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Director

NATIONAL BUREAU OF STANDARDS
HYDRAULIC LABORATORY BULLETIN
SERIES A

CURRENT HYDRAULIC LABORATORY RESEARCH IN THE UNITED STATES

BULLETIN IX
January 1941

WASHINGTON

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DIRECTORY.

CURRENT HYDRAULIC LABORATORY RESEARCH IN THE UNITED STATES

Compiled by the National Bureau of Standards,
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Hydraulic Laboratory Section,
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Volume IX January 1941

INTRODUCTION

The following list shows what issues of National Bureau of Standards Hydraulic Laboratory Bulletins, Series A and B, have appeared and which are still available for distribution.

Series A. Current Hydraulic Laboratory Research in the United States.

Volume I-1,	April 1, 1933.	Supply exhausted.
" I-2,	July 1, 1933.	" "
" I-3,	October 1, 1933.	" "
" II-1,	January 1, 1934.	" "
" II-2,	July 1, 1934.	" "
" III-1,	January 1, 1935.	" "
" III-2,	July 1, 1935.	" "
" IV-1,	January 1, 1936.	
" IV-2,	July 1, 1936.	
" V-1,	January 1, 1937.	
" V-2,	July 1, 1937.	" "
" VI,	January, 1938.	
" VII,	" 1939.	
" VIII,	" 1940.	

Series B. Hydraulic Laboratories in the United States.
First issue, 1933. Supply exhausted.
" revision, 1935.

The information contained in these bulletins is compiled with the cooperation of the various hydraulic and hydrologic laboratories in the United States. The Series A bulletins give an annual summary of research that is in progress in these laboratories and thus make known to hydraulic laboratory staffs, to engineers who design hydraulic structures, and to hydrologists the existence of studies that frequently would come to their attention only at much later dates, when the results are published.

The Series B bulletins give a brief description of the hydraulic laboratories in the United States and their experimental equipment. They are issued only at infrequent intervals. These bulletins perform a useful service by showing at a glance where facilities exist for tests that require very special equipment or conditions. Another bulletin in this series is contemplated in the near future.

Series A was originally restricted to reporting hydraulic laboratory studies. However, the growing extent of hydrological research, particularly by government agencies, and the close relation that much of this research bears to the planning and design of hydraulic structures led to the decision in 1938 to broaden the scope of the bulletin to include reports on such research in the future. The response to this decision in the later bulletins indicates that it is advisable to continue on this basis.

It is emphasized again that the National Bureau of Standards does not have in its files reports or detailed information regarding the research projects reported by other organizations. Any person who wishes to obtain information regarding any project reported in this Bulletin should write to the Correspondent listed under (e) for that project. The Correspondent's address can be found in the Directory at the beginning of this Bulletin.

Copies of this bulletin are supplied to interested persons and organizations without charge. A mailing list is maintained which includes the names of such persons as have requested in writing that this service be furnished them.

In writing to the National Bureau of Standards in regard to any matter concerning this bulletin, please refer to our reference VI-6/INHU.

Key to Projects.

(a) Title of project:
(b) Project conducted for:
(c) Nature of project:
(d) Investigators:
(e) Correspondent:
(f) Purpose:
(g) Method and scope:
(h) Progress:
(i) Remarks:

CURRENT PROJECTS IN HYDRAULIC LABORATORIES.

UNIVERSITY OF CALIFORNIA (College of Agriculture).

(1157) (a) PHYSICAL AND CHEMICAL FACTORS AFFECTING SOIL INFILTRATION RATES.
(b) U. of C., College of Agriculture, Los Angeles.
(c) Experiment Station project.
(d) M. R. Huberty, A. F. Pillsbury.
(e) Prof. M. R. Huberty.
(f) Study of factors affecting soil infiltration rates, primarily as to effect on irrigation practices.
(g) Field plots and laboratory investigation under controlled conditions.
(h) A continuing project, certain phases of which have been completed.
(i) Certain preliminary results indicate:
(1) Chemical factors: The sodium percentage of a water is recognized as influencing the porosity of a soil. However, it has been found that even without a high sodium percentage, other chemicals such as ammonium sulphate may so alter the structure of the surface soil, even of highly calcareous soils, as to greatly reduce infiltration rates.
(2) Physical factors: Organic matter incorporated in a soil increased infiltration rates, as did shading of the soil surface. Where sprinklers were operated on a freshly cultivated soil under controlled conditions, infiltration rates and total application without runoff decreased with increasing drop size.

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(1158) (a) HYDROLOGIC STUDIES IN COACHELLA VALLEY, CALIFORNIA.
(b) University of California, College of Agriculture.
(c) A sub-project of California Agricultural Experiment Station, Project 1108, Hydrology of irrigation water supplies in California (See Bulletin VII, 1939, Project 607, p. 103.
(d) Martin R. Huberty, A. F. Pillsbury, and V. P. Sokoloff.
(e) Prof. Martin R. Huberty.
(f) To evaluate present hydrologic conditions, and to secure information which will provide a basis for studying the effect, if any, of imported Colorado River water.
(g) Scope --
Determination of: (1) chemical composition of surface and ground waters, (2) analysis of Coachella Valley County Water District's 21-year record of ground-water elevations, (3) studies on salt removal from highly saline soils.
Method--
(1) One or more complete chemical analyses were made on waters from 15 streams and 110 wells.

(2) Records have been compiled of static water-level measurements made by Coachella Valley County Water District of approximately 100 test wells over a period of 21 years.

(3) Collected information regarding present irrigation use of water, as well as consumptive use.

(4) Determination in the field and in the laboratory of infiltration rates. Measurements were made of salt removal from the soil profile by percolation and by surface flushing.

(h) Field work completed. Report being prepared for publication in Hilgardia series of University of California, College of Agriculture.
(i) Preliminary data have been made available to U. S. Bureau of Reclamation.

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CALIFORNIA INSTITUTE OF TECHNOLOGY (Cooperative Laboratory, Soil Conservation Service.)

(659) (a) MECHANICS OF SUSPENDED LOAD TRANSPORTATION.
(b) Sedimentation Division, Soil Conservation Service. U. S. Department of Agriculture.
(c) Cooperative research program with Soil Conservation Service.
(d) Prof. Robert T. Knapp, Dr. Vito A. Vanoni.
(e) Prof. Robert T. Knapp, Dr. Vito A. Vanoni.
(f) To investigate the internal mechanics of transportation of suspended load by flowing water; the effects of the material in suspension upon the velocity distribution of the flow; the distribution of sediment in open channel flow.
(g) The experiments are carried on in a flume 33 inches wide by 60 feet long arranged so the slope can be adjusted to any value up to 1:60. A pump connected to the closed-circuit system of the flume is capable of circulating mixtures of sediment and water at continuously varying rates up to 5 cubic feet per second. Velocity and sediment distribution are obtained from direct measurements made at different elevations in the flow. Velocities are measured with a Prandtl Pitot tube, and sediment concentrations are determined from samples siphoned from the flow at rates corresponding to the velocity of the water at the sampling point.
(h) Velocity and sediment distribution measurements have been made with three sediments of uniform size. These experiments show that suspended sediment has some unexpected effects on stream flows. A thesis report by Vito A. Vanoni entitled, "Experiments on the Transportation of Suspended Sediment by Water", was submitted to the California Institute of Technology in June 1940. A report

covering the same material is awaiting publication. The research is being continued with a view to finding the effect of suspensions of high concentrations and of determining the transporting capacity of flows.

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(660) (a) DEVELOPMENT OF A HOT-WIRE VELOCITY METER FOR USE IN WATER.
(b) Sedimentation Division, Soil Conservation Service, U. S. Department of Agriculture.
(c) Cooperative research program with Soil Conservation Service.
(d) Vito A. Vanoni, E. E. Simmons.
(e) Prof. Robert T. Knapp, Dr. Vito A. Vanoni.
(f) To develop an instrument suitable for use in determining velocity distribution in flows carrying sediments.
(g) Calibration of hot-wire instrument with alternating and direct current circuits in a 3/4-inch orifice.
(h) Work on this problem was interrupted after some preliminary tests had been made and before sufficient progress was realized to warrant a report. The project is still inactive owing to lack of personnel.

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(661) (a) THE USE OF HYDRAULIC MODELS IN THE DESIGN OF SUSPENDED-LOAD SAMPLERS.
(b) Hydrologic Division, Soil Conservation Service, U. S. Department of Agriculture.
(c) Cooperative research program with the Soil Conservation Service.
(d) J. Pat O'Neill.
(e) Professor Robert T. Knapp, Dr. Vito A. Vanoni.
(f) The development of a multiple-unit suspended-load sampler and of single-unit line-suspended samplers that cause little disturbance to the flow and, therefore, are satisfactory in suspensions of particles having appreciable fall velocities.
(h) Research completed and following papers published:- (1) The Use of Hydraulic Models in The Design of Suspended Load Samplers. By J. Pat. O'Neill. Trans. Am. Geophs. Union 1940, Part I, p. 78. (2) Designs for Suspended Load Samplers, by J. Pat. O'Neill. Publication No. SCS-TP-33 1940. The latter publication is being distributed by the Soil Conservation Service, Sedimentation Division, Washington, D. C.

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(810) (a) THE STUDY OF SEDIMENT-LADEN FLOWS (DENSITY CURRENTS) IN RESERVOIRS.
(b) Sedimentation Division, Soil Conservation Service.
(c) Cooperative research program with Soil Conservation Service.
(d) Prof. Robert T. Knapp, Hugh Stevens Bell.

(810) (e) Prof. Robert T. Knapp, Dr. Vito A. Vanoni, Project Supervisor.
(f) To investigate density currents resulting from suspensions of fine sediments in reservoirs, and to attempt to establish principles governing their behavior.
(g) Experiments conducted in glass-walled tank 3-inches wide by 10-inches deep by 5-feet long, using a suspension of clay in water to represent the sediment-laden flow.
(h) A systematic set of experiments has been made to determine qualitatively the mechanism of density flows and how they are affected by such factors as the sediment load of the flow, the slope of the channel, and the viscosities of the fluids. A few experiments were also made to investigate the possibility of density currents resulting from suspensions caused by wave action either on beaches or in bottom deposits in shallow water. In the latest experiments the knowledge gained in the earlier studies is being applied in developing methods of selectively removing from a reservoir layers that have formed by density stratification. Such methods are intended for use in the operation of reservoirs to pass the undesirable water, such as that containing salt or sediment, thus preserving the storage space for the better water. A report on the above research is being prepared for publication.

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(812) (a) HYDRAULIC DESIGN OF EROSION-CONTROL STRUCTURES BY MEANS OF MODEL TESTS.
(b) Hydrologic Division and Operations Division, Southwest Region, Soil Conservation Service, U. S. Department of Agriculture.
(c) Cooperative research program with Soil Conservation Service.
(d) Brooks T. Morris, Vito A. Vanoni.
(e) Prof. Robert T. Knapp, Dr. Vito A. Vanoni, Project Supervisor
(f) To improve existing designs and develop new designs for erosion-control structures used in field operations.
(g) Proposed designs of specific structures are tested and modified through hydraulic model studies in the laboratory. Typical structures intended to cover a wide range of field conditions are also tested with a view to improving design standards. In this work close and active cooperation is maintained between the laboratory and field.
(h) Study completed. A formula has been derived for the hydraulic design of small dams of the free overfall type which are used in gully control by the Soil Conservation Service. The formula covers all ranges of rate of flow and height of fall that are encountered in field work. The results of this work are already in use in the field and they are now being prepared for publication.

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(815) (a) FIELD SAMPLING EXPERIMENTS ON BEACH SAND FROM MUSTANG ISLAND, TEXAS.
(b) Sedimentation Division, Soil Conservation Service, U. S. Department of Agriculture.
(c) Cooperative research program with Soil Conservation Service.
(d) George H. Otto.
(e) Prof. Robert T. Knapp, Dr. Vito A. Vanoni, Project Supervisor, George H. Otto.
(f) See Bulletin VIII, 1940.
(g) " " " "
(h) The research has been completed and a rough draft of a report prepared.
Completion of the report is delayed because of reduction in staff.

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(831) (a) AN EXPERIMENTAL STUDY OF TURBULENT MIXING IN OPEN CHANNEL FLOW AND THE EFFECT ON THE SUSPENSION OF SEDIMENT.
(b) Sedimentation Division, Soil Conservation Service, U. S. Department of Agriculture.
(c) Cooperative Research Program with Soil Conservation Service.
(d) E. R. Van Driest.
(e) Prof. Robert T. Knapp, Dr. Vito A. Vanoni, Project Supervisor.
(f) To obtain by direct measurement the variation of the fluid-mixing coefficient with depth in an open channel and to determine the relation between the fluid-mixing coefficient and the sediment-mixing coefficient.
(g) Experiments are performed in a closed-circuit flume 10" wide by 10" deep and 40' long, with an adjustable slope. A five-foot glass window permits photographic observations, and control of the discharge is effected by a variable-speed pump drive. The fluid-mixing coefficient was determined at various depths for several flows from photographic observations of the diffusion of small immiscible globules injected into the flow at a point.
(h) This study was completed and reported in a thesis by Edward R. Van Driest entitled "An Experimental Investigation of Turbulence Mixing - A Factor in the Transportation of Sediment in Open-Channel Flow", which was submitted to the California Institute of Technology in June 1940.

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(1098) (a) INFLUENCE OF SAMPLE WEIGHT AND SIEVING TIME ON SIEVE ANALYSIS OF SANDS.
(b) Sedimentation Division, Soil Conservation Service.
(c) Cooperative research program with Soil Conservation Service.
(d) George H. Otto and Melvin L. Wat.
(e) Prof. Robert T. Knapp, Dr. Vito A. Vanoni, Project Supervisor
(f) See Bulletin VIII, 1940.
(g) See " " "
(h) The laboratory work has been completed, an oral report has been presented, and a rough draft of a written report prepared. Completion of the report is delayed because of the reduction in staff.

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(1101) (a) THE STABILITY OF NATURAL SEDIMENTS UNDER LOCALLY CONCENTRATED ATTACK OF FLOWING WATER.
(b) Sedimentation Division, Soil Conservation Service, U. S. Department of Agriculture.
(c) Cooperative Research Program with Soil Conservation Service.
(d) Brooks T. Morris.
(e) Prof. Robert T. Knapp, Dr. Vito A. Vanoni, Project Supervisor.
(f) To establish a rational basis for the prediction of the rate of scour of natural or artificially placed sediments or pavements at the foot of drop structures, overfall dams, and natural waterfalls.
(g) Through the identification and individual evaluation of the variables (geometric, flow, fluid and sediment characteristics in a scour-hole model, the rate of scour under varying conditions is to be established quantitatively. The model accomplishes scour through a jet directed vertically downward on the sediment bed.
(h) The rate of scour-hole growth in single-sized sediments was determined for a selected range of jet velocities. Analysis of these data has indicated that scour can be expressed by equations similar to those of suspended-load transportation, and this type of relation was fitted to the data. The analytical as well as the experimental research is continuing.

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(1102) (a) THE DEVELOPMENT OF METHODS OF DISSIPATING ENERGY BELOW DROPS.
(b) Hydrologic Division, Soil Conservation Service, U. S. Department of Agriculture.
(c) Cooperative Research Program with Soil Conservation Service.
(d) Walter L. Moore and Brooks T. Morris.
(e) Prof. Robert T. Knapp and Dr. Vito A. Vanoni, Project Supervisor.
(f) To study energy dissipation in a drop with a view to evaluating the effectiveness of the various design features of drop structures in producing stilling and minimizing down-stream erosion.
(g) The studies are carried on in a two-dimensional model having an 18-inch drop and a flat apron without a sill. The energy gradient through the structure is determined by velocity and surface profile measurements at sections in the structure. Investigations are made for different discharges and tail-water depths.
(h) The study has been completed, and a report on the work is awaiting publication.

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CALIFORNIA INSTITUTE OF TECHNOLOGY, HYDRAULIC STRUCTURES LABORATORY.

(832) (a) THE REDUCTION OF THE DISTURBANCES PRODUCED BY CHANGES OF DIRECTION OF SHOOTING FLOW IN OPEN CHANNELS.
(b) Laboratory project.
(c) Research for thesis for Ph. D. degree.
(d) W. O. Wagner.
(e) Prof. Robert T. Knapp, W. O. Wagner.
(f) A continuation of Projects 357 and 636 to study additional methods of control for high-velocity channels.
(g) The equipment used in Project 636 and a short variable slope flume of the same cross section are being used for the experiments. The lines of investigation are being drawn on the basis of the analysis of the mechanism of flow developed in the previous projects.
(h) Research complete and thesis in preparation.

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(1097) (a) INVESTIGATIONS OF FLOW IN CURVED NON-RECTANGULAR CHANNELS.
(b) Laboratory project.
(c) Research for thesis for M. S. degree.
(d) O'Dean Anderson, Justus A. Olsson.
(e) Dr. Robert T. Knapp.
(f) Methods of minimizing disturbances in non-rectangular flumes due to high-velocity flow in curves.
(h) Research complete and thesis presented. One method of reducing disturbance in the curves of trapezoidal channels was developed on the basis of principles brought out in Project 856. Copy of this thesis is available in the library of the National Hydraulic Laboratory.

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(1098) (a) PULSATING FLOW CHARACTERISTICS OF PIPE LINES.
(b) Shell Oil Research Fellowship.
(c) Laboratory investigation.
(d) P. S. Devirian, Jr.
(e) Prof. R. L. Daugherty, Prof. R. T. Knapp, P. S. Devirian.
(f) To determine frictional and operating characteristics of pipe lines subject to pulsating flow.
(g) Controlled pulsating flow produced by mechanically driven valve in pipe line of approximately 2400 diameters length. Flow characteristics were determined for pulsation frequencies at or near resonance with natural surge frequency of line.
(h) Research complete and thesis presented.

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(1159) (a) INVESTIGATION OF THE RESISTANCE COEFFICIENT OF A RECTANGULAR CHANNEL FOR BOTH TRANQUIL AND SHOOTING FLOWS.
(b) Laboratory Project.
(c) Research for thesis for M. S. degree.
(d) L. G. Waigand, R. H. Weight.
(e) Prof. Robert T. Knapp, Dr. V. A. Vanoni.
(f) To determine the effect of change in flow type on the resistance coefficient of the channel.
(g) Experiments will be conducted in a brass channel 18" wide and 100 ft long. Both slope and discharge will be varied to cover the desired range.
(h) Apparatus being set up.

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CALIFORNIA INSTITUTE OF TECHNOLOGY, HYDRAULIC MACHINERY LABORATORY.

(818) (a) STUDY OF PRACTICAL LIMITS OF SPECIFIC SPEED FOR GRAND COULEE PUMPING PLANT.
(b) U. S. Bureau of Reclamation.
(c) Cooperative Research Program with U. S. Bureau of Reclamation.
(d) Hydraulic Machinery Laboratory Staff.
(e) Professors R. T. Knapp, R. L. Daugherty, and Th. Von Kármán.
(f) See (a).
(g) Tests covering a wide specific speed range were made on large-scale model pumps. Cavitation performance and head-capacity characteristics determined from precise dynamometer tests were compared for several typical designs at each specific speed. For a description of the special laboratory equipment used for this work, see A.S.M.E. Transactions for November, 1936, Hyd-58-5 by R. T. Knapp, "The Hydraulic Machinery Laboratory at the California Institute of Technology."
(h) Investigations completed. A summary of the main conclusions were incorporated in a paper entitled "Centrifugal Pump Performance as Affected by Design Features", presented by R. T. Knapp at the 1940 Fall Meeting of A.S.M.E., to be published in A.S.M.E. Transactions.

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(819) (a) AN INVESTIGATION OF THE CHARACTERISTICS OF SEVERAL TYPES OF PUMP CASINGS AND A COMPARISON OF THEIR ADVANTAGES.
(b) U. S. Bureau of Reclamation.
(c) Cooperative research program with U. S. Bureau of Reclamation.
(d) Hydraulic Machinery Laboratory Staff.
(e) Professors Th. von Kármán, R. T. Knapp, and R. L. Daugherty.
(f) A systematic and accurate comparison is desired for the several types of pump casings proposed for the Grand Coulee installation.
(g) Precise dynamometer tests of pumps using a variety of casing types furnished data necessary for comparison of such items as cavitation performance, head-capacity-power characteristics, and unbalanced radial forces.
(h) Same as for Project (818).

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(820) (a) STUDY OF ENERGY LOSSES IN DIFFUSERS INSTALLED AT THE DISCHARGE FLANGE OF CENTRIFUGAL PUMPS.
(b) Hydraulic Machinery Laboratory Research Program.
(c) General Laboratory Investigation.
(d) Hydraulic Machinery Laboratory Staff.
(e) Professors Th. von Kármán, R. T. Knapp, and R. L. Daugherty.
(f) An accurate knowledge of losses in such diffusers is necessary for the proper evaluation of pump and line loss characteristics.
(g) Precision tests of pumps with diffusers of various angles of divergence provided data used in this analysis. Accurate comparisons are possible from measured overall losses and measured pressure distributions along the diffusers.
(h) Investigations completed. Measurements have shown that a portion of the energy normally charged as loss to the pump and diffuser is recovered downstream from the diffuser and measuring station. This apparent gain is explained as a pressure increase accompanying a redistribution of the velocity, and hence kinetic energy, in the pipe line following the diffuser. Consequently, care must be taken in location of discharge pressure taps if the pump performance is not to be penalized by this behavior.

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(821) (a) STUDY OF PRE-ROTATION AND REVERSE FLOW AT THE EYE OF A CENTRIFUGAL PUMP.
(b) U. S. Bureau of Reclamation Research Program.
(c) Research for thesis for Ph. D. degree.
(d) James W. Daily.
(e) Professors R. T. Knapp, R. L. Daugherty and Th. von Kármán.
(f) Experimental verification of the flow characteristics within a centrifugal pump, especially in the region near the impeller eye.
(g) Special equipment has been constructed for use with the cylindrical direction-finding type pitot tube. Velocity and static pressures as well as direction of flow are obtained with the aid of zero-volume differential gages. The existing flow picture is correlated with the performance characteristics of the pump.
(h) Measurements have shown conclusively that pre-rotation existing in the pipe leading to the inlet of a centrifugal pump is accompanied by an actual mass transfer of water out of the impeller at the periphery of the eye. This mass of water flows upstream along the periphery of the pipe with a rotational component dependent upon the speed of the pump and the mean rate of flow. The increase in pressure at the pipe wall due to the rotation often results in measured pressure gradients increasing in the direction of the mean flow. At low capacities the back flow can amount to many times the magnitude of the mean flow through the pump.

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(822) (a) STUDY OF EFFECT OF AIR CONTENT ON CAVITATION PERFORMANCE OF CENTRIFUGAL PUMPS.
(b) U. S. Bureau of Reclamation.
(c) Cooperative research program with U. S. Bureau of Reclamation.
(d) Hydraulic Machinery Laboratory Staff.
(e) Professors R. T. Knapp, R. L. Daugherty, and Th. von Kármán.
(f) To determine effect of dissolved air on cavitation performance.
(g) Investigation of the validity of bubble point as cavitation parameter. An apparatus was constructed for the purpose of accurately determining the bubble-point pressure as a function of temperature. Bubble-point measurements were correlated with the cavitation limits determined from precise dynamometer tests.
(h) Preliminary results of bubble-point measurements for water samples taken from pumping circuit during cavitation tests indicate that within the limits of the amounts of air dissolved under equilibrium pressures ranging from 1 to 0.1 atmosphere the effect on the pump efficiency in the vicinity of the breakoff point and on the breakoff point itself probably does not exceed 1% or 2%.

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(823) (a) STUDY OF EFFECTS OF ANGULAR VELOCITY COMPONENTS ON CYLINDRICAL DIRECTION-FINDING PITOT TUBE
(b) U. S. Bureau of Reclamation.
(c) Cooperative Research Program with U. S. Bureau of Reclamation.
(d) Hydraulic Machinery Laboratory Staff.
(e) Professors R. T. Knapp, R. L. Daugherty, and Th. von Kármán.
(f) The cylindrical direction-finding pitot tube is being used to measure high-velocity flows where the direction of the flow may be at any angle with respect to the tube position. An accurate knowledge of its characteristics under such conditions is desirable.
(g) Special apparatus was constructed to permit the cylindrical tube to be inserted in high-velocity streams at known angles of yaw. Characteristics were determined in the form of measured pressure distributions around the cylinder.
(h) Investigation complete. Report to sponsor in preparation.

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(824) (a) STUDY OF THE EFFECTS OF THE VELOCITY AND PRESSURE DISTRIBUTION AT THE IMPELLER EYE UPON THE CAVITATION PERFORMANCE OF CENTRIFUGAL PUMPS.
(b) U. S. Bureau of Reclamation.
(c) Cooperative Research Program with U. S. Bureau of Reclamation.
(d) Hydraulic Machinery Laboratory Staff.
(e) Professors Th. von Kármán, R. T. Knapp, and R. L. Daugherty.

(f) See (a)
(g) Velocity and pressure distributions are determined in a normal plane immediately upstream from the impeller eye for several types of inlets. Also a device was constructed for controlling the velocity distribution at the inlet flange. With this device a wide range of symmetrical velocity distribution could be obtained. Cylindrical direction-finding pitot tubes were used for traversing the plane. Both the magnitude and the direction of the velocities were determined. These velocity and pressure distributions were then correlated with the cavitation limits determined from precise dynamometer tests.
(h) Investigation complete. Report to sponsor in preparation.

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(825) (a) INVESTIGATION OF THE FLOW CHARACTERISTICS OF PUMP INLET PIECES USING MODELS IN AIR STREAM.
(b) U. S. Bureau of Reclamation.
(c) Cooperative Research program with U. S. Bureau of Reclamation.
(d) Hydraulic Machinery Laboratory Staff.
(e) Professors Th. von Kármán, R. T. Knapp, and R. L. Daugherty.
(f) The effect of the inlet condition on centrifugal characteristics is associated with the resulting velocity distribution at the impeller eye. The effect of variations in the inlet on the velocity profiles can be readily determined with air model studies.
(g) A wind tunnel for use with pyralin models is available with power supply for developing Reynold's numbers up to approximately one million based on 2-ft throat diameter.
(h) Investigation suspended indefinitely.

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(826) (a) DETERMINATION OF UNBALANCED RADIAL FORCES IN THE VOLUTE OF A CENTRIFUGAL PUMP AND THEIR CORRELATION FOR DIFFERENT TYPES AND DESIGNS OF PUMPS.
(b) U. S. Bureau of Reclamation.
(c) Cooperative Research Program with U. S. Bureau of Reclamation.
(d) Hydraulic Machinery Laboratory Staff.
(e) Professors Th. von Kármán, R. T. Knapp, and R. L. Daugherty.
(f) Shaft deflections and resultant wear between rotating and stationary parts of centrifugal pumps, as well as accurate interpretation of observed peculiarities in pump performance, requires a knowledge of unbalanced radial forces in the volute.
(g) Static pressure distributions obtained from piezometer stations located in the volute walls are supplemented by actual deflection measurements for the wide variety of pumps tested in the laboratory.
(h) Investigation complete. Brief discussion presented in article referred to under project 818.

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(827) (a) DETERMINATION OF BOTH AVERAGE AND INSTANTANEOUS VELOCITY AND PRESSURE DISTRIBUTIONS IN THE VOLUTE OF A CENTRIFUGAL PUMP.
(b) Hydraulic Machinery Laboratory Research Program.
(c) General Laboratory Investigation.
(d) Hydraulic Machinery Laboratory staff.
(e) Professors Th. von Kármán, R. T. Knapp, R. L. Daugherty.
(f) Experimental verification of the flow characteristics in the pump volute.
(g) By means of a precision dual-slide valve and special differential gage, instantaneous readings of velocity and pressure are being obtained. Their correlation with the average distributions furnish an experimental basis for an analytical examination of centrifugal pump performance.
(h) Measurements have been completed for two different types of volute pumps. Correlation of the results with existing theoretical flow pictures is being made.

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(828) (a) STUDY OF CAVITATION FLOW IN CENTRIFUGAL PUMP IMPELLERS.
(b) Investigation complete. An analytical discussion of the problem entitled "A Theory of Cavitation Flow in Centrifugal Pump Impellers" was presented by C. A. Gongwer at the 1940 Semi-Annual Meeting of A.S.M.E. To be published in A.S.M.E. Transactions.

