poor quality.

With respect to coal gasification facilities, the major conclusion is that these facilities could be located nearly anywhere in the Upper Basin. The coal gasification industry would have a relatively small demand even at the very high production levels projected and thus it would make little difference in what river basin(s) they are located.

In order to predict the effect on the Lower Basin for a given level of development in the Upper Basin, three key inputs are required for hydrologic modeling: (1) an assumption as to the future virgin flow of the Colorado River; (2) interpretation of the Colorado River Compact; and (3) operating criteria for the mainstem reservoirs (CRSP Reservoirs). With respect to the first item, Mr. McDonald observed that for this study, modeling was based on the historic period of record from 1906 to 1974, so that the average annual estimated virgin flow at Lee Ferry was 15.2 million acre-feet. He also stated that there was a great deal of uncertainty associated with this kind of study since, when a model is run on historic data, the period of record chosen is critical in determining average condition. For example, if the period of record from 1930 through 1974 had been used, there would have been 1.4 million acre-feet less in average annual virgin flows at Lee Ferry. With respect to the third item, continued application of the existing operating criteria for the mainstem Colorado River storage reservoirs was assumed.

The projected effects of the energy development scenarios on the flow of the Colorado River below Lake Powell in the year 2000 are shown in Table 6.10-4. As one would anticipate, the expected flow* decreases as one goes from present levels of development through the HWA scenario, which projects a high level of non-EET development coupled with accelerated synfuel development. The same table also shows that as consumption in the Upper Basin increases, the probability that the flow would exceed 8.23 million acre-feet/yr becomes increasingly smaller. Thus, for the HWA scenario, there is a 40 percent chance that the flow at Lees Ferry will exceed 8.23 million acre-feet/yr. (The reason for the 8.23 million acre-feet/yr figure is because the existing operating criteria call for an "objective" of maintaining a minimum release of 8.23 million acre-feet/yr from Lake Powell.) It should be noted that if one used the period of record from 1930 through 1974, with about 1.4 million acre-feet less annual inflows, it is estimated that the probability that the flow would exceed 8.23 million acre-feet/yr would, in each instance, probably decrease by 20 to 25 percentage points. In other words, for the HWA scenario the probability that the flow would exceed 8.23 million acre-feet/yr would be only 15 to 20 percent.

The effect of this decrease in the amount of water released from Lake Powell on deliveries of water to the Central Arizona Project (CAP) and the Metropolitan Water District (MWD) in the Lower Basin, in the year 2000, are shown in Table 6.10-5. As Upper Basin depletions increase (depletions that represent use of the Upper Division state's Compact entitlements), the amount of water supplied to these two projects decreases, but the MWD delivery remains well above the minimum allowable 550,000 acre-feet/yr.

With respect to the second definition of water availability, Mr. McDonald has tentatively arrived at two conclusions from this study. The first relates to the Upper Basin as a whole. It appears that the entitlement of the Upper Basin is sufficient to support even

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*"Expected" is used here in the statistical sense of the sample mean.

TABLE 6.10-4

ESTIMATED FLOWS AT LEES FERRY, ARIZONA,
IN THE YEAR 2000

Scenario	Expected Flow (KAF)	Probability Flow Will Exceed 8.23 MAF[1]
Present	11,190	90%
LWO	10,350	70%
LWB	10,120	60%
MWO	10,000	60%
MWA	9,620	50%
HWO	9,730	50%
HWA	9,300	40%

1. Assumes continued application of existing operation criteria to Colorado River Storage Project reservoirs.

Source: U.S. Bureau of Reclamation CRSS model output (1978), based upon 1906-1974 natural flow estimates.

TABLE 6.10-5

EXPECTED ANNUAL DELIVERIES TO THE CENTRAL ARIZONA PROJECT
AND METROPOLITAN WATER DISTRICT, YEAR 2000[1]
(In Thousand Acre-Feet[2])

Scenario	CAP	MWD
LWO	1,730	830
LWB	1,580	760
MWO	1,380	710
MWB	1,240	710
HWO	1,260	710
HWA	1,070	700

1. Assumes continued application of existing operating criteria to Colorado River Storage Project Reservoirs.

2. Rounded to nearest 10,000 acre-feet.

Source: U.S. Bureau of Reclamation CRSS Model Output (1978), based upon 1906-1974 natural flow estimates.

the largest amount of EET development foreseen in this study without having to reduce or forego other consumptive uses. The second conclusion relates to the fact that some Upper Basin states may near their entitlement limits, due to all types of development, more rapidly than some other states. This could affect the siting patterns of the energy industries within the Upper Basin.

