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Abstract

Needed Research in Irrigation and Drainage*

by

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On 19, 20, and 21 March, 1964, an Irrigation and Drainage Research Conference was held in Logan, Utah to "delineate and stimulate high quality research needed in selected subject areas in order to advance the status of knowledge, and thereby improve the quality of engineering in the planning, design, operation, and maintenance of irrigation and drainage systems." The conference was one of the activities of the Research Committee of the Irrigation and Drainage Division in coordination with the Executive Committee of the Irrigation and Drainage Division of the ASCE. The conference was an outgrowth of a survey which had been conducted earlier, designed to elicit information from the profession on the status of current research and future research needed in the general field of irrigation and drainage. The results of this survey showed clearly that there were six major areas needing expanded research programs. They are as follows:

1. Evaporation from water and soil
2. Salinity and alkali problems
3. Stable channels
4. Small, low-cost hydraulic structures for conveyance and distribution systems
5. Weather modification
6. Ground-water management

The conference consisted of special speakers having national reputations in the fields closely related to irrigation and drainage together with panels for each of the six subject areas--the membership being selected from throughout the United States and the world in order to have on each panel those individuals who are best informed on each particular subject.

A report is in preparation giving the detailed information from each of the panels. This paper is a summary of the report.

The results of the conference showed clearly that there is a considerable need for research on specific technical subjects--but there is also considerable need for expanding public relations activities, instrumentation development centers, and computing centers. There is also a clear indication that additional conferences and committees need to be developed.

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Introduction

This paper is a report on a research conference held in Logan, Utah on 19, 20, and 21 March, 1964. The conference was the outgrowth of several years of activity and efforts on the part of the ASCE Irrigation and Drainage Research Committee, the ASCE Irrigation and Drainage Executive Committee, the ASCE Research Committee, staff officers of ASCE Headquarters, and many other individuals and groups. The purpose of the conference was to "delineate and stimulate high quality research needed in selected subject areas in order to advance the status of knowledge, and thereby improve the quality of engineering in the planning, design, operation, and maintenance of irrigation and drainage systems."

This conference was one of the steps taken by the Irrigation and Drainage Division Executive Committee together with the Irrigation and Drainage Research Committee in discharging its responsibilities. The purpose of the Irrigation and Drainage Division of ASCE is "to promote advancement in thought and practice in the field, to clarify fundamental principles, to disseminate knowledge of current practice and the results obtained therefrom..." The Research Committee of the Irrigation and Drainage Division has the more specific purpose "to initiate, organize, sponsor, and coordinate research in the field of irrigation and drainage..."

When the Research Committee of the Irrigation and Drainage Division was established in 1956, it established as its specific responsibilities the following:

1. Help to develop recognition of the value of research among those in the civil engineering profession--particularly those directly or indirectly associated with irrigation and drainage.
2. Identify and define subject areas of needed research in irrigation and drainage.
3. Stimulate and assist the initiation, the conduct, and the reporting of research in irrigation and drainage.

With these responsibilities in mind, the Committee developed, circulated, analyzed and reported the results of the 1958 survey questionnaire designed to elicit information from the profession on the status of current research and future research needed in the general field of irrigation and drainage. The results of this survey were reported formally by a series of papers at the ASCE Cleveland convention of 4-8 May 1959.

The information obtained from this questionnaire was both specific and general--but the specific information was spotty and rather incomplete in its scope. This information was most helpful, however, in giving the Committee the viewpoint held by the various researchers, planners, and designers in the field of irrigation and drainage with respect to the general research needs.

The limited specific information obtained demonstrated clearly that more intensive, detailed study needed to be given to certain subjects by a group of experts. For this reason, the Committee decided in July 1962 to initiate and develop a Specialty Conference on Research. This conference would assemble a selected and limited group of

experts to discuss in detail certain of the topics indicated by the results of the questionnaire to be of greatest importance. The Conference at Logan, Utah on the campus of Utah State University in March, 1964 was the result of this decision. This conference is also one of the types of activities recommended by the 1962 ASCE Research Conference for technical divisions to develop in their various specialty areas. The Irrigation and Drainage Research Committee will use the results of the conference to take whatever further steps are needed and feasible to stimulate, initiate, conduct and report on research recommendations made at the conference.

In designing the conference, the Committee had the benefit of the experience of the Gordon-type engineering research conferences which have been sponsored by the Engineering Foundation, and the symposium on civil engineering research related to water resources which was held on the campus of Colorado State University in Fort Collins in June, 1961. The primary similarities of the Logan Conference to these previous conferences were that a limited number of experts in a given field were assembled to discuss a rather specific subject in considerable detail without distracting influences for a period of several days. Furthermore, there was no feeling of obligation on the part of the panelists to produce something in writing themselves. Spontaneous, fresh, and unrehearsed ideas were considered to be the most desirable and the most valuable. Only the chairman and reporter of each panel had responsibility to produce written material.