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(829) (a) COMPILATION OF COMPLETE CHARACTERISTIC PERFORMANCE OF CENTRIFUGAL PUMPS OF VARIOUS TYPES AND SPECIFIC SPEEDS.
(b) Hydraulic Machinery Laboratory Research Program.
(c) General laboratory research.
(d) R. T. Knapp, and James W. Daily.
(e) Professors Th. von Kármán, R. T. Knapp, and R. L. Daugherty.
(f) and (g) Complete characteristic diagrams of centrifugal pumps are necessary for use in analyzing the transient behavior of pumps in specific installations. A series of diagrams for all types of centrifugal pumps is being compiled for comparison purposes.
(h) Preliminary publication made in A.S.M.E. Transactions, November, 1937, Hydr.-59-11 by R. T. Knapp, "Complete Characteristics of Centrifugal Pumps and their use in the Prediction of Transient Behavior". A brief discussion of complete characteristic diagrams and calculated transient behavior for two additional pumps is presented in the article referred to under Project 818.

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(830) (a) AN EVALUATION OF STEPS NECESSARY IN ANALYTICAL REDUCTION OF DATA OBTAINED FROM PRECISION TESTS OF HYDRAULIC MACHINES.
(b) Hydraulic Machinery Laboratory Research Program.
(c) General laboratory research.
(d) James W. Daily.
(e) Professors Th. von Kármán, R. T. Knapp, and R. L. Daugherty.

(f) Refinements in testing equipment and technique require that thorough attention be given to methods of evaluation, including determination of physical constants, if all the advantages of the precision tests are to be obtained. Information is being collected and analytical methods developed for use in the Hydraulic Machinery Laboratory which are thought to be of general interest and importance. A summary of data and a description of methods are being prepared for distribution.

(h) Additional progress has been made in arranging material for presentation but has been deferred pending completion of Projects 818 - 829.

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CARNEGIE INSTITUTE OF TECHNOLOGY.

(1160) (a) MODEL STUDY OF A PROPOSED SELF-TRIPPING PLUNGER-OPERATED WICKET FOR OHIO RIVER DAMS.

(b) United States War Department.

(c) Laboratory study of a model furnished by the U. S. Engineer Office.

(d) H. A. Thomas, C. M. Wellens, W. E. Sidney, E. P. Schuleen, and W. J. Hopkins.

(e) Prof. H. A. Thomas.

(f) To obtain basic data from the model for the hydraulic and structural design of the wicket, and to demonstrate its performance under various headwater and tailwater conditions.

(g) The studies involve the determination of the plunger loads under a variety of head conditions, and for various positions of the wicket. In addition, the tripping stages will be determined as a means of checking the computed tripping moments. The model wicket has been correctly weighted so that simulation of the tripping effects is possible.

(h) Testing of this model is about 80% complete.

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(1161) (a) MODEL STUDIES OF THE SPILLWAY FOR THE CLEVILLE DAM.

(b) Nantahala Power and Light Company.

(c) Laboratory investigation of spillway design.

(d) J. Hackney, H. A. Thomas, and associates.

(e) Prof. H A. Thomas.

(f) To determine the hydraulic performance of the spillway, and to make such revisions in the design as might be necessary to provide better flow conditions.

(g) The spillway control consisted of two Taintor gates and a series of ea rth embankments, or fuse plugs. The fuse plugs are placed at different elevations between piers located at regular intervals along the top of the spillway. For floods of excessive magnitude which can not be fully controlled by the gates, progressive overtopping will occur, resulting in removal of the plugs, making the operation of the spillway automatic to a large degree. The studies were limited to the spillway and to the hydraulic phenomena which would occur under various operating conditions.

(h) Testing on this model is at an advanced stage of completion.

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(1162) (a) MODEL STUDIES OF THE SPILLWAY FOR THE NANTAHALA DAM
(b) Nantahala Power and Light Company.
(c) Laboratory investigation of spillway design.
(d) J. Hackney, H. A. Thomas, and associates.
(e) Professor H. A. Thomas.
(f) To note the hydraulic performance of the spillway, provide necessary revisions, and obtain such data as is necessary to ascertain that the design is entirely satisfactory.
(g) The spillway control consisted of a series of seven Taintor gates set in the spillway channel in the hillside forming one bank of the dam. The entire spillway discharge is controlled by the gates. Studies were restricted to the spillway and to the hydraulic phenomena which would occur under various operating conditions.
(h) Construction of the model has been completed, and tests were recently commenced.

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(1163) (a) CAVITATION ON BAFFLE PIERS BELOW DAMS.
(b) Thesis for Master's Degree in Civil Engineering.
(c) Laboratory investigation of baffle-pier design.
(d) Professor H. A. Thomas and Jack A. Borchardt.
(e) Professor H. A. Thomas.
(f) To determine the cavitation which may be expected under various conditions in connection with the use of baffle piers below dams.
(g) The project includes model study and correlation of data to actual field conditions. The thesis will cover all conditions to which a baffle pier may be subjected between minimum and maximum dam heights, minimum and maximum heads on said dams, and for several ranges of tailwater depths.
(h) The project is approximately 30% complete.

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COLORADO SCHOOL OF MINES.

(1164) (a) THE INFLUENCE OF INTERMITTENT FLOW ON HEAT TRANSFER.
(b) Department of Mechanical Engineering.
(c) Master's thesis.
(d) Frank R. Campbell, Instructor.
(e) Prof. John C. Reed.
(f) In observing the flow of water through a glass tube containing minute particles, it was observed that, where intermittent flow was produced, the boundary layer thickness was considerably reduced. The purpose of this investigation is to determine the possibility of increasing the coefficient of heat transfer by producing intermittent flow.
(g) This project will be carried out upon a simple one-pipe condenser erected in the laboratory. Very hot water or steam will circulate in one pipe, while cold water circulates through the other pipe. In the first series of tests, intermittent flow will be produced by the opening and closing of a quick-closing valve operated by hand. Automatic operation to be considered later.

(h) The apparatus has been designed and installed. Adjustments will be completed and testing will begin about November 1, 1940.

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THE STATE UNIVERSITY OF IOWA.

(316) (a) HYDROLOGIC STUDIES - RALSTON CREEK WATERSHED.
(b) and (c) Cooperative project - Iowa Institute of Hydraulic Research, U. S. Department of Agriculture and U. S. Geological Survey.
(e) Prof. J. W. Howe.
(h) Continuous records since 1934 of precipitation, runoff, groundwater levels, and cover. Drainage area 8 sq miles of rolling agricultural land near east city limits of Iowa City.

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(317) (a) COOPERATIVE SURFACE WATER INVESTIGATIONS IN IOWA.
(b) Iowa Institute of Hydraulic Research.
(c) Cooperative project with the U. S. Geological Survey.
(d) U. S. Geological Survey, Water Resources Branch, and Iowa Institute staffs at Iowa City, Iowa.
(e) L. C. Crawford and E. W. Lane.
(f) Continuous records of stage and discharge of Iowa streams.
(g) Standard methods on a state-wide basis.
(h) Gaging stations are maintained cooperatively and on a continuing basis.

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(844) (a) STUDY OF EVAPORATION FROM LAKE SURFACES.
(b) Cooperative project, U. S. Weather Bureau, Iowa Lakeside Laboratory, and Iowa Institute of Hydraulic Research.
(c) Observations of evaporation under various conditions at Lake Okoboji, Iowa.
(d) Staff members of cooperating parties.
(e) B. S. Barnes.
(f) To determine the laws governing evaporation from water surfaces of lakes under various conditions.
(g) Extensive observations on evaporation and controlling hydrological conditions will be made on lakes centering around Lake Okoboji for a wide variation of conditions, such as size, depth, etc.
(h) Studies are just begun, observations with standard and insulated pans at edge of Lake Okoboji under way.

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(845) (a) STUDY OF HYDROLOGY OF RAPID CREEK.
(b) Cooperative project - U. S. Geological Survey, U. S. Weather Bureau, and Iowa Institute of Hydraulic Research.
(c) Development of index basin for vicinity of Iowa City.
(d) Staffs of cooperating parties.

(e) Iowa Institute of Hydraulic Research.
(f) To develop the relation between rainfall and stream flow as an aid in predicting the flood flows of larger streams.
(g) Measurements of stream flow, rainfall, and groundwater level will be observed and correlated.
(h) Stream flow and rainfall measurements under way; groundwater observing stations not yet installed.

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(846) (a) HYDROLOGIC STUDIES - BASINS OF UPPER MISSISSIPPI REGION.
(b) Iowa Institute of Hydraulic Research.
(c) Cooperative project - U. S. Weather Bureau.
(d) B. S. Barnes, Hydrologic Supervisor, Upper Mississippi Region, and staff.
(e) B. S. Barnes.
(f) To determine the relation between precipitation and runoff, and particularly the form of discharge hydrograph resulting from a given rainfall, with a view to the more accurate prediction of daily river stages.
(g) Study of climatological records; construction and analysis of discharge hydrographs, especially of the smaller basins. Field studies include the obtaining of records of momentary rainfall intensities and some special evaporation experiments.

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(849) (a) AN INVESTIGATION OF FISHWAYS.
(b) Iowa Institute of Hydraulic Research in cooperation with Iowa Conservation Commission.
(c) Library and laboratory research.
(d) A. M. McLeod and Paul Nemenyi.
(e) Prof. E. W. Lane.
(f) To develop more effective and economical fishways.
(g) Models about 8 x 6 inches in cross section and 5 ft in length were studied, both as to their hydraulics and as to their ability to pass small fish. Full size fishways were installed at the Laboratory dam for a comparison of various designs, checking results of model tests, and collecting data for a study of the migratory habits of fish. Extensive bibliographic studies supplemented the experimental work.
(h) The first stage of all studies mentioned has been completed, and reports have been prepared. The report on the experimental studies is being published in the biennial report of the Iowa Conservation Commission. The bibliographic part of the studies is being published as a bulletin of the University of Iowa. See abstracts of these two papers as found in this Bulletin. The general program for the second stage of the experimental investigation has been laid out, and new designs to be tested in small-scale models are being prepared.

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(1024) (a) TRANSITIONS IN RECTANGULAR OPEN CHANNELS WITH SUPER-CRITICAL VELOCITIES.
(b) Department of Mechanics and Hydraulics.
(c) Doctor's Thesis (experimental)
(d) Warren Wilson.
(e) Prof. E. W. Lane.
(f) To determine behavior of high-velocity flow at open-channel transitions as a guide in channel design.
(h) Thesis completed. See abstract in this Bulletin.

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(1025) (a) STUDY OF EQUIPMENT AND TECHNIQUE FOR SUSPENDED-SEDIMENT SAMPLING AND ANALYSIS.
(b) U. S. Departments of War, Interior, Agriculture, Tennessee Valley Authority, and Iowa Institute of Hydraulic Research.
(c) A study is being made to determine the errors resulting from present methods and equipment of sediment sampling and to devise means of reducing them. An investigation of present methods of sediment concentration and size analysis will also be carried out and the possibility of improved methods will be studied.
(d) U. S. Departments of War, Interior, Agriculture, Tennessee Valley Authority, and Institute of Hydraulic Research.
(e) Prof. E. W. Lane.
(f) To increase accuracy and reduce cost of sediment sampling and analysis.
(g) Review of present status of suspended-sediment sampling equipment, field technique, and laboratory analysis, with office and laboratory studies of the errors involved and the possibility of developing improved methods and equipment.
(h) Report on present status of suspended-sediment and bed-load sampling equipment and technique completed.

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(1165) (a) STUDIES IN CHANNEL STABILITY.
(b) The China Foundation for the Promotion of Education and Culture and the Iowa Institute of Hydraulic Research.
(c) Fundamental research.
(d) Dr. Ing. Pang-Yung Ho.
(e) Prof. E. W. Lane.
(f) To investigate channel stability as affected by the solids load transported, by defining the limits where bed-load or suspended-load effects are predominant, and the particle sizes where cohesion may become important.
(g) Compa risons are being made of computed sediment load carried as bed and suspended load for a wide range of slopes, depths, and bed material size. A study of suspended load transportation in a rectangular flume is being carried on to investigate the reliability of the suspended-load formulas used to determine the relative magnitudes. An investigation is under way of the particle sizes which produce cohesive effects.
(h) Laboratory work under way.

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(507) (a) THE CONVERSION OF KINETIC INTO POTENTIAL ENERGY.
(b) Iowa Institute of Hydraulic Research in cooperation with the Am. Soc. of C. E. Committee on Hydraulic Research.
(c) Independent research.
(d) A. A. Kalinske and C. C. Lomax.
(e) Prof. A. A. Kalinske.
(f) To investigate the basic physical phenomena of flow in divergent conduits with particular reference to the conversion of energy.
(h) Analysis of laboratory experiments in progress. Report will be ready during the coming year.

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(743) (a) SIMULTANEOUS FLOW OF AIR AND WATER IN CLOSED CONDUITS.
(b) Iowa Institute of Hydraulic Research in cooperation with Committee on Hydraulic Research, American Society of Civil Engineers.
(c) Laboratory research.
(d) A. A. Kalinske and J. M. Robertson.
(e) Dean F. M. Dawson.
(f) To obtain data on the flow of water in partly full conduits when air is being dragged along, when the air is flowing faster than the water, and when the air flows counter to the direction of the water.
(g) A rectangular closed conduit 8" x 7" by 50' long with transparent sides is used. Provisions for air-flow measurement will be made at both ends of the conduit. Surface friction between the air and the water is one of the important items to be investigated.
(h) Tests are now being made with special emphasis on wave formation at the air-water interface.

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(851) (a) HYDRAULICS OF VERTICAL DRAIN AND OVERFLOW PIPES.
(b) Iowa Institute of Hydraulic Research in cooperation with the National Association of Master Plumbers.
(c) Laboratory research.
(d) A. A. Kalinske and C. C. Lomax.
(e) Dean F. M. Dawson or A. A. Kalinske.
(f) To determine head-discharge relationship for various sizes and lengths of vertical drain pipes and overflow pipes which do not flow full. Air-flow measurements are also to be made.
(g) An apparatus has been constructed which will insure radial flow into pipes of diameters ranging from 6 inches to one inch.
(h) Tests are in progress and will be completed this year.

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(853) (a) AIR-CHAMBERS FOR WATER-HAMMER RELIEF
(b) Iowa Institute of Hydraulic Research in cooperation with the National Association of Master Plumbers.
(c) Laboratory research.
(d) Dean F. M. Dawson and A. A. Kalinske.
(e) Prof. A. A. Kalinske.

(f) To determine a relation between water velocity, pipe size, air-chamber volume, length of pipe, and water-hammer pressure reduction.
(g) All the variables mentioned in (f) are being varied for a simple straight pipe. In addition, the effect of a restriction between the pipe and air-chamber is being studied.
(h) Tests are being continued. Some of the results were published in a paper, "Methods of Calculating Water-Hammer Pressures", Jour. of Amer. Water Works, Vol. 31, Nov. 1939, p. 1855.

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(1026) (a) TURBULENCE AND SUSPENDED MATERIAL TRANSPORTATION IN A SMALL OPEN CHANNEL.
(b) Iowa Institute of Hydraulic Research.
(c) Laboratory research.
(d) A. A. Kalinske, C. L. Pien, and J. M. Robertson.
(e) Prof. A. A. Kalinske.
(f) To measure the diffusion characteristics of water flowing in an open channel, and to correlate such data with observations on suspended material transportation. The channel being used is 11 inches wide, 10 inches deep and 70 feet long.
(g) The photographic technique for determining the diffusion characteristics of turbulence that was developed in Project 855 will be used in this project. Special study is to be made of the suspension near the bottom.
(h) The apparatus is complete and the preliminary experiments have begun.

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(1027) (a) INVESTIGATION OF OPERATION OF GREASE INTERCEPTORS.
(b) Iowa Institute of Hydraulic Research in cooperation with the National Association of Master Plumbers.
(c) Laboratory research.
(d) Dean F. M. Dawson, A. A. Kalinske, A. M. McLeod.
(e) Dean F. M. Dawson.
(f) To determine the basic principles of grease interceptor design.
(g) Tests are being made on various types of commercial grease interceptors. Later a more fundamental study is to be made on the effect of baffles, water turbulence, and water velocity on the carrying of particles lighter and heavier than water such as the grease and solids which ordinarily enter into an interceptor.
(h) A standard method for testing grease interceptors has been developed.

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(1028) (a) DESIGN OF WATER-SUPPLY SYSTEMS FOR BUILDINGS.
(b) Iowa Institute of Hydraulic Research in cooperation with the National Association of Master Plumbers.
(c) Library and Laboratory Investigation.
(d) Dean F. M. Dawson and A. A. Kalinske.
(e) Dean F. M. Dawson.

(f & g) To compile and organize all existing data on friction loss in iron, lead, and copper pipe and for all types of fittings and plumbing fixtures. These data are to be used in developing simplified methods of water-piping sizing for plumbing systems. Laboratory tests will be made on those fittings or fixtures for which data are not available.

(h) The library investigation has been made and the report is being organized.

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(1166) (a) ENTRAINMENT OF AIR IN PIPES BY FLOWING WATER.
(b) Iowa Institute of Hydraulic Research in cooperation with Waldo Smith Fellowship Committee of American Society of Civil Engineers.
(c) Laboratory research and Doctor's Thesis.
(d) J. M. Robertson.
(e) Prof. A. A. Kalinske.
(f) To determine the conditions necessitating use of air valves on water pipe-lines and obtain data for determining their size and location.
(g) Tests will be made on various sizes of pipes placed at different slopes. Transparent pipes will be used to permit photographing the phenomena.
(h) Apparatus being set up for tests on 6-inch pipe.

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(1167) (a) ANALYSIS OF VELOCITY FLUCTUATION DATA FOR MISSISSIPPI RIVER.
(b) Iowa Institute of Hydraulic Research in cooperation with Rock Island Illinois District U. S. Engineer Office.
(c) Analytical study.
(d) A. A. Kalinske.
(e) Prof. A. A. Kalinske.
(f) To obtain quantitative data on turbulence in Mississippi River as recorded by standard current meter.
(g) Data were obtained in such a manner that the time for each revolution of the current meter was recorded. This permits the obtaining of the velocity for intervals of time of the order of 1 second, and thus the fluctuation in velocity can be measured. Both the intensity and the scale of the turbulence can be obtained from the data.
(h) Data near the surface, midpoint, and near the bottom have been analyzed for some six different points on the river for various flow conditions.

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(1168) (a) EFFECT OF EXCESS TURBULENCE ON PRESSURE DROP IN STRAIGHT PIPES, PIPE FITTINGS, AND VARIOUS CONTROL APPARATUS.
(b) Iowa Institute of Hydraulic Research.
(c) Laboratory Research.
(d) A. A. Kalinske.
(e) Prof. A. A. Kalinske.

(f) to obtain quantitative data on the turbulence and to determine its effect on the friction loss in straight pipes and various fittings and control apparatus such as elbows, reducers, expansions, valves, etc.
(g) The excess turbulence will at first be induced by grids and screens in order that its intensity and scale may be properly controlled. Photographic study will be made in order to obtain a measure of the turbulence and to observe the phenomena of decaying turbulence in general.
(h) Laboratory apparatus is being designed. Data obtained in wind-tunnel work on effect of turbulence on drag of bodies have been investigated.

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(859) (a) EFFECT OF FREEBOARD UPON EVAPORATION FROM STANDARD LAND PAN.
(b) Department of Mechanics and Hydraulics.
(c) Master's thesis (experimental).
(d) Russell W. Revell.
(e) Prof. J. W. Howe.
(g) Level in two land pans held constant by Marriotte flask apparatus. Both pans given same exposure but operated with different free boards. Air and water temperatures, relative humidity, wind velocity over the pan, and evaporation observed.
(h) Nearing completion.

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(1029) (a) DETERMINATION OF BEST PROPORTIONS FOR CANAL BENDS.
(b) Department of Mechanics and Hydraulics.
(c) Doctor's Thesis (experimental).
(d) Chen-Hsing Yen.
(e) Prof. J. W. Howe.
(f) To determine effect of different proportions of cross section upon losses in bends.
(g) Experimental flume, one foot square in cross section, about 90 feet long, containing 90° bend, to be tested under various slopes, depths, and proportions of cross section.
(h) In progress.

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(1030) (a) SEDIMENT BEHAVIOR IN UPWARD FLOW.
(b) Department of Mechanics and Hydraulics.
(c) Master's thesis (experimental research).
(d) W. W. DeLapp.
(e) Prof. H. Rouse.
(f) To determine the variation in sediment concentration in upward flow for conditions ranging between the limits of percolation and suspension.
(h) Thesis completed. See abstract in this Bulletin

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(1031) (a) (STRUCTURAL) TESTS OF FLUME CORNERS.
(b) Department of Mechanics and Hydraulics.
(c) Research, including Master's thesis.
(d) Prof. C. J. Posey and O. Kefoid.
(e) Prof. C. J. Posey.
(f) To find most satisfactory design for flume corners which are subject to tension on the inside.
(g) Tension tests of knees with shear and moment similar to actual values in flumes.
(h) Completed.
(i) Design developed that is superior to standard design in strength and toughness, and which will permit considerable economies in reinforced-concrete flume-construction. Publication planned.

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(1032) (a) EFFECTS OF CERTAIN FLUID PROPERTIES UPON THE PROFILE OF THE HYDRAULIC JUMP.
(b) Department of Mechanics and Hydraulics.
(c) Master's thesis.
(d) Prof. C. J. Posey, M. D. Dubrow, J. C. Goodrum.
(e) Prof. C. J. Posey.
(f) To study effect of viscosity and surface tension on the profile of the jump.
(g) Various fluids in recirculating hydraulic demonstration table.
(h) Experimental work substantially complete; results to be available soon.

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(1033) (a) INTEGRATED STUDY OF PROPULSION OF GRANULAR MATERIALS BY FLUIDS IN TURBULENT FLOW.
(b) Iowa Institute of Hydraulic Research.
(c) Survey and research.
(d) Paul Nemenyi.
(e) Dr. Paul Nemenyi.
(f) Unification of the various physical, geophysical (Hydro- and aerological), geomorphologic, and civil engineering studies and results relevant for the problem.
(g) The method of the study is primarily survey, dimensional analysis and comparison. It is intended to find the main dimensionless variables common to all phenomena in question as distinguished from the specific variables (as e.g. slope and "form factors" for the river problems). The limits within which these variables are competent will be discussed. Controversies will be clarified by determining the limits of validity for the different contradicting statements; for the decision of certain controversial issues special experiments will be proposed.
(h) A paper giving a general outline of the problem, especially of its methodical aspects, has been completed and published in the Transactions of the American Geophysical Union, 1940,

under the title "The Different Approaches to the Study of Propulsion of Granular Materials and the Value of their Coordination." Special studies along the lines indicated therein are being started.

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(1034) (a) SECONDARY CURRENTS IN STRAIGHT OPEN CHANNELS.
(b) Iowa Institute of Hydraulic Research.
(c) Experimental research.
(d) Paul Nemenyi.
(e) Dr. Paul Nemenyi.
(f) Exploration of types of secondary currents for a variety of cross sections, different slopes, roughnesses, and régimes of flow. A qualitative theoretical explanation will be attempted. Also the analogous phenomena in closed conduits will be examined. Possible applications to river and channel engineering will be considered.
(g) The experimental work will be mostly observational; however some quantitative measurements will be made. The observed secondary currents will be correlated with measured distributions of longitudinal velocity.
(h) A comparative examination of existing observations and opinions has been made. The experimental work is being continued.

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(1169) (a) CHEZY'S "C" IN A RECTANGULAR FLUME WITH DEFINITE ARTIFICIAL ROUGHNESS.
(b) Iowa Institute of Hydraulic Research and Ralph W. Powell of the Ohio State University.
(c) Research.
(d) Ralph W. Powell.
(e) Prof. Ralph W. Powell.
(f) To find how "C" varies with the size and spacing of roughness elements, and with the other factors involved.
(g) Measurements made in an 8 inch flume, 50 feet long at depths of from 1 to 5 inches, and slopes of 0.0005, 0.002, 0.008, and 0.031. Roughness elements are 1/8 in. and 1/4 in. square, spaced 2-1/2 in., 5 in., 10 in., and 20 in. apart, in various combinations.
(h) Measurements completed. Computations in progress.

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(108) (a) MISSISSIPPI RIVER, LOCK & DAM NO. 4, ALMA, WISCONSIN.
(b) Corps of Engineers, U. S. Army, St. Paul District.
(c) Design project.
(d) U. S. Engineer Department Staff.
(e) Martin E. Nelson, Engineer.
(f) To determine water loads on a proposed double-leaf, vertical-lift gate, the self-cleaning characteristics of sills for submergible gates, dimensions for stilling basins, backwater caused by the dam and current conditions at critical points on the dam and in the navigation channel.
(g) Water loads were computed from pressures on piezometers.

(g) (continued)
Measurements of pressures and stilling basin studies were made in sectional models. A fixed-bed river model was tested for backwater and navigation data.
(h) The final report is in draft form.

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(109) (a) INVESTIGATION OF LOCK HYDRAULIC SYSTEMS.
(b) Corps of Engineers U. S. Army, St. Paul District.
(c) Design project.
(d) U. S. Engineer Department Staff.
(e) Martin E. Nelson, Engineer.
(f) To eliminate as many as possible of the features now found to be unsatisfactory in river navigation locks and to increase the efficiency of the hydraulic systems of such locks.
(g) A typical barge lock was constructed 1/15th prototype size and was subsequently altered to conform to changes indicated by tests.
(h) A final report is being prepared.

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(390) (a) MISSISSIPPI RIVER, LOCK AND DAM NO. 11, DUBUQUE, IOWA.
(b) Corps of Engineers, U. S. Army, St. Paul District.
(c) Design project.
(d) U. S. Engineer Department Staff and Rock Island District personnel.
(e) Martin E. Nelson, Engineer.
(f) To provide information on a layout for the dam spillways which would cause least damage to the highway bridge approach fill and to investigate the scour caused by various gate operation procedures.
(g) A part fixed-bed, part movable-bed model with the spillway made of wood was studied for spillway locations. Later, the roller and Tainter gates and stilling basins were made of metal to exactly simulate the prototype dam, ground coal was introduced as bed material, and scour tests were run.
(h) The final report is completed. See abstract in this Bulletin.

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(397) (a) MISSISSIPPI RIVER, EFFECT OF POOL NO. 5 ON HYDRAULIC CONDITIONS NEAR MINNEISKA, MINN.
(b) Corps of Engineers, U. S. Army, St. Paul District.
(c) See title.
(d) U. S. Engineer Department Staff.
(e) Martin E. Nelson, Engineer.
(f) To determine whether or not the Whitewater River, when affected by backwater from Dam No. 5, will deposit the heavy load of silt it often carries so as to reduce the waterway through bridges located upstream from its mouth.
(h) Final report is completed. See abstract in this Bulletin.

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(448) (a) WEEP HOLES.
(b) Corps of Engineers, U. S. Army, St. Paul District.
(c) Design project.
(d) U. S. Engineer Department Staff.
(e) Martin E. Nelson, Engineer.
(f) To determine the conditions under which gravel will be discharged from weep holes.
(g) The final report is completed. See abstract in this Bulletin.

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(744) (a) HYDRAULIC LABORATORY INSTRUMENTS.
(b) Corps of Engineers, U. S. Army, St. Paul District.
(c) Design project.
(d) U. S. Engineer Department Staff.
(e) Martin E. Nelson, Engineer.
(f) To develop and improve instruments required in the investigation of hydraulic problems.
(g) Instruments have been developed along theoretical lines and modified to meet practical requirements. Especial attention has been given to instruments necessary for the study of fluid mechanics.
(h) The final report on instruments developed is being prepared.

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(860) (a) MISSISSIPPI RIVER SUBMERGIBLE TAINTER LOCK GATES FOR ST. ANTHONY FALLS LOCKS, MINNEAPOLIS, MINN.
(b) Corps of Engineers, U. S. Army, St. Paul District.
(c) Design project.
(d) U. S. Engineer Department Staff.
(e) Martin E. Nelson, Engineer.
(f) To study hydraulic conditions in the locks when the chambers are filled by means of submergible Tainter gates which also replace the conventional upstream miter gates. The Tainter gate will be used also for passing flood discharge.
(g) Tests were conducted in a model on a scale of 1 to 22.4 and observations were made with respect to turbulence, surging, hawser pull, and duration of leakage. Tests were made on a 1/7 size model of a section of submergible Tainter gate to study crest shapes.
(h) A complete lock model was tested with various gate operation schedules until the one causing minimum mooring hawser stress could be determined. From studies on the large-scale gate model, designs have been developed for the shape of gate. A final report is being prepared.

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(861) (a) MISSISSIPPI RIVER, FILLING AND EMPTYING SYSTEM FOR NEW LOCK NO. 2, HASTINGS, MINN.
(b) Corps of Engineers, U. S. Army, St. Paul District.
(c) Design project.
(d) U. S. Engineer Department Staff.
(e) Martin E. Nelson, Engineer.
(f) To develop a satisfactory system to fill and empty the lock, employing short culverts around the lock gates.
(g) Tests were conducted in a model on a scale of 1 to 30; observations were made with respect to turbulence, surging, hawser pull, and duration of lockage.
(h) The final report is being prepared.

