VALUE OF WATER RESEARCH TO STATE AND NATION

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First, let me say that this Fifteenth Annual Conference and the attractive and commodious new building soon to be occupied by the Water Resources Research Institute are ample testimony to the value that New Mexico places on water research. Those responsible, particularly Dr. Ralph Stucky, deserve recognition and congratulations for their leadership in advancing the cause of water research. I am delighted to be here on this occasion. Attendance at this conference, moreover, has special meaning to me because this is my first visit to a State Water Resources Research Institute since my appointment as director, Office of Water Resources Research (OWRR).

The value of water research rarely has instant visibility. It's like debating the worth of an idea, or a new concept, or a new but untried method, technique or innovation. Some people resist change because the present way has already worked, or for other reasons these people are not receptive to innovation. One may not feel a need for new ideas because he hasn't yet used all of the old ones. There is the story about the Georgia farmer who was invited by a county agent to attend a meeting on how to farm better. The farmer declined the invitation, saying, "He guessed there really wasn't any point in his coming because he wasn't doing as good as he knew how already."

From the viewpoint of the budget examiner and others who must take a hard look on justification of funds for scientific studies, a measure of the value of water research, or any kind of research for that matter, is the time lag in application of results. We know that the time lapse between useful research findings and their adoption is seldom predictable. It may be measured in years or hundreds of years. Leonardo daVinci whose life span extended from 1452 to 1519, developed basic principles of aerodynamics and engineering processes that were not put to use until long after his death. His research on open channel hydraulics was ignored for more than 250 years and some engineers today still don't know how to apply his teachings in practice. DaVinci, a man of many parts - painter, musician, engineer, geologist - worked on projects for river diversions and developed a canal system with locks that are still in operation in Milan. Some research on the other hand, salk's vaccine is an example, finds acceptance within a relatively short period, three or four years or less.

A study by the Illinois Institute of Technology under a grant from the National Science Foundation found that basic research was highly significant in five recent technological innovations of wide value and diverse application. For each innovation, experts traced the critical results,

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reports, and experimental tests, backward in time to the innovation's origin in fundamental research. Each critical result, report, or test was termed a "key event" and was classified as due to nonmission research, mission-oriented research, or development and application. These key events were traced as far back as the 1850's. Of the 341 key events documented, the Illinois group identified about 70 percent that were nonmission research, 20 percent that were mission-oriented, and 10 percent development and application. An example of one technical innovation from their study was magnetic ferrites, which are substances used in computer memories and similar equipment. Traced backwards, the development of hard ferrites in the late 1950's at the Phillips Research Laboratories in Holland was preceded by two mission-oriented research inputs at Phillips in the early 1950's. In turn, these efforts were preceded by a sequence of nine non-mission events in crystal chemistry. These included Pauling's bond theory of crystals in 1929, Bragg's work on X-ray diffraction in crystals between 1914 and 1920, and Roentgen's discovery of X-rays in 1895. The trace further revealed communication between disciplines and complicated interconnections involving contributions in addition to those of crystal chemistry. These additional contributions of nonmission research, mission-oriented research, and development and application to the history of magnetic ferrites came from the fields of telecommunication, ceramic materials, and magnetic theory. In their overall study, the Illinois team found that about 90 percent of the basic research behind an innovation had been accomplished a decade before development of the innovation. These findings by the Illinois Institute of Technology highlight the latent utilization of the results of much research, whether problem or non-problem oriented.

In the above connection there is much concern today in the scientific community as well as in OWRR about transfer of research results. The question is, "How can we improve the communication between the scientist in the university and the practitioner faced with real-life water problems?" Obviously, water research will not have much value if the potential user is unaware of research recommendations and conclusions that may have direct bearing on his own experience and which may have practical application to a water problem demanding action. Because of this concern about technology transfer and the application gap, the Office of Water Resources Research retained the consulting firm of Leeds, Hill and Jewett, Inc., to submit a plan for a comprehensive water resources research information system. The consultants examined the nature and effectiveness of present procedure used by OWRR and the 51 State Water Resources Research Institutes to obtain information on problems requiring research and to disseminate results of research projects. Some 26 recommendations, a number of which have already been acted upon, appear in the final report. One recommendation still under examination calls for the adoption by OWRR and the State Institutes of a two-level water resources information exchange system. In this plan, OWRR would assume responsibility for national and regional dissemination of research results from State Institutes and Title II contractors and for

obtaining information on national water problems needing research. The State Institutes would be responsible for exchange of water resources research information at the State and local level.