For this conference, the most knowledgeable speakers and panelists available in the nation were assembled together with several experts from other countries. In a sense, this conference was an experiment for ASCE to determine whether this type of invitational conference, with only a limited attendance, was of sufficient value to warrant future conferences of a similar nature. The results of the conference were most gratifying because of both the enthusiastic response of the participants and the great value of the material and information produced by the conference.

Approximately 125 persons attended the conference. Participating on the conference panels were 24 representatives from federal, state and regional government offices; 29 representatives from educational institutions and associated research laboratories; 8 representatives from consulting engineering firms and industry, and 2 attorneys. Furthermore, the participants were from all parts of the United States, 1 was from Canada and 1 from England. Others attending the conference were members of the program and arrangements committee, guests, speakers, and observers. Although observers were not encouraged to attend the panel sessions, they were encouraged to attend the general sessions of the conference and to attend the panel sessions provided they remained only as observers and did not interfere with the panel discussions.

The Panels

The results of the 1958 survey showed rather clearly that there were six major subject areas of primary interest and concern for future research. These are as follows:

1. Evaporation from water and soil.
2. Salinity and alkali problems.

3. Stable channels
4. Small, low-cost hydraulic structures for conveyance and distribution systems.
5. Weather modification.
6. Ground-water management.

Each of the panels were instructed to consider the following questions in regard to its particular topic.

1. Why is the selected subject important?
2. Where do we stand in this field at present?
3. Where are the deficiencies in knowledge and practice?
4. What direction does research need to take on this subject in the future in order to advance most significantly the status of knowledge and practice?

Furthermore, each panel member was asked in advance to eliminate as much as possible all prejudice and bias so as to stimulate and permit a free and unhibited flow and exchange of ideas among the panelists. Outlines on a suggested scope of discussion were prepared and distributed by each panel chairman prior to the conference. These outlines were not intended to be rigid in any sense, but rather simply to stimulate thinking and creative and imaginative ideas for research study using new and unconventional lines of approach. The panels were purposely kept small in size-- 10 to 15 as a maximum--to promote free discussion, and panel members were chosen with the goal of having each member representing a slightly different point of view on the subject matter being considered.

The Special Speakers

In order to complement the work of the panels, several principal addresses were given throughout the conference. The individuals selected were nationally known for their work in planning and research related to irrigation and drainage, and their addresses were intended to give the panelists a broader base and outlook from which to work.

At the opening session of the meeting, Floyd E. Dominy, Commissioner of Reclamation, spoke on "The Overall Importance of Irrigation and Drainage, both Nationally and Internationally." He pointed out that "increased efficiency in water use presents great challenges to us because it involves inter-relationships of people, economics and social attitudes, planning and operating, physical features, and other complex factors." T. W. Edminster, Associate Director, Agricultural Research Service, spoke on, "The Need for New and Creative Research in Irrigation and Drainage." He stressed the need for creativity in research, rather than adhering to the "applied classical approaches." George D. Clyde, Governor of Utah, and a Fellow of the ASCE, spoke at the evening banquet on "Half a Century of Research in the Field of Irrigation and Drainage." William C. Ackermann, Office of Science and Technology, Executive Office of the President, discussed the "Need for Cooperative Effort and Coordination in the Water Research Field." The panelists were asked to consider the broad ideas which they obtained from these more general addresses.

General Recommendations

A number of important recommendations of a general, non-technical nature resulted from the deliberations of the panelists, the papers presented by the speakers, and other discussions held in connection with the conference. These recommendations are associated with research and can help to establish a better climate for research or make the results of research more effective and useful. They are as follows:

1. Further specialized conferences and workshops should be held on subjects of limited scope with relatively small groups of the nation's most competent individuals. Specific programs need to be formulated and follow-up meetings and conferences need to be held.
2. A series of task forces need to be established to:
 - a. Develop standard terminology.
 - b. Study and make recommendations on standard specifications and criteria for design and operation.
 - c. Delineate and recommend specific subjects or areas needing research to improve design and operation.
3. Various procedures and programs need to be established for bringing the practicing engineer up to date on new developments. This can be accomplished by such procedures as the following:
 - a. Emphasizing the publication of information in the Division Journals which would be helpful specifically to the practicing engineer.
 - b. Because there is such a large delay from the time information is developed to the time it can be disseminated and adopted by the profession, some means needs to be developed for getting new information to the practicing engineer more quickly. This would be materially aided by establishing continuing education activities such as a system of visiting lectureships for experts to give lectures to groups and organizations of engineers who are in engineering practice.
4. A publication of Summaries of Current Research in progress needs to be developed to help keep the profession informed. From this information the engineer doing planning, design, or research can learn more quickly the results of the work of others, incorporate these results and build on them in his own work. This could be a special annual edition of a publication such as the ASCE Irrigation and Drainage Division Journal.

5. Programs and procedures need to be developed in public information so that the public will have a better understanding and a greater appreciation for the works of the engineer. A better informed public can be helpful in increasing the effectiveness of engineering activities. An example of a specific area in which public information is especially needed is Weather Modification.
6. Research is needed for development of new instruments and problem-solving techniques. Examples include new uses of digital and analog computers.
7. Instrumentation centers, data processing centers, and advisory services need to be developed and established in various places so that they are readily available to those needing such services.
8. Programs and techniques need to be developed for closer liaison and cooperation with individuals and groups in all disciplines who are concerned with irrigation and drainage. Such cooperation should be developed through the professional organizations representing these disciplines.