DEFINITION 3. In a broader institutional sense.

Water availability can be viewed in a broader institutional sense in that there are a number of environmental and regulatory laws and programs, primarily at the federal level, that have been passed in the last 10 or 15 years which can indirectly affect water availability. Although these laws are not a part of the traditional body of laws that govern the use and distribution of water, they may well affect the manner, timing, location, and even ultimately the extent of future water resources development. Examples of such regulatory laws are the water quality standards for salinity on the Colorado River, the Rare and Endangered Species Act, Wild and Scenic River designations, and Wilderness Area designations. There is no way to quantify the impact of such legislation on water resources development.
Mr. McDonald commented that, in conclusion, these environmental and regulatory laws and programs may be major constraints on water availability for EET development.

Mr. McDonald ended his presentation by stating that water availability is not likely to be a constraint on any level of coal gasification and oil-shale development postulated in this study. Furthermore, he believes that this is a conclusion that is also held by the energy development companies.

QUESTIONS

Q: Is the Bureau selling industrial water out of the Flaming Gorge Reservoir?

A: There are a couple of small contracts out of Flaming Gorge right now. The water in the reservoir is available for sale. The Bureau of Reclamation owns the water rights and, given the operating criteria for Flaming Gorge, there is a portion of the water in Flaming Gorge for sale.

Q: Does the water have to be used in one of the Upper Basin states?

A: Flaming Gorge Reservoir physically lies within the states of Wyoming and Utah. Any user in the Upper Basin that would like to buy water out of Flaming Gorge can do so at a charge against the state from which the user came. In practical fact, that is going to mean only one of two things -- people in Wyoming pumping water directly out of Flaming Gorge or the people in Utah either pumping it out of Flaming Gorge or, more likely, pumping it out of the river downstream after a scheduled release out of Flaming Gorge.

Q: Is is true that California or Arizona cannot buy water from the Upper Basin on a contract for release?

A: Yes. The practical fact is that if they are going to buy, they are going to buy from Lake Powell or Lake Mead.

Q: Have you looked at the salinity implications of the different scenarios for water delivered to the Lower Basin?

A: The Bureau's CRSS computer simulation model does have a salt loading transport subroutine. However, there is a concern that historic salt load-to-flow relationships have changed since the closing of Lake Powell, making the salt models questionable.

The seven Colorado River Basin states are also concerned with future salinity problems, but have also been unsuccessful with their salt models.

Q: Do you know if any states in the Upper Colorado River Basin are having difficulty in distributing water rights so as to satisfy the energy industries as well as the established users?

A: Given the water rights system as it stands in the Upper Colorado River Basin, the problem is not a state's, but the industry's. It is the energy industry that must "wait in line." Whether or not the industry can get a reliable water yield from the system is not under the control of the executive branches of the state governments. They have little to say in who gets water and who doesn't.

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6.11 ACTIVITIES OF THE NAVAJO WATER COMMISSION

M. Eliza Scudder

Staff Attorney
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Window Rock, Arizona

The statement presented by Ms. Scudder, who recently became an attorney for the Navajo Tribal Council, was prepared by Hanson Ahasteen, Staff Representative of the Navajo Water Commission, who was unable to attend this session of the conference.

The Navajo Water Commission was established by the Navajo Tribal Chairman in 1976 to manage the Navajo Nation's water resources. The Commission is composed of five members of the council and two non-council members. The Navajo Tribal Council is the governing body of the 160,000 people living on the reservation. The Navajo reservation is located in the northeastern corner of Arizona, the northwestern part of New Mexico and the southeastern corner of Utah. It is 25,000 square miles in extent and contains portions of the Colorado River Basin, the San Juan River Basin, the Little Colorado River Basin and the Rio Grande Basin. The mainstem of the Colorado River flows through the reservation. In addition to municipal and industrial uses of the water, the present agricultural use of water on the reservation includes a 110,000-acre farm near Farmington, New Mexico, irrigated with water from the San Juan River. In the future, the tribe intends to put more of its water to beneficial use. The commission is now in the planning stage of this increased use.