One should not forget that in the dissemination of information, conciseness and clarity of the language used in communication have great importance. Value judgments or estimates on completed water research are based initially on the published report and later confirmed or revised after field evaluation and demonstration and other considerations, including economic feasibility. Many reports, unfortunately, are too long and rambling and too difficult to read. One research hydrologist writes for another research hydrologist. The Congressman who might want to pick up a research report to comment on the good things going on in his State finds little to talk about. Similarly, consultants, planning officials, professional engineers in private practice, action agencies and others must sift through pages of verbose text to uncover the significance of the results in practical terms. A short time ago, one of the Washington newspapers published a complaint by a member of Congress on the length of government reports. He recalled that the Lord's Prayer has only 56 words; Lincoln's Gettysburg Address, 266 words; the Ten Commandments, 297 words; and the Declaration of Independence, 300 words. But a recent government order covering the pricing of cabbages was 26,911 words long!

My foregoing remarks have been of a general nature as to the value of water research. I now would like to identify some of the more pressing water problems, State and nationwide, and offer a few examples of potential or actual contributions from OWRR-sponsored water research in confronting these problems.

A major problem in New Mexico, as you all know, is finding new sources of water supply to supplement entitlements from interstate compacts and the Supreme Court decree on the Colorado River. About two-thirds of the irrigated agricultural land in New Mexico depends wholly or partly upon ground water. In 1965, according to the Geological Survey, the irrigation use of ground water in the State was estimated as 1.4 million acre-feet, most of which was mined. That is, well supplies are depleted in many places where average annual discharge exceeds average annual recharge with resultant decline in ground water levels. Total water withdrawn - surface and ground water - in 1965 for irrigation approximated 3.1 million acre-feet which include about 410,000 acre-feet conveyance loss. A second principal problem in addition to ground water mining is nonbeneficial use of water by evapotranspiration, especially along the Pecos and San Juan Rivers and the Middle Rio Grande. The total nonbeneficial use in the State has been estimated at 1.16 million acre-feet per year, including 330,000 acre-feet lost by direct evaporation from reservoirs. Sedimentation of channels and reservoirs and erosion of crop and grazing lands are other problems.

The State Planning Office, I understand, has assigned the responsibility for planning of the water and related land resource aspects of the overall resource plan to the Interstate Stream Commission and to the State

Engineer. In development of a total State water plan, research carried on by the New Mexico Water Resources Research Institute should prove to be of considerable value. The recently undertaken comprehensive resources analysis of the Pecos River basin by an interdisciplinary-interuniversity team from seven academic departments at three universities has developed basic concepts which should contribute materially to the State plan. A similar study in the Rio Grande basin involving New Mexico State University, the University of New Mexico, and the New Mexico Institute of Mining and Technology is scheduled for completion June 1970. A completed study under the OWRR allotment program has demonstrated that by means of subsurface irrigation, cotton yields can be increased by about 25 percent with reduction at the same time of about 20 percent in consumptive water use. Research under an OWRR Title II grant involving water requirements for salinity control in unsaturated soils suggests that amounts of leaching water recommended for salinity control can be revised downward, resulting in a potential saving of water in a water short area. These are only some of the kinds of studies the Water Resources Research Institute is conducting in behalf of the State.

Nationwide, water problems are numerous - concern about the quality of the environment; urban water resources management; waste treatment and disposal; conserving ecological values in water resources planning; control of heated water discharges; conservation of the estuarial water resource; water supply; water law and institutions; and the list could go on. For fiscal year 1971 which will begin July 1, 1970, OWRR identified certain major subject fields as meriting priority consideration in the selection of research proposals under the Title II provision of the Water Resources Research Act of 1964. For the benefit of those in the audience not familiar with the Title II program this authorizes financial support to any individual, foundation, university, consultant, watershed or irrigation district, State or local government agency, or private firm qualified to conduct water resources research. Funds are limited and competition for support is keen. Unlike the Title I program authorizing financial support only to State Water Resources Research Institutes and the universities participating in the program, the Title II provision of the Act is non-restrictive. Seven priority areas were established as follows:

1. Analysis of Planning, Managerial, Financial, Operating and Regulatory Policies of Water Resources Institutions.
2. Water Resources Policy and Political Institutions.
3. Hydrologic Systems Analysis.
4. Urban-Metropolitan Water Resources Problems.
5. Environmental Considerations in Water Resources Planning and Management.
6. Evaluation of Economic Importance of Various Uses of Water, Cost Allocation, Cost Sharing, Pricing and Repayment.
7. Evaluation of Social Objectives in Water Policy.

Some examples of research (both Title I and II) on nation-wide water problems will be of interest. A project by the American Society of Civil Engineers covered in the first year's report the following subjects:

1. Prefeasibility studies to determine possible effectiveness, cost and time requirements for: (a) a comprehensive systems engineering analysis of all aspects of urban water (two studies); (b) a general economic analysis of cost and pricing parameters of cost and pricing parameters of all aspects of urban water (two studies).

2. A state-of-the-art study of mathematical models and related simulation methods potentially usable for analyzing urban rainfall-quality processes.

3. Requirements for assessment of drainage damage and alternatives to direct storm water runoff control, such as utilization of recharge basins or other storage schemes.