Specific Recommendations

The following specific recommendations have been extracted and condensed from each of the panel reports:

Panel No. 1 - Evaporation from Water and Soil Surfaces

- A. Improvements in methods of measuring evaporation and evapotranspiration are needed.
- B. Research is needed to make improved efficiency of water use possible through instrumentation and techniques for monitoring soil moisture in cultivated fields and using that knowledge in farm and project water management.
- C. The relationships among plant growth and development, water use, and accessibility to water require intensive study.
- D. More study of the theory of evaporation from soil under unsteady state conditions is needed. The theory should be tested under a variety of field and laboratory conditions.
- E. For suppressing evaporation from free-water surfaces better methods of applying and maintaining a film are needed. There is a need for substances which when crumpled by the wind will reform into an effective film and which will resist biological and physical attrition.
- F. Better methods are needed to evaluate the effectiveness of evaporation-suppression techniques.
- G. Studies are needed to learn if it is practicable to modify (either increase or decrease) the albedo of a water surface for both long-wave and short-wave radiation.
- H. Improvements in high-speed sensing and recording equipment are needed to permit field measurement of heat and water-vapor flux, both at a point and integrated along a line.
- I. Using data provided by the above mentioned equipment, investigations of the diffusivities of heat, water vapor, and momentum should be made both in the laboratory and in the field to determine the relationships among them with stable, unstable and adiabatic lapse rates.
- J. The U. S. Weather Bureau should be encouraged to add observations of long-wave radiation (atmospheric radiation) to its present solar radiation (short-wave) network.
- K. A better understanding must be developed of the processes of soil physics and plant physiology related to water losses.

Panel No. 2 - Salinity and Alkali Problems

A. Criteria for Adequate Ground Water Control. --The effects of stable and fluctuating ground water tables on crop yields as related to soil texture, salinity control, oxygen diffusion in the zone of low water tension, root distribution, and nutrient supply and uptake should be determined.

B. Salt Tolerance of Plants. --More information is needed on the effect of varying salinity within the root zone on plant growth, the physiology of salt tolerance by plants, the relation between the level of production and apparent salt tolerance, and on salinity-fertility relationships.

C. Critical Processes and Properties of the Soil-Water-Salt System--The development of valid working models of transient or dynamic systems will depend on additional research studies concerning the following processes and properties of the soil-water-salt system:

1. Cation and anion exchange reactions under non-equilibrium conditions.
2. Precipitation and solution of salts in and from moving soil solutions.
3. Biochemical reactions.
4. Rates and directions of salt and water movements due to dynamic pressure distribution.
5. Clay minerals and their behavior under various levels of salinity.

D. Behavior of Salt-Water-Salt Systems. --There is a need for the development of models that can describe the transmission properties of the soil-water-salt system as affected by the properties of soil, soil and water management practices, and by the composition of salts in the soil and in the applied water.

E. Methods of Measurement. --The study of soil, salt, and water as a dynamic system will require the development of improved instrumentation and better methods for measuring the following parameters:

1. Matric suction and volumetric moisture content at various points in a profile.
2. Capillary conductivity as a function of volumetric moisture content.
3. Concentration of salts.
4. Composition of salts.

5. Temperature.

6. Saturated permeabilities.

F. Field Evaluation of Model Systems. --Once suitable laboratory and mathematical models are devised, they must be tested under field conditions. Two aspects are involved:

1. The development of designs that will test the hypothesis embodied in the model; and,
2. The development of a comprehensive theory based on the field results that can be used widely in engineering applications.

Panel No. 3 - Stable Channels

A. Establishment within ASCE or other suitable organization of an interdisciplinary advisory committee to assist with the investigation, direction, and coordination of research efforts on stable channels on a broad scale.

B. Research is needed to develop better design criteria in the following specific subject areas:

1. Bed forms and resistance: This needs to be determined for a wider range of field and laboratory conditions, and the various types of bed forms need more detailed definition.
2. Bed material samples: More accurate and simpler techniques need to be developed for sampling bed materials--particularly coarse bed materials--both on the surface of the bed and below it.
3. Bed material prediction: Size, size distribution, variation of size and size distribution with depth and origin of bed materials needs to be studied and analyzed to make them more predictable.
4. Coarse bed materials: Additional information is needed on the arrangement, rearrangement, configuration, and movement of gravel and cobble size bed materials.
5. Bed material size changes: These changes need to be determined for changes in discharge and different variation in size distribution.
6. Armor plating: The mechanics of armor plating needs to be developed in greater detail.
7. Degradation: This is a phenomenon which is inadequately understood and needs considerable research to improve the accuracy of design.