The three primary areas of activity of the Navajo Water Commission are as follows:

1. Coordination of the nonlegal aspects of the two major water rights suites in which the tribe is currently involved. The first suit, brought in 1975 by the State of New Mexico and presently in the New Mexico state court, is a general stream adjudication of the San Juan River involving the Navajo Tribe, along with all others claiming an interest in the water from the San Juan River in New Mexico. The second suit that is currently in litigation is the adjudication of the Little Colorado River in Arizona. It was brought to the Federal District Court in Phoenix by the Navajo Tribe one month ago. In connection with this litigation, the commission is coordinating with the Williams Brothers Engineering Company of Tulsa, Oklahoma, for preparation of a technical survey of water resources of the Navajo Nation.

2. Development of a Navajo Nation Water Code, which will provide a structure for rational regulation and management of the Navajo Nation's water resources.

3. Preservation and enhancement of the quality of the Navajo Nation's water through the monitoring of ground water use by mining companies operating on the reservation with the purpose of discouraging wasteful use of high quality Navajo water and cleaning up water pollution caused by mining activities. The commission, working with federal agencies, is particularly anxious to clean up the pollution caused by uranium.

In concluding, Ms. Scudder pointed out that the Navajo Water Commission faces the same challenge that any western water user faces -- that of making optimal use of the available water resources. The Commission hopes it can meet the challenge so successfully that it will become a model for water management in the southwest.

QUESTIONS

Q: Are the Navajo water rights to Colorado River water part of the state's entitlement or is that part of the problem?

A: That is currently an issue that is being adjudicated.

Q: Can you give us an idea what the Navajo Nation will be using water for?

A: The Navajo Nation uses water in all areas: agriculture, industrial, and community consumption. Currently, along with enterprises such as Navajo Forest Product Industries, much of the industrial use has been by mining companies from outside the Navajo Nation. The Navajo Nation is developing more beneficial uses for its water in all areas.

CHAPTER 7

PANEL DISCUSSION SUMMARY

Chairman: E. John List, Professor of Environmental Engineering Science, California Institute of Technology

Panel: Stanley M. Barnes, Manager of Water Resources, J.G. Boswell Company, Corcoran, California

H. Stuart Burness, Associate Professor of Economics, University of New Mexico, Albuquerque.

James H. Drake, Vice-President, Southern California Edison Company

Harrison C. Dunning, Professor of Law, University of California at Davis

Larry E. Moss, Former Executive Director, California Planning and Conservation League, Trinidad, California

Donald A. Twogood, General Manager, Imperial Irrigation District, California

Summary

The session chairman briefly recapitulated the major ideas that, in his view, had emerged in the previous presentations. These were supply, use and management concerns. In the consideration of supply problems, the difficulties and possible gains of forecasting methods were reviewed; ground water overdrafts were clearly an issue as were new storage facilities and supply structures such as the Peripheral Canal. Rights and allocations were also an area of difficulty. Uses of water were obviously of some contention and specific problems of consequence that speakers had addressed were agricultural subsidies, salinity control projects, instream uses, power plant siting and energy development in general. The question of supply guarantees and sources for new growth also were raised. Specific management approaches had been voiced. These included freeing the market, legislative control, court adjudication, more state planning, new facilities and conservation, and leaving the *status quo*.

Subsequent to this brief summary, the chairman requested that each panel member spend a brief period stating, from his point of view, the crucial problem, its possible solutions and the research necessary.

James H. Drake

Mr. Drake stated that he believes that the fundamental problem was one of growth and that this should be faced directly instead of by *de facto* control via sewer connections or water supply or rationing of electricity. The electrical utility industry had had reasonable reliability conditions imposed on it by Public Untilities Commission edits; nevertheless, other state agencies were restricting utilities' ability to provide for this requirement. If growth is to be controlled, Mr. Drake believes it should be faced directly rather than controlled through *de facto* means or through the creation of emergencies.

H. Stuart Burness

In Burness's opinion, the basic difficulty is the uncertainty of supply and the constriction of dealing with this through the system of appropriative water rights. It was his opinion that non-structural solutions were appropriate for consideration and this could be accomplished by institutional changes in the system of water rights. A free water market would obviate the necessity for federal and state control; no more federal water projects would be required.

Donald A. Twogood

There are two basic problems: quantity and quality. Conservation is a recognized means of extending supply. Improved irrigation management is consonant with this. With the Colorado River being diminished in supply through diversions to the Central Arizona Project, efficiency of operation will become very important. Salt management will also become an important problem with reduced flows, especially since PL. 93-320, Title II, is lagging. Conservation and irrigation management will be a strong interim solution.