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(862) (a) MISSISSIPPI RIVER, FILLING AND EMPTYING SYSTEM FOR LOCK NO. 19, KEOKUK, IOWA.
(b) Corps of Engineers, U. S. Army, Rock Island District.
(c) Design project.
(d) U. S. Engineer Department Staff.
(e) Martin E. Nelson, Engineer.
(f) To develop a satisfactory system to fill and empty the lock, employing (1) culverts and ports in the floor of the lock chamber, or (2) short culverts in the upper and lower gate sills, or (3) a filling system using a combination of submergible Tainter gate and short sill culverts, and an emptying system with short culverts under the lower gate sill.
(g) Four models of such a nature as to be adaptable to the same flume were used to investigate different phases of the design problem. Three models were scaled 1/24 and the fourth 1/30.
(h) The final report is in draft form.

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(1035) (a) PROTOTYPE LOCK HYDRAULICS TESTS TO VERIFY MODEL EXPERIMENTS.
(b) Corps of Engineers, U. S. Army, Ohio River Division.
(c) See title.
(d) U. S. Engineer Department Staff.
(e) Martin E. Nelson, Engineer.
(f) To obtain data on the filling and emptying characteristics of navigation locks in the Ohio River Division and to observe navigation conditions in the lock approaches and flow conditions in dam stilling basins for comparison with similar model and prototype data.
(g) Rates of filling and emptying and pressure changes in culverts and ports were observed on special pneumatic manometers. Velocities at the lock chamber ends of filling and emptying ports were measured by means of a pitot bar. Measurements were made at several locks in the Tennessee and Ohio Rivers.
(h) Tests are complete, and a report is being prepared.

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(1036) (a) DISCHARGE COEFFICIENTS FOR OBSTRUCTIONS TO SUPER-FLOOD FLOWS.
(b) Corps of Engineers, U. S. Army, Rock Island District.
(c) Design project.
(d) U.S. Engineer Department Staff.
(e) Martin E. Nelson, Engineer.
(f) To evaluate the obstruction offered to super-flood flows by bridges, dams, river walls, and other contractions in river channels.
(g) A generalized model of a river reach with a tributary was constructed 1/120th prototype size. A number of bridges of various types were installed in the model and tested at depth submerging the decks. City conditions were simulated on the overbank areas.
(h) Final report is being assembled for publication.

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(1038) (a) DIVERSION CHANNEL STILLING BASIN, DRY RUN FLOOD CONTROL PROJECT, DECORAH, IOWA.
(b) Corps of Engineers, U. S. Army, St. Paul District.
(c) Design project.
(d) U. S. Engineer Department Staff.
(e) Martin E. Nelson, Engineer.
(f) To develop a suitable stilling basin above the outlet of the proposed Dry Run Diversion Channel.
(h) The final report is completed. See abstract in this Bulletin.

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(1170) (a) MISSISSIPPI RIVER, NAVIGATION CONDITIONS IN THE UPSTREAM APPROACH TO LOCK NO. 10, CUTTENBURG, IOWA.
(b) Corps of Engineers, U. S. Army, St. Paul District.
(c) Design project.
(d) U. S. Engineer Department Staff.
(e) Martin E. Nelson, Engineer.
(f) To determine what corrective measures can be used economically and effectively to eliminate hazardous currents in the upstream lock approach channel.
(g) Tests were made on a model having a horizontal scale 1/125 and a vertical scale 1/50. The model included the lock-and-dam structures and 2 miles of the upstream approach channel, part of which was removable.
(h) The final report is being prepared.

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THE JOHNS HOPKINS UNIVERSITY.

(1171) (a) THE 90° V-NOTCH WEIR AS A MEASURING DEVICE.
(b) Project is being conducted in the hydraulics laboratory of The Johns Hopkins University.
(d) Professor F. W. McDaugh.
(e) Professor F. W. Medaugh.
(f) To determine a practical setting and stilling device for a 90° triangular weir which will give consistent and precise results, and to check these against the results of other investigators.

(g) Water will be the only liquid used. Nickel and brass weir plates with ground upstream surfaces will be used, and carefully calibrated standard orifices will be used for feeding the weir and at the same time for measuring the discharge.
(h) The orifices have been partly calibrated, and one of the weir plates has been made.

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LOUISIANA STATE UNIVERSITY AND AGRICULTURAL AND MECHANICAL COLLEGE.

(28) (a) HYDROLOGICAL STUDY OF CITY PARK LAKE DRAINAGE AREA.
(b) Cooperative between the U. S. Geological Survey and the College of Engineering, Louisiana State University.
(c) General scientific research.
(d) Dr. Glen N. Cox and assistants.
(e) Dr. Glen N. Cox.
(f) Study of rainfall, runoff, and evaporation.
(g) The rainfall is measured in six standard cans and a Ferguson Weighing Recording Rain Gage, placed at various points over the 507 acre drainage area. The control is a concrete weir. An attempt will be made at arriving at the evaporation from the lake by knowing the amount of water that is being turned into the lake during dry periods and the amount that is being discharged.
(h) During the past summer, a report entitled, "A Summary of Hydrologic Data, Bayou Duplantier Watershed, 1933-39, by Glen N. Cox, Ph. D., University Bulletin, Louisiana State University", has been published covering the results of this investigation, and copies are available for distribution.

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(224) (a) FACTORS AFFECTING THE EVAPORATION FROM A LAND PAN.
(b) Cooperative between the U. S. Geological Survey and the College of Engineering, Louisiana State University.
(c) General scientific research.
(d) Dr. Glen N. Cox and assistants.
(e) Dr. Glen N. Cox.
(f) To determine the effect of the various meteorological factors on evaporation.
(g) This station consists of a standard U. S. Weather Bureau land pan, and a standard U. S. Weather Bureau rain can. Other meteorological data are obtained from a nearby station maintained by the Geology Department of the University.
(h) Records have been taken since June 1, 1938, and will be reported as a University Bulletin about June, 1940.

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(225) (a) COMPARISON OF EVAPORATION BETWEEN A LAND PAN AND A FLOATING PAN.
(b) Cooperative between the U. S. Geological Survey and the College of Engineering, Louisiana State University.
(c) General scientific research.
(d) Dr. Glen N. Cox and Assistants.
(e) Dr. Glen N. Cox.
(f) Evident from title.
(g) A U.S.Geological Survey type floating pan is used, about which a barricade has been placed to reduce wave action. A recording thermometer and an anemometer have been installed so that a continuous record of lake temperatures and of wind movement may be obtained. A standard rain can is used.
(h) Records have been taken since October, 1933, and will be reported as a University Bulletin about June, 1940.
(i) The original galvanized pan was replaced by a copper one and the change was accompanied by a considerable increase in evaporation.

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MASSACHUSETTS INSTITUTE OF TECHNOLOGY, DEPARTMENT OF CIVIL AND SANITARY ENGINEERING, RIVER HYDRAULIC LABORATORY.

(1172) (a) AN EXPERIMENTAL INVESTIGATION OF THE EFFECT OF VARIATIONS OF REYNOLDS NUMBER UPON THE COEFFICIENT OF FRICTION IN OPEN-CHANNEL FLOW.
(b) River Hydraulic Laboratory, M.I.T.
(c) Master's thesis.
(d) Lt. Augustine P. Little, Jr., and Lt. Robert F. Seedlock, Corps of Engineers, U. S. Army.
(e) Dr. K. C. Reynolds.
(f) See (a)
(g) A tilting wooden flume of rectangular cross-section was used, having varnished walls and bottom. The width was reduced successively from 24 in. to 12 in., to 6 in., to 3 in. The flow was always uniform.
(h) Thesis with title of (a) submitted in October, 1940.
(i) This thesis was a continuation of (1053) reported in Bulletin VIII and is part of a long-range study of open channel flow.

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(1173) (a) AN EXPERIMENTAL INVESTIGATION FOR THE DETERMINATION OF THE VARIATION OF FRICTION FACTOR " f", WITH REYNOLDS NUMBER, R, FOR THE UNIFORM FLOW OF WATER IN OPEN CHANNELS.
(b) River Hydraulic Laboratory, M. I. T.
(c) Master's thesis.
(d) Lt. Dean C. Swaft, and Lt. John A. Morrison, Corps of Engineers, U. S. Army.
(e) Dr. K. C. Reynolds.
(f) See (a).

(g) A tilting wooden flume of rectangular cross-section was used, 38 ft. long, 12 in. wide and 16-1/2 inches high. Two conditions of channel roughness were investigated: 1) rough bottom and smooth sides; 2) rough bottom and sides.
(h) Thesis with title of (a) submitted in October 1940.
(i) This thesis was a continuation of #(1052) reported in Bulletin VIII and is part of a long-range study of open-channel flow.

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(1174) (a) STREAM DOUBLE REFRACTION IN THE STUDY OF HYDRAULIC FLOW.
(b) River Hydraulic Laboratory, M. I. T.
(c) Master's thesis.
(d) Lt. Jack W. Chapman and Lt. David B. Parker, Corps of Engineers, U. S. Army.
(e) Dr. K. C. Reynolds.
(f) To further develop a means of observing flow lines in open channels.
(g) Method has been used by Dr. E. A. Hauser and D. R. Dewey of Chemical Engineering Department, M. I. T., whereby a solution of bentonite passes through polarized light, thus giving lines of stress similar to photoelastic method with celluloid structural models.
(h) Thesis with title of (a) submitted in October 1940. This thesis is <u>not</u> available for loan. This is part of an exhaustive investigation by the Chemical Engineering Department, who expect to have available within a few months information as to theory, technique, etc.

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(1175) (a) THE DEVELOPMENT OF A PHOTOGRAPHIC METHOD FOR THE MEASUREMENT OF POINT VELOCITIES IN FLOWING FLUIDS.
(b) River Hydraulic Laboratory, M. I. T.
(c) Master's thesis.
(d) Lt. Vincent C. Frisby, Corps of Engineers, U. S. Army.
(e) Dr. K. C. Reynolds.
(f) See (a).
(g) Suspended droplets of a fluid of the same density as water but with a different coefficient of diffraction wer introduced into water flowing in an open channel and were photographed.
(h) Thesis with title of (a) submitted in October 1940.
(i) The investigation was carried to the point where it was proved to be one method for observing velocities.

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(1176) (a) AN EXPERIMENTAL INVESTIGATION OF THE EFFECT OF FLOWING WATER ON CAISSONS.
(b) River Hydraulic Laboratory, M. I. T.
(c) Master's thesis.
(d) Lt. Jackson Graham and Lt. Gerard J. Forney, Corps of Engineers, U. S. Army.

(e) Dr. K. C. Reynolds.
(f) See (a).
(g) Nine models of different-shaped bridge caissons were placed with different drafts in water flowing with different velocities and at various angles. Two components of pressure and the moment were observed, requiring over 3000 individual observations.
(h) The experimental work has been completed but the thesis has not yet been submitted.

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(1177) (a) AN EXPERIMENTAL INVESTIGATION OF THE HYDRAULICS OF SIPHONS.
(b) River Hydraulic Laboratory M. I. T.
(c) Master's thesis.
(d) Lt. John G. Schermerhorn and Lt. Giles L. Evans, Corps of Engineers, U. S. Army.
(e) Dr. K. C. Reynolds.
(f) See (a).
(g) Three models of the 9-foot Marked Tree Siphon in Arizona were built to model scales of 1 to 24, 1 to 36, 1 to 48. Pressures were observed on the largest model, while flow conditions and the coefficient of discharge were obtained for all three models.
(h) The experimental work has been completed but the thesis has not yet been submitted.

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MASSACHUSETTS INSTITUTE OF TECHNOLOGY, (SANITARY ENGINEERING LABORATORY).

(874) (a) EXPERIMENTAL STUDY OF SHORT-CIRCUITING THROUGH MIXING CHAMBERS.
(b) Sanitary Engineering Laboratory, M. I. T.
(c) Bachelor's thesis.
(d) C. F. Pock, Jr. and R. D. Taylor.
(e) Prof. T. R. Camp.
(f) To reexamine work done on previous theses and to determine suitability of models for studying short-circuiting in mixing chambers by means of dyes.
(g) Two model chambers, one a duplicate of the other but several times larger are being studied to determine if dye patterns can be duplicated and if the Froude model law is satisfactory.
(h) In progress.

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(877) (a) ELECTRIC NETWORK ANALYZERS FOR HYDRAULIC ANALYSIS OF WATER DISTRIBUTION SYSTEMS
(b) Dept. of Civil and Sanitary Engineering and Dept. of Electrical Engineering, M. I. T.
(c) Master's thesis.
(d) A. E. Cook.
(e) Prof. T. R. Camp or Prof. H. L. Hazen.
(f) To study practicability of using lamps as resistance units to represent pipes in an electrical model of a pipe network.

(g) Study comprises investigation of change of resistance in lamp filaments with temperature with view to selecting lamps and corresponding current range for which $V = rI^x$ to correspond with analogous pipe friction formula $h = kQ^x$.
(h) Previous work by H. T. Strandrud and G. J. Laurent completed; Cook's work in progress.

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(1058) (a) EXPERIMENTAL AND THEORETICAL STUDY OF THE MECHANISM OF FILTRATION IN RAPID SAND FILTERS.
(b) Sanitary Engineering Laboratory, M.I.T.
(c) Doctor's thesis.
(d) P. C. Stein.
(e) Prof. T. R. Camp.
(f) To develop a rational theory of filtration and the rate of clogging of filters to facilitate design and operation.
(g) Experimental and theoretical studies were made of the manner in which floc deposits within the interstices of the sand bed and the relations thereof with the head loss through the bed. Accompanied by photomicrographs and motion pictures.
(h) Complete.
(i) Small floc particles found to be removed by a contact process which can be formulated by rational equations.

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(1059) (a) EXPERIMENTAL AND THEORETICAL STUDY OF THE EFFECT OF TURBULENCE UPON THE REMOVAL OF DISCRETE PARTICLES IN SETTLING TANKS.
(b) Sanitary Engineering Laboratory, M.I.T.
(c) Doctor's thesis.
(d) W. E. Dobbins.
(e) Prof. T. R. Camp.
(f) To evaluate the effect of turbulence upon the retardation of settling in settling tanks.
(g) The mathematical theory of turbulence is being adapted to the settling problem, and efforts are to be made to check the theory experimentally in settling containers equipped with stirrers to produce vertical mixing.
(h) In progress.

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(1060) (a) MODEL STUDIES OF SHORT-CIRCUITING THROUGH FLOCCULATION CHAMBERS.
(b) Sanitary Engineering Laboratory, M.I.T.
(c) Bachelor's thesis.
(d) J. Echarte.
(e) Prof. T. R. Camp.
(f) To determine the effect of shape on short-circuiting through common types of flocculation chambers.
(g) Two model chambers, one cubical in shape and equipped with a stirring paddle and the other of the round-the-end baffled type, were studied by means of dyes.
(h) Complete.

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UNIVERSITY OF MINNESOTA, ST. ANTHONY FALLS HYDRAULIC LABORATORY.

(94) (a) TRANSPORTATION OF SEDIMENT.
(c) University hydraulics research project.
(e) Dr. Lorenz G. Straub.
(b), (f) and (g) (Details given in earlier bulletins.)

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(190) (a) FLOW CONDITIONS IN OPEN CHANNEL.
(c) University hydraulics research project.
(e) Dr. Lorenz G. Straub.
(b), (f), (g) and (i) (Details given in earlier bulletins.)

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(676) (a) FRICTION LOSS IN PLUMBING-SYSTEM PIPE LINES.
(c) Cooperative research project with the Sanitary Division of the Minnesota State Board of Health and the Hydraulics Department of the University of Minnesota.
(e) Dr. Lorenz G. Straub.
(b), (f) and (g) (Details given in earlier bulletins.)

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(677) (a) SEDIMENTATION AT THE CONFLUENCE OF RIVERS.
(c) In cooperation with the Committee on Hydraulic Research of the American Society of Civil Engineers.
(e) Dr. Lorenz G. Straub.
(b), (f), (g) and (i) (Details given in earlier bulletins.)

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(679) (a) STABILITY OF SAND DUNES.
(b) Project continued in cooperation with Committee on Seepage and Erosion of the American Society of Civil Engineers.
(e) Dr. Lorenz G. Straub.
(f), (f) and (g) (Details given in earlier bulletins.)

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(985) (a) HIGH-VELOCITY FLOW IN OPEN CHANNELS.
(b) Project continued in cooperation with Committee on Hydraulic Research of the American Society of Civil Engineers.
(e) Dr. Lorenz G. Straub.
(f), (f), (g) and (h) (Details given in earlier bulletins.)

(1061) (a) STUDY OF FLUID TURBULENCE AS RELATED TO SEDIMENT TRANSPORTATION.
(c) An experimental study of the mode of transportation of sedimentary material under idealized conditions.
(e) Dr. Lorenz G. Straub.
(b), (f), (g) and (h) (Details given in earlier bulletins.)

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(1062) (a) COMPARISON OF FLOW CONDITIONS THROUGH CHANNEL CONTRACTION WORKS WITH MOVABLE AND FIXED BEDS, RESPECTIVELY.
(c) The equilibrium conditions of rigid bed and movable bed channels are being studied at channel contraction works by means of a laboratory set-up.
(e) Dr. Lorenz G. Straub.
(b), (d), (f), (g) and (h) (Details given in earlier bulletin.)

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NEW YORK UNIVERSITY

(881) (a) FREE OUTFALL FROM CIRCULAR CONDUITS.
(b) New York University.
(c) Master's thesis.
(d) J. C. Morgan.
(e) Prof. J. K. Vennard.
(f) To obtain the characteristics of jet trajectory, drop-down curves, etc., for use in the design of leaping weirs, and with a view toward using the outfall as a metering device.
(g) Laboratory measurements using 4" to 12" transite pipes, with flows up to 2.0 cfs.
(h) All experimental work completed and results being analyzed and correlated.

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(1008) (a) A STUDY OF SHARP-EDGED ORIFICES.
(b) New York University.
(c) Undergraduate thesis.
(e) Prof. J. K. Vennard.
(f) To obtain complete and non-dimensional data on orifice coefficients.
(g) Experimental measurements of coefficients for orifices from 0.045" to 3" diam. operating under heads from zero to 5 ft.
(h) Project temporarily inactive.

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(1009) (a) A STUDY OF THE MANNING "n" IN VARIED FLOW.
(b) New York University.
(c) Master's thesis.
(d) T. J. Driscoll.
(e) Prof. J. K. Vennard.
(f) To observe the variation of "n" with velocity and hydraulic radius in varied flow.
(g) Laboratory measurements in 4" to 12" transite pipes flowing partially full.
(h) All experimental work completed and results being analyzed and correlated.

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(1010) (a) A STUDY OF SIDE-CHANNEL WEIRS.
(b) New York University.
(c) Master's thesis.
(d) F. A. Busse and P. E. Palle.
(e) Prof. J. K. Vennard.
(f) To obtain a general equation for side-channel weirs.
(h) Equipment under construction. Tests should begin in January 1941.

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(1178) (a) A STUDY OF APRONS FOR DROP STRUCTURES.
(b) New York University.
(c) Master's thesis.
(d) R. D. Ley and W. P. Comstock, Jr.
(e) Prof. J. K. Vennard.
(f) To study the effects of different apron curvatures on submerged and free discharge conditions, types of hydraulic jump, etc.
(g) Tests with various aprons of parabolic shape with different discharges, drops, and tailwater elevations. A record of results and effects to be obtained photographically and presented mathematically if possible.
(h) Equipment under construction. Tests should begin in January 1941.

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NORTH CAROLINA STATE COLLEGE OF AGRICULTURE AND ENGINEERING.

(1179) (a) INVESTIGATION FOR CAPACITY OF GUTTER INLETS ON VARYING GRADES.
(b) City of Raleigh, North Carolina.
(c) Involves a determination of the relation between shape of intake and grades of gutter. The capacities of intakes of different designs with varying gutter grades will be determined.
(d) Harry Tucker, Director, Engineering Experiment Station, North Carolina State College, Raleigh, N. C.
(e) Harry Tucker.
(f) To determine the most effective type of intake for various rates of grades.
(g) Intakes of different types will be built on artificial gutter grades, which will be constructed below a reservoir. By measuring the quantities of water handled by each particular type of intake, the relation between capacity and rate of grades can be determined.
(h) Project has just been started.

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OHIO STATE UNIVERSITY.

(526) (a) DETERMINATION OF DISCHARGE COEFFICIENT OF FLOW NOZZLES.
(b) A.S.M.E. Special Research Committee on Fluid Meters.
(c) Calibration to determine accurately the coefficients of standard nozzles.
(e) Prof. S. R. Beitler.
Experimental work completed and partial report made to A.S.M.E. in December 1940. Final analysis of other data expected by end of year 1941.

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(636) (a) STUDY OF THE EFFECT OF PULSATIONS ON ORIFICE METERS.
(b) American Gas Association.
(c) Cooperative project.
(d) S. R. Beitler and J. E. Overbeck.
(e) Prof. S. R. Beitler.
(f) To determine the error in reading of orifice meter caused by pulsating flow and to determine methods of eliminating this error.
(g) Tests are being made on meters installed on the inlet and outlet of compressor stations to determine the error caused by pulsations, and, after these tests are analyzed, an attempt will be made to design eliminators. A device has been developed to record the intensity and frequency of pulsations, and the meter is set in series with a meter not subject to pulsation so that the error caused by the pulsation is determined.
(h) Preliminary tests completed and tests set up for special study available for work to continue during 1941.

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(1180) (a) CONTINUED INVESTIGATION OF NOZZLES AND VENTURI TUBES.
(b) Various meter manufacturers.
(c) Commercial testing.
(d) S. R. Beitler.
(e) Prof. S. R. Beitler.
(f) Determination of coefficients and discharge of large nozzles and Venturi tubes - results of which are to be used for extending the present available data on these primary elements.

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OREGON STATE COLLEGE.

(1181) (a) STUDY OF THE MECHANICS OF THE WATER EROSION PROCESS IN IRRIGATION.
(b) Cooperative research program between the Hydrologic Division, Soil Conservation Service, U.S.D.A. and Oregon Agricultural Experiment Station.
(c) Hydraulics of small streams.
(d) M. R. Lewis, John M. Haley.
(e) M. R. Lewis, John M. Haley.

(f) To determine the laws governing the flow of water and the erosion of soil by small or shallow streams such as are used in irrigation furrows, corrugations, and strip borders.
(g) A flume 22 feet long, 1 foot deep, and 1 foot wide, was constructed. A stilling box and means to provide a constant head were installed at the upper end of the flume. For purposes of study the mid-section of the flume is being used. The section of study is 10 feet long. Within the 1 foot by 1 foot flume, various types and shapes of cross-sections have been and are being studied. Sections studied have been a smooth 90-degree, triangular, pyralin flume, a sanded, 90-degree, triangular, pyralin flume, a fairly smooth, 90-degree, triangular, cemented-earth flume, and a cemented-earth flume similar to a field furrow. The quantity of flow varies, for purpose of study, from 0.001 to 0.06 cfs. The slope is varied between 0.0% and 4.0%. An attempt has been made to analyze the data in terms of the more modern fluid mechanics.
(h) Experiment in progress.

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(1182) (a) EXPERIMENTAL STUDY OF VENTURI METERS MADE FROM COMMERCIAL FITTINGS.
(b) Leupold-Volpel Instrument Co., Portland, Oregon.
(c) Cooperative research project with Dept. Civil Engineering, Oregon State College, and Leupold-Volpel Co. on a venturi meter made from commercial fittings.
(d) C. A. Mockmore, J. C. Stevens, Rex Elder.
(e) Prof. C. A. Mockmore.
(f) To obtain coefficients suitable for meters made as far as possible from commercial fittings.
(g) To include several meters up to 12 inches in size.
(h) In construction stages.

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(1183) (a) EFFECT OF ANGLE OF APPROACH ON ORIFICE COEFFICIENTS.
(b) (c) Research project, Dept. of Civil Engineering.
(d) C. A. Mockmore, F. Merryfield.
(e) Prof. C. A. Mockmore.
(f) To study effect of angle of approach on discharge coefficient of sharp-edged orifices under varying heads.
(g) A series of circular sharp-edged orifices 1 inch in diameter and with angle of approach varying by 15 degrees have been constructed. Facilities are available for varying the head up to 100 feet.
(h) Preliminary test has been made under heads of 3, 6, and 9 feet, and a progress report has been prepared, a limited number of copies of the report being available.

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PACIFIC HYDROLOGIC LABORATORY.

(916) (a) STUDY OF INCREASING THE IMPERMEABILITY OF CLAY MEMBRANE BY USE OF SODIUM CHLORIDE.
(b) Golden Gate International Exposition, Department of Works, Treasure Island, San Francisco, California.
(c), (d), (e), (f), (g), (h) (See complete report of this project in earlier bulletins.)
(i) Paper describing the experimental work and application of method developed published as paper entitled "Sealing the Lagoon Lining at Treasury Island with Salt" by Charles H. Lee, M. Am. Soc. C.E., February, 1940, Proceedings A.S.C.E., Vol. 66, No. 2, Discussion in June and subsequent issues of Proceedings.

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(1039) (a) HYDRAULIC-FILL DAM INVESTIGATION.
(b) The Livingood Placers, Inc.
(c), (d), (e), (f), (g) (See complete report of this project in Bulletin VIII, January, 1940.
(h) Construction work in progress. Excavation for foundation, cutoff trench, and upstream and downstream toes completed. Work shut down for winter. Hydraulic fill to be placed summer of 1941.
(i) Technical paper awaits completion of construction.

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UNIVERSITY OF PENNSYLVANIA.

(1014) (a) EFFECT OF INSTALLATION ON COEFFICIENTS OF VENTURI METERS.
(b) For A.S.M.E. Fluid Committee and manufacturers.
(c) About 125 tests of various set-ups.
(d) W. S. Pardoe.
(e) Prof. W. S. Pardoe.
(f) To determine limiting conditions for installations.
(g) Weighed-water tests on four 8" Venturi meters of different ratios.
(h) About half done and reported in Transactions, A.S.M.E., November 1936 and November 1937.
(i) May be completed by 1942.

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(1184) (a) EFFECT OF RATIOS ON COEFFICIENTS OF VENTURI METERS.
(b) For A.S.M.E. Fluid Meter Committee and manufacturers.
(c) 12" x 1", 10" x 4", 9" x 4", 7" x 4", 6" x 4", and 3" x 4" coefficient curves.
(d) W. S. Pardoe.
(e) Prof. W. S. Pardoe, University of Pennsylvania, Philadelphia Pa.
(f) To check empirical formulas now in use.
(g) About 12 weighed-water calibrations, using the same throat but different main sections.

(h) Nearly completed.
(i) May be published some time in future.

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(1185) (a) EFFECT OF AMBIENT TEMPERATURE ON COEFFICIENTS OF VENTURI METERS.
(b) W. S. Pardoe.
(c) To determine above effect at low Reynolds Number.
(d) W. S. Pardoe.
(e) Prof. W. S. Pardoe.
(f) Reynolds Number was found unsatisfactory for water at low velocities in an unlarged meter.
(g) Water at various temperatures with room at 70°F. used to bring out this effect.
(h) Complete.
(i) To be presented at December meeting. A.S.M.E.

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RENSSELAER POLYTECHNIC INSTITUTE

(887) (a) THE USE OF A RUBBER DIAPHRAGM FOR MEASURING STATIC HEAD DURING FLUID FLOW AND THE DEVELOPMENT OF AN INSTRUMENT FOR RECORDING THE SAME.
(b) General scientific research.
(c) Undergraduate thesis.
(d) Richard Winthrop May.
(e) Grant K. Palsgrove, Professor of Hydraulic Engineering.
(f) To design, build, and test an instrument using a rubber diaphragm to measure and record static head in flowing fluids.
(g) A sheet of rubber or rubberized fabric is stretched over the open side of a cup-shaped holder, which in turn is placed so that the diaphragm is flush with the surface subject to pressure. If pressure is exerted on the cup side of the diaphragm of equal intensity to that on the pressure side, there will result no deflection. Mechanical means to accomplish zero deflection have been noted in previous Bulletins. In these tests, deflection was prevented by having the cup filled with liquid (practically incompressible) and then devising an instrument to create an equal and opposite pressure in the cup to balance that to be measured and to record the same. Such a combination results in a device which is independent of suspended foreign matter in the flowing fluid to be measured.
(h) For a six-inch Parshall flume the results show definitely that results may be obtained without appreciable error for any head with accompanying velocities up to two and one half feet per second. Project report available at Rensselaer Polytechnic Institute Library or through Mr. Richard W. May of W. & L. E. Gurley Co., Troy, N. Y.

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STANFORD UNIVERSITY.