8. Cohesive bed materials: The effect of cohesive properties on bed forms and resistance need greater study.
9. Wash load: More information is needed regarding the effect of wash load on the movement of sediment and design criteria.
10. Non-uniform flow: The influence of changes in section needs to have further study.
11. Channel Bends: Basic and applied data and information is needed including flow patterns, bed characteristics, and energy loss.
12. Altered flow patterns: Determination needs to be made on the influence of altered flow patterns on channel stability, e. g. , regulation, diversions, accretions, and structures.
13. Structures: More refined determinations need to be made on the effect of control structures in alluvial channels.
14. Unsteady flow: Develop predictable criteria for sediment movement under unsteady flow conditions.
15. Channel periphery: The characteristics of the bed material along the periphery of natural and artificial channels needs to be determined so as to be predictable.
16. Analysis of sediment: Improved methods are needed for measurement and analysis of size, size distribution, shape, and hydraulic characteristics.
17. Laboratory materials: Further study needs to be made on the sediment materials which can best be used for laboratory research.
18. Slope measurements: A simpler and more precise method needs to be developed for slope measurement.
19. Navigation channels: Studies are needed on proper width, depth, bed material, and bank material for navigation channels where there are large fluctuations in flow.
20. Sediment discharge equations: The basic theory and equations need to be improved for sediment discharge.
21. Influence of turbulence: The role of turbulence in the basic mechanics of flow and sediment discharge in open channels needs to be determined.
22. Secondary circulation: Causes and patterns of secondary circulation need to be defined for more exact design.

23. Rigid channels: The shear distribution, flow pattern, and sediment carrying characteristics of flow in rigid channels needs study.

24. Geologic and geomorphic influences: The effects of these factors need to be determined.

25. Environmental influences: Determination needs to be made of the influence of such factors as groundwater conditions (influent or effluent), temperature variations, and chemical and biological factors.

Panel No. 4 - Small, Low-Cost Hydraulic Structures for Conveyance and Distribution Systems

A. Hydraulic Roughness. --Basic, imaginative research is needed to better understand and characterize the effect of roughness on flow. The utilization of roughness for energy dissipation and flow control needs further investigation.

B. Flow Measurement. -- Research is needed for development of entirely new measurement concepts as well as further investigation in modifications of older methods.

C. Energy dissipation. -- The dissipation of energy using simple structures needs intensive study. New and unconventional concepts for dissipation and conversion of energy should be investigated.

D. Pipelines. --Water hammer, surge, air entrainment, and other hydraulic problems, require that an intensive research program be initiated for design of improved pipeline structures and design.

E. Piping. --A better understanding of piping and methods of prevention are needed.

F. Canal Lining and Seepage. --Better and cheaper canal linings are a continuing need. Improved methods of seepage measurement must be developed.

G. Construction Methods. --Development of uses and procedures for construction using prefabricated and modular sections are needed.

H. Materials. --The use of new materials which show promise of lowered costs and/or more satisfactory structural or hydraulic properties needs more investigation. Standards and specifications for these materials are needed.

I. Codes and Standards for Small Hydraulic Structures. --The concept of a "calculated risk" applied to small structures will result in a more economical design. This requires a re-evaluation of allowable stresses and recommended factors of safety.

J. System Design. --The entire farm irrigation system design needs intensive study and design improvement. Considerations include labor saving and better application efficiency through automation, better structures, and methods of water application.

K. Specific Problems. --Specific items needing further study and development include: Turnouts, metergates, flow measuring devices, trapezoidal structures, side channel weirs, siphons and regulations, stilling basins and wells, transitions, bank erosion control, wave suppressers, seepage measuring devices, canal sealants, sediment control devices, moss and/or weed elimination devices, automatic flow controls, and rescue and safety devices.

Panel No. 5 - Weather Modification

Because of the importance of water supply to the United States, a long-range program related to development of an engineering approach to the problem of extracting increased amounts of water from the clouds is recommended. Such an approach will require the multi-disciplinary efforts of engineers, scientists, lawyers, politicians and the various other professions concerned. Changes in weather due to seeding are small relative to natural variations and are therefore difficult to detect; nevertheless small changes in precipitation can be of considerable economic significance.

Uniform laws should be developed for regulating cloud-seeding operations to protect the public, but in such a way that research is not handicapped. Any program of applied weather modification will require the understanding and support of the general public; therefore, an improved public information program is strongly recommended.

ASCE should arrange for a meeting in the immediate future of all interested groups and individuals to assess the problems of weather modification and take whatever continuing action seems desirable to further the objective of practical weather modification to increase water supply.

Specific research items recommended are:

1. Further study of physical properties of ice, and ice forming processes.
2. Condensation and growth of raindrops by coalescence (warm cloud process). Computer models of this process need to be developed as a prelude to field testing.
3. Action of natural and artificial ice-forming nuclei, search for new artificial nuclei and new and improved seeding techniques.
4. Investigate condensation nuclei for both warm and cold clouds.