Larry E. Moss

Conservation and more efficient utilization should have the highest priority in extending the use of present supplies; this has had the least development so far in California. Mr. Moss claimed that the State Water Project and Central Valley Projects have not lived up to their promises to northern California (exportation of excess water only). The most important and compelling issue is the north/south institutional problem with respect to water use. Better economic data upon which the water development community can rely are needed; new supplies versus conservation and more efficient use is an area in which better economic analyses are required. Clearly, economics favor conservation at this time.

Stanley M. Barnes

The recommendations of the Governor's Commission to Review California Water Rights Law, if implemented, will depart from existing protection of property rights. More formalized ground water management in the San Joaquin Valley does not mean more efficiency. There is no Salton Sea in the San Joaquin Valley into which to drain irrigation runoff and there is no choice but to be efficient irrigators when the vertical percolation is one foot per year. Water quality in the Delta has been enhanced by Central Valley Projects; now should this quality be guaranteed?

Harrison C. Dunning

Ground water overdrafting is a problem regarding not only water, but also the increments of energy needed for pumping.

Further, water supply projects, although paid for by users, still tie up capital needed for other activities. The solution to the problem is the recognition that all parts of a system are interconnected. For example, a free market in water rights would cause sale of rights to water that would be replaced by uncontrolled ground water pumping. Research is required into the social aspects of continued overdraft. Who will win or lose when the ground water table is stablized at a given depth? Large operations control the water districts because voting is by acreage; this means big pumpers gain most by private control of ground water management.

CHAPTER 8

WESTERN WATER ISSUES*

Edmund G. Brown Jr., Governor
State of California

This is going to be a relatively modest presentation, since I'm amongst experts. I occasionally have an opportunity to make some of the policies and that is what I'll address tonight. Then, if you would like to ask questions, I'll try to respond as best I can.

In this state, it is fair to say that water is a far more significant issue than energy. We are right now experiencing the pain of long lines at the gas stateion. There is the specter of electrical problems in the years to come. We are actively evaluating what our nuclear future ought to be. Yet, even as important as all those issues are they will probably be resolved long before we fully secure our water future. The production of energy generally can be accomplished if sufficient funds are committed. But the production of water is not quite so simple and there is a fixed amount in the cycle that affects California. We import water from the Colorado River that soon will be transferred to other owners in Arizona. As a matter of fact, some of the Indian tribes have claims that, if upheld, would even take more water from California. We have only that amount of water which nature provides us and while we all like to think of ourselves as in an expanding frontier that keeps getting bigger, the fact is that there is only so much water. It is fixed until someone invents a more realistic desalting process and that doesn't seem to be likely soon. So we have to manage it; we have to transport it; and we have to use it in accordance with some wise principles.

*Presented to "Conference on Western Water Issues" at the California Institute of Technology in Pasadena, California, on May 17, 1979.

I've taken the position that the California Water Project should be completed; that certain off-stream storage facilities should be built; that the Peripheral Canal should be constructed; and that the Delta should be protected. Water quality and fish habitat should be respected while we expand the amount of water available for the farmers and the people living in southern California. These to me are very important matters. They are not assured by any means because the legislature is still considering whether or not it should authorize a Peripheral Canal. How it will come out is not clear yet, but certainly, in my judgement, the completion of the water project makes sense and it's part of a larger program of water management and conservation. Speaker McCarthy has said that he didn't want to see a Peripheral Canal bill until there was a ground water management bill. While there is a great deal of resistance to the concept of ground water management, nevertheless it's an idea whose time has come. Whether that time is 1979 or 1980 or 1982, I can't tell you, but it strikes me that the notion of limits is the metaphor that will be defining our future here in California.

I've spoken of an era of limits and that made people frustrated. Some people got angry; they felt I was antibusiness; they thought I was somehow suppressing expectation, and failing to dream the possibilities that have made this state what it is. But, at some point, we do live in a relatively closed system, and we have to learn to live with the resources that are available. The fixed limit on water is a reality and there are competing values.

I personally don't think that the people of this state are going to yield the values of wilderness or wild rivers to fuel the expansion of population and production in the state. I know some would disagree with that, but as the population expands and the forces of progress move on, the values of a wild river will then become more important. For those who are holding out for changing the law so that we can dam the Eel River to put more water into southern California, I think they will be holding out a very long time, because it's not going to happen -- at least if my judgement about the temper of the people of this state is accurate. People are concerned about that, and it is becoming clear that as we expand resources, then we attract more people and we attract more use. Then we find ourselves in the same deficit position. We are seeing this in our gasoline lines. The formula by which gasoline is allocated is based on the year 1972. Now in some states, the difference between 1972 and 1979 is hardly worth noting. In California it runs into well over a million new jobs, a million new people, probably a million new registered vehicles and all that goes with that. So, the more people, the more consumption, the more pressure on the resources.