(1019) (a) STEEP SLOPE FLOW PHENOMENA.
(b) Research.
(c) Research.
(d) J. Hedberg.
(e) Prof. J. Hedberg.
(f) Characteristics of roller waves.
(g) A redwood channel 9 inches wide and 40 feet long, has an adjustable slope. Flow is regulated with an orifice meter.
(h) Profiles for different roughness conditions now being obtained.

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(1020) (a) FLOW OF FLUIDS IN FRACTIONATING COLUMNS.
(b) Standard Oil Company.
(c) Research.
(d) P. B. Saltler.
(e) Prof. J. Hedberg.
(f) To determine the proper size and shape of barrier weirs on the bubble-cap trays.
(g) A full-scale reproduction of 1/4 of a tray is fitted with weirs and bubble caps. Air bubbling through water simulates operating conditions.
(h) Data being obtained.

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UNIVERSITY OF TEXAS.

(1021) (a) AN INVESTIGATION OF MINIMUM SEWER GRADES.
(b) Department of Civil Engineering, The University of Texas.
(c) Master's Thesis.
(d) Jack Neal.
(e) Quintin B. Graves.
(f) To determine the practicability of the practice of permitting the use of a larger pipe at a smaller grade than may be used with a conventionally designed size and grade.
(g) Sand grains of a certain sieve size introduced into a sewer (in the laboratory) just below the point where water entered. The sand passing out of the sewer was caught by means of cloth sacks, after which it was dried and weighed. Rates of flow, sewer size, sewer grades, and amounts of sand were varied so as to obtain pertinent information. Only two kinds of sewer pipes were used: (1) vitrified clay and (2) transite.
(h) The work has been completed.
(i) The Thesis is on file in the University of Texas Library.

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(1186) (a) A LABORATORY STUDY OF HYDRAULIC JUMPS.
(b) Bureau of Engineering Research and Department of Civil Engineering, The University of Texas.
(d) G. Doyle Proch and Quintin B. Graves.
(e) Quintin B. Graves.
(f) To check with the Hardy Cross method of analysis.
(h) The experimental work for the first network of constant diameter pipe is nearly completed.

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WORCESTER POLYTECHNIC INSTITUTE.

(1187) (a) TEST OF PITOT-LOCK METHOD OF WATER MEASUREMENT.
(b) Allis Chalmers Mfg. Co., Milwaukee, Wisconsin.
(c) Research.
(d) William Rheingans, C. W. Hubbard, L. J. Hooper.
(e) Prof. C. M. Allen.
(f) To test the Pitot-Lock Method of water measurement in a 40" penstock and check the results with a calibrated venturi and weir. Calibration of weir and venturi by weighing tank.
(g) The Pitot-Lock Method consists of a grid of properly located Pitot Tubes mounted on a frame. Each tube is connected to an outside manometer glass. The manometer connections are closed simultaneously by a gang valve and the observations of the deflections made. Several readings are made at each flow. The pressure head is measured by wall piezometers, although side piezometers on special tips were used in some of these tests. The range of flow used in the tests was from twenty to about forty-five cubic feet per second.
(h) Tests have been completed, although the data are not yet completely worked up.
(i) These tests showed remarkably good agreement of the Pitot-Lock Method with the calibrated venturi meter and weir over the range of flows tested.

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(1188) (a) MODEL STUDY OF NORTHAMPTON PUMPING PLANT.
(b) U. S. Engineer Office, Providence District, Lt.-Col. J. S. Bragdon, District Engineer.
(c) Check of design.
(d) L. J. Hooper and J. Hamer.
(e) Prof. C. M. Allen.
(f) To determine the flow conditions past and over a side-channel spillway.
(g) A 1:10 model was built of the project, comprising the superstructure or basement of the plant.
(h) Tests in progress.

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(1189) (a) MILL RIVER CONDUIT.
(b), (c), (d) and (e) as above.
(f) To determine the flow conditions throughout the length of the conduit when flowing part full.
(g) A 1:60 model of the conduit was built of wood and galvanized iron. The grade and bottom half of the shape of the conduit were reproduced, but the side walls were continued above the top elevation of the conduit, and the top was left off so that the wave formations could be observed.
(h) Tests in progress.

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(1190) (a) MILL RIVER CONDUIT ENTRANCE.
(b), (c), (d), and (e) as above.
(f) To determine the capacity and the drop-down curve of the water surface at the entrance to the conduit for various flow conditions.
(g) The 1:20 model of the entrance and a section of the conduit thereafter was constructed of galvanized iron and wood. The discharge was measured with an 8" x 4" meter and water-surface elevations with a point gage.
(h) Tests in progress.

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(1191) (a) MILL RIVER CONDUIT SNOW DUMP.
(b), (c), (d) and (e) as above.
(f) To determine the water elevation in the snow dump for various discharge and tailwater conditions.
(g) A 1:20 model was constructed for the study, the conduit being constructed of galvanized iron and the snow dump itself of wood.
(h) Tests completed. Report in progress.
(i) The design was found to be satisfactory.

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(1192) (a) PARK RIVER CONDUIT EXIT.
(b), (c) (d) and (e) as above.
(f) To determine the character of the flow conditions at and near the exit of the Park River conduit into the Connecticut River.
(g) A 1:60 wooden model was constructed of the last 350 feet of conduit, and approximately one-half of the Connecticut River was represented.
(h) Tests completed. Report in progress.
(i) It was found that the discharge from the conduit did not cause any erosion with the contemplated bank protection in place. Flow conditions in the Connecticut River were not too disturbed for navigation.

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(1193) (a) PARK RIVER CONDUIT ENTRANCE.
(b), (c), (d) and (e) as above.
(f) To study the flow conditions at the entrance to the Park River Conduit.

(g) A 1:30 model of the entrance and about 250 ft of the conduit is being constructed of lucite.
(h) Construction work in progress.

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(1194) (a) BIRCH HILL OUTLET WORKS.
(b), (c), (d) and (e) as above.
(f) To determine the discharge characteristics of the outlet works.
(g) A 1:30 model was constructed of the approach channel, the outlet gates and the downstream channel as far as the Miller's River. Water was measured with an 8" x 4" Venturi and with a 4" x 2" Venturi. Tailwater elevations were controlled with a swing gate at the downstream end of the model.
(h) Tests are in progress.

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BEACH EROSION BOARD.

(1153) (a) A STUDY OF OSCILLATORY WAVES IN WATER.
(b) Beach Erosion Board.
(c) Laboratory research.
(d) M. A. Mason.
(e) Colonel E. J. Dent.
(f) To study the characteristics of oscillatory waves in water.
(g) Waves are generated by a vertical plunger in a horizontal-bottom wave tank. Characteristics are measured under conditions of steady oscillation.
(h) Tests completed; report in progress.

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(1195) (a) ABRASION OF BEACH MATERIALS BY WAVE ACTION.
(b) Beach Erosion Board.
(c) Laboratory research.
(d) M. A. Mason, C. A. Schulte.
(e) Colonel E. J. Dent.
(f) To determine the existence and nature of abrasive action due to wave motion on a beach.
(g) A beach of material of nearly uniform size and shape is subjected to wave action in a small tank. Measurements of the beach material size and shape are made at periodic intervals.
(h) Preliminary runs for the adjustment of wave size and beach-material character are in progress.

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(1196) (a) CHARACTERISTICS OF POSITIVE TRANSLATION WAVES.
(b) Beach Erosion Board and National Bureau of Standards.
(c) Research.
(d) M. A. Mason for Beach Erosion Board,
G. H. Keulegan for National Bureau of Standards.
(e) Colonel E. J. Dent.

(f) To compare theoretical with observed characteristics of translation waves.
(g) Comparisons are made of velocity of propagation, shape, and damping of waves.
(h) Computations are in progress.

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U. S. GEOLOGICAL SURVEY.

(1197) (a) FIELD PUMPING TESTS TO DETERMINE PERMEABILITY OF WATER-BEARING FORMATIONS.
(b) U. S. Geological Survey in cooperation with the University of Arkansas, College of Agriculture.
(c) Observations on the drawdown and recovery of water levels in observation wells resulting from the pumping of a central well.
(d) Kyle Engler and L. K. Wenzel.
(e) L. K. Wenzel.
(f) To evaluate the accuracy of the several field discharge methods of determining permeability.
(g) Making pumping tests at various localities in the Grand Prairie region.
(h) About 10 tests have been run.

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(1198) (a) FIELD PUMPING TESTS ON DOMESTIC AND STOCK WELLS TO DETERMINE NATURE OF CONE OF DEPRESSION, PERMEABILITY, AND SPECIFIC YIELD OF TIGHT MATERIALS.
(b) U. S. Geological Survey in cooperation with the Conservation and Survey Division, University of Nebraska.
(c) Measurement of drawdown and recovery of water level in observation wells near central pumped well.
(d) R. C Cady.
(e) R. C. Cady.
(f) In part to perfect a technique of field determination of permeability and specific yield of tight materials by pumping wells of low yield. Also to shed light on the failure or weakening of domestic and stock wells during droughts as a result of the local removal of water from storage in tight materials.
(g) Two tests were run in Richardson County, Nebraska.. The tests consisted of measuring weekly the water levels in pumped wells and observation wells that were put down nearby and the discharge of the pumped wells over a long period of time; in addition, intensive observations were made at each test site during a period of controlled pumping.
(h) The data have not yet been analyzed, and the tests are still in progress.

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(1199) (a) FLUCTUATIONS OF WATER LEVELS CAUSED BY EARTHQUAKES.
(b) U. S. Geological Survey.
(c) Observations of the fluctuations of the water levels in wells during an earthquake.
(d) Division of Ground Water, U. S. Geological Survey.
(e) O. E. Meinzer, Geologist in Charge.
(f) The purpose of these studies is to determine the nature and extent of fluctuations of water table and piezometric surface of aquifers caused by earthquakes in order to obtain information on physical characteristics of the aquifers, particularly their elasticity and compressibility; and to obtain information as to the transmission of earthquake waves.
(g) About 275 wells throughout the country are equipped with water-level recorders in connection with regular ground-water investigations. The time and magnitude of the fluctuations of the water levels are noted at times of known earthquakes.
(h) Observations of water levels caused by earthquakes are given by D. G. Thompson in the 1940 Transactions of the American Geophysical Union, page 435, and by H. E. Thomas in the Bulletin of the Seismological Society of America, volume 30, pages 93-97, 1940.

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THE PANAMA CANAL HYDRAULICS LABORATORY.

(1013) (a) MANIFOLD RESEARCH.
(b) The Panama Canal Third Locks Project.
(c) Design project.
(d) The Hydraulic Section personnel under the supervision of F. W. Edwards, Senior Hydraulic Engineer.
(e) The Governor, The Panama Canal.
(f) and (g) See Bulletin VIII, 1940.
(h) Tests on single ports (square-cornered and round-cornered) have been completed. Progress report is in preparation. Multiple port apparatus has been constructed and tests have been started.

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(1200) (a) CONTROL OF SURGES IN CANAL.
(b), (c), (d), and (e), see (1013).
(f) The purpose of the investigation is to study methods for controlling surges caused by lock operations in the narrow 8-3/4 mile reach of the Canal between Pedro Miguel locks and Gatun Lake.
(g) Observations for verification of the 1/60 scale model were made on the prototype. The proposed Third Lock was added to the model later and surges observed for various lock operations. Two plans for controlling surges are being studied. One involves proper scheduling of lock operations, while the other utilizes a surge reservoir adjacent to the new lock. The rate of flow from the Canal, consequently the surges, can be

reduced greatly by filling the greater portion of the lock directly from the reservoir while the reservoir is allowed to refill slowly from the ship channel.

(h) Verification tests have been completed. Preliminary tests for various operation schedules with and without the surge reservoir have been conducted.

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(1201) (a) LOWER APPROACHES TO LOCKS

(b), (c), (d), and (e), see (1013).

(f) The purpose of the investigation is to study navigation conditions in the lower approaches to the locks caused by spilling and by density currents when lock gates separating fresh and salt water are opened.

(g) A 1/60 scale model representing the area of the lock chamber, the width of the lock at the approach, and the downstream channel, has been constructed. Various types of outlets and various lengths and degrees of flare of arched and solid approach walls may be inserted readily. Tests may be conducted under steady flow conditions or under conditions simulating actual spilling operations. Velocity distribution in the approaches has been determined. Liquids of different density have been used for studying density currents.

(h) Testing is now in progress.

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(1202) (a) MODEL OF EXISTING PEDRO MIGUEL LOCK.

(b), (c), (d), and (e), see (1013).

(f) The purpose of the investigation is to provide a direct comparison between the performance of proposed designs of hydraulic systems for the Third Locks and the performance of the existing locks.

(g) A 1/25 scale model incorporating all pertinent features of the hydraulic system is to be used. Filling and emptying characteristics of the model will be compared with the prototype. Hawser stresses on models of various ships will be determined for comparison with those obtained in lock models of the Third Locks.

(h) Construction of the model is in progress.

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(1203) (a) MODEL OF PROPOSED LOCK

(b), (c), (d) and (e), see (1013).

(f) The purpose of the investigation is to develop a satisfactory hydraulic system.

(g) A 1/25 scale model is to be used for studying various designs of hydraulic systems. Hawser stresses are to be determined for various operating conditions.

(h) Construction of the model is in progress.

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(1204) (a) MODEL OF LOCK INTAKE.
(b), (c), (d), and (e), see (1013).
(f) The purpose of the investigation is to develop satisfactory intake and valve sections for the Third Locks hydraulic systems.
(g) A 1/20 scale model incorporating a portion of the forebay, the intake structure, the upstream valve section, and a short reach of the tunnel is planned. Hydraulic characteristics of proposed designs will be studied.
(h) Plans for the model are being prepared.

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U.S. SOIL CONSERVATION SERVICE.

(1205) (a) STREAM AND VALLEY SEDIMENTATION.
(b) Soil Conservation Service, U. S. Department of Agriculture.
(c) Investigation of the processes, causes and effects of stream and valley sedimentation throughout the United States, as influenced by accelerated soil erosion.
(d) Stafford C. Happ and others.
(e) Stafford C. Happ, Head, Stream and Valley Section, Sedimentation Division.
(f) To obtain quantitative data on processes and effects of stream and valley sedimentation as related to accelerated soil erosion, throughout the United States.
(g) Field surveys involving measurement of areal distribution and depths of deposits of determinable age; measurements of effects of sedimentation on flood heights, crop production, and other factors subject to damage or benefit; studies, surveys, and measurements of sediment sources, and of remedial or control measures for reducing sedimentation damage or directing sedimentation to minimize damage or provide benefits.
(h) Field surveys and studies in progress in various parts of the United States. One report published, "Some principles of accelerated stream and valley sedimentation," by Stafford C. Happ, Gordon Rittenhouse, and G. C. Dobson. U. S. Dept. of Agr. Tech. Bul. 695, 134 pp., illus. 1940.

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(1206) (a) RESERVOIR SILTING.
(b) Soil Conservation Service, U. S. Department of Agriculture.
(c) Investigation of the processes, causes, and effects of reservoir silting throughout the United States as influenced by accelerated soil erosion and land use.
(d) Carl B. Brown and others.
(e) Carl B. Brown, Head, Reservoir Section.
(f) To establish an accurate record of silting conditions in American reservoirs; to ascertain the rates and processes of, and determine and evaluate the factors involved in, reservoir sedimentation; and to establish the relationship between silting conditions in various types of reservoirs and physical conditions of soil, slope, climate, erosion, and land use in their watersheds.

(g) (1) Bibliographic survey of all literature, (2) widespread reconnaissance field investigation, (3) detailed surveys of selected reservoirs, (4) special studies of watershed conditions to determine sources of sediment.
(h) Research in progress. Bulletins issued:
Barnes, F. F., Kraebel, C. J., and LaMotte, R. S., "Effect of Accelerated Erosion on Silting in Morena Reservoir, San Diego County, Calif." (In cooperation with the Forest Service.) U. S. Dept. Agr. Tech. Bul. 639, 21 pp., illus. 1939.
Eakin, H. M., "Silting of Reservoirs". U. S. Dept. Agr. Tech. Bul. 524, 142 pp., illus. 1936. (Revised by Carl B. Brown, 1939.)

In addition, 35 advance reports on individual reservoir surveys have been issued in mimeographed form.

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(1207) (a) COMPACTION OF SEDIMENT IN RESERVOIRS.
(b) Soil Conservation Service, U. S. Department of Agriculture.
(c) Investigation of the factors of compaction of sediment in relation to its effect on the maintenance of storage capacity of reservoirs.
(e) Carl B. Brown, Head, Reservoir Section.
(f) The objectives are to determine the factors involved in sediment compaction, the amount and rate of compaction of reservoir sediments, and the effect of compaction on computing the useful life of a reservoir under a given rate of sediment influx.
(g) The investigation includes the design of samplers for collecting undisturbed samples of sediment from the bottom of a reservoir for volume-weight determinations, development of statistical patterns of sampling to determine the average volume weight of all sediment in a reservoir, and laboratory studies conducted in tubes to determine the degree of compaction of various types of sediment with changing conditions of temperature, salinity, and with time and superincumbent load of sediment.

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U.S. SOIL CONSERVATION SERVICE En oree River Sediment Load Station

(937) (a) MEASUREMENT OF TOTAL SEDIMENT LOAD TRANSPORTED BY NATURAL STREAMS.
(b) Soil Conservation Service, U. S. Department of Agriculture.
(c) General research.
(d) Joe W. Johnson, Alvin G. Anderson, H. Albert Einstein.
(e) Chief, Soil Conservation Service.
(f) To provide a continuous record of the amount and composition of the suspended and bed loads carried by a natural stream. To correlate these data with the hydraulic functions of the stream and the topography, land use, and hydrologic conditions of the watershed.

(g) The bed load is removed hydraulically from the subdivisions into which the bottom of the river has been divided, while simultaneous observations are made of suspended load and velocities.
(h) Suspended load, bed load, dissolved load, discharge, water surface slope and precipitation records are available for Enoree River, from January 1, 1939.

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NATIONAL BUREAU OF STANDARDS (National Hydraulic Laboratory).

(42) (a) INVESTIGATION OF THE PHYSICS OF PLUMBING SYSTEMS.
(b) National Bureau of Standards.
(c) General research.
(d) R. B. Hunter, E. Hermansen, L. O. Olsen, F. B. Leonard.
(e) The Director, National Bureau of Standards.
(f) To obtain data on which to base logical estimates of the capacities of vertical and sloping drain pipes in plumbing systems, and to make a study of safety requirements with special reference to back-siphonage and venting.
(g) It is proposed to collect and correlate as far as possible existing data on these subjects and to make such supplementary experiments as may be necessary to meet the purpose of the investigation.
(h) A paper, National Bureau of Standards Report BMS65,"Methods of Estimating Loads in Plumbing Systems", by R. B. Hunter, has been prepared for publication and will be available about March 15, 1941. This report will be available for purchase from the Superintendent of Documents, Government Printing Office, Washington, D. C., at 10 cents per copy (stamps not accepted).
(i) This project is being carried on in conjunction with Project 797, also reported in this Bulletin.

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(43) (a) INVESTIGATION OF PIPE BENDS.
(b) National Bureau of Standards.
(c) General research.
(d) K. H. Beij, G. H. Keulegan.
(e) The Director, National Bureau of Standards.
(f) To obtain the general laws of head loss in pipe bends; to correlate, insofar as possible, all available results of previous investigations; to obtain practicable formulas for use by engineers; and to extend the results to include flow of other fluids, such as oils, steam, etc.
(g) Laboratory tests are planned on smooth and rough pipe bends of various diameters and central angles; and on miter bends and cast fittings.
(h) Experiments on 1-inch smooth pipe coils of one to ten or twelve turns and radii up to about four feet are under way.

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(496) (a) DETERMINATION OF DISCHARGE COEFFICIENTS OF FLOW NOZZLES.
(b) A paper entitled "Discharge Coefficients of Long Radius Flow Nozzles used with Pipe Wall Pressure Taps," presented at the annual meeting of the ASME, Dec. 1940, gives the results of a correlation of a part of the data obtained from this and projects (526), (587), and (617). The coefficients given in this paper are presented in the form of curves. The combining and presentation of the results over the entire range of conditions covered by the several cooperative programs has yet to be completed, as has also a comparison of these results with those from other sources, notably I.S.A.
(i) Project inactive.

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(563) (a) AGING TESTS ON PIPES.
(b) U. S. Treasury Department.
(c) Cooperative project with the Division of Metallurgy, National Bureau of Standards.
(d) K. H. Beij, E. Hermanson.
(e) The Director, National Bureau of Standards.
(f) To determine the effects of long-continued service on the hydraulic friction of pipes.
(g) Specimens of 1-1/4 inch pipes of nine different materials have been installed in a cold-water line in constant service, and specimens of 3/4 inch pipes of seven different materials have likewise been installed in hot-water service lines at the National Bureau of Standards. It is planned to determine the hydraulic resistance coefficients of these specimens at intervals over a period of 20 years.
(h) Preliminary tests (before aging) were made in 1936; observation tests were made in 1937, 1938, and 1940. The next tests are scheduled for August, 1942.

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(564) (a) DENSITY CURRENTS.
(b) National Bureau of Standards.
(c) General research.
(d) G. H. Keulegan, G. W. Patterson, H. N. Eaton, T. E. Ferguson.
(e) The Director, National Bureau of Standards.
(f) To determine the laws of currents in miscible stratified fluids.
(h) A new series of experiments is being carried out with a larger testing channel for the purpose of ascertaining the extent of the scale effect on the process of mixing between the two liquids of different densities.
(i) As soon as these experiments have been completed, a paper will be prepared for publication.

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(616) (a) FLOW IN OPEN CHANNELS.
(b) National Bureau of Standards.
(c) General research.
(d) G. H. Keulegan, G. W. Patterson.

(e) The Director, National Bureau of Standards.
(f) To investigate the phenomena of open-channel flow in the light of modern concepts of turbulent flow. This will involve a study of the dependence of the hydraulic friction factor on the cross-section of the channel and on the roughness of its surfaces, the apparent friction of the free surfaces, and the depression of the filament of maximum velocity.
(i) Project temporarily inactive. Some of the results are being used in the papers prepared in connection with Project 977 reported in this Bulletin.

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(797) (a) PLUMBING MATERIALS AND EQUIPMENT AS RELATED TO LOW-COST HOUSING.
(b) National Bureau of Standards.
(c) Part of a coordinated program of research on low-cost housing.
(d) R. B. Hunter, E. Hermansen, L. O. Olsen, F. B. Leonard.
(e) Dr. H. L. Dryden, Coordinator of Program, National Bureau of Standards.
(f) To assemble the data necessary for developing uniform standards and specifications for materials and construction for plumbing installations in low-cost housing construction under Federal control.
(g) A review and study of existing standards as they apply to the field of low-cost housing will be made, together with an experimental study of plumbing piping layouts (water-supply, drain, and vent pipes) relative to minimum requirements for the efficient functioning of the system.
(h) Experimental work on this project has been completed, and the results are being prepared for publication in the National Bureau of Standards Building Materials and Structures Series. A paper, "Methods of Estimating Loads in Plumbing Systems", has been completed and will be published shortly. Other papers dealing with the capacities of building water-distributing systems, capacities of building drainage systems, and the theory and practice of venting in plumbing systems are in progress.
(i) The following reports on this project and the related Project 42 have been or are in process of being published and may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., at prices indicated (stamps not accepted):

National Bureau of Standards Research Paper RP1086, "Cross-connections in Plumbing Systems", by R. B. Hunter, G. T. Golden, and H. N. Eaton, April 1938, 15 cents per copy.

National Bureau of Standards Report BMS28, "Backflow Prevention in Over-rim Water Supplies", by G. T. Golden and R. B. Hunter, August 1939, 10 cents per copy.

National Bureau of Standards Report BMS65, "Methods of Estimating Loads in Plumbing Systems", by R. B. Hunter, available about March 15, 1941, 10 cents per copy.

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(977) (a) MATHEMATICAL THEORY OF FLOOD WAVES.
(b) Cooperative project with the U. S. Weather Bureau.
(c) General research.
(d) G. H. Keulegan and G. W. Patterson for the National Bureau of Standards, R. T. Zoch for the U. S. Weather Bureau.
(e) The Director, National Bureau of Standards.
(f) To review and supplement the European and American literature on the mathematical theory of waves which is applicable to the phenomena of flood waves.
(g) The results of this review will be extended and coordinated and published in a series of papers dealing individually with the following topics:
(1) The irrotational flow theory of translation waves.
(2) The effect of turbulence and channel slope on the propagation of translation waves.
(3) The quasi-permanent régime of rivers and the routing of floods.
(4) Recent advances in the unrestricted two-dimensional theory of surface waves.
(h) The first paper of the series, "The Mathematical Theory of Irrotational Translation Waves", was published in the Journal of Research of the National Bureau of Standards, Volume 24, p. 47-101 (January 1940) as Research Paper RP1272. Reprints are available from the Superintendent of Documents, Government Printing Office, Washington, D. C., at a cost of 10 cents per copy (stamps not accepted). An abstract of this paper appears in Bulletin VIII of this series, and also in Science Abstracts, Sect. A, Physics, Vol. 43, No. 507 (March 25, 1940), abstract No. 623, p 166. A review of the paper appeared in Mathematical Reviews, Vol. 1, No. 9 (Sept. 1940) p 284-285. Manuscripts of the second and third papers of the series are in the course of preparation. An experimental and theoretical study of the damping of standing waves is also being carried on.

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(978) (a) MODEL STUDIES, INDIAN ROCK DAM.
(b) U. S. Engineer Office, Baltimore, Md., Col. Wm. A. Johnson, District Engineer.
(c) Study of performance of side-channel spillway, tunnel intake, and outlet works for spillway channel and tunnel.
(d) K. H. Beij for the National Bureau of Standards; F. W. Edwards and C. L. Winslow for the U. S. Engineer Office. M. A. Mason, L. L. DeFabritis, C. W. Elliot, J. W. Boyd, B. F. Husten, F. B. Leonard.
(e) The District Engineer, U. S. Engineer Office, Baltimore, Md.

(f) To check rating curve of spillway weir and capacity of spillway channel; to determine effect of bend in spillway channel; to study flow at conservation dam and intake of tunnel; to study design of outlet works of spillway channel and tunnel; and to study scour in lower river valley.

(g) Two models were built and tested. Model No. 1, on a scale of 1 to 60, included the complete spillway weir and channel, the outlet works, a portion of the reservoir, and a considerable section of the lower river valley. Model No. 2, on a scale of 1 to 22.4, included the tunnel with intake and outlet works, a conservation dam, and a small section of the downstream river bed.

(h) The final report, covering this project was submitted to the District Engineer, Baltimore, Md., on April 18, 1940. The project is completed.

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(979) (a) STUDY OF DREDGE SUCTION BOOSTER.

(b) The Division Engineer, U. S. Engineer Office, Richmond, Va.

(c) Tests on the suction-line of a pipe-line dredge with and without a booster pump at the suction-line entrance.

(d) L.L. DeFabritis and F. H. Beij for the National Bureau of Standards; Lt. Col. D. L. Neuman for the U. S. Engineer Office. L. O. Olsen, B. F. Husten, H. Hessing, E. Hermansen, C. W. Elliot.

(e) The Division Engineer, U. S. Engineer Office, Richmond, Va.

(f) To compare the concentration of solids and pressure gradients in the suction pipe of a small-size pipe-line dredge with and without a booster-pump at the suction entrance, for different velocities in the pipe and dredging from a sand bed that moves relatively to the line, with the view to determining the effect of the booster on the concentration of solids, sand output, and required vacuum at the intake of the dredge pump.

(g) A sloping, 3-inch diameter suction line with an enlargement to a 4-inch diameter entrance remained fixed relative to the submerged sand tank. The 3-inch main pump was set up in three positions attached to the sloping suction line by: (1) a short horizontal pipe; (2) a long horizontal pipe; (3) a long pipe rising at 45 degrees. When worn, the 4-inch diameter axial-flow propeller was replaced by a single-stage, mixed-flow pump assembly, 4-inch nominal diameter, complete with suction and discharge bowls and guide vanes.

(h) Authorized tests and a further series at higher booster speeds have been completed. A report to the Division Engineer has been prepared.

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(982) (a) FUNCTIONAL CHARACTERISTICS OF PLUMBING FIXTURES AND FITTINGS.
(b) Cooperative project with Plumbing Fixtures Manufacturers Associations.
(c) General research on plumbing fixtures.
(d) Gene E. Golden.
(e) Gene E. Golden, National Bureau of Standards.
(f) To determine the functional characteristics of plumbing fixtures with a view toward developing functional and test specifications.
(g) Recording of the variable phenomena that occur in plumbing fixtures is being done by photographic and mechanical means in order to allow more detailed analysis.
(h) Studies of water closets and the supply and drainage of other fixtures are under way.