4. Discussion of political, economic, legal and social problems related to urban water management.

Cornell University has commenced work on a study entitled "Metropolitan Water Resources Systems Analysis." Investigations pertain to application of systems methodology of preliminary planning, staging, design and operation of metropolitan water resources projects under hydrological, economic and political uncertainty. Mathematical planning models will be structured for defining and evaluating preliminary alternative designs and policies for municipal and regional water resources systems such as supply, distribution and treatment works, urban runoff collection, storage and treatment facilities. Also, to be investigated are methods for predicting the effect of alternative pricing policies on design, capacity, and operation of water supply systems. Methods will be developed for use as tools by municipal planners to aid in establishment of rational prices or rates for various types of water use.

At Illinois work has been completed on a mathematical model to relate hydraulic parameters, such as velocity, width, depth, and cross-sectional area to drainage area and flow frequency of a stream. Because of encouraging initial results in development of hydraulic geometry equations useful in the planning of projects for control or development of rivers, this study is being expanded nationwide to include streams representing a wide variety of physiographic and hydraulic conditions.

Further insight to the diversified water research underway or recently completed is apparent from such project titles as these: Evaluating Urban Core Usage of Waterways and Shorelines; Computer Simulation of Euthrophication; Factorial Analysis of Price-demand and Demand-cost Functions for Municipal Water Systems; Evaluation of the Decision Process in Water Resources Planning; Socio-economic Study of Multiple Use Water Supply Reservoirs; Systems Analysis of the Great Lakes; and Case Study of Remedial Flood Management in an Urban Area.

The Secretary of the Interior is convening a National Conference on Urban Water Research next week in Atlanta. This will be a closed work session

of about 60 experts in urban water studies and practice who will review and discuss a planned program of metropolitan water resources research. OWRR, I might add, has been designated the lead government agency in urban water research by the Federal Council for Science and Technology. The significance of urban water resources management becomes apparent in view of the fact that three-fourths of the population of the United States now live and work in urban areas. Five working committees will consider these aspects: (1) water resources planning and management policies; (2) economic-financial functions; (3) urban hydrology, storm drainage, flood plain management; (4) socio-political-legal considerations in urban water resources; and (5) general research plan.

The question sometimes arises as to the value of regional research projects involving two or more institutes and the position of OWRR in this activity.

The Office of Water Resources Research strongly encourages State water research institutes or centers to approach regional water problems on a cooperative basis and to pool their talents and resources. Authority to develop regional programs and objectives appears in Section 103 of Public Law 88-379 (Water Resources Research Act of 1964) which reads: "The institutes are hereby authorized and encouraged to plan and conduct programs financed under this Act in cooperation with each other and with other agencies and individuals as may contribute to the solution of the water problem involved, and moneys appropriated pursuant to this Act shall be available for paying the necessary expenses of planning, coordinating, and conducting such cooperative research."

Few projects have involved collaboration of two or more State institutes. Interest by the institutes in the identification, assessment, and solution of regional water problems is, however, increasing. Assessment of regional problems and exploration of meaningful water research coordination are being made primarily through regional conferences. Some examples of regional efforts to coordinate research are briefly described.

The New England Council of Water Centers Directors is composed of the Directors of the Water Resources Research Institutes or centers in Maine, Vermont, New Hampshire, Massachusetts, Connecticut, and Rhode Island. Its general purpose is to identify and share work on water resources research needs of common interests. The Council has received a charter from the New England Governors' Conference and enjoys close working relationships with the New England River Basins Commission of which the Council chairman is an ex-officio member. Recent activity has included regional conferences on water rights law and water resources planning and recommendations to the New England Regional Commission for a regional legislative program.

The Northeast Association of Water Resources Research Institute Directors is a thirteen State organization established to evaluate research needs and to exchange information on regional water problems and individual research programs. Membership stems from the following States: West

Virginia, Virginia, Maryland, Delaware, Pennsylvania, New Jersey, New York, Connecticut, Massachusetts, Rhode Island, Vermont, New Hampshire, and Maine. Topics covered in recent meetings dealt with opportunities for water supply augmentation in the Northeast and with institute-State agencies relationships.

In the Midwest, research interest in regional water problems such as agricultural pollution resulted in organization of a group known as the Midcontinent Water Research Directors. Conferences have been held on evapotranspiration and on the theme, "Agriculture and Water Quality."

Discussions have taken place among the Water Institute Directors of 11 states in the far West on cooperative research for meeting future regional water needs. The general objective would be to explore and evaluate the input-output methods as an effective tool for weighing alternative water resources management policy and program decisions within a regional context. States participating in these discussions are Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming.

In closing, I want to compliment the New Mexico Water Resources Research Institute on its excellent record of accomplishment. Dr. Stucky and his associates have developed a fine working relationship with other universities within New Mexico, with cooperating State and Federal agencies, with advisory groups including ranchers, farmers and businessmen concerned with State water problems, and certainly with OWRR.

We, in Washington, are very pleased that Dr. Stucky is Director of the New Mexico Institute.