With respect to water, it is also a treadmill. I think we have to take as a given the recognition that we are going to maintain the wild rivers just like we maintained the expansion of the Redwood National Park. Some of the same thoughts were expressed at that time. "We need those redwood trees. After all, hot tubs are selling well. Bar tables, roofs and many other good things come from redwood trees." Nevertheless, the federal government allocated some $700 million just to leave those trees there. I think they were right to do that. At the time everyone said that the world was going to come to an end and Eureka would have an economic recession. I don't think that has quite happened. The same people who are saying that the Eel River is going to have a dam across it are as unrealistic because that is an important value. People can sense that in the year 1990 or the year 2000, it would be very nice to have some of the things we have today. We don't want to look at what used to be a wild river or what used to be a slice of wilderness. We'd like a little larger area to walk around in and let the next generation and the generation after that receive some of the same benefits we have. So once you arrive at that position -- and I think that is the majority sentiment, or if it isn't I think it will be in the next few years -- then your water supplies are even more limited, and that leads unescapably to ground water management.

The problem with ground water management is that people say, "the water is under my turf. That's my ground, I paid for it, I own it." Well, that's true, but it's also true that we are living increasingly in an interdependent society. Man hardly creates water. It is part of a cycle and we will have to use it in the common interest. It will have to be managed in as wise a way as we can. The Governor's Commission to Review California Water Rights Law suggested that in each county there be developed a ground water management plan. The concept of that is to eliminate or at least help eliminate the excessive overdraft from which we are now suffering in the San Joaquin Valley. I understand that water management is not enough and we need additional supplies. We have to build storage facilities and dams. That will happen, but along with that it is very important that we use the water as wisely as we can. That takes some rules and that always will be resisted. But as we get a sense that water is the common patrimony of all the people of the state and has to be used wisely because it is limited, then those ground water management rules will be developed at the local level, but nevertheless, in accordance with state standards.

Right along the same vein is water conservation, water recycling and water reclamation. The talent that we have in the state will increasingly be directed toward better use of water, to reusing it and to using it very wisely in both the urban and the agricultural areas. Many parts of California are essentially deserts. Yet, we see green lawns and lush shrubbery as though we were not necessarily in a rain forest, but at a much higher latitude, when perhaps the more characteristic landscape might be rocks, lizards, cactus and other drought resistant flora. I'm not saying it's going to happen overnight, but increasingly I think people in this state will have to become closer in tune with that which nature feels most comfortable with. When one is either in a desert or near a desert, one can't act as though he were in a more rainy area. We will have to adjust our landscaping concepts to take this into account in urban areas. In agricultural areas we will have to use drip irrigation. We'll have to select those crops that bring the highest value for the amount of water used because that really is the economics of it.

A lot of this will develop naturally out of the market system. But some of it will have to come from new state laws and rules at the local level. We're forced into this becuase we are running a water deficit, just as in Washington, where we spend what we don't have and get inflation. In the State of California, we mine water to the tune of about a million and a half acre-feet overdraft every year. At some point we get subsidence. We get to a point where the water isn't there or it's uneconomic to bring it up. We can't continuously mine water. We are working to try to correct that. This is the aim of our overall water policies of more storage, more transfer facilities, water management, water conservation, and water reclamation.

It all seems to me to come down to the concept of managing our resources in an era of limits and maximizing the benefits for all the people of the state. This takes a commonality of purpose that is different from that of the last century -- the cowboy ethic where each one tries to grab as much as he can without worrying about those who come after. That day is rapidly vanishing. In order to guide us through, the state government will play a strong role. While some people will say, "We don't want the state involved in this," nevertheless it has to play a role if we're able to maximize the economic and the environmental values, both now and in the generations to come.

So, those are the policies. They're hardly out of one house of the legislature. There are a number of pitfalls, but it is hoped that out of this gathering we may get a clear sense of the alternatives because we are definitely overdrawing our water capital -- and doing so in a context of archaic assumptions and water regulations. They will have to be changed. In so doing, there will be a struggle with those who resist the new and try to hang on to the old. But the movement of history is inexorable and as people sense and see the limits that are imposed on the water resources, they will be more inclined to accept what is a reasonable husbanding and management of these resources.

That's a general outline of my policy.

Now, I'd like to open this to questions.