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(981) (a) INSTALLATION REQUIREMENTS FOR HEAD METERS SUCH AS ORIFICE, FLOW NOZZLE, ETC.
(b) Cooperative research sponsored by A.S.M.E. Special Research Committee on Fluid Meters with the National Bureau of Standards.
(c) Laboratory investigation simulating certain possible plant conditions.
(d) A.S.M.E. Fluid Meters Committee, National Bureau of Standards.
(e) H. S. Bean, National Bureau of Standards.
(f) To verify and extend previous tests to determine the minimum necessary conditions of installation of head meters, particularly orifices and nozzles.
(g) Using orifices and nozzles in 4-inch pipe to determine the effects of bends, valves, etc., on the inlet side, upon the indications of the meter. At present all tests are being made with water.
(h) This work was undertaken as an extension of the Flow Nozzle Research Program sponsored by the A.S.M.E. Fluid Meters Committee. Tests were made during the summer of 1939, were taken up again in the summer of 1940, and are still in progress.

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(1152) (a) TRANSPORTATION OF SAND IN PIPES.
(b) Chief of Engineers, U. S. Army, Washington, D. C.
(c) Research.
(d) L. L. DeFabritis and K. H. Beij for the National Bureau of Standards; Col. E. J. Dent and H. K. Armstrong, for the U. S. Engineer Office. L. O. Olsen, B. F. Huston, H.Hessing, A. A. Lamberta, C. W. Elliot.
(e) Chief of Engineers, U. S. Army, Washington, D.C.
(f) To determine the general laws of head loss in pipes carrying sand and water mixtures.
(g) Tests are planned on standard black steel pipes having nominal diameters of 2, 3, 4, and 6 inches. Relatively complete study of the 4-inch size will include measurement of the head loss for a range of velocities transporting sand of a carefully controlled grain size in

concentrations ranging from zero to the maximum possible, repeating the procedure with each of a sufficient series of grain sizes and arbitrary mixtures of grain sizes. Similar studies, but less intensive, will be made on the 2- and 3-inch pipe sizes over a corresponding range of conditions and on the 6-inch pipe size over a narrower range of velocities and concentrations.

(h) Materials have been procured and the apparatus has been set up. Preliminary trials revealed the necessity for changes in the apparatus which are now being made.

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(1208) (a) ARTIFICIAL STREAM CONTROLS.
(b) U. S. Geological Survey.
(c) Model study of weirs, a cooperative project with the U. S. Geological Survey.
(d) Evald Hermansen, K. H. Beij, and H. N. Eaton, (National Bureau of Standards), C. H. Pierce (U. S. Geological Survey).
(e) The Director, National Bureau of Standards.
(f) To study the performance at high heads of the various designs of stream control structures of several district offices of the Survey.
(g) Models built to scales varying from 1:2 to 1:7.2 are calibrated in a 20-inch wide flume. Head-discharge relationships are established, and, where necessary, dye injections are used to study eddies and currents which affect the head-discharge relationship.
(h) Eight models of 5 different types of controls have been calibrated, and laboratory work is about 90% completed.

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(1209) (a) TESTS OF SPILLWAYS, CIRCULAR IN PLAN.
(b) U. S. Geological Survey.
(c) Model studies of semi-circular spillways, a cooperative project with the U. S. Geological Survey.
(d) Evald Hermansen, K. H. Beij and H. N. Eaton (National Bureau of Standards), O. W. Hartwell (U. S. Geological Survey).
(e) The Director, National Bureau of Standards.
(f) To study the discharge characteristics of two semi-circular spillways, and, in particular, to obtain from models the head-discharge relationships for the prototypes.
(g) Two 1:10-scale wooden models will be tested in a 25 ft by 35 foot tank, with the respective river-bed contours reproduced and provision made for measuring head, velocity, and discharge.
(h) The models have been built, and the testing tank is nearly completed.

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(1210) (a) LAWS OF SIMILARITY AS APPLIED TO MODEL TESTS:
(A) SCALE EFFECT ON SPILLWAY SECTIONS.
(b) National Bureau of Standards.
(c) General research.
(d) K. H. Beij, E. Hermanser, H. N. Eaton.
(e) The Director, National Bureau of Standards.
(f) To determine the conditions under which the laws of similarity are valid in the conduct of model tests for engineering purposes. (A) Study of generalized and special weir sections to determine scale effect....
(g) The effects of size, surface roughness, shape of approach channel, etc., on the head-discharge relationship for a generalized weir section with no discontinuities will be determined. The equation for this section is $y/a = (1 - (x/\ell)^2)^2$, where y is the ordinate measured upward from the level of the approach-channel bed, x is the abscissa measured from the center-line of the section, and a and ℓ are parameters. For the first series of weirs $a = \ell$, and for the weir now under test, $a = \ell =$ 20 cm. The shape of this generalized weir section is a very close approximation to the curved portion of the Creager weir crest. Later similar work will be done on other weir sections, including those most important from an engineering standpoint.
(h) Preliminary tests on the first model have been completed. The results of the preliminary calibration give a head-discharge curve which is an unbroken straight line on logarithmic paper for heads ranging from 0.1 cm (0.003 ft) to 21.3 cm (0.7 ft).

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TENNESSEE VALLEY AUTHORITY.

A. CURRENT HYDRAULIC LABORATORY RESEARCH PROJECTS.

Items (b) (d), and (e) are the same for all projects. They have been omitted from the individual projects to avoid unnecessary repetition. Their significance is as follows:

(b) Tennessee Valley Authority.
(d) Laboratory staff under direction of G. H. Hickox.
(e) A. S. Fry, Head Hydraulic Research Engineer, Tennessee Valley Authority, Knoxville, Tennessee.

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(494) (a) PICKWICK LANDING DAM, SPILLWAY DESIGN.
(c) Investigation of stilling basin and shape of crest for Pickwick Landing Dam.
(f) To determine a satisfactory and economical design of apron below the dam in order to dissipate energy, and to determine the best shape of spillway crest.

(g) Tests made on models built to three different scales. Action of stilling basin for 1:50 and 1:25 sectional models observed through glass panels in side of flume. Results checked on 1:100 model of entire dam. Discharge coefficients, pressures on face of spillway, and on spillway gate piers for various combinations of gate operation were carefully measured on a 1:25 model. Supplementary studies were also made to determine the size of air passages necessary for satisfactory aeration of the nappe.
(h) Tests completed.
(i) Report in progress.

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(574) (a) HIWASSEE DAM, SPILLWAY DESIGN.
(c) Investigation of stilling basin and spillway discharge coefficients for Hiwassee Dam.
(f) To determine the most satisfactory and economical design of stilling basin at the toe of the dam, and to measure spillway discharge coefficients.
(g) Tests were made on a 1:55 scale model placed behind a glass panel to allow visual observation of erosion in the bed below the stilling basin.
(h) Tests completed.
(i) Report in progress.

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(708) (a) GUNTERSVILLE DAM, SPILLWAY DESIGN.
(c) Investigation of stilling basin and spillway discharge coefficients for Guntersville Dam.
(f) To determine a satisfactory and economical design of apron below the dam for dissipation of energy and prevention of bed erosion, and to determine spillway discharge coefficients.
(g) Tests of the apron design were made on a 1:25 scale model of 3 spillway bays in a flume with glass panels which permitted observation. The final design was checked on a 1:100 scale model of the entire spillway. Discharge coefficients were determined on models at scales of 1:25 and 1:50.
(h) Tests completed.
(i) Report in progress.

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(709) (a) CHICKAMAUGA DAM, SPILLWAY DESIGN.
(c) Investigation of stilling basin and spillway discharge coefficients for Chickamauga Dam.
(f) To determine a satisfactory and economical design of apron below the dam for dissipation of energy and prevention of bed erosion, and to determine spillway discharge coefficients.
(g) Tests of the apron design were made on a 1:25 scale model of 3 spillway bays in a flume with glass panels which permitted observation. The final design was checked on a

1:100 scale model of the entire spillway. Discharge coefficients were determined on models at scales of 1:25 and 1:50.
(h) Tests completed.
(i) Report in progress.

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(939) (a) HIWASSEE DAM, CAVITATION AT SLUICE ENTRANCES.
(c) Investigation of possibility of cavitation at entrance of discharge sluices.
(f) To develop an entrance shape which would prevent cavitation under all normal operating conditions.
(g) A 1:15 scale model of the upper portion of the sluice including the entrance was built and provided with piezometer connections along its length and at all points where local pressure reductions might occur. Pressures were measured for test conditions simulating various reservoir elevations and discharges.
(h) Tests completed.
(i) Report in progress.

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(1129) (a) KENTUCKY DAM, SPILLWAY DESIGN.
(c) Investigation of spillway section and apron for Kentucky Dam.
(f) To develop the most suitable form of spillway section, apron, and stilling basin to provide for: (1) the safety of the dam against erosion at the toe, (2) the minimum disturbance of the thick gravel deposits overlying the rock in the river bottom, (3) a minimum interference with navigation by waves and adverse currents.
(g) Tests were made on a 1:30 scale model of 3 spillway bays in a flume with glass panels which permitted observation. This model was used to develop the shape of crest and stilling basin and to provide general information regarding the movement of river bed material and the formation of waves on the water surface. The entire dam and a portion of the river was molded to a scale of 1:121 in order to make a more detailed study of the effects of gate operation and apron design on movement of bed material and on navigation.
(h) Tests completed.
(i) Report completed.

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(1133) (a) NORRIS DAM, SLUICE CALIBRATION.
(c) Calibration of sluices for discharge.
(f) To obtain accurate data for discharge rating of sluices.
(g) Gate openings and pool levels obtained from operating records at the dam have been correlated with the river discharge at a gaging station immediately below the dam. Additional measurements needed to fill gaps in the data will be made when the sluices are again placed in operation.

(h) All data now available have been utilized. Work will be resumed when further releases are made through the sluices.

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(1135) (a) WATTS BAR DAM, SPILLWAY DESIGN
(c) Investigation of stilling basin and shape of crest for Watts Bar Dam.
(f) To develop an apron which would cause a minimum of disturbance to navigation and eliminate scouring where it would be harmful to structures.
(g) Shape of crest and tentative apron design were developed on a 3-bay model built at a scale of 1:25 in a flume provided with glass panels which permitted observation. The effects of the apron design and various methods of gate operation on navigation were observed on a 1:121 scale model of the entire dam. Particular attention was paid to the presence and size of waves which might have an adverse effect on navigation.
(h) Tests completed.
(i) Report in progress.

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(1136) (a) WILSON DAM, SPILLWAY DISCHARGE.
(c) Study of discharge over Wilson Dam spillway.
(f) To provide a satisfactory discharge rating for Wilson Dam crest gates.
(g) Tests were made on 3 bays of Wilson Dam spillway at a scale of 1:39.4. Discharges were measured for all gate openings and reservoir elevations over the entire operating range. Measurements were made for all 3 gates discharging and for the center gate alone. Profiles of the water surface between the piers were obtained and compared with similar measurements made on the prototype.
(h) Tests completed.
(i) Report completed.

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(1211) (a) KENTUCKY DAM, LOCK GUARD BOOM.
(c) Investigation of a floating type of guard wall for the upper entrance of Kentucky lock.
(f) To investigate the forces which would be exerted on the lock wall by a floating guard boom due to the action of wind waves on the surface of the reservoir.
(g) A 1:100 scale model of the upper end of the lock and the proposed floating boom was built. A wave machine was constructed to produce waves of any desired frequency and amplitude. The floating boom was connected to the lock wall by means of a special elastic measuring device. By changing the characteristics of the connection, it was possible to estimate the forces exerted by the waves on the boom.

(h) Tests completed.
(i) Report completed.

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(1212) (a) HALES BAR DAM, NAVIGATION MODEL.
(c) Investigation of navigation conditions below the dam.
(f) To determine the extent of dredging operations immediately below the existing Hales Bar spillway necessary to provide suitable navigation conditions, and to study the effect of possible future reconstruction of the dam on the present dredging program.
(g) Tests were made on a 1:120 scale model of the Tennessee River that included about 1200 feet of channel above the dam and 6000 feet below the dam. The effect of various proposed dredging operations on navigation was studied by observing current directions and behavior of a model barge tow.
(h) Tests completed.
(i) Report completed.

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(1213) (a) WHEELER DAM, FLOWMETER CALIBRATION.
(c) Calibration of hydraulic equipment.
(f) To calibrate an 8-inch flowmeter used in measuring the water used in the generator cooling system at Wheeler Dam.
(g) The meter was calibrated by placing it in an 8-inch pipe line in series with a calibrated diaphragm orifice. Observations were made covering the range of flow to be expected at the dam. It was found that the design of the meter was faulty, causing inaccuracies in calibration. The tests were then expanded to include a study of the most practicable modifications of the meter.
(h) Tests completed.
(i) Report completed.

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(1214) (a) CHICKAMAUGA DAM, WAVE ACTION BELOW LOCK WALL EXTENSION.
(c) Measurement of wave heights in navigation channel below lock.
(f) To determine wave heights existing in the navigation channel below the lock for the purpose of supplying information to bidders on proposed dredging and to provide a check on the results of model tests.
(g) Gages have been installed at suitable locations in the channel. Observations are made at selected river discharges by means of motion pictures. Comparison with results of model tests is made as data become available.
(h) Tests in progress.

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(1215) (a) FORT LOUDOUN DAM, NAVIGATION MODEL.
(c) Investigation of effect of location of structures on navigation through the lock.
(f) To study various proposed layouts of structures with a view to determining their relative advantages with respect to navigation.
(g) A 1:130 scale model of the Tennessee River was built which extended approximately 3500 feet above the dam and 10,000 feet below. Observations of current directions and the behavior of model barges were made to determine the effect on navigation. The reach below the dam includes the confluence of the Little Tennessee River, and observations of navigation conditions at this point are being made in order to study the possible effect on future dredging operations.
(h) Tests in progress.

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(1216) (a) FORT LOUDOUN DAM, SPILLWAY MODEL.
(c) Investigation of the stilling-basin design.
(f) To determine a satisfactory and economical design of apron below the dam for dissipation of energy and prevention of erosion.
(g) Tests of the apron design were made on a 1:25 scale model of three spillway bays in a flume with glass panels which permitted observation. A tentative design of apron was selected as a result of these tests. Additional tests will be made on a 1:130 scale model of the entire dam to study the special conditions which exist at the ends of the spillway.
(h) Tests in progress.

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(1217) (a) HIWASSEE DAM, PROTOTYPE CHECK.
(c) Verification of results predicted by model tests.
(f) To calibrate the spillway and sluices of Hiwassee Dam and to measure pressures in the sluice entrance for the purpose of comparison with laboratory tests.
(g) Water will be released through the sluices and over the spillway at constant rates of discharge which will be maintained for a long enough period so that reliable determinations may be made at the gaging station immediately below the dam. Piezometers have been provided in the sluice entrance lining to allow measurement of pressures at these points. It is expected that observations of pressures at these points will be compared with pressures measured in a model of the sluice entrance described in project (936).
(h) Observations will be made when water is available and when the reservoir level is at suitable elevations.

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(1218) (a) CHEROKEE DAM, SPILLWAY MODEL.
(c) Investigation of stilling basin design.
(f) To determine a satisfactory and economical design of apron below the dam for dissipation of energy and prevention of erosion.
(g) Tests of four spillway bays at a scale of 1:30 were made in a flume with glass panels which permitted observation. A tentative design developed on the 1:30 scale model was tested further on a model of the entire dam at a scale of 1:70. On this model it was possible to study the effects of unsymmetrical spillway-gate and sluice operation, and to make such modifications of the stilling basin as seemed desirable. The 1:70 model was also used to investigate special conditions existing at the ends of the apron.
(h) Tests completed.
(i) Report in progress.

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(1219) (a) CHEROKEE DAM, SLUICE MODEL.
(c) Investigation of possibility of cavitation at entrance and outlet of discharge sluices.
(f) To check the design of the entrance to ensure that no cavitation conditions would exist under normal operating conditions, and to develop an outlet which would satisfy requirements imposed by the stilling basin without danger of cavitation.
(g) Models of the sluice entrance and outlet were constructed at a scale of 1:15. Piezometers were provided at all points of curvature of flow where cavitation might possibly exist. Pressures at these points were measured for a normal range of operating conditions.
(h) Tests completed.
(i) Report in progress.

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B. CURRENT HYDROLOGICAL AND HYDRAULIC FIELD INVESTIGATIONS.

Items (b) and (c) are the same for all projects. Their significance is as follows:
(b) Tennessee Valley Authority.
(c) A. S. Fry, Head Hydraulic Research Engineer, Tennessee Valley Authority, Knoxville, Tennessee.

(950) (a) DETERMINATION OF SILT CARRIED IN SUSPENSION BY TENNESSEE RIVER AND TRIBUTARIES.
(d) Hydrology Section, Hydraulic Data Division, under direction of G. N. Burrell.
(f) To determine the quantity of silt carried by streams from which to estimate life of reservoirs, and to furnish data on relative erosion from various areas and planning of corrective measures.

(g) Samples of water are collected periodically at stations in the Basin, analyzed to determine the suspended silt content, and correlated with river discharge to determine the suspended silt load at each station.
(h) Data are being collected.

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(951) (a) EVAPORATION IN THE TENNESSEE RIVER BASIN.
(c) A study of the evaporation of water from reservoir surfaces.
(d) Hydrology Section, Hydraulic Data Division, under direction of G. N. Burrell.
(f) To derive a general rule applicable to the Tennessee River Basin that will permit the computation of evaporation from known meteorological phenomena.
(g) Accurate daily measurements are made of evaporation from a pan at four locations in the Basin, together with readings of standard meteorological equipment.
(h) The stations were established between October 1934 and April 1935, and continuous records have been kept.

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(955) (a) GROUND-WATER INVESTIGATIONS.
(c) Hydrological study.
(d) Hydrology Section, Hydraulic Data Division, under direction of G. N. Burrell.
(f) To determine effect of filling of reservoirs on adjacent water table.
(g) Observation wells are dug, and the record of the level of the water in these wells is compared with rainfall and river stages for periods before and after reservoir filling. Studies are being made for Chickamauga, Guntersville, Pickwick, Watts Bar, Wheeler, and Kentucky Reservoirs.
(h) Installations are complete, and records are being collected. Preliminary reports have been prepared for the projects at which construction work is nearing completion.

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(956) (a) FLOOD INVESTIGATIONS--TENNESSEE RIVER AND TRIBUTARIES.
(c) Survey to obtain field data for hydraulic studies.
(d) Field Investigations Section, Hydraulic Data Division, under direction of J. E. Goddard.
(f) To provide data on past and current floods necessary in planning flood-control projects.
(g) High-water marks are set and observations made as current floods occur; field search is made for high-water marks of past floods, and data are collected on rainfall-runoff and damages during such floods.
(h) Work is in progress.
(i) Report in progress.

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(958) (a) INVESTIGATION OF SPRINGS AND RUNS BELOW DAMS.
(c) Hydrologic investigation having application to construction activities.
(d) Field Investigations Section, Hydraulic Data Division, under direction of J. E. Goddard.
(f) To measure flows for springs and runs below dam sites before and after construction of dams to determine leakage.
(g) Measuring weirs were constructed at Tennessee Valley Authority dams and are observed regularly. The records are being analyzed to account for current rainfall.
(h) Observations are being continued.

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(959) (a) PRECIPITATION IN TENNESSEE RIVER BASIN.
(c) A comprehensive study of rainfall and other weather phenomena in and adjacent to the watershed.
(d) Hydrology Section. Hydraulic Data Division, under direction of G. N. Burrell.
(f) To furnish meteorological data for use in planning water-control projects, for agricultural and other purposes.
(g) Records from 489 TVA, U. S. Weather Bureau, and private rain gages in Tennessee Valley are collected, compiled, and analyzed. Special investigations are made of unusual storms.
(h) Bulletins are issued monthly presenting the data collected.

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(960) (a) RESERVOIR TEMPERATURES.
(c) Hydrographic investigation to obtain data on reservoir water temperatures.
(d) Field Investigations Section, Hydraulic Data Division, under direction of J. E. Goddard.
(f) To determine the variations of water temperature from the surface to the bottom in the entire body of water throughout the year for use in connection with water utilization.
(g) Established ranges on Norris, Hiwassee, Chickamauga, Wheeler, Pickwick, and Guntersville Reservoirs are sounded monthly with a resistance thermometer, and readings are taken at every 5 or 10 feet of depth.
(h) Monthly records are obtained. Reports are prepared periodically.

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(961) (a) RUNOFF-SILT INVESTIGATIONS ON SMALL WATERSHEDS.
(c) Hydraulic-hydrological research to give data on runoff and silt erosion from areas of varying degrees of forest cover.

(d) Technical Studies Unit, Hydraulic Data Division, under direction of B. E. Morriss.
(f) To determine the relation between rainfall, runoff, and silt over three small tributaries of Norris Reservoir that have been selected for forest influence studies.
(g) Rainfall, runoff, and silt data are collected and studied for individual storm periods, and correlations are made between rainfall and peaks of discharge and silt loads to determine the effect of variables upon runoff and upon the suspended silt load.
(h) Reports are in progress.

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(962) (a) SILTING OF EXISTING RESERVOIRS.
(c) Hydrographic investigation to give data on silting of existing reservoirs.
(d) Technical Studies Unit and Hydrology Section, Hydraulic Data Division, under direction of B. E. Morriss and G. N. Burrell.
(f) To determine the quantity of silt deposited by the stream, the probable life of the reservoir, the effect of silt storage upon navigation channels and upon the silting of downstream reservoirs, and to obtain data for estimating the probable silting in comparable future developments.
(g) Selected ranges were probed and sounded for original and present bottom elevations, volumetric samples of deposited silt were collected and analyzed, and the quantity and distribution of silt were computed. Investigations have been made of Lake Davy Crockett on the Nolochucky River, Andrews Reservoir on the Hiwassee River, Parksville Reservoir on the Ocoee River, and Chickamauga, Hales Bar, Guntersville, and Wilson Reservoirs on the Tennessee River.
(h) Comprehensive silt report is in preparation.

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(963) (a) SILT TRAVERSES--TENNESSEE RIVER TRIBUTARIES.
(c) Hydrographic research.
(d) Hydrology Section, Hydraulic Data Division, under direction of G. N. Burrell.
(f) To determine the relation of silt concentration to velocity distribution and whether any definite relation exists between the river discharge and the quantity of silt transported.
(g) Cross sections have been selected at three tributary gaging stations at which silt samples have been collected. A large number of silt samples will be taken at varying depths and points on the cross section, at rising, falling, and crest stages. Velocity measurements will be taken at all the points at which samples are collected.
(h) Field work will be undertaken during high-water season.

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(1220) (a) RADIO GAGES FOR REPORTING RAINFALL AND RIVER STAGES.
(c) Development and testing of new equipment for collection of hydraulic data.
(d) Technical Studies Unit, Hydraulic Data Division, under direction of B. E. Morriss.
(f) To obtain a practical and economical method for obtaining and rapidly reporting hydraulic data from relatively inaccessible locations.
(g) Mechanical devices were developed for translating depths of rainfall and stream stages into electrical impulses that are broadcast by short-wave radio transmitters for reception in a central office.
(h) Seven radio rain gages and eight radio stream gages are now being operated with a high degree of reliability. Additional installations featuring new improvements are under construction.
(i) They have provided a prompt means of obtaining reports when other forms of communication have been disrupted and from localities where other forms of communication are not available or services of observers cannot be obtained.

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(1221) (a) WAVE TRAVEL IN NATURAL RIVER CHANNELS.
(c) Hydraulic research.
(d) Forecasting Section Hydraulic Data Division, under direction of J. H. Wilkinson.
(f) To verify by data observed in natural river channels the published theoretical studies on phenomena of translatory wave travel.
(g) Translatory waves resulting from stream-flow regulation were analyzed, and observed wave velocities were compared with velocities computed by theoretical formulas.
(h) Investigation completed.
(i) Report now in preparation.

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(1222) (a) INVESTIGATION OF WINDS AND WAVE HEIGHTS.
(c) Hydraulic research.
(d) Technical Studies Unit, Hydraulic Data Division, under direction of B. E. Morriss.
(f) To obtain a relation between wind velocity and wave heights under reservoir conditions.
(g) Two installations that measure and record wave heights and wind velocities and directions were placed in Wheeler Reservoir, one in water 30 feet deep and the other in water 10 feet deep. Special apparatus capable of measuring waves 7 feet in height was designed. Records collected over a period of several years will be correlated to show the relation between winds and wave heights and the frequency of occurrences of high waves.
(h) Observations now being made.

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(1223) (a) BACKWATER EFFECT OF RESERVOIRS ON SMALL TRIBUTARIES.
(c) Hydrological study.
(d) Field Investigations Section, Hydraulic Data Division, under direction of J. E. Goddard.
(f) To determine effect of reservoirs on water-surface profiles of small tributaries.
(g) On small tributaries where backwater from reservoirs might conceivably cause tributaries to flood adjacent lands at elevations higher than level pool, automatic crest markers have been located to record the crest elevations reached by the tributary floods. Profiles obtained before the reservoir is filled will be compared with those for similar discharges after reservoir is filled to determine effect of backwater from the reservoir.
(h) A total of 188 crest markers have been established in Kentucky Reservoir, and pre-reservoir profiles are being obtained. Similar studies on a smaller scale are being made in Chickamauga Reservoir.

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(1224) (a) MEASUREMENT OF VISIBILITY IN FOGS.
(c) Development and testing of measuring equipment.
(d) Fog Committee, Hydraulic Data Division, under direction of B. E. Morriss.
(f) To obtain practical equipment for measuring and obtaining a continuous record of fogs.
(g) Devices are being developed and tested for measuring visibility by recording photo-electric equipment. An instrument to measure the free water in the air is also being studied. Instruments will be calibrated and tested under field conditions to determine whether they may be used to supplant present manual observations of visibility.
(h) Equipment is in preliminary stage.

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U. S. WATERWAYS EXPERIMENT STATION.

(415) (a) MODEL STUDY OF THE MISSISSIPPI RIVER HELENA, ARKANSAS, TO THE GULF OF MEXICO.
(b) The President, Mississippi River Commission, Vicksburg, Miss.
(c) Model study of flood-control plans.
(d) Experiments are conducted at the U. S. Waterways Experiment Station by personnel thereof under the general supervision of the Director of the Station.
(e) The Director, U. S. Waterways Experiment Station.
(f) To test the effectiveness of various flood-control plans for improvement of the Lower Mississippi River.
(g) The model is of the fixed-bed type with scale ratios: horizontal dimensions, 1 to 2000; vertical dimensions, 1 to 100. Reproduced in the model are: the main channel of the Mississippi River from Helena, Arkansas (mile 300 below Cairo, Illinois) to Donaldsonville, Louisiana

(mile 900 below Cairo, Illinois); the entire Atchafalaya Basin as far south as the Gulf of Mexico; and the backwater areas of the Arkansas, White, Yazoo, Ouachita, and Red Rivers.

(h) A study of flow lines for review of Mississippi River project was completed. The model was revised and adjusted for a study of flow distribution in the latitude of Old River. Tests of the Eudora Floodway were also in progress.

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(480) (a) MODEL STUDY OF PLANS FOR THE ELIMINATION OF SHOALING IN GALVESTON HARBOR.

(b) The District Engineer, U. S. Engineer Office, Galveston, Texas.

(c) Model study of proposed harbor improvements.

(d) and (e) See (415).

(f) 1. To determine possible sources of the material producing shoaling in Galveston Channel.

2. To determine the effects of any proposed improvement plan on the Galveston Channel, and corrollary to that, the most feasible and economical plan.

3. To determine the effects of the improvement plans on the other ship channels (Texas City Channel, Houston Ship Channel, and Intracoastal Canal) in lower Galveston Bay.

(g) The fixed-bed, silt-injection type model included an area bounded by the Gulf of Mexico, Hanna's Reef in the East Bay, Redfish Reef in Galveston Bay, and Karankawa Reef in West Bay. Scale ratios were: horizontal dimensions, 1 to 800; vertical dimensions, 1 to 80. An area approximately 188 ft by 150 ft was covered by the model. Stucco and gravel were used to insure proper roughness, and shoaling was simulated by means of fine gilsonite powder. Natural tides were reproduced by the action of four automatic tide-control gates. To supplement tidal currents, wave action was reproduced by means of four wave machines.

(h) All tests have been completed.

(i) Tests results are incorporated in the final report, Technical Memorandum No. 127-1, titled "Model Study of Plans for Elimination of Shoaling in Galveston Channel and Connecting Waterways, Galveston Bay, Texas."

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(643) (a) MODEL STUDY OF MANCHESTER ISLANDS REACH, OHIO RIVER (MILE 394.6 TO MILE 396.8 BELOW PITTSBURGH, PENNSYLVANIA).

(b) The District Engineer, U. S. Engineer Office, Cincinnati, Ohio.

(c) Study of proposed channel improvements.