5. Study electrification phenomena.
6. Development of techniques for tracing or predicting the drift and diffusion of cloud-seeding nucleant and the resultant precipitation particles.
7. Development of instrumentation systems for observing operations.
8. Seeding of stratified clouds. The supercooled stratus cloud is the next most complex step above the laboratory.
9. Seeding of warm-season convective clouds. Most of the rainfall of the humid east originates from clouds of this type which also contribute to precipitation regimes of orographic cloud systems. Apparently the warm-rain mechanism dominates. However, subsequent freezing and splintering indicates reduced potential for rain inducement, but improved prospects for hail suppression.
10. Meso-scale structure and its role in weather modification--- especially winter storms, particularly in orographic areas.
11. Wind patterns studies and seeding trials of orographic winter storms in mountain areas.

Panel No. 6 - Ground Water Management

- A. Legal, Legislative and Organizational. --Investigate existing law and develop an adequate body of law under which the jurisdiction and powers of an organization best suited to administer areal ground water activities can be established to further optimum economic and social benefits in proper relationship with existing agencies.
- B. Economic. --Determine the economic effects of alternative methods of organizing and operating integrated surface water and ground water systems in terms of both quantity and quality.
- C. Hydrology and Storage Capacity of Ground Water Reservoirs. --Improve methods of determining and estimating hydrologic properties of aquifers and aquitards, geophysical tools, understanding of inter-relations between surface and ground water, and knowledge of changes in hydrologic properties with time and applied stresses.
- D. Quality Control. --Develop:
 1. Models for computer analysis evaluation of quality changes due to increasing water use and associated economic effects.

2. A concept of the input-output ratio of quality depressants in specific basins.
3. Procedures for optimum use of capacity of the soil mantle and cover for quality improvement.
4. Analytical methods for detecting and evaluating new chemical pollutants; and collect, correlate and evaluate current data on a continuing basis for interpretation in relation to plans for optimum management.

E. Recharge. --Develop improved methods of operation and maintenance of facilities through better understanding of pertinent factors involving sedimentation, chemical and biological activity, intermittent saturation, multi-purpose use of land, improvement of physical and chemical characteristics of water and soil, and economically feasible artificial geophysical structural modifications.

Summary of Critique Questionnaire Comments

Near the end of the conference, a questionnaire was prepared with the help of the ASCE Research Manager and was circulated among the participants to obtain their evaluation of the conference. About 50 questionnaires were completed. We hope the results of the questionnaire will be useful in planning and conducting future activities. The comments obtained were summarized as follows:

Question 1. "What is your opinion in regard to the time, effort, expense (both individual and organizational) that had to go into this Conference VS the results of the Conference as you see it?"

Most of the comments were something in the nature of: Well worthwhile both personally to the participant as well as to employers and others. Many stated the final report would be very important as far as lasting value of the Conference was concerned. Some suggested the Conference would have accomplished more if the panel members had advance preparation. (Note: Several efforts were made to promote advance exchange of information without much success. It seemed as though the Conference itself was needed to stimulate the desired cross exchange of ideas.) A few felt that the initial session was too long and some of the time would have been better spent with the panels in session, even though the prepared talks were excellent. (Note: Generally the program committee agreed but this was not evident during the planning stage.)

Question 2. "What are your comments on the program structure (i. e. number of sessions, type of sessions, time allotted to each phase, number of panels, panel subjects, panel participants, observers, etc.)?"

The need for prior preparation was mentioned several times. The initial session was criticized as being too long. More time was suggested although many stated that added time would have unjustifiably extended the Conference. Some suggested that merely more time in the panels and less in the joint sessions was the answer. The Committee recognizes that the first reporting session may have seemed to be superfluous, but it believes that this session still has value in forcing the chairman of each panel to bring ideas into an early summary form in order to have the ideas in the best possible final form by the end of the conference.

Question 3. "It was hoped that the Conference would stimulate new thinking and free discussion. Has this been accomplished and what are the things that have helped or hindered these objectives? "

Most answers indicated that free discussion was accomplished but many questioned whether there was enough time to really have obtained new ideas. One more day or session seemed to be needed for new thinking on old problems. The Conference seemed to accomplish good statements of the problem. More effort was needed following the Conference or at later conferences that would stimulate new ideas.

Question 4. "In what ways do you think this conference has been or will be worthwhile? "

"(a) To the field of irrigation and drainage? "

The answers varied considerably, but all noted some form of benefit. The range covered stimulation of new research development, better understanding, crystallized thinking in several areas, justification for financial support of new research, show what can be done as well as what cannot be done, and develop increased contact between researchers.

"(b) To you personally? "

To many it was valuable in the planning of future programs to avoid duplication and work on more significant problems. Better understanding of other points of view were gained. It was a good opportunity to test ideas for new work.

Question 5. "What are your comments on the general arrangements and local arrangements for the Conference (logistics, etc.)? If you are not satisfied, how may specific items have been handled better? "

Everyone was pleased with arrangements. The only real comments were on the accessibility of the location and this was a minor comment to those who mentioned it.

Question 6. "In addition to publication of the proceedings, what are other things that might be done as follow up to make best use of the Conference results ? "

Recommendations were for ASCE and others to encourage research in the directions indicated by the panels , find people and agencies to do the research, encourage other meetings to follow up on recommendations being made, publish and publicize the results , continually point out the ideas developed, formulate specific programs and carry them out, bring the report to the attention of other organizations including those outside of the engineering profession. By far, follow-up meetings were favored to keep the ideas active and growing.