QUESTIONS

Q: What do you see as the options for supplying power to pump water for the California Aqueduct after 1983? The PG & E contract will expire and the time is short.

A: Well, the Department of Water Resources is busily designing a coal plant and entering into contracts for geothermal energy. We're looking at a variety of energy sources. We don't have it ready to turn the switch, but we're searching a variety of sources.

Q: What about the cost? Will we be able to afford it?

A: We'll always afford water. Water will get more expensive; it will get a lot more expensive. But I think we will pay for it. One of the dilemmas is that to build a coal plant requires water, as does a nuclear plant, and yet moving water over the Tehachapis also requires energy. So we need energy to move water to use to make energy to move water. I don't know how all that works out, but I know it's going to be expensive.

Q: To ask a practical question about the legislature, I see a stalemate right now involving southern California interests, the farmers in central California, the Delta farmers and northern Californians who think we're stealing all the water. What exactly are you going to do to provide leadership to end the stalemate?

A: That's a good question. I've tried to provide leadership by supporting a bill to complete the California Water Project, by establishing a Governor's Commission to Review California Water Rights Law, by speaking to the legislators involved, by talking to different groups, and by coming here tonight to give recognition to the seriousness of the water problem facing California. Yet, the votes are still not in the legislature. Sometimes if I manifest a disinterest, they begin to get interested on their own and try to send me a bill. Then they wonder whether I'll sign it or not.

I think that the nature of the political process is such that there are competing interests and until people acutely feel a problem, very little gets done because if you do one thing, you will offend one group; if you do the other, you'll offend the other group. So, I think that the tension level hasn't quite risen high enough on the Peripheral Canal and the water projects. I think it will, but whether this is the year, I don't know. There is a rising no-growth sentiment and if that combines with the parochial divisions, then water development could be stalled for a number of years. It's hard for me to predict the outcome.

The legislature is a co-equal body. It is composed of 120 separate individuals who are just as independent as I am and until they want to vote for something, they won't. Maybe it's like the energy problem -- until people see it and feel it, it's hard to get moving. I will try my best this year to get the appropriate bill, but I don't know. I have some doubts. I was riding back from Washington with one of the leaders of another political party who is a member of the State Senate and he assured me that the water bill we're supporting would not emerge this year. So if he's right, maybe that will happen. But I will do everything I can. If anyone has any suggestions, I'll be glad to listen to them, but I can't vote for senators and assemblymen; they have to vote themselves, and at this point, they are a bit reluctant to bite the bullet on completing the California Water Project.

Q: Governor, in the lower San Joaquin Valley, they are turning up large areas of mesquite and planting rice. Do you happen to know whether the water to be used for the rice is part of the overdraft or is it water that is coming down under the California Water Project?

A: No, I don't, as a matter of fact. But if your point is that rice is a water intensive crop, I guess the next question would be: Are there other crops that are less water intensive and should they be planted? I think those are the kind of questions that the rising cost of water will tend to resolve. At this point, people plant whatever they want, assuming they've got the water and the soil and the capital. I think the rising curve of water costs will begin to rationalize how we use our water. One person expressed to me the puzzlement of taking tomatoes and putting all that water into them and then exporting them. He said we're just exporting our water and putting tomatoes around it and that didn't make a lot of sense. I don't express any opinion about that, other than to say obviously what we plant is increasingly going to reflect the water that is available. I think that is a fair conclusion.

Q: What's going to be done to keep Mono Lake from drying up?

A: Well, I was just talking to Ron Robie about that, our Director of Water Resources, and he has assured me that he is taking some steps to do what he can to prevent that. As I was walking out of here, I did not get a chance to inquire further as to what those steps were and as a matter of fact, I have a little briefing paper that says "Mono Lake." I won't bore you by reading it, but I think that is not an item that I have yet addressed myself to. But it's one that we're aware of and we're working on. I cannot give you any more than that

Q: The Central Arizona Project is supposed to go on line in 1983, I believe, and then we're going to lose some water?

A: Yes, I think it will go on a little later than that, but, yes, we're going to lose some water.

Q: What's going to happen to an area like Los Angeles? Are we going to have water lines in front of faucets? Do you have a plan for preventing that, because the Peripheral Canal isn't going to be ready in 1985?