(d) and (e) See (415).

(f) To study the feasibility of certain plans for channel improvement, and to determine the practicability and location of a new navigation channel.

(g) The model is of the movable-bed type with scale ratios: horizontal dimensions, 1 to 300; vertical dimensions, 1 to 80. The reproduced area includes the section of the Ohio River from mile 392 to mile 400 below Pittsburgh, Pennsylvania, and the adjacent overbank area to an elevation above the high water of 1937. In this reach two islands divide the Ohio River into three channels, two of which are either too narrow or too shallow for navigation at normal stages. The third channel (on the Kentucky side of the river) is used for navigation at all except high-river stages, but requires excessive dredging for maintenance.

(h) All testing has been completed; preparation of the final report is in progress.

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(786) (a) DETERMINATION OF THE TOPMOST FLOWLINE AND MEASUREMENT OF PRESSURES IN THE SUPPLEMENTARY DAM AT THE U.S. WATERWAYS EXPERIMENT STATION.

(b) The Soils Laboratory.

(c) Scientific research.

(d) and (e) See (415).

(f) To determine the variation in the position of the topmost flowline in the structure, and to observe the distribution of pressure in the foundation with Goldbeck pressure cells.

(g) Biweekly observations of the wells are made to add to the general fund of knowledge concerning seepage through such structures. Semiannual observations of the Goldbeck pressure cells are made.

(h) The observations are being continued.

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(793) (a) MODEL STUDY, FLOOD-CONTROL PROJECT, JOHNSTOWN, PENNSYLVANIA.

(b) The District Engineer, U. S. Engineer Office, Pittsburgh, Pa.

(c) Model study of flood-control plans.

(d) and (e) See (415)

(f) To determine satisfactory designs for the improvement of channels in the Conemaugh River, Little Conemaugh River, and Stony Creek in the vicinity of Johnstown, Pennsylvania, so that floods of the magnitude of that of March 17-18, 1936, would be carried within banks.

(g) A fixed-bed model with scale ratios: horizontal dimensions, 1 to 200, vertical dimensions, 1 to 80, reproduces 5.8 miles of Stony Creek, 3.8 miles of the Little Conemaugh River, and 4.7 miles of the Conemaugh River. The model was so constructed that the effects of bridge piers, curves, changes in section, roughness of wall and bed, etc. are represented in correct ratio.

(h) Additional tests of improvement plans are requested from time to time by the District Engineer; preparation of the final report is in progress.

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(966) (a) MODEL STUDY OF PLANS FOR CHANNEL IMPROVEMENT, VICINITY OF BOSTON BAR, MISSISSIPPI RIVER (MILE 2 TO MILE 13 ABOVE CAIRO, ILLINOIS).
(b) The District Engineer, U. S. Engineer Office, St. Louis, Mo.
(c) Model study of proposed improvement plans.
(d) and (e) See (415).
(f) To test the feasibility of several proposed plans for channel improvement in the Boston Bar reach.
(g) The model was of the movable-bed type with scale ratios: horizontal dimensions, 1 to 600; vertical dimensions, 1 to 100. Reproduced was that reach of the Mississippi River between miles 16.3 above and 4.0 below Cairo, Illinois, together with adjacent overbank area extending to the levee on each bank. Within this reach (vicinity of Boston Bar) navigation has been difficult during low stages following the annual high-water period.
(h) All tests have been completed.
(i) Test results are incorporated in the final report, Technical Memorandum No. 159-1, titled "Model Study of Plans for Channel Improvement in Vicinity of Boston Bar, Mississippi River."

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(969) (a) MODEL STUDY OF WAVE FORCE AGAINST BREAKWATERS.
(b) The Division Engineer, Great Lakes Division, Cleveland, Ohio.
(c) Model study of distribution and intensity of wave forces.
(d) and (e) See (415).
(f) To develop vertical pressure curves, showing the pressures resulting from waves striking against breakwaters, to be used as a basis for the design of breakwaters. Four variables will be investigated and the resulting vertical pressure curves developed. These variables are: (1) heights and lengths of waves; (2) depth of water and slope of bottom; (3) shape of breakwater; and (4) angle of impingement of waves.
(g) The investigation is being conducted in a wave tank, approximately 40 ft by 20 ft, equipped with a 4- by 8-ft viewing window in tank side at breakwater. A plunger-type wave machine capable of producing a 1-ft wave is used. Water pressure is measured by a bank of specially developed pressure cells and recorded simultaneously with wave heights on a seven-element oscillograph. Wave heights are determined by means of an electric wave-height-measuring device developed at the Experiment Station. Additional data will be recorded photographically.
(h) Construction of tank, wave machine, and appurtenances has been completed. Calibration and adjustment of the apparatus and a comprehensive study of the action and form of waves is in progress.

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(970) (a) SECOND SERIES, MODEL STUDY OF PLANS FOR ELIMINATION OF SHOALING IN THE DELAWARE RIVER ENTRANCE TO THE CHESAPEAKE AND DELAWARE CANAL.
(b) The District Engineer, U. S. Engineer Office, Philadelphia, Pa.
(c) Model study of channel improvement plans.
(d) and (e) See (415).
(f) 1. To devise a plan for modification of the existing jetties that will eliminate or reduce shoaling in the Delaware River entrance to the canal.
2. To determine the relative shoaling in the Delaware River ship channels under existing and proposed jetty conditions.
(g) The model was of the fixed-bed, silt-injection type with scale ratios: horizontal dimensions, 1 to 800; vertical dimensions, 1 to 80. Reproduced were 17 miles of the Delaware River from New Castle, Delaware, to Artificial Island, and the eastward 3 miles of the Chesapeake and Delaware Canal. Tides and tidal currents were accurately reproduced on the model by means of three automatic tide gates: one at Artificial Island, one at New Castle, and one in the canal. Unusual tidal currents in the canal cause large quantities of silt to be carried into the canal from the Delaware River and deposited near the mouth of the Delaware River entrance. Finely ground gilsonite was used to simulate silt and was introduced into the model from three points, the injection apparatus having been adjusted until the gilsonite traveled in suspension and settled in the channels as in the prototype.
(h) All tests have been completed.
(i) Tests results are incorporated in the final report, Technical Memorandum No. 93-3, titled "Model Study of Plans for Elimination of Shoaling in the Delaware River Entrance to the Chesapeake and Delaware Canal."

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(971) (a) MISSISSIPPI RIVER NAVIGATION STUDY.
(b) The President, Mississippi River Commission, Vicksburg, Miss.
(c) Model study of low-water flow conditions.
(d) and (e) See (415).
(f) To study low-water phenomena in the Mississippi River from Cape Girardeau (mile 52 above Cairo, Illinois) to Cottonwood Point (mile 125 below Cairo, Illinois), and in the Ohio River from Dam No. 53 to the mouth.
(g) The model was of the fixed-bed type with scale ratios: horizontal dimensions, 1 to 1000; vertical dimensions, 1 to 100. Reproduced were channels of the Mississippi River from Cape Girardeau to Cottonwood Point, and of the Ohio River from Dam No. 53 to the mouth. The model was designed and constructed to study channel flows between extreme low-water and bankfull stages.
(h) All scheduled tests of improvement plans have been completed and a preliminary report submitted.

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(1137) (a) MODEL STUDY OF INTAKE AND CONDUIT, CONTROL STRUCTURES FOR DENISON DAM.
(b) The District Engineer, U. S. Engineer Office, Denison, Texas.
(c) Model study of intake and conduit structures.
(d) and (e) See (415).
(f) To investigate hydraulic conditions through the control structures and through the flood-control conduits.
(g) The 1-to-25-scale model reproduced one entire section of the control works which included (1) intake passages to a pair of gates (each conduit served by two gates), (2) the pair of gates, (3) transition below the gates, and (4) conduit below the transition. The entire model was constructed of transparent pyralin. Each flood-control conduit was designed for a capacity of 20,000 cfs with the pool at spillway-crest elevation.
(h) All testing has been completed.
(i) Tests results are incorporated in the final report, Technical Memorandum No. 161-1, titled "Hydraulic Model Study of the Control Structures for the Denison Dam, Red River."

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(1138) (a) MODEL STUDY OF STILLING BASIN, CONTROL STRUCTURES FOR DENISON DAM.
(b) The District Engineer, U. S. Engineer Office, Denison, Texas.
(c) Model study of stilling-basin action.
(d) and (e) See (415).
(f) To investigate hydraulic conditions within and below the stilling basin, and in the tailrace below the power plant.
(g) The 1-to-76-scale model reproduced (1) outlet sections of the five power conduits and three flood-control conduits, (2) tailrace below the power conduits, (3) stilling basin below the flood-control conduits, and (4) the exit channel to its confluence with the Red River. The eight conduits will discharge uncontrolled during the diversion period; under such conditions their combined capacity will be 83,500 cfs with the pool at cofferdam elevation. The flood-control conduits will also have a capacity of 69,000 cfs with pool at spillway-crest elevation. Elements of the stilling basin are diverging spray walls, baffle piers, and weirs. The model study had two phases: investigation of performance of stilling basin under all conditions of operation for the flood-control conduits; and investigation of tailrace action with the power conduits discharging freely under conditions of diversion.
(h) All testing has been completed.
(i) Tests results are incorporated in the final report, Technical Memorandum No. 161-1, titled "Hydraulic Model Study of the Control Structures for the Denison Dam, Red River."

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(1139) (a) MODEL STUDY OF INTAKE STRUCTURE (PLAN A), FORT PECK DAM.
(b) The Division Engineer, Missouri River Division, Kansas City, Mo.
(c) Model study of intake structure.
(d) and (e) See (415).
(f) To investigate the hydraulic characteristics of a modification of the original plans of the Fort Peck Dam intake structures.
(g) The 1-to-20-scale model included a section of the reservoir area, one complete interior chamber, and half portions of the adjacent chambers. The covering trash racks, the bracing wall, and the transition section in the complete chamber, and 200 ft of one tunnel were reproduced. Pulverized coal was used as a medium for tracing flow lines.
(h) All testing has been completed.
(i) Tests results a re incorporated in the final report, Technical Memorandum No. 160-1, titled "Model Study of Intake Structure (Plan A) for the Fort Peck Dam, Missouri River."

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(1140) (a) MODEL STUDY OF SPILLWAY FOR SANTEE RIVER DAM.
(b) The South Carolina Public Service Authority, Charleston, S.C.
(c) Model study to determine suitable spillway design.
(d) and (e) See (415).
(f) To develop the most advantageous design for those elements of the spillway whose functions are the dissipation of energy contained in flow from the spillway gates.
(g) The 1-to-36-scale model reproduced a central section of the spillway (consisting of six complete bays), 330 ft of the approach channel, and 900 ft of the exit channel. Three of the bays contained gang-operated gates, and three contained individually operated gates (tainter gates reproduced schematically). In the prototype, initial flows up to 50,000 cfs will be passed through the remaining 56 gates after the tailwater has been built up to the normal elevation corresponding to a discharge of 50,000 cfs. The spillway has been designed to discharge a flood flow of 800,000 cfs. In the model the bed below the spillway was molded in sand to permit the study of erosion. Various types of toe-deflector sills were investigated by means of supplementary tests conducted on a 1-to-50-scale, single-bay, movable-bed model in a glass flume.
(h) All tests have been completed.
(i) Tests results are incorporated in the final report, Technical Memorandum No. 168-1, titled "Model Study of the Spillway for the Santee River Dam."

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(1141) (a) MODEL STUDY OF PLANS FOR THE ELIMINATION OF SHOALING IN RICHMOND HARBOR, JAMES RIVER.
(b) The District Engineer, U. S. Engineer Office, Norfolk, Va.
(c) Model study of plans for the elimination of shoaling.
(d) and (e) See (415).
(f) To determine the effects of proposed works (1) in eliminating shoaling in Richmond Harbor, and (2) on flood heights through and above the reach in which the works are to be located.
(g) Immediately above Richmond there is a steep reach of the James River containing rapids in which the river falls about 100 ft in 10 miles, thus blocking the further progression upstream of the tidal wave. At the Richmond waterfront the river is almost twice as wide as the portion downstream which has been contracted by groins. Deposition of material in the project channel near Richmond Harbor necessitates a more or less continuous dredging program. The model is of the movable-bed type with scale ratios: horizontal dimensions, 1 to 72; vertical dimensions, 1 to 36, and reproduces that reach of the James River from the head of tidewater to about 1 mile below the City of Richmond locks. Provisions have been made for the introduction of freshwater discharge at the upper end of the reach, and for automatic reproduction of tidal effects at the lower end of the reach.
(h) Construction of the model and all scheduled tests has been completed. Preparation of the final report is in progress.

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(1142) (a) MODEL STUDY OF CHANNEL IMPROVEMENT, FLOOD-CONTROL PROJECT, HORNELL, NEW YORK.
(b) The District Engineer, U. S. Engineer Office, Binghamton, N. Y.
(c) Model study of channel improvement plans for flood control.
(d) and (e) See (415).
(f) To supplement and verify hydraulic design computations for determination of final design plans for the channel improvement of Canisteo River, Canacadea Creek, and Chauncey Run, at Hornell, New York.
(g) The 1-to-40-scale fixed-bed model includes 3000 ft of Canacadea Creek, 10,800 ft of Canisteo River, and 700 ft of Chauncey Run. Three drop structures and one trapezoidal weir fall within the reproduced reaches. Canisteo Channel is designed to discharge 21,000 cfs; Canacadea Channel, 8000 cfs; and Chauncey Channel, 3000 cfs. The Canacadea Creek section of the model was operated for one month as a separate model. Care was taken to simulate correctly the bed roughness of the prototype.
(h) The testing program has been completed. Preparation of the final report is in progress.

(1143) (a) MODEL STUDY OF CHANNEL IMPROVEMENT, ABSECON INLET, ATLANTIC CITY, NEW JERSEY.
(b) The District Engineer, U. S. Engineer Office, Philadelphia, Pa.
(c) Model study of proposed jetty designs.
(d) and (e) See (415).
(f) To determine the effects of several proposed jetty designs at the mouth of Absecon Inlet with special attention to their efficacy in maintaining a ship channel, and their probable effect on the beaches at Atlantic City.
(g) The model is of the movable-bed type (the movable-bed reach extends from Ventnor, New Jersey, to a point on Brigantine Beach 22,000 ft northeast of Absecon Inlet). Scale ratios are: horizontal dimensions, 1 to 500; vertical dimensions, 1 to 100. Provisions are made for reproducing waves from any direction from south to east, tides of any type, and littoral drift either up or down the beach.
(h) Hydraulic adjustment of the model has been completed; verification tests are in progress.

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(1144) (a) MODEL STUDY OF TUNNEL NO. 1, FORT PECK DAM.
(b) The Division Engineer, Missouri River Division, Kansas City, Mo.
(c) Model study of hydraulics of tunnel and Y-branches.
(d) and (e) See (415).
(f) 1. To investigate the surge phenomena in Tunnel No. 1 resulting from turbine gate operation, and to evaluate the effects of the main control shaft upon these phenomena.
2. To determine the relative efficiencies of four shapes of Y-branches for the penstocks.
3. To make tests of practical value for the design of the prototype surge-tank installation.
(g) The 1--to-20-scale model, approximately 250 ft in length, includes the intake structure, emergency control shaft, main control shaft, Y-branch, penstocks, and surge tanks. Each penstock is fitted with a valve mechanically operated so as to simulate turbine gate closure. The model is constructed of transparent pyralin. Instantaneous measurement of pressure waves and surges at critical points is accomplished by means of pressure cells and electrodes in circuit with a seven-element oscillograph. Tests are conducted for a maximum discharge of 9000 cfs.
(h) Tests are in progress.

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(1145) (a) MODEL STUDY OF STRUCTURES FOR FUTURE POWER DEVELOPMENT. FRANKLIN FALLS DAM.
(b) The District Engineer, U. S. Engineer Office, Boston, Mass.
(c) Model study of powerhouse design.
(d) and (e) See (415).
(f) To investigate the adequacy of the design of powerhouse forebay and appurtenant structures, and to develop improvements, if necessary, with respect to the following requirements: (1) efficient functioning for power development; (2) safe passage of full tunnel flow with intake gates inoperative; and (3) no interference of tailrace discharge with proper stilling-basin action.
(g) The 1-to-25-scale model includes the tunnel, forebay, forebay weir, penstocks, tailrace, two short portions of the flood-control conduits, flood-control-outlet stilling basin, and 400 ft of the exit channel. The maximum discharge required for the turbines is 3200 cfs. However, the 23-ft-diameter tunnel, forebay, and forebay weir must be able to pass safely a discharge of approximately 20,000 cfs.
(h) The testing program has been completed; preparation of the final report is in progress.

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(1147) (a) MODEL STUDY OF PLANS FOR THE ELIMINATION OF SHOALING, VICINITY OF THE HEAD OF PASSES, MISSISSIPPI RIVER.
(b) The District Engineer, U. S. Engineer Office, New Orleans, La.
(c) Model study of plans for channel improvement.
(d) and (e) See (415).
(f) To study and develop plans for the improvement and maintenance of the deep-water channel from Head of Passes to the Gulf of Mexico through Southwest Pass.
(g) The model is of the movable-bed type with scale ratios: horizontal dimensions, 1 to 500; vertical dimensions, 1 to 150. Reproduced are 7 miles of the Mississippi River above the Head of Passes, all of South and Southwest Passes, the upper 2 miles of Pass a l'Outre, and the upper half mile of Cubits Gap. Cubits Gap and Pass a l'Outre are controlled to discharge fixed percentages of the flow, while South and Southwest Passes are controlled by maintaining mean Gulf level at their lower ends. Water-surface elevations at the exits of the four Passes are regulated by electrically operated automatic valves which replace tailgates in this model.
(h) Hydraulic adjustment of the model has been completed. Verification tests are in progress.

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(1148) (a) MODEL STUDY OF BREAKWATER LOCATIONS IN SAN JUAN HARBOR, PUERTO RICO.
(b) The District Engineer, Puerto Rico District, in conjunction with the U. S. Navy Department.
(c) Model study of breakwater locations.
(d) and (e) See (415).
(f) To study the effects of various breakwater installations for the reduction of wave heights in the proposed San Juan Harbor hydroplane base.
(g) The 1-to-100-scale model was of the fixed-bed type and reproduced that part of San Juan Harbor seaward of a line from Catano Point to Yaboa Shoal, together with an area extending seaward approximately 3800 ft to the north of Morro Point. The model limits extended from 1700 ft east of Morro Point to 1000 ft west of Palo Seco Point. The criterion for the design of the breakwater was that 8-ft ocean waves be reduced to the following maximum dimensions over the hydroplane harbor: (1) 2 ft for wave lengths of 40 ft or more; (2) 3 ft for wave lengths less than 40 ft. A plunger-type wave machine was used to generate waves from west, north, or east, or from any intermediate direction. Wave heights were recorded by an electric measuring device.
(h) Construction of the model and the testing program have been completed.
(i) Tests results are incorporated in the final report, Technical Memorandum No. 173-1, titled "Model Study of Breakwater Locations in San Juan Harbor, San Juan, Puerto Rico."

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(1149) (a) MODEL STUDY OF SPILLWAY AND STILLING BASIN, JOHN MARTIN (FORMERLY CADDOA) DAM, ARKANSAS RIVER.
(b) The District Engineer, U. S. Engineer Office, Caddoa, Colorado.
(c) Study of spillway and stilling-basin action.
(d) and (e) See (415).
(f) To investigate the hydraulic performance of the spillway and stilling basin, to improve flow characteristics, and to determine possible economies in design.
(g) The proposed John Martin Dam will be an earth structure with an overflow spillway located within the main section of the dam. Flow regulation will be afforded through conduits in the spillway section, the outflow being limited to 10,000 cfs. For extreme floods 16 taintor gates surmounting the spillway crest will be used. The spillway is designed to pass a flood of 630,000 cfs under a head of 30 ft. The 1-to-36-scale model reproduced a longitudinal section of the spillway embracing eight gate bays, together with 500 ft of the approach channel and 1100 ft of the exit channel. The spillway was constructed of concrete, the crest-gate piers of treated wood, the taintor gates of sheet metal, and the conduits of sheet metal and pyralin (one conduit). A movable bed

of sand was provided below the spillway for qualitative study of erosion under various operating schedules.

(h) Design, construction, and operation of the model have been completed.

(i) Tests results are incorporated in the final report, Technical Memorandum No. 166-1, titled "Model Study of the Spillway and Stilling Basin for John Martin (Formerly Caddoa) Dam, Arkansas River."

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(1150) (a) HYDROLOGICAL RESEARCH PROJECT.

(b) The Chief of Engineers, U. S. Army, Washington, D. C.

(c) Scientific investigation of general hydrological phenomena.

(d) and (e) See (415).

(f) To augment pertinent data and to advance the knowledge of the hydrological characteristics of any drainage basin through the comprehensive study of the hydrology of a typical small watershed -- that of the Experiment Station lake.

(g) This study of the small watershed of the artificial lake on the reservation of the U. S. Waterways Experiment Station includes the following investigations:

1. A study of the rainfall-runoff relation using the unit-h drograph method. Five recording rain gages and 23 non-recording gages, six inflow stream-gaging stations and one outflow gaging station will be used to obtain this data.
2. An evaporation study using three methods of measurement: one land and one floating evaporation station, and one installation for the determination of evaporation by the moisture concentration in the turbulent layer.
3. A study of wave formation on the lake by means of specially designed wave-height and wind-velocity measuring and recording devices.

(h) Installation of equipment is nearly complete; measurements are being obtained on installed apparatus.

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(1225) (a) MODEL STUDY OF EXPERIMENT STATION LAKE SPILLWAY AND DURDEN CREEK CHANNEL.

(b) The President, Mississippi River Commission, Vicksburg, Miss.

(c) Model study of spillway and channel improvements.

(d) and (e) See (415).

(f) To detect and correct all unsafe and undesirable conditions that exist, and to obtain data for use in connection with the hydrological survey of the Experiment Station lake's drainage area (see No. 1150).

(g) The Experiment Station lake is impounded by a dam 450 ft long and 20 ft high. Normal flow from the lake is controlled by a gate and conduit through the dam. Flood flows are discharged over a concrete-chute-type spillway in the east abutment of the dam. Discharges from both

the spillway and conduit empty into Durden Creek which flows through the Experiment Station grounds. The 1-to-25-scale model is molded of concrete and has the proper surface roughness. Provisions have been made for a movable-bed section immediately below the stilling basin. The model includes 240 ft of the approach to the spillway, the spillway, stilling basin, conduit exit, and 890 ft of exit channel.

(h) Design and construction of the model are complete. Tests are in progress.

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(1226) (a) MODEL STUDY OF THE MILL CREEK FLOOD-CONTROL PROJECT, CINCINNATI, OHIO.

(b) The District Engineer, U. S. Engineer Office, Cincinnati, Ohio.

(c) Model study of flood-control plans.

(d) and (e) See (415).

(f) To determine the hydraulic performance of structures proposed for the protection of Cincinnati, Ohio, from Ohio River floods.

(g) This study involves the proposed levee and flood wall to be constructed across Mill Creek to prevent Ohio River flood waters from backing up into the creek valley, and a barrier dam and pumping station for the purpose of discharging the flood waters of Mill Creek during high water in the Ohio River. The barrier dam is to be equipped with a gate-controlled discharge bay which will furnish an outlet for Mill Creek during normal stages in the Ohio River. The dam will also contain the nine pump units of the pumping station. Each pump is designed to discharge a maximum of 2000 cfs. Two fixed-bed models are being used in the study. (1) A 1-to-50-scale model reproduces about 3100 ft of Mill Creek from its confluence with the Ohio River to a point 100 ft north of West Street Bridge. Although the model is built of concrete, it is so constructed that alterations can be made to reproduce either the existing channel or conditions with the barrier dam in place. Investigations are made of discharges up to 70,000 cfs. (2) A 1-to-25-scale model reproduces Mill Creek in the vicinity of the proposed barrier dam. The model is so constructed that changes in design of the dam and pumphouse can be easily introduced.

(h) Design and construction of the model have been completed. The testing program is in progress.

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(1227) (a) MODEL STUDY OF SPILLWAY AND STILLING BASIN, ARKABUTLA DAM, COLDWATER RIVER.

(b) The District Engineer, U. S. Engineer Office, Vicksburg, Miss.

(c) Model study of spillway and stilling-basin performance.

(d) and (e) See (415).

(f) To investigate the hydraulic performance of the proposed structure with especial reference to hydraulic safety at maximum discharge.
(g) The proposed Arkabutla Dam will be an earth structure with a 300-ft, chute-type spillway located within the north abutment and an outlet conduit located within the main section of the dam. The spillway is designed to pass a flood of 89,000 cfs with a head of 18 ft, and will be provided with a conventional jump-action stilling basin. The 1-to-25-scale model reproduced a 100-ft section of the spillway and included about 500 ft of the approach channel and 375 ft of the exit channel.
(h) Design, construction, and operation of the model are complete.
(i) Tests results are incorporated in the final report, Technical Memorandum No. 169-1, titled, "Model Study of the Spillway and Stilling Basin for Arkabutla Dam, Coldwater River."

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(1228) (a) MODEL STUDY OF OUTLET STRUCTURES FOR ARKABUTLA DAM, COLDWATER RIVER.
(b) The District Engineer, U. S. Engineer Office, Vicksburg, Miss.
(c) Model study of outlet-structure performance.
(d) and (e) See (415).
(f) To investigate the hydraulic performance of the proposed structures, with especial reference to hydraulic safety at maximum discharge and optimum performance at medium discharges.
(g) The 1-to-25-scale model reproduced a 500-ft reach of the approach channel (250 ft wide), intake structure with the three control gates, transition section, conduit, stilling basin, and a section of exit channel 625 ft long and 250 ft wide. The intake structure, transition, and conduit were molded of transparent pyralin. The conduit is designed for a capacity of 10,000 cfs with pool at spillway-crest elevation. The intake passage for the center gate is 14 ft higher than the intake passages of the side gates. During normal operation it is planned to leave only this center gate open to act as a control for the conservation pool.
(h) Design, construction, and operation of the model are complete.
(i) Tests results are incorporated in the final report, Technical Memorandum No. 167-1, titled "Model Study of the Outlet Structures for Arkabutla Dam, Coldwater River."

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(1229) (a) MODEL STUDY OF THE SPILLWAY, DENISON DAM, RED RIVER.
(b) The District Engineer, U. S. Engineer Office, Denison, Texas.
(c) Model study of spillway performance.

(d) and (e) See (415).
(f) To investigate the hydraulic capacity of the spillway, to improve flow characteristics, and to attempt to effect economies in design.
(g) The Denison Dam spillway will be located in a saddle to the south of the control structures and is designed to pass a flood of 750,000 cfs with a head of 21 ft. The ogee spillway crest (2000 ft long) is curved in plan to a 2400-ft radius. Below the crest the spillway converges and drops about 125 ft into a stilling basin also curved in plan but to a radius of 1700 ft. The spillway discharge will flow from the stilling basin into Shawnee Creek by way of a shallow exit channel. The 1-to-80-scale model reproduces 2500 ft of approach channel, a portion of the earth embankment, the spillway proper, the stilling basin, 3000 ft of exit channel, and about 2500 ft of the Shawnee Creek area below the exit channel.
(h) Design, construction, and operation of the model have been completed. Preparation of the final report is in progress.

*(See footnote).....

(1232) (a) MODEL STUDY OF PLANS FOR ELIMINATION OF SHOALING IN DEEPWATER POINT RANGE, AND NEW CASTLE AND FINNS POINT RANGES, DELAWARE RIVER.
(b) The District Engineer, U. S. Engineer Office, Philadelphia, Pa.
(c) Model study of shoaling elimination.
(d) and (e) See (415).
(f) To test proposed plans for reducing shoaling in the Deepwater Point range, and New Castle and Finns Point ranges of the Delaware River ship channel.
(g) The Chesapeake and Delaware Canal model (see No. 970) as revised for the Wilmington Harbor model study (see above) is being used in the accomplishment of this study.
(h) Hydraulic adjustment of the model has been completed. The testing program is in progress.

.....

(1233) (a) MODEL STUDY OF SAVANNAH RIVER HARBOR ENTRANCE.
(b) The District Engineer, U. S. Engineer Office, Savannah, Ga.
(c) Model study of channel improvements.
(d) and (e) See (415).
(f) To study means of improving and maintaining the ship channel from Savannah, Georgia, to deep water in the Atlantic Ocean, with consideration being given to the protection and maintenance of adjacent recreation beaches.

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*Two projects (1230) and (1231), inadvertently omitted at this point, appear on pages 114 and 115.