Question 7. "The Research Committee of the Irrigation and Drainage Division has been considering ways of keeping the profession better informed (currently, systematically, and in brief and concise form) regarding:

"(a) Current and new research on subjects related to Irrigation and Drainage.

"(b) Recent publications on subjects related to Irrigation and Drainage.

"What are your comments on the usefulness of such information if it is truly brief and concise and yet with enough detail to enable you to decide whether you want to see or study the (a) research or (b) publication in greater detail? What form might this information take? "

Abstract services were commented on very favorably to be obtained either separately or in some type of publication form. Most felt such a service would be very valuable to researchers in particular. A subscription service might also be provided for interested parties only. A selective dissemination system was preferred.

Special reports , reviews , or summaries were suggested by several, either in review series or in a form such as periodic annotated bibliographies.

Several answers suggested that opportunities be provided for informal exchange of ideas in brief published form or in open discussion sessions at conferences.

Conclusions

The following conclusions are those of the writer which have been gleaned from consideration of the various comments, suggestions, and recommendations of the speakers and panels of the conference.

1. Additional specialized conferences, workshops, and follow-up meetings must be held on subjects of limited scope with small groups of experts from various disciplines concerned with the subject in question. These should be stimulated by the Executive Committee of the Irrigation and Drainage Division, as well as the Research Committee of ASCE and the Secretariat of ASCE in New York.
2. Special task forces need to be established to develop standard terminology, to develop standard specifications and criteria for design and operation, and to delineate and recommend specific subjects needing research.
3. Specific plans need to be developed and established for bringing the practicing engineer up to date on new developments.
4. Summaries of current research in progress in irrigation and drainage need to be published to help keep the profession informed.
5. Public information programs need to be developed so that the public will have a better understanding and a greater appreciation for the work of the engineer.
6. New instruments and instrumentation centers need to be developed.
7. Data processing centers need to be developed for specific use of those in irrigation and drainage research and study.
8. A more specific interdisciplinary approach needs to be developed on research and study in the field of irrigation and drainage.
9. The civil engineering profession must give strong and continual support to the education and training of engineers for research, design, and operations to make the necessary progress on the many complex problems which confront the civil engineer.
10. Crash programs and sharp variations in the level of support for research and study are bound to lead to inefficient yields in terms of results. The maximum yield will result from continued efforts even if they are modest in extent.

11. A series of Research Councils of an interdisciplinary nature need to be established within the structure of ASCE in accordance with the administrative provisions for establishing Research Councils adopted in October, 1959 by the Board of Direction of ASCE. The following are examples of specific Research Councils which need to be established to focus on a specific research topic to meet the needs for a coordinated and interdisciplinary approach to research, study, and action:

- a. A Research Council on instrumentation and data processing.
- b. A Research Council on the interactions of soil, water, plants, and climate.
- c. A Research Council on small, low-cost hydraulic structures.
- d. A Research Council on weather modification.
- e. A Research Council on ground-water management.

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This conference represents many hours of thought and effort on the part of a multitude of individuals, without which the conference would not have been possible. The Research Committee of the Irrigation and Drainage Division, who had the immediate responsibility of developing the conference, is deeply indebted to the following individuals and organizations: Each of the panelists who devoted valuable time away from his employment for the success of the conference; to the panel chairmen, vice-chairmen and recorders who carried out their pre-conference and post-conference assignments with enthusiasm and promptness; to the guest speakers for their careful presentation of ideas and information on their assigned topics; to the many organizations and employers who willingly endorsed the attendance of the participants at the conference; to those who skillfully presided over the conference sessions and social events, to Utah State University for providing the necessary facilities, staff and other assistants in their role as host for the conference; to the Bureau of Reclamation and the National Science Foundation for providing the financial and other support necessary to conduct the conference and insure that the best talent available could be obtained for the conference; to the local arrangements committee at Utah State University for their tireless efforts in accommodating the multitude of needs of the conferees; to the Utah Section of ASCE for their cooperating in co-sponsoring the main conference banquet; and to the ASCE staff for their continuing advice and support.

Specifically, Don P. Reynolds, Assistant Executive Secretary of ASCE, was very helpful in the initial concepts and planning of the Conference. Donald C. Taylor, Research Manager of ASCE, was especially helpful all through the development of the Conference, the conduct of it, and the writing of the report--his tireless efforts are most appreciated.

Each of the members of the Research Committee of the Irrigation and Drainage Division gave freely of his time in all stages of development and conduct of the Conference. A. R. Robinson and C. W. Thomas, Vice-Chairman and Secretary of the Research Committee respectively, spent endless hours throughout--especially in the writing of the report.

Finally, I speak for all members of the Research Committee in expressing appreciation to the Executive Committee of the Irrigation and Drainage Division, under the successive chairmanships of Nephi A. Christensen, Herbert E. Prater, and Paul H. Berg, for their cooperation, encouragement, interest and help in the development and conduct of the Conference.