A: Well, we have it figured out that we're going to be able to make it. Obviously, if we keep getting more people and people keep getting more lawns and washing their cars and all these other things, we might have water lines someday. We're trying to instill an ethic of conservation so that doesn't happen. The drought helped somewhat, but I think that it's going to take a lot of conservation. Already in the planning of the California Water Project, it's a lot different than it was ten years ago. We are assuming massive amounts of conservation and I have a hunch we will even have to require more just to make it. That's what we're doing. It's conservation; it's the set of projects that are designated in the Ayala bill; and it's the effort at managing water better and then reclaiming it and recycling it. We have an Office of Water Recycling, but even there we're having some trouble because some of this water is very hard to recycle because it has toxic material in it which is hard to get out. So that's what we're doing and whether or not it will be enough I think only time will tell.

Q: Is the Ayala bill a water conservation bill?

A: No, this is a water development bill. But Speaker of the Assembly McCarthy has said he doesn't want any water development bill unless it is linked to a conservation program and a ground water management program and so now that should all be stirred together and put through into a law fairly soon, if we're not going to have the water lines you are talking about. Now whether or not we're going to be that wise is not in my power; that requires a legislative vote and that really depends on the interest groups that have a lot to say about it. I think ultimately we're going to get what we need, but so far the votes aren't there yet.

Q: Would you favor a policy that would have agriculture pay a greater portion for irrigation water than what it is paying now under federal law?

A: Our water department has advocated more realistic pricing. This is all tied up in the 160-acre limitation question and water subsidies. At some point, it is reasonable that a resource bear its true cost. That would certainly imply rising rates for water. Some of these things are tied into long-term contracts and I don't know if you can change them, but certainly anything not subject to the contracts will be rising very rapidly. I think that is just essential.

Q: On a long-term basis, say beyond the year 2000, what do you see as a sensible, overall approach to the problem of water supply in California?

A: Well, that's a really broad question. First of all, I think there is a carrying capacity to the state. If we start with the premise that there is only so much this system can support by way of life, hopefully we will reach some balance in the number of people and the way they live. I think that's important. Water is connected with everything else in society -- the crops that are grown; the shrubbery and landscaping and the use of water. My own hunch is that when we get to the year 2000, there will be a more frugal style that will characterize the way we live. I think that adjustment will be somewhat painful, but it is just part of what has to be. That is another way of saying "conservation." It's another way of saying that as we realize the limited nature of our resources, we'll have to treat them with more respect than when we had less people and it seemed like we could always dam up rivers and move the water around and have no consequences. It will get expensive.

One item I haven't mentioned is the necessity of building a drain to take away the salts that accumulate in any irrigated water situation. Now we know from past history that hydraulic civilizations tend to collapse. That certainly happened in the civilization near the Tigris and Euphrates. They didn't remove the salt. If we look back at the ancient records, we find that over a period of a thousand years, the crop yield steadily declined. The theory behind that is that the salt content is the soil rose and the productive capacity declined. So building a drain is another item of perhaps $700 million. That is going to add to the cost. Each of these cost items will then shape the way water is used. Water will be very expensive. We're getting a little taste of what happens when the price of gasoline goes up. Well, water is obviously a lot more important than gasoline and we'll see it follow the same cost curves. It may change the way we make food and how we grow it and what we grow. It'll change the way we conduct ourselves in the urban areas and we'll try to come up with a way to get the most for the water we have.

Q: Governor, as you're probably aware, Congress loves water projects, especially in their own home districts. As an executive, how do you supply the leadership that is able to counter all the incentives of the system that promote ineffecient projects paid for by the entire state, or at the national level, by the entire United States?

A: Well, I think the leadership is developing because the crunch is on and everyone now is talking about balancing the budget. The demands on spending are increasing while the need to economize also increases. So, I think a lot of questionable projects will be re-evaluated. The people in the so-called frost belt, New England or the Midwest, where they don't have large water projects, are going to take a very jaundiced view of any project that can't be very strongly justified. While President Carter was rebuffed in some of his water ideas, I think those ideas ultimately will be closer to what the future looks like than those of his critics. Cost and the regional rivalries of this country will inexorably push us in that direction and the leadership will emerge out of that political context.

Q: Governor, earlier you pointed out that we have to endure crises before we learn lessons. I'm wondering what lessons we learned from the crisis in water of the recent drought? Particularly, if we didn't have enough reserve capacity of water, what should we be doing to make sure that we have that reserve capacity and to maintain it?