(g) Two models will be used in this study. The first model will be of the fixed-bed type with scale ratios: horizontal dimensions, 1 to 1000; vertical dimensions, 1 to 150. It will include the Savannah River from the head of tidewater to the mouth and all areas in the vicinity of the mouth which are subject to tidal flow. Two automatic tide controls will be used for tidal reproduction. After completion of the fixed-bed study, a larger scale movable-bed model of the river mouth and adjacent beaches will be constructed for a study of the effects of jetty extensions. Tide data obtained from tests on the fixed-bed model will be used to control the operation of the movable-bed model.
(h) Design and construction of the fixed-bed model are in progress.

.....

(1234) (a) MODEL STUDY OF PROTECTION OF SLOPES AGAINST WAVE ACTION.
(b) The South Carolina Public Service Authority, Charleston,S.C.
(c) Model study of wave wash on embankments.
(d) and (e) See (415).
(f) To determine the efficacy of porous concrete slabs and triangular concrete blocks used for protection against wave wash on embankments in quickly relieving uplift pressure resulting from wave recession.
(g) The model consisted of a wooden box, 26 in. deep, 27 in. wide, and 24 ft long, so constructed that it could be tilted to any desired slope. For testing purposes the flume was filled with gravel covered by either porous concrete slabs or triangular concrete blocks. Water was introduced, and drawn off at various rates to simulate wave action. Resulting pressures above and below the revetment were measured by means of pressure cells connected by an amplifier to an oscillograph. The oscillograph recordings were compared to determine what uplift pressure, if any, developed and the magnitude of the pressure. Dynamic forces of the waves were not considered in these tests.
(h) Design, construction, and operation of the model are complete.
(i) A report of tests results was submitted to the South Carolina Public Service Authority.

.....

(1235) (a) STUDY OF THE MEANDERING OF MODEL STREAMS.
(b) The President, Mississippi River Commission, Vicksburg, Miss.
(c) Model study of the characteristics of meandering streams.
(d) and (e) See (415).
(f) To study the characteristics of meandering model streams.

(g) The movable-bed study is being conducted in a 133-x 41.5-ft flume which has an unobstructed bed area of 125 ft by 40 ft. The flume is spanned by a steel-trussed walkway which may be rolled, on an adjustable-grade track, the entire lengt of the flume. A 20-ft-high photographic tower can be mounted on rollers on the walkway and placed at any location on the model. Machined bars and molding templets attached to the upper and lower chords, respectively, of one truss of the walkway facilitate the molding of the model bed and the obtaining of water-surface and bed elevations. Crushed coal is being used at present as the movable-bed material. Prior to each test a straight channel is molded along the center line of the flume, water is introduced at one end of the channel, and the stream allowed to meander at will. The data obtained consist of soundings, water-surface profiles, and photographs taken throughout the various tests.

(h) Design and construction of the model have been completed. The testing program is in progress.

.....

(1136) (a) MODEL STUDY OF WAVE ACTION, GRAND MARAIS HARBOR, MINNESOTA.

(b) The District Engineer, U. S. Engineer Office, Duluth, Minn.

(c) Model study of wave action.

(d) and (e) See (415).

(f) To study wave action in Grand Marais Harbor with particular attention to the action within the proposed small-craft harbor along the west shore.

(g) Grand Marais Harbor is a small natural indentation in the north-western shore line of Lake Superior. The harbor does not provide sufficient area to damp the waves entering between the present breakwaters at its entrance, and as a result storm waves make the harbor unsafe for small craft. To provide adequate protection, an inner harbor within the main harbor is contemplated and will be tested on the model. The 1-to-[illegible]-scale model is of the fixed-bed type and reproduces all of Grand Marais Harbor and the adjacent shore lines. A plunger-type wave machine is used to generate waves from east, southeast, south, and southwest. Wave heights are measured by an electric measuring device, and the primary lake waves will range from 0 to 24 ft (prototype dimensions).

(h) Design and construction of the model have been completed. Hydraulic adjustment tests are in progress.

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(1237) (a) MODEL STUDY OF INTAKE, BAYOU BODCAU DAM OUTLET STRUCTURES, BAYOU BODCAU, LOUISIANA.
(b) The District Engineer, U. S. Engineer Office, Vicksburg, Miss.
(c) Model study of performance of intake structure.
(d) and (e) See (415).
(f) 1. To investigate the hydraulic performance of the intake structure at maximum head and to determine what changes in design, if any, are necessary to produce satisfactory flow conditions.
2. To determine a rating curve of the proposed intake.
(g) The 1-to-19.2-scale model reproduced the intake, transition, and tunnel. The transition section and tunnel were molded of transparent pyralin to facilitate the study of flow conditions. The egg-shaped tunnel has a vertical height of 14 ft (prototype dimension) and is designed to discharge 4000 cfs with a head of 60 ft at the intake invert.
(h) Design, construction, and operation of the model are complete.
(i) A report of tests results has been submitted to the District Engineer.

.....

(1238) (a) MODEL STUDY OF CULVERT SYSTEM FOR DRYDOCK NO.4, PUGET SOUND NAVY YARD.
(b) The U. S. Navy Department.
(c) Model study of flow conditions in a culvert system.
(d) and (e) See (415).
(f) 1. To ascertain the existence of unfavorable flow conditions in the suction chamber and to evaluate their possible effect on the satisfactory operation of the pumps.
2. To determine how such unfavorable conditions, if present, might best be controlled or alleviated.
3. To investigate certain plans for improvements in the design of the suction chamber.
(g) The 1-to-10-scale model will reproduce the bell-mouthed pump intakes, the suction chamber with its sluice gates and inlets, the side culverts and their interconnection, and the floor drains. A sufficient section of the walls and floor of the drydock will be reproduced to insure proper flow conditions into the floor drains leading to side culverts and suction chamber. The suction chamber and pump intakes will be molded of transparent pyralin to permit visual observation of flow conditions.
(h) Design of the model is complete; construction is in progress.

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(1239) (a) MODEL TESTS ON CANTON RESERVOIR SPILLWAY AND INTEGRAL SLUICEWAYS.
(b) The District Engineer, U. S. Engineer Office, Tulsa, Oklahoma.
(c) Model study of spillway and sluiceway performance.
(d) and (e) See (415).

(f) 1. To analyze the hydraulic characteristics of the Canton Dam spillway, integral sluices, and spillway approach and exit channels, as designed.
2. To test certain proposed alterations in the design of these elements.
3. To develop means of correcting any uneconomic, unsafe, or otherwise undesirable conditions which may exist in the proposed design.

(g) Three models will be used in this study. (1) A 1-to-100-scale model of the entire problem area will reproduce the approach channel, spillway and sluices, stilling basin and exit channel. (2) A 1-to-24-scale section model of two interior bays, without sluice or tainter gates, reproduces a portion of the approach channel, the spillway, stilling basin, and a portion of the exit channel. (3) A precisely constructed, 1-to-27 scale section model will reproduce a portion of the approach channel, two center bays, two tainter gates, one center pier, one sluice and its appurtenances, and a portion of the stilling basin and exit channel.

(h) Design and construction of the 1-to-24-scale section model have been completed and tests are in progress. Design and construction of the general model are complete except for a small area which will be constructed on completion of tests on the 1-to-24-scale section model. Design of the 1-to-27-scale section model has been undertaken.

.*(See.footnote).....

UNITED STATES WEATHER BUREAU.

(1240) (a) INVESTIGATION OF EDDY-CONDUCTIVITY METHOD OF DETERMINING EVAPORATION FROM LAND AND WATER SURFACES.
(b) U. S. Weather Bureau.
(c) Experimental verification of theory of moisture transport through the atmosphere and development of instrumentation necessary for field application of the procedures.
(d) Division of Education and Research.
(e) Merrill Bernard, Supervising Hydrologist and Service Coordinator.
(f) To furnish a rational procedure for measuring evaporation from land and water surfaces.

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(1241) (a) MAXIMUM POSSIBLE RAINFALL OVER OHIO RIVER BASIN ABOVE PITTSBURGH, PA.
(b) Corps of Engineers, U. S. Army.
(c) Flood control works.
(d) Hydrometeorological Section, Office of Supervising Hydrologist and Service Coordinator.
(e) Merrill Bernard, Supervising Hydrologist and Service Coordinator.

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*Two other projects of the U. S. Waterways Experiment Station inadvertently omitted from this listing, appear on pages 114 and 115.

(f) To determine maximum possible storm for use in design of flood works.

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UNIVERSITY OF ILLINOIS.

(739) (a) EFFECT OF RADIUS OF CURVATURE ON THE FLOW OF WATER AROUND PIPE BENDS.
(c) Research.
(e) Prof. F. B. Seely.
(h) Completed. Data being analyzed.

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(740) (a) THE HYDRAULICS OF THE FLOW OF SEWAGE SLUDGE.
(b) Engineering Experiment Station.
(c) Scientific research.
(d) H. E. Babbitt, D. H. Caldwell.
(e) Prof. H. E. Babbitt.
(h) Study completed and results published in Bulletins No. 319 and 323 of the Engineering Experiment Station.

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(843) (a) A STUDY OF THE HYDRAULIC CHARACTERISTICS OF VALVES.
(c) Student thesis.
(e) Prof. F. B. Seely.
(h) Tests nearly completed.

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(1063) (a) AN ANALYTICAL AND EXPERIMENTAL STUDY OF HYDRAULIC RAMS.
(c) Research.
(d) W. G. Dugan Prof. W. M. Lansford.
(e) Prof. F. B. Seely.
(f) Tests have been made on a 4-inch ram having a thick resilient waste valve and on a 2-inch ram which has a very hard and stiff waste valve.
(h) Tests have been completed, and results will be published in Engineering Experiment Station Bulletin No. 326, which is now in press.

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(1064) (a) EFFECTS OF VANES ON THE VELOCITY DISTRIBUTION IN A 24-INCH PIPE.
(b) Student thesis.
(d) C. E. Tarpley: Prof. W. M. Lansford.
(e) Prof. F. B. Seely.
(f) To study the effect on the velocity distribution downstream from a 90° bend in a 24-inch pipe of vanes in or near the bend and to determine the loss in head caused by such vanes.
(h) Tests have been completed as outlined and thesis is on file in the University Library.

.....

(1065) (a) A STUDY OF TRANSLATORY WAVES IN AN OPEN CHANNEL.
(b) Student thesis.
(c) H. E. Romine; Prof. W. N. Lansford.
(e) Prof. F. B. Seely.
(g) Tests in progress.

.....

(1066) (a) STUDY OF RELIEF VALVES.
(c) Student thesis.
(d) Edward Maue ; Prof. C. P. Kittredge.
(e) Prof. F. B. Seely.
(f) To study the hydraulic operating characteristics of two types of relief valves.
(h) One series of tests completed and thesis on file in the University Library.

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(1067) (a) STUDY OF THE EFFECT OF SUBMERGENCE ON THE VELOCITY DISTRIBUTION IN A PIPE NEAR ITS OUTLET.
(c) Student thesis.
(d) W. H. Chamberlin; Prof. C. P. Kittredge.
(e) Prof. F. B. Seely.
(g) Use of Pitot tube.
(h) Tests on outlet without submergence completed and thesis on file in the University Library.

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(1068) (a) STUDY OF TURBULENT FLOW THROUGH ANNULAR TUBES.
(c) Student thesis.
(d) J. R. Bishop; Prof. C. P. Kittredge.
(e) Prof. F. B. Seely.
(f) Loss of head and use of a Pitot tube for determining velocity distribution in annular tube having outside diameter of 6 inches.
(h) Preliminary tests completed and thesis on file in University Library. Further tests in progress.

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(1069) (a) HYDRAULICS OF FLOW IN WELLS.
(b) Engineering Experiment Station.
(c) Research.
(d) H. E. Babbitt.
(e) Prof. H. E. Babbitt.
(f) To test existing hypotheses of flow of water into wells.
(g) Observation of laboratory experiments and of wells in the field.
(h) Tests in progress.

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(1070) (a) RADIAL OUTWARD FLOW OF WATER BETWEEN DISKS.
(b) Research.
(c) Tests of fixed and movable geometrically similar disks in a range of sizes.
(d) Prof. P. E. Mohn.
(e) Prof. F. B. Seely.
(f) To obtain design data and experimental verification of theoretical analysis.
(g) Experimental.
(h) Tests in progress.

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COLORADO STATE COLLEGE.

(1079) (a) METER FOR DITCH FLOWS.
(b) Soil Conservation Service, Division of Irrigation, U.S.D.A., and the Colorado Experiment Station, cooperating.
(c) To perfect a new type of water-measuring device with a recording and indicating mechanism attached.
(d) R. L. Parshall and assistants.
(e) R. L. Parshall, Senior Irrigation Engineer, Division of Irrigation, Soil Conservation Service, Fort Collins, Colorado.
(f) To develop a useful and practical meter of relatively cheap design to meet the need of distributing irrigation water supplies to farmers.
(g) To develop the new type of measuring device and recording instrument in the laboratory; also to test out under practical field conditions.
(h) Temporarily inactive.

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(1080) (a) SIPHON SAND TRAP.
(b) Soil Conservation Service, Division of Irrigation, U.S.D.A., in cooperation with the Colorado Agricultural Experiment Station.
(c) To set up laboratory apparatus as a model to investigate the possibilities of this type of sand trap.
(d) R. L. Parshall and assistants.
(e) R. L. Parshall, Senior Irrigation Engineer, Division of Irrigation, Soil Conservation Service, Fort Collins, Colorado.
(f) To develop a new type of sand-trap device capable of removing bed load from a channel under limited sluicing facilities and conditions.
(g) To arrange model apparatus in the laboratory whereby the bedload in a channel can be removed and deposited at a higher elevation, by advantage of differences in water stages in channel and outside. Should laboratory studies warrant, a full-scale device is to be tried out under practical conditions in the Arkansas Valley in Colorado.
(h) Temporarily inactive.

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(1081) (a) COLLECTION OF SNOW-SURVEY DATA.
(b) Soil Conservation Service, Division of Irrigation, U. S. D. A., in cooperation with the Colorado Agricultural Experiment Station.
(c) Collection of field data in cooperation with several federal and state cooperators.
(d) R. L. Parshall and assistants.
(e) R. L. Parshall, Senior Irrigation Engineer, Division of Irrigation, Soil Conservation Service, Fort Collins, Colorado.
(f) The collection of snow-cover data as the basis of forecasting irrigation water supplies.
(g) Cooperating agencies make monthly snow surveys at definite locations in the high mountain country of Colorado, Wyoming, New Mexico and Utah. These observations are usually made the first of February, March, April and May each year.
(h) Such surveys have continued each winter since February 1936, and the records now accumulated form the working basis of establishing the relationship between snow cover and stream flow.
(i) This is a continuing project.

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(1082) (a) METERS FOR PIPE FLOWS.
(b) Soil Conservation Service, Division of Irrigation, U. S. D. A., in cooperation with Colorado Agricultural Experiment Station.
(c) To make laboratory tests on apparatus preliminary to design, and later to operate under practical field conditions.
(d) R. L. Parshall and assistants.
(e) R. L. Parshall, Senior Irrigation Engineer, Division of Irrigation, Soil Conservation Service, Fort Collins, Colorado.
(f) To investigate the possibilities of developing useful and practical instruments for indicating and totalizing the flow or discharge in pipe lines as a means of more efficient operation of pumping plants, and other purposes.
(g) Test out present ideas as applicable to the problem by preliminary apparatus set up in the laboratory. The present scope of the problem involves two different plans of approach.
(h) Temporarily inactive.

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(1083) (a) RELATION OF SNOW COVER TO RUN-OFF.
(b) Colorado Experiment Station and Soil Conservation Service, Division of Irrigation, cooperatively.
(c) Compilation and analysis of snow-cover and streamflow data.
(d) R. L. Parshall, Wm. E. Code, and Carl Rohwer.
(e) R. L. Parshall, Colorado Experiment Station, Fort Collins.

(f) Preparation of charts and diagrams for the purpose of forecasting stream flow from snow-pack observations for agricultural, industrial, and municipal interests.
(g) From the data gathered from the snow surveys and the records of stream flow as furnished by the U. S. Geological Survey and various State engineers, diagrams are being made from the plottings of these two quantities. This is the simplest form of study, and other means may be employed of a more detailed character later when records covering a greater period of time have accumulated. From such charts, experience in other states has shown that stream flow from the snow cover can be predicted with reasonable accuracy.
(h) Only four years of snow-survey records are available. This record is so short that no general conclusions are yet possible.
(i) More precipitation stations are needed at high altitudes in order to determine the effects of late snows and early rains. More stream-gaging stations are needed in some localities for rational subdivision of areas controlled by any one snow course.

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(1084) (a) USE OF GROUND WATER IN THE SOUTH PLATTE BASIN IN COLORADO FOR 1940.
(b) Colorado Experiment Station and Soil Conservation Service.
(c) Evaluation of output of irrigation pumping plants.
(d) W. E. Code and assistants.
(e) W. E. Code, Colorado Experiment Station, Fort Collins, Colorado.
(f) Determination of the extent of use of ground water for irrigation, its growth and the possible effect upon the water table and return flow to the South Platte.
(g) The discharge of each pumping plant will be determined if possible by using pump capacity and test data available in a large number of cases and by controlled estimates in others. The total volume will be arrived at through the amount of electricity or fuel oil used or pumping records. About 1400 plants will be investigated. The measurement of return flow or seepage has received some attention by the Colorado Experiment Station and the State Engineer since 1891. A study of these measurements in connection with the pumping and the total water supply of the basin will be made.
(h) Project is just getting started and will be finished in the summer of 1941.
(i) Only a small degree of accuracy in the data is anticipated.

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(1085) (a) GROUND-WATER FLUCTUATION.
(b) Colorado Experiment Station and Soil Conservation Service, cooperatively.
(c) See (a).
(d) W. E. Code and assistants.
(e) W. E. Code, Colorado Agricultural Experiment Station, Fort Collins, Colorado.
(f) To determine in certain areas the effects of pumping and irrigation on the height of the water table.
(g) Twice annually, before and after the irrigation season, steel-tape measurements are made to the water surface in about 125 observation wells. The wells are located only in pumping districts of the South Platte and Arkansas Basins.
(h) This program was started in 1928 and 1929 and has been carried on continuously.
(i) Records show that definite conclusions may be drawn in a number of pumping areas.

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(1086) (a) INVESTIGATION OF PHOTOGRAPHIC METHOD FOR MAKING SNOW SURVEYS.
(b) The Colorado Experiment Station and the Soil Conservation Service, Division of Irrigation, cooperating.
(c) Photographs are made of a section of the watershed at high elevations and from them the percentage of area covered by snow is determined.
(d) Maxwell Parshall, N. A. Christenson.
(e) Maxwell Parshall.
(f) To devise a photographic method of forecasting runoff from snow cover and to eliminate, where possible, much time and effort in making snow surveys by the present method.
(g) The method consists of taking monthly photographs during the snow season of a definite section of the watershed at high elevation, from an easily accessible location, and determining the percentage of area covered by snow. A comparison of area covered to runoff is hoped to be the basis of stream forecast. At present only one location is being investigated.
(h) Preliminary analytical work shows excellent agreement with results obtained on the Cameron Pass Snow Course.
(i) Arrangements have been made to use airplanes in order to take photographs for the coming winter.

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(1087) (a) METEOROLOGICAL OBSERVATIONS FOR CLIMATOLOGICAL RECORD.
(b) The Colorado Experiment Station.
(c) Observations are made of the various meteorological elements.
(d) Maxwell Parshall.
(e) Maxwell Parshall.

(f) To determine the climate of Fort Collins, Colorado, and to furnish such meteorological data as may be necessary for research programs in the various departments of the Colorado Experiment Station.
(g) Observations are made twice daily, at 7 a.m. and 7 p.m. and consist of: barometric pressure, maximum and minimum temperatures, dewpoint and relative humidity, terrestrial radiation thermometer temperature, soil temperature at 3, 6, 12, 24, 36, and 72 inches depth, and wind movement for 24 hours. During the ice-free season - April 1 to about November 15 - observations are made at the same times of day on evaporation from a free water surface. These observations consist of the loss of water in inches, temperature of the water, maximum and minimum temperatures of the water during the 24-hour period, and wind movement over the water surface. Rainfall and snow depths are measured when they occur. General remarks of meteorological phenomena are recorded. A graphic record is made of wind direction, wind velocity, sunshine, barometric pressure, and temperature. During the entire year, graphic records of precipitation are made.
(h) The meteorological record is complete as indicated from 1887 to date, while the evaporation record was not initiated until May 1890, but is complete from that date to the present.
(i) The official meteorological station has been moved during the past summer. Observations were made at both stations during the months June to September inclusive. Comparison of the data taken at the two stations is being prepared.

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(1088) (a) COMPARISON BETWEEN OBSERVED AND CALCULATED EVAPORATION, USING FORMULA DEVELOPED BY CARL H. ROHWER.
(b) The Colorado Experiment Station and the Soil Conservation Service, Division of Irrigation, cooperating.
(c) The preparation of tables of observed and calculated rates of evaporation at the Colorado Experiment Station.
(d) Maxwell Parshall, Roger Smith.
(e) Maxwell Parshall.
(f) To compare the observed and calculated evaporation rates as observed at the Colorado Experiment Station.
(g) The method consists of tabulating the original evaporation observations and checking the monthly total and averages. The rate of evaporation is calculated for 12-hour intervals where sufficient data are available, and the observed evaporation is tabulated alone where insufficient data are available for calculating the rate of evaporation. The observed evaporation data are available during the ice-free season from May 1890 to date.

(h) Evaporation records are available for the past fifty years and are completely tabulated. Calculations using the Rohwer formula have been made for approximately half the number of years for which evaporation records are available.
(i) N.Y.A. student assistance is being used for a majority of the work.

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(1089) (a) DESIGN OF HYDRAULIC SAND-SEPARATOR.
(b) Colorado Experiment Station in cooperation with the Soil Conservation Service, Division of Irrigation.
(c) This is to be a laboratory investigation, the purpose of which is to design a hydraulic sand-separator which may be used to (a) synthesize sands for hydraulic model studies and (b) analyze sands moved in irrigation streams.
(d) Dr. Dwight Gunder and assistants.
(e) Dr. Dwight Gunder, Professor of Mathematics, Colorado State College.
(f) This proposed apparatus, when perfected, will be used in connection with a larger investigation on the similarity principles governing the motion of sand in fluid flows.
(g) A design will be made and its performance checked in the hydraulic laboratory. The scope is to be limited to the perfection of a satisfactory separator which may be used for the purpose already mentioned.
(h) Activity on this project has been temporarily halted until the completion of Project 1090.
(i) This project may be resumed later in the year.

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(1090) (a) DESIGN OF FALL-VELOCITY APPARATUS.
(b) Colorado Experiment Station in cooperation with the Soil Conservation Service, Division of Irrigation.
(c) A laboratory investigation in order to perfect an apparatus which may be used to measure the fall velocity of particles in water.
(d) Dr. Dwight Gunder and assistants.
(e) Dr. Dwight Gunder, Professor of Mathematics, Colorado State College.
(f) This apparatus is a part of the larger investigation, the purpose of which is to discover the similarity principles which will make possible quantitative hydraulic model studies in which sands are being moved by the flow.
(g) This project will be conducted in the laboratory and is limited to the development of a satisfactory apparatus for the measurement of fall velocity of particles in water.
(h) One instrument was designed and constructed which satisfactorily measured fall velocity. A second piece of equipment is now in the process of construction. This new equipment is designed to not only determine the fall velocity of particles, but to provide a method whereby the sample can simultaneously be

analyzed on the basis of percentage of weight corresponding to each fall-velocity interval occurring in the sample.

(i) Work on this project should be completed by the end of 1940.

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CORNELL UNIVERSITY.

(1242) (a) STEEL OPEN CHANNELS.
(b) Graduate thesis.
(c) Experimental study with some theoretical correlation.
(d) Chen Hso Tang.
(e) Prof. E. W. Schoder.
(f) Check on roughness index.
(g) Steel 8 x 8 angle and 14 x 12 H beam, each 40 ft long used as flumes. Slopes up to 0.20; mean velocities up to 20 fps, the higher ones created at flume entry by special sluice orifices. Flow measured in tanks for small slopes and by calibrated inferential meters for steep slopes.
(h) Thesis completed.
(i) Variations in roughness during tests are compared with Nikuradse's sand-grain index.

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(1243) (a) VELOCITY DISTRIBUTION IN OPEN CHANNELS.
(b) Graduate thesis.
(c) Experimental and analytical study.
(d) Melvin J. Greaves.
(e) Prof. E. W. Schoder.
(f) Study of velocity contour patterns.
(g) See previous description. In addition slender, long-nose, Pitot tubes were used.
(h) Thesis completed: Preparation of paper in progress.
(i) Close check between "Conjugate circular pipe" and actual pipe.

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(1244) (a) WEIRS WITHOUT END CONTRACTIONS IN NARROW CHANNELS WITH HIGH HEADS.
(b) Staff research.
(c) Experimental study.
(d) E. W. Schoder and the late K. B. Turner.
(e) Prof. E. W. Schoder.
(f) To extend discharge coefficients to high heads; to delineate upper and lower profiles of overflow nappes; to record data on characteristic standing waves in channel of approach for some of the weirs of small height.
(g) Approach channels 42 ft long, 18 ft deep, of widths 1, 2, and 3 ft, all with rounded entry, with weir heights from 0 to 10 ft, total heads 1.5 to 7.5 ft. Flows measured by a "standard" weir 16 ft long and 5.5 ft high. Some current meter and Pitot tube measurements in narrow channels of approach.

(h) Preparation of paper under way.

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S. MORGAN SMITH COMPANY.

(1245) (a) ADJUSTABLE-BLADE AXIAL-FLOW-PUMP EFFICIENCY, HORSE-POWER AND DISCHARGE TESTS.
(b) Pusey and Jones Corp., Wilmington, Delaware.
(c) Commercial research.
(d) R. Sahle, H. B. Bennett and testing crew of the S. Morgan Smith Co.
(e) Engineering Department, George A. Jessop, Chief Engineer.
(f) To determine the discharge in gpm, the horse-power and efficiency of a full-size axial-flow pump under field heads.
(g) The pump and direct-connected motor were mounted in the laboratory and tested.
(h) Tests are completed.

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(1246) (a) ADJUSTABLE-BLADE AXIAL-FLOW-PUMP EFFICIENCY, HORSE-POWER AND DISCHARGE TESTS.
(b) Union Electric Co. of Illinois, Venice #2 Station. Stone and Webster Engineering Corporation, Boston, Mass.
(c) Commercial research.
(d) R. Sahle, H. B. Bennett and testing crew for the S. Morgan Smith Co.
(e) Engineering Department, George A. Jessop, Chief Engineer.
(f) To determi e the discharge in gpm, the horse-power and efficiency of a full-size, adjustable-blade, axial-flow pump in its permanent field setting. To obtain complete information so that the pump can be most efficiently operated over the entire range of total dynamic heads from 15 to 45 ft.
(g) An exact model was made from the prototype impeller, guide-vane casing, elbow suction-tube and discharge tube. Tests were conducted at a number of blade angles, and at each position efficiency, horse-power, and discharge tests were conducted over large range of speeds to cover the required proportional speed as determined by the field head conditions.
(h) The test was conducted as an acceptance test for the Stone and Webster Engineering Corp.
(i) This design of pump will be used in a circulating, water cooling, condenser system in a steam-power station.

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(1247) (a) FRANCIS-TURBINE EFFICIENCY AND POWER TEST - MODEL TEST CONDUCTED WITH THREE DESIGNS OF RUNNERS AND WICKET GATES.
(b) Fort Peck Project, U. S. Engineer Office, Missouri River Division.
(c) Commercial research.
(d) R. Sahle, H. B. Bennett, and testing crew for the S. Morgan Smith Co., F. H. Littrell, U. S. Engineer Office, Missouri River Division.
(e) Engineering Department, George A. Jessop, Chief Engineer.
(f) To determine the capacity and efficiency of the three types of runners and wicket gates. To select the most efficient design to meet the required conditions.
(g) Investigation was carried out in plate-steel spiral scroll-case and plate-steel elbow draft-tube. All tests were conducted over a large range of speeds and sufficient number of gate openings so that curves can be drawn to determine the exact opening to produce the maximum efficiency.
(h) The final test was conducted as an acceptance test for the Fort Peck Project.

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(1248) (a) FRANCIS TURBINE EFFICIENCY AND POWER TEST -ALTERATION MADE TO RUNNER DESIGN.
(b) Aluminum Power Co., Ltd., Chute-A-Caron Development.
(c) Commercial research.
(d) R. Sahle, H. B. Bennett and testing crew for the S. Morgan Smith Co.
(e) Engineering Department, George A. Jessop, Chief Engineer.
(f) To obtain additional power and still maintain high efficiency by making alterations to the design of runner now at the Chute-A-Caron Development.
(g) Investigation was carried out in an open flume and on vertical draft tube.
(h) Tests are completed.