Roster

Executive Committee of the Irrigation and Drainage Division

Paul H. Berg, Chairman
William W. Donnan
Dean F. Peterson, Jr.
Harold A. Scott
Leland J. Walker
Carl R. Wilder
Herbert E. Prater, Past Chairman
Nephi A. Christensen, Past Chairman

Research Committee of the Irrigation and Drainage Division (Program Planning Committee)

Maurice L. Albertson, Chairman
A. R. Robinson, Jr.
Charles W. Thomas
Dean F. Peterson, Jr.
Robert L. Hardman
Dell G. Shockley

Local Arrangements Committee

Calvin G. Clyde, Co-Chairman
J. E. Christiansen, Co-Chairman
Mrs. A. Alvin Bishop
Calvin G. Clyde
Don Chery
M. K. Jeppesen
Fred Keifer
A. A. Bishop
Jack Keller
Bruce H. Anderson
Jay M. Bagley
E. C. Olson

Panels

No. 1 - Evaporation from Water and Soil

G. Earl Harbeck, Jr., Chairman
Jack E. Cermak, Vice-Chairman
Bruce H. Anderson, Recorder
C. Brent Cluff
Walter U. Garstka

Vaughn E. Hansen
T. E. A. van Hylckama
Rolland F. Kaser
Tor J. Nordenson
Wyndham J. Roberts

No. 2 - Salinity and Alkali Problems

C. Dawson Moodie, Chairman
R. C. Reeve, Vice-Chairman
Lyman S. Willardson, Recorder
Norman A. Evans
Clyde E. Houston

C. R. Maierhofer
John Maletic
Donald R. Nielson
Wynne Thorne

No. 3 - Stable Channels

D. B. Simons, Chairman
Carl Miller, Vice-Chairman
Gordon Flammer, Recorder
Thomas Blench
D. C. Bondurant

W. M. Borland
H. A. Einstein
Olin Kalmbach
Gerald Lacey
Vito A. Vanoni

No. 4 - Small, Low-cost Hydraulic Structures for Conveyance and Distribution Systems

John T. Phelan, Chairman
G. V. Skogerboe, Recorder
G. W. Birch
Fred Blaisdell
G. L. Corey
Benson Kelly

A. J. Peterka
A. F. Pillsbury
Tyler Quackenbush
D. G. Shockley
C. W. Thomas
C. R. Wilder

No. 5 - Weather Modification

Robert D. Elliott, Chairman
Vincent J. Schaefer, Vice-Chairman
Joel L. Fletcher, Recorder
John C. Bellamy
Roscoe R. Braham, Jr.
Lyle D. Calvin
Quentin L. Florey

Paul B. McCready, Jr.
Wendell A. Mordy
Edward A. Morris
Richard A. Schleusener
Patrick Squires
Pierre St. Amand

No. 6 - Ground-water Management

Harvey O. Banks, Chairman
A. E. Bruington, Vice-Chairman
J. P. Riley, Recorder
C. S. Conover
J. H. Krieger
P. H. McGauhey

S. E. Reynolds
Leonard Schiff
Stephen Smith
William Tapp
J. E. Upson

Objectives:

The objectives of the Conference are to delineate and stimulate high-quality research needed in selected subject areas in order to advance the status of knowledge and thereby improve the quality of engineering in the planning, design, operation and maintenance of irrigation and drainage systems.

Six panel sessions are planned for the Conference to discuss the following subjects: (1) Evaporation from Water and Soil; (2) Salinity and Alkali Problems; (3) Stable Channels; (4) Small, Low-Cost Hydraulic Structures for Conveyance and Distribution Systems; (5) Weather Modification; and, (6) Ground-Water Management.

In each panel the following questions will be investigated: (1) Why is the selected subject important? (2) Where do we stand in this field at present? (3) Where are the deficiencies of knowledge and practice? and (4) What direction does research need to take on this subject in order to advance most significantly the status of knowledge and practice?

As a result of the Conference, a report of the deliberations will be prepared, published and distributed for reference of scientists, engineers, and others concerned with irrigation and drainage research.

Program Planning Committee:

M. L. Albertson, Chairman
A. R. Robinson, Jr., Vice Chairman
Charles W. Thomas, Secretary
Dean F. Peterson, Jr.
Robert L. Hardman
Dell G. Shockley
Herbert Prater

Local Arrangements Committee:

Calvin G. Clyde } Chairmen
J. E. Christiansen, }
Mrs. A. Alvin Bishop, Ladies' Activities
Calvin G. Clyde, Motels and Hotels
Don Chery, Transportation
M. K. Jeppesen, Budget and Finances
Fred Keifer, Registration
A. A. Bishop }
Jack Keller } Dining Arrangements
Bruce H. Anderson }
Jay M. Bagley }
E. C. Olson, Press and Photography

PROGRAM

Thursday, March 19, 1964

*7:00 a.m. Cafeteria - Union Building
to
8:00 a.m. Breakfast

8:00 a.m. Lobby of Engineering and Physical
to
9:00 a.m. Science Building - Registration

*9:00 a.m. Engineering Auditorium
to
11:30 a.m. Opening Session - Presiding, Dr. Vaughn E. Hansen,
Director of Engineering Experiment Station, Utah State University.