A: Well, we probably would not have had enough reserve capacity if the drought kept going. That drought was more serious than was envisioned in the assumptions that went behind the California Water Plan. The problem is that as we develop water storage and get ready for the seven dry years, if they should occur, people say, "Well, what are you keeping all that water for?" "Why don't we use it?" "Why don't we make some money out of it?" "Let's plant." OK, then we draw the water down. So, if you hold the water back, they say, "that's silly," but then if you use it, we run out. I think you get down to the problem of how much water use can we operate on? What is the amount of water for agricultural and urban uses? As we plant more and use more in the agricultural sector and as we bring more people in to flush their toilets and drink their water and water their lawns and do all those things, we keep using more and more water. The steady state or balance as required by our water resources is something we haven't quite arrived at because there is no agreement on it. I would think the drought certainly was instructive. The fact we're all here talking about it tonight is another sign that we're focusing. But I think we're really looking 10, 20 years for the development of a water policy that is sustainable over a long period of time. We evolve and learn, not overnight, and not in four-year segments, but over much longer periods. I think that will have to happen in the development of a water policy. People have been talking about these ideas for decades and many of them have not yet been adopted.

I hope you've got a sense of the water problem. It is as much a political problem as it is a water problem. I hope that out of these meetings we get a greater sensitivity. It is very hard when the water is there to prepare for the future. If there is one style which characterizes this age we're in, it is a spending down of capital, of resources. We must try to develop a politics and a mentality that is one of stewardship and building for the future and preparing for it and living according to certain limits whether they be energy or water or land. That requires a level of maturity that is quite different than the skills and the attributes that went into building the state from the beginning of the gold rush. So, as we change those attitudes and recognize that the constituency of the future requires planning, requires thoughtful preparation, we'll have enough water and we'll have enough energy and we will come to terms with the fact that there is a carrying capacity in the biological systems of which we're a part. The rules of that system are inexorable and once we learn them, we'll begin to follow them.

Thank you very much.

CHAPTER 9

LIST OF CONFERENCE SPEAKERS AND ATTENDEES

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APPENDIX

ADDITIONAL COMMENTS ON THE OWENS VALLEY AND MONO BASIN WATER CONFLICTS*

Emilie Martin
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For the record, and to be included in the proceedings of the conference on Western Water Issues, I submit the following facts:

The Owens Valley litigation does not threaten or take from either Los Angeles, the Metropolitan Water District (MWD), or San Diego 50 percent of its water supply as some have claimed. Rather, the County of Inyo objects to an increase of 48,000 acre-feet yearly that the City of Los Angeles wants to pump from the aquifers beneath the Owens Valley, underlying city, private and federal government lands. This is an increase in ground water pumping over the average 10 cubic feet per second (7,240 acre-feet/year) that Los Angeles has pumped for the last 50 years before the completion of its second aqueduct in 1972. Forty-eight thousand acre-feet/year DOES NOT COME CLOSE to being 50 percent of either MWD's yearly total, Los Angeles' supply or the amount of water that San Diego residents consume. The County of Inyo, its citizens, and the experts it has retained contend that conservation in the City of Los Angeles will easily yield the additional 48,000 acre-feet the city wants to pump and export from the Owens Valley aquifers each year.

Another related issue, the shrinking of Mono Lake, has also concerned residents of the Mono-Owens Valley and Basin recently. Water export from both these areas has been studied carefully by the League of Women Voters of Eastern Sierra. In a statement directed to the task force searching for a long-term solution to the protection of Mono Lake, the League pointed out that the 213,000 acre-feet/year of water saved in Los Angeles through conservation and reclamation (at a 15 percent

*Submitted by letter after the conference, and edited by conference staff.

conservation rate) could be reallocated according to the environmental/human needs of the regions and watersheds which supply the city in the following manner:

a. 85,000 acre-feet per year to Mono Lake;

b. 105,125 acre-feet per year to Owens Valley;

c. 22,475 acre-feet per year to Metropolitan Water District

The following table shows the present and future water supply for Los Angeles if this proposal (suggested by the League) were implemented:

TABLE A-1

Present and Proposed Future
Los Angeles Water Supply*

Source	Present LA Use In Acre-Feet/Year	Future LA Use In Acre-Feet/Year	Local Allocation In Acre-Feet/Year	Reduction
Mono Basin	100,000	14,500	85,500	85%
Owens Valley	382,000	276,875	105,125	28%
MWD	70,000	47,525	22,475	32%
Local wells	102,000	102,000	0	0
Reclamation	0	115,000		
	654,000	555,900		

*This figure is derived from the 1977 Phase I Report of the Orange and Los Angeles Counties Water Reuse Study. It is a conservative estimate from their projections.

Therefore, as the figures should show, Owens Valley does not threaten other cities' water supplies.