Opening Remarks-Milton R. Merrill,
Vice President, Utah State University.

"The Overall Importance of Irrigation and Drainage Both Nationally and Internationally,"
Floyd E. Dominy,
Commissioner of Reclamation.

"Need for New and Creative Research in Irrigation and Drainage," T. W. Edminster,
Associate Director, Agricultural Research Service, Soil and Water Conservation Research Division.

"Charge of Responsibility to the Panels," Maurice L. Albertson,
Director, Office of International Programs, Colorado State University,
and Chairman, Committee on Research Irrigation and Drainage Division, ASCE.

11:30 a.m. Panel Meeting Rooms
to
12:00 noon Organization Session for Each of the Six Panels.

Panel No. 1 - "Evaporation from Water and Soil Surfaces,"
Room L-241.
G. Earl Harbeck, Chairman;
Bruce H. Anderson, Recorder.

Panel No. 2 - "Salinity and Alkali Problems,"
Room L-245.
Milton Fireman, Chairman;
Lyman Willardson, Recorder.

PROGRAM

11:30 a.m. Panel No. 3 - "Stable Channels,"
to
12:00 noon Room L-247.
Daryl B. Simons, Chairman;
Gordon Flammer, Recorder.

Panel No. 4 - "Small, Low-Cost Hydraulic Structures for Conveyance and Distribution Systems,"
Room L-259.
John T. Phelan, Chairman;
Gaylord Skogerboe, Recorder.

Panel No. 5 - "Weather Modification,"
Room L-290.
Robert D. Elliott, Chairman;
Joel Fletcher, Recorder.

Panel No. 6 - "Ground-Water Management,"
Room L-292.
Harvey O. Banks, Chairman;
Paul Riley, Recorder.

*12:15 p.m. Cafeteria - Union Building
Luncheon - Toastmaster, Dr. Gordon H. Flammer,
Associate Professor of Civil and Irrigation Engineering, Utah State University.

"Need for Cooperative Effort and Coordination," William C. Ackermann,
Office of Science and Technology,
Executive Office of the President.

2:00 p.m. Panel Meeting Rooms
to
5:00 p.m. Panel Discussions.

*5:30 p.m. Logan Country Club
to
6:30 p.m. Social Hour

*6:45 p.m. Union Building
to
7:30 p.m. Informal Buffet

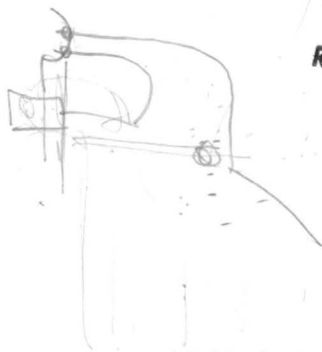
8:00 p.m. Panel Meeting Rooms
Work Session (if needed)

PROGRAM

Friday, March 20, 1964

- *7:00 a.m. Cafeteria, Union Building
to
8:15 a.m. Breakfast
- 8:30 a.m. Panel Meeting Rooms
to
12 noon Panel Discussions and Preparation of Brief Preliminary Progress Reports.
- *12:15 p.m. Cafeteria, Union Building
Luncheon
- *1:30 p.m. Engineering Auditorium
to
5:00 p.m. Presentation of Preliminary Progress Reports and Open Discussion in Interdisciplinary Topics, Presiding, William W. Donnan, Branch Chief, Agricultural Research Service, and Vice Chairman, Executive Committee, Irrigation and Drainage Division, ASCE.
- *5:30 p.m. Logan Country Club
to
6:30 p.m. Social Hour
- *7:00 p.m. Union Building
Dinner - Toastmaster, Dr. A. Alvin Bishop, Professor of Civil and Irrigation Engineering, Utah State University.

"Half a Century of Research in the Field of Irrigation and Drainage," George D. Clyde, Governor, State of Utah.



PROGRAM

Saturday, March 21, 1964

- *7:00 a.m. Cafeteria, Union Building
to
8:15 a.m. Breakfast
- 8:30 a.m. Panel Meeting Rooms
to
12:00 noon Panel Discussion and Preparation of Final Reports.
- *12:30 p.m. Cafeteria, Union Building
Luncheon
- *2:00 p.m. Engineering Auditorium
to
5:00 p.m. Final Session,
Presiding, Paul H. Berg, Assistant Director, Region 7, USBR, and Chairman, Executive Committee, Irrigation and Drainage Division, ASCE.

Submission of Final Reports of Panels and Discussion - Panel Chairmen.

Closing Remarks, Paul H. Berg.

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* Public Sessions.

Coffee will be available each forenoon and afternoon of the Conference in the Breezeway Lobby.

IRRIGATION and DRAINAGE RESEARCH CONFERENCE

March 19, 20, 21, 1964

Engineering and Physical Science Building

Utah State University

Logan, Utah

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