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(1249) (a) FRANCIS TURBINE HYDRAULIC-THRUST TEST.
(b) S. Morgan Smith Co.
(c) Research.
(d) R. Sahle, H. B. Bennett and tes ting crew for the S. Morgan Smith Co.
(e) Engineering Department, George A. Jessop, Chief Engineer.
(f) To obtain minimum hydraulic thrust by making alteration to the runner. Hydraulic thrust was obtained on three types of runners.

(g) Investigation was carried out on elbow draft-tube and scroll case. Total weight of revolving parts and hydraulic thrust were taken on platform scales.
(h) Tests are completed.

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(1250) (a) ADJUSTABLE-BLADE-PUMP CAVITATION TESTS.
(b) S. Morgan Smith Co.
(c) Commercial research.
(d) R. Sahle, H. B. Bennett and testing crew for the S. Morgan Smith Co.
(e) Engineering Depa rtment, George A. Jessop, Chief Engineer.
(f) To determine the cavitation limits for the full-size pumps in their field setting.
(g) A complete pump model was used for the cavitation tests. The suction bell and discharge tube were connected to large steel tanks. Movable gates control the water level in each of the tanks. The pressure in the suction tank was lowered by steps to correspond to a minimum level, approximately 16 feet below the center line of the impeller, the intake being always submerged. Sigma was determined by the usual method.
(h) Tests are completed.

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(1251) (a) INVESTIGATION OF FLOW CONDITIONS EXISTING IN A PENSTOCK PARTITIONED OFF BY A PIER FOR A WASTE-WAY.
(b) S. Morgan Smith Co.
(c) Research.
(d) R. Sahle, H. B. Bennett and testing crew for the S. Morgan Smith Co.
(e) Engineering Department, George A. Jessop, Chief Engineer.
(f) To observe flow condition existing in approach canal, intake, and penstock.
(g) A model, 1/124th full scale, representing a canal, penstock, pier, and waste-way was constructed entirely of transparent Lucite. Study of flow conditions was made at various velocities.
(h) Tests are completed.

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(1252) (a) FIXED-BLADE AXIAL-FLOW-PUMP EFFICIENCY, HORSE-POWER, AND DISCHARGE TESTS.
(b) Nonconnah and Cypress Creek Pumping Station, Shelby County, Tennessee. War Department. U. S. Engineer Office, Memphis, Tenn.
(c) Commercial research.
(d) R. Sahle, H. B. Bennett and testing crew for the S. Morgan Smith Co.

(e) Engineering Department, George A. Jessop, Chief Engineer.
(f) To determine the maximum discharge at maximum head within the capacity of the motor. To obtain complete information so that the pump can be most efficiently operated over the range of head from 5 to 28 ft.
(g) An exact model was made of the prototype impeller, guide-vane casing, suction bell and elbow discharge tube. The tube was made of plate steel and was built up in sections and welded to conform with the prototype size. Tests were conducted at three positions of the impeller blades. At each position efficiency, horsepower, and discharge tests were conducted over a large range of speeds to cover the required proportional speed as determined by the field head condition.
(h) The final test was conducted as an acceptance test for the U. S. Engineer Office.

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COLUMBIA UNIVERSITY.

(987) (a) HYDRAULICS OF BROADCRESTED WEIRS.
(b) Research.
(c) A comprehensive appraisal of the physical aspects of the phenomena.
(d) Professor B. A. Bakhmeteff, N.V.Feodoroff, and others.
(e) Prof. B. A. Bakhmeteff.
(h) The project is near completion.

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(1253) (a) FLOW THROUGH GRANULAR MEDIA.
(b) Research.
(c) Investigation of resistance coefficients in flow of air through uniform and composite granular beds. Equivalent diameters for composite beds.
(d) Professor B. A. Bakhmeteff,
N. V. Feodoroff.
(e) Prof. B. A. Bakhmeteff.
(h) Project to be completed in 1941.

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(1254) (a) NATURE OF HYDRAULIC FRICTION.
(b) Research.
(c) Mechanism of hydraulic friction, particularly with regard to boundary layer flow in hydraulic structures.
(d) Professor B. A. Bakhmeteff and collaborators.
(e) Prof. B. A. Bakhmeteff.
(h) Project in initial stage.

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UNIVERSITY OF WISCONSIN.

(764) (a) EFFECT OF VISCOSITY AND SURFACE TENSION ON V-NOTCH WEIR COEFFICIENTS.
(c) Ph. D. thesis.
(e) Professor Arno T. Lenz.
(h) Project completed. Ph. D. thesis on file in the library of the University of Wisconsin. A paper on this study has been written and submitted for publication.

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(768) (a) STANDARD WEIR AND ORIFICE STUDIES.
(c) Departmental research project in cooperation with the Graduate School.
(d) Mr. James R. Villemonte.
(e) Professor J. G. Woodburn.
(f) Study of measurement of flow of water by means of rectangular weirs and orifices without end contractions.
(g) Previous studies on this project with a sharp-crested full-width weir in a flume 2 ft wide have furnished a comparison of accuracy of standard weir formulas for heads up to 1 ft. Most of the test points with the weir are within 1/2% of the mean curve for heads above 0.15 ft. For lower heads, however, there is more scattering of the points, in spite of all improvements in technique of measurement that it appears possible to make.

For flows corresponding to heads lower than the 0.15 ft on the rectangular weir, it appears that a V-notch weir or an orifice provides a more accurate method of measurement. In this study a rectangular orifice was formed in the flume by means of an inverted crest plate similar to the weir plate and inserted into the flume in the same vertical plane as the weir. The opening between the two plates forms the rectangular orifice. Various heights of opening are being tested from 1/2 in. to 3 in.

(h) Discharge coefficients have been determined for openings of 1/2 in. and 1 in. The vertical thickness of the jet at a distance of one-half the height of opening from the face of the orifice is being measured, and coefficients of contraction and velocity based on this vertical height are being computed. Interesting surface tension phenomena have been observed, but no vortex has been formed, even at very low heads.

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(1022) (a) FLOW OF LIQUIDS IN OPEN CHANNELS.
(c) Ph. D. thesis.
(d) Mr. E. R. Dodge.
(e) Professor J. G. Woodburn.
(f) To investigate the physical nature and the applicability of empirical formulas for flow in open channels.

(g) Investigations are to be made of the flow of oil and water at different temperatures in a rectangular glass flume 10 in. wide, 7 in. deep, and 40 ft long, with variable slope.
(h) The flume with its connections and pumping equipment has been installed, and flow tests will start in the near future. Preliminary pilot tests with water in a wooden flume 1 ft wide, 7 in. deep, and 80 ft. long have been completed.

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(1023) (a) TESTS ON APPARATUS OF TRUCK-TANK DISCHARGE SYSTEMS.
(b) National Truck Tank Association.
(c) Experimental investigation of the flow of liquids through valves, meters, fittings, and other apparatus used by the truck-tank industry.
(d) Professor L. H. Kessler, Mr. W. Hancock, and Mr. V. Soderstrom.
(e) Mr. J. E. Julian, President, National Truck Tank Association, 120 S. La Salle St., Chicago, Illinois.
(h) Tests have been completed, and a report is being prepared for early publication by the Association.

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(1255) (a) MODEL TESTS OF THE SPILLWAY OF THE PROPOSED PETENWELL DAM.
(b) Thesis project in cooperation with Consolidated Water Power and Paper Company.
(c) M.S. and B.S. theses.
(d) Professor A. T. Lenz, Director; Messrs. R. Goodier, S.T.Mastingen, L. Rall, J. Coyne, G. F. Finner, J. F. Manthey, C. M. Metcalf.
(e) Professor Arno T. Lenz.
(f) Study of the stilling pool design to prevent destructive erosion of the fine sand river bed below the dam.
(g) A 1:40 scale model of a section of the dam including 4 gates has been constructed in a flume and tested under flood flows up to 70% greater than the maximum on record. Studies have been made of flood action in the center of the proposed gate section of the dam and at the retaining wall where the spillway section joins the non-overflow section of the dam.
(h) A thesis has been written and is on file at the University of Wisconsin Library. A supplementary report was completed in August 1940. Another thesis party is now working on other phases of the project.

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(1256) (a) TESTS OF SMALL BROAD-CRESTED WEIRS.
(c) M.S. thesis.
(d) Mr. M. O. Schmidt.
(e) Professor J. G. Woodburn.
(f) To study characteristics of flow over broad-crested weirs 3 in. high and from 1 to 4 ft broad in a flume 1 ft wide.

(f) Discharge and head will be measured, as well as pressures across the crest. The weir has been constructed of terazzo blocks with an entrance corner of brass lips rounded to various radii. It is expected to extend the study later to broad-crested weirs in a flume 2 ft wide.
(h) Construction of the weir is complete and a few tests have been made.

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(1257) (a) RESERVOIR DROP-OUTLETS OF CIRCULAR CROSS-SECTION.
(c) B. S. thesis.
(d) Mr. E. C. Brown and Mr. W. F. Faulkes.
(e) Professor J. G. Woodburn.
(f) Model study of hydraulic characteristics of drop-outlet spillways of circular cross-section for small dams.
(g) The first tests will be made on a model formed with 4-inch standard iron pipe. The entrance will be rounded. Two different heights of vertical section will be tested and two or three different lengths of horizontal section. The tests of model with circular cross-section will be compared with model tests of outlets with square cross-section which have previously been made at this laboratory.
(h) Equipment is being assembled for the study.

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UNIVERSITY OF CALIFORNIA.

(426) (a) HYDRAULIC ROUGHNESS IN CLOSED CHANNELS.
(b) Laboratory research.
(c) R. G. Folsom, F. Jonassen.
(d) Professor M. P. O'Brien.
(e) To study relationship between friction factor "f" and surface geometry at fully developed turbulence, using artificially roughened surfaces.
(f) The pressure drop is determined experimentally for air flowing through a rectangular redwood duct by means of grooves cut transversely to the flow. By changing the width of the duct, the relative roughness may be altered and also the absolute roughness by increasing or decreasing the pitch of the grooves.

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(C34) (a) SAN DIMAS METERING FLUME.
(b) Cooperation with California Forest and Range Experiment Station.
(c) Laboratory project.
(d) Wilm, Stoker, Bermel.
(e) Professor M. P. O'Brien.
(f) Calibration of metering flume under various conditions of bed slope, roughness, shape, size.

(g) Tests on 6-inch flume have been completed, and tests are now in progress on a one-foot concrete flume. Tests will be extended to flow transporting bed load.
(h) Construction of bed-load equipment now in progress. A discussion by R. L. Stoker describing these experiments appeared in the Proceedings of the American Society of Civil Engineers for June 1938.

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(723) (a) RECOVERY EFFICIENCY OF VARIOUS TYPES OF SLOWLY MOVING FLUID INTERFACES.
(b) Standard Oil Company of California Research Fellowship.
(c) Laboratory project.
(d) R. G. West.
(e) Professor M. P. O'Brien.
(f) To determine the most efficient method of repress ring media for oil recovery.
(g) Measure recovery of oil from a cylinder of oil-saturated sand using water and gas drives.
(h) Continuation of work of D. R. Rankin and R. L. Parsons.

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(726) (a) PUMP TESTING LABORATORY.
(b) Laboratory investigation.
(d) R. G. Folsom, D. Drake, E. Janssen.
(e) Professor M. P. O'Brien.
(f) Research in the general field of pumping.
(g) Present investigations include:
1. Research in the field of deep-well and propeller pumps.
2. Analysis of laboratory and field methods of testing, development of test standards, and calibration of test instruments.
3. Tests of motors, bearings, and other auxiliary equipment.
4. Tests of manufacturers' types.
5. Tests on specific pumps and pump accessories and equipment.
(h) The equipment is in operation. See note under abstracts in this Bulletin.

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(799) (a) EFFECT OF VISCOSITY UPON THE CHARACTERISTICS OF CENTRIFUGAL PUMPS.
(b) Laboratory investigation.
(c) Master's thesis.
(d) Paul Hecks.
(e) Professor M. P. O'Brien.
(f) To predict the performance of a centrifugal pump pumping viscous fluids after obtaining the pump characteristics, using water.
(g) Testing of 2-inch centrifugal pump using water and oils of different viscosities.
(h) Continuation of work of H. Van de Verg. Testing in progress.

(801) (a) FRICTION LOSSES IN ANGULAR-CONTACT THRUST BEARINGS.
(b) Laboratory investigation.
(c) Master's thesis.
(d) W. Johnson.
(e) Professor M. P. O'Brien.
(f) To determine friction losses in angular-contact thrust bearings under conditions of use in deep-well turbine pumps.
(g) To determine by tests
1. Friction of ball on race.
2. Oil pumping losses.
3. Losses due to misalignment.
(h) Experiments in progress.

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(802) (a) THE DESIGN OF A PROPELLER TURBINE.
(b) Laboratory project.
(c) Ph. D. thesis.
(d) F. Jonassen.
(e) Professor M. P. O'Brien.
(f) To predict the characteristics of a propeller turbine having airfoil section blades.
(g) Using a small vertical turbine, the predicted results will be checked experimentally. Effects of vertical blade interference will be studied using a direction pitot-tube.
(h) Equipment assembled. Experiments in progress.

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(1040) (a) DAMS ON PERVIOUS FOUNDATIONS.
(b) Laboratory project.
(c) Ph. D. thesis.
(d) M. A. Selim.
(e) Professor M. P. O'Brien.
(f) Study of the percolation line and collection of data for empirical formulas for the length of the impervious flow and depth of cut-off walls.
(g) Use will be made of the electric analogy and small-scale models.
(h) Experiments with the electric analogy are now in progress.

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(1044) (a) MODEL STUDY OF WAVE REFRACTION.
(b) Laboratory project.
(c) Master's thesis.
(d) Lieutenant F. Milner and Lieutenant W. B. Stelzenmuller.
(e) Professor M. P. O'Brien.
(f) To check experimentally existing wave-refraction theories.
(g) Experiments take place in basin approximately 58' x 38' x 2' deep. A wave machine is located at one end. Various seashore forms to be built in basin to study refraction.

(h) Continuation of work of Wilhoyt and McCrone with certain modifications in equipment. See abstract in this Bulletin.

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(1045) (a) UNSTEADY FLOW OF FLUIDS THROUGH POROUS MEDIA.
(b) Laboratory project.
(c) Ph. D. thesis.
(d) J. A. Putnam.
(e) Professor M. P. O'Brien.
(f) To predict unsteady flow characteristics of porous media for homogeneous and nonhomogeneous fluids.
(g) Using a linear channel filled with uniformly compacted sand, measurements will be made of the variation of pressure with time and space for various boundary conditions. Both homogeneous fluids and gas-liquid mixtures will be used.
(h) Experiments in progress.

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(1258) (a) FLOW CHARACTERISTICS OF DRILLING MUDS.
(b) Laboratory investigation.
(c) Master's thesis.
(d) R. E. Loeck.
(e) Professor M. P. O'Brien.
(f) To determine design data for flow of drilling fluids.
(g) Measurement of pressure drops in tubes of different diameters. Study of the plastic properties of drilling muds in relation to head loss.
(h) Testing in progress.

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(1259) (a) UNSTEADY FLOW THROUGH POROUS MEDIA FROM A FREE SURFACE.
(b) Laboratory investigation.
(c) Master's thesis.
(d) Capt. R. C. Miller.
(e) Professor M. P. O'Brien.
(f) To determine the response of ground-water level in relation to variation in free-water surface
(g) Use will be made of a linear channel packed with sand and equipped with a forebay in which the free water surface elevation may be varied.
(h) Equipment under construction.

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(1260) (a) THE EFFECT OF WALL FRICTION ON WAVES IN A STRAIGHT CHANNEL.
(b) Laboratory investigation.
(c) Master's thesis.
(d) Capt. A. D. Chaffin.
(e) Professor M. P. O'Brien.
(f) To determine the effect of side-wall friction on the damping of gravity waves in an experimental wave channel and to compare results with a proposed theory.

(g) Use is made of a wave tank 1 foot wide, 3 feet deep and 60 feet long, equipped with flapper-type wave generator. Width of channel to be varied by means of movable side wall. Amplitudes and velocities of waves will be measured in channels of different widths.

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U. S. BUREAU OF RECLAMATION

(48) (a) HYDRAULIC MODEL EXPERIMENTS FOR THE DESIGN OF BOULDER DAM.
(b) to (g) See Report in Bulletin VIII, page 79.
(i) Work progressing intermittently.

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(547) (a) HYDRAULIC MODEL EXPERIMENTS FOR THE DESIGN OF THE GRAND COULEE DAM.
(b) to (h) See Report in Bulletin VIII, page 79.
(i) Testing has been completed. Reports will be prepared as time is available.

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(548) (a) IMPERIAL DAM AND ALL-AMERICAN CANAL STRUCTURES.
(b) to (i) See Report in Bulletin VIII, page 79.

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(554) (a) BARTLETT DAM SPILLWAY AND OUTLET WORKS.
(b) to (g) See Report in Bulletin VIII, page 79.
(h) Completion of report delayed by more urgent work.

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(919) (a) SHASTA DAM SPILLWAY AND OUTLET WORKS.
(b) to (g) See Report in Bulletin VIII, page 79.
(h) Testing is in progress.

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(920) (a) FRIANT DAM SPILLWAY AND OUTLET WORKS.
(b) to (g) See Report in Bulletin VIII, page 79.
(h) Testing has been tentatively completed and model designs incorporated in prototype. Reports will be prepared as time is available.

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(924) (a) GRAND COULEE POWER PLANTS DRAFT TUBES.
(b) to (g) See Report in Bulletin VIII, page 83.
(i) Completed. Report about three-fourths completed.

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(927) (a) PENSTOCK RELIEF VALVES AND ENERGY ABSORBERS.
(b) to (h) See Report in Bulletin VIII, page 83.

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(928) (a) NEEDLE VALVE CAVITATION.
(b) to (i) See Report in Bulletin VIII, page 84.

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(929) (a) SEALS FOR PENSTOCK HEAD GATES AND SLUICE GATES.
(b) and (g) See Report in Bulletin VIII, page 84.
(h) Tests complete. Report about three-fourths complete.

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(930) (a) BENDS AND ELBOWS IN LARGE PENSTOCKS.
(b) to (g) See Report in Bulletin VIII, page 84.
(h) Tests completed. Report is in progress.

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(1117) (a) GRAND COULEE PUMPING PLANT DISCHARGE SYPHONS.
(b) to (h) See Report in Bulletin VIII, page 84.

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(1261) (a) JET PUMP STUDIES.
(b) Bureau of Reclamation.
(c) Laboratory studies for design data.
(d) Hydraulic Machinery Laboratory.
(e) Chief Engineer, Bureau of Reclamation, Denver, Colorado.
(f) To determine the apparent shear between the concentric jets of a jet pump.
(g) Two concentric circular nozzles discharging into the atmosphere, the inner nozzle with high velocity, and the outer nozzle with low velocity.
(h) Tests complete. Report about three-fourths complete.

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(1262) (a) INVESTIGATION OF VALVE CHARACTERISTICS USING AIR AS THE FLUID.
(b) Bureau of Reclamation.
(c) Model studies of pressure distribution and coefficient of discharge of various valve designs.
(d) Hydraulic Machinery Laboratory.
(e) Chief Engineer, Bureau of Reclamation, Denver, Colorado.
(f) To determine quickly the general hydraulic characteristics of valve designs.
(g) By means of one-eighth sectional plaster models operating with air as the fluid.
(h) Tests are in progress.

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(1263) (a) KESWICK DAM SPILLWAY AND FISHWAY.
(b) Bureau of Reclamation.
(c) Specific design investigation.
(d) Hydraulic Structures Laboratory.
(e) Chief Engineer, Bureau of Reclamation, Denver, Colorado.

(f) A complete model of the dam and spillway is being used to determine the hydraulic behavior at the downstream approach to a fishway and to determine adequacy of the spillway stilling pool for energy dissipation. A sectional model of the spillway is being used to improve the energy dissipation in the stilling pool and a complete model of the fishway to a scale of 1:10 to study its behavior.
(h) Testing is in progress.

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U. S. SOIL CONSERVATION SERVICE.

(1264) (a) RUNOFF STUDIES ON SMALL DRAINAGE BASINS.
(b) Soil Conservation Service, U. S. Department of Agriculture.
(c) Hydrologic field investigations.
(d) D. B. Krimgold, John L. Weber, and others.
(e) C. E. Ramser, Chief, Hydrologic Division, Soil Conservation Service, (Attention D. B. Krimgold).
(f) To secure data on rates and amounts of runoff for use in the design of conservation structures and practices in a number of runoff problem areas of the United States.
(g) 97 small drainage basins ranging in size from about 10 acres to 2,000 acres and typical, with respect to physiography, soils, cover, and tillage, of runoff-problem areas in various parts of the United States were established. Rates and amounts of precipitation are measured by means of recording raingages. Rates and amounts of runoff are obtained by means of triangular weirs with trapezoidal crests and type H flumes equipped with water-level recorders. Continuous records of temperature and humidity are secured by means of hygrothermographs. Topographic, soil, and cover and tillage maps are prepared for each of the drainage basins.
(h) The construction of the necessary installations on all drainage basins was completed. Records of precipitation and runoff and of related information for periods ranging from one to three years were obtained from all watersheds. The compilation of the field data is now in progress. Methods for analyses are being developed.
(i) The runoff studies are conducted on the demonstration projects of the Soil Conservation Service. The geographic distribution of the drainage basins under investigation is as follows:

Cohocton, N.Y.	4	Hamilton, Ohio	4	Safford, Ariz.	6
Freehold, N.J.	4	Garland, Texas	6	Albuquerque, N.M.	3
Hagerstown, Md.	5	Bentonville, Ark.	6	Santa Fe, N.M.	3
College Park, Md.	9	Edwardsville, Ill.	4	SantaPaula, Cal.	5
Chatham, Va.	3	Fennimore, Wis.	4	Watsonville, Cal.	4
Blacksburg, Va.	2	Vega, Texas	3	Newberg, Ore.	4
Americus, Ga.	4	Colorado Springs, Colo.	4	Emmett, Idaho	2
Athens, Ga.	1			Moscow, Idaho	2
		Muskogee, Okla.	4	Dayton, Wash.	1

SOIL CONSERVATION SERVICE, Spartanburg Outdoor Hydraulic Laboratory.

(931) (a) STUDY OF THE EFFECT OF LINING CHARACTERISTICS ON THE HYDRAULIC BEHAVIOR OF CONSERVATION CHANNELS.
(b) Soil Conservation Service, U. S. Department of Agriculture.
(c) Studies in conservation hydraulics.
(d) W. O. Ree, W. P. Law.
(e) Chief, Hydrologic Division, Soil Conservation Service, (attention D. A. Parsons).
(f) To obtain data on channel capacities for direct application in the design of the hydraulic works constructed in soil and water conservation operations.
(g) Measured flows are passed through outdoor test channels of various cross-sections and slopes, and precise measurements of the hydraulic elements are made to determine the effect of different linings on channel capacity. Special emphasis is placed on the study of vegetal linings.
(h) Vegetations tested to date include Bermuda, Centipede, Dallis, and Sudan grasses, as well as Lespedeza Sericea, Common Lespedeza, and Kudzu. Tests of soil-cement and cotton-reinforced bituminous linings are also under way.
(i) For further description see Civil Engineering, October, 1938.

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(932) (a) STUDY OF THE CAPACITIES OF NOTCHES AND OTHER APERTURES IN CONSERVATION STUDIES.
(b) Soil Conservation Service, U. S. Department of Agriculture.
(c) Studies in conservation hydraulics.
(d) W. O. Ree, W. P. Law.
(e) Chief, Hydrologic Division, Soil Conservation Service, (Attention D. A. Parsons).
(f) To obtain data on notch capacities for direct application in the design of the hydraulic works constructed in soil and water conservation operations.
(g) Full-size apertures of various shapes and dimensions are tested by passing measured flows of water through them. Additional data are obtained by testing models of the notches.
(h) The test program has been completed. The results have not yet been published.

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(933) (a) STUDY OF ALLOWABLE VELOCITIES FOR VEGETAL CHANNEL LININGS.
(b) Soil Conservation Service, U. S. Department of Agriculture.
(c) Studies in conservation hydraulics.
(d) W. O. Ree, W. P. Law.
(e) Chief, Hydrologic Division, Soil Conservation Service, (attention D. A. Parsons).
(f) To obtain data on the protective characteristics of various types of vegetation for direct application in the design of the hydraulic works constructed in soil and water conservation operations.

(g) The outdoor test channels used in the study of hydraulic characteristics of linings are also utilized for the determination of allowable velocities. For each vegetation the rates of scour are determined for flows of various magnitudes and compared with the scour rates for other vegetations and for unlined channels.
(h) Allowable velocities have been determined for all of the vegetal linings itemized in the description of the study of the hydraulic characteristics of channel linings.
(i) For further description see Civil Engineering, October, 1938.

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(934) (a) STUDY OF ALLOWABLE VELOCITIES FOR ARTIFICIAL CHANNEL LININGS.
(b) Soil Conservation Service, U. S. Department of Agriculture.
(c) Studies in conservation hydraulics.
(d) W. O. Ree, W. P. Law.
(e) Chief, Hydrologic Division, Soil Conservation Service, (Attention D. A. Parsons).
(f) To obtain data on the protective characteristics of inexpensive artificial channel linings for direct application in the design of hydraulic works constructed in soil and water conservation operations.
(g) Test channels lined with various types of artificial linings will be tested to failure under high-velocity flows. The deterioration of these linings under weathering will also be studied.
(h) Tests on soil-cement and cotton-reinforced bituminous linings are under way.
(i) For further description see Civil Engineering, October, 1938.

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(935) (a) STUDY OF THE PROTECTION OF CHANNELS BELOW DROPS AND OTHER CONSERVATION STRUCTURES.
(b) Soil Conservation Service, U. S. Department of Agriculture.
(c) Studies in conservation hydraulics.
(d) W. O. Ree, W. P. Law.
(e) Chief, Hydrologic Division, Soil Conservation Service, (attention D. A. Parsons).
(f) To develop practical and inexpensive methods of preventing excessive scour below the structures constructed in soil and water conservation operations.
(g) A channel of adjustable height discharges water into a scour pit in which various types of aprons, pools, baffles, and other protective works will be constructed for test. The height of fall, the discharge and the characteristics of the protective works can be varied.
(h) The testing program was scheduled to begin during the spring of 1940, but has been delayed. The basin has been constructed.
(i) For further information see Civil Engineering, October, 1938.

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SOIL CONSERVATION SERVICE, ST. ANTHONY FALLS HYDRAULIC LABORATORY, MINNEAPOLIS.

(1265) (a) STUDY OF RATE-OF-RUNOFF-MEASURING DEVICES.
(b) Hydrologic Division, Soil Conservation Service, U. S. Department of Agriculture.
(c) Instrumentation research.
(d) A. N. Huff, F. W. Blaisdell.
(e) Chief, Hydrologic Division, Soil Conservation Service (Attention: D. A. Parsons).
(f) The development and calibration of more suitable devices for the measurement of rates of runoff from experimental areas.
(g) Work will be continued on the V-shaped type of control now in considerable use by the Soil Conservation Service. Models will in general be used.
(i) This is a continuation of previous work done at the Hydraulic Laboratory, National Bureau of Standards and the Hydraulic Laboratory at Cornell University.

.....

(1266) (a) DESIGN OF EROSION-CONTROL STRUCTURES.
(b) Hydrologic Division, Soil Conservation Service, U. S. Department of Agriculture.
(c) Studies in conservation hydraulics.
(d) A. N. Huff, F. W. Blaisdell.
(e) Chief, Hydrologic Division, Soil Conservation Service, (attention: D. A. Parsons).
(f) To determine the most economical, hydraulically correct, erosion-control structures.
(g) Model tests of particular structures, proposed or in place, will be made, especially of the drop inlet, steep chute, and culvert types.

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SOIL CONSERVATION SERVICE, ALABAMA AGRICULTURAL EXPERIMENT STATION.

(341) (a) STUDY OF MEASURING FLUMES.
(b) Hydrologic Division, Soil Conservation Service, U. S. Department of Agriculture.
(c) Instrumentation research.
(d) D. A. Parsons.
(e) Chief, Hydrologic Division, Soil Conservation Service (attention: D. A. Parsons).
(f) The development and calibration of more suitable devices for the measurement of rates of runoff from experimental areas.
(g) The immediate study will be confined to the determination of the most suitable types of approach conditions for the type H and HS flumes from the standpoint of the maintenance of a stable head-discharge relationship with a small storage correction and relative freedom from silt deposition within the installation.

(h) After the construction and trial of many types of flumes, the H and HS designs have been selected for use for flows up to thirty cubic feet per second. Plans and calibration tables have been prepared.
(i) The work on this study was transferred from the Hydraulic Laboratory, National Bureau of Standards, to Auburn, Alabama in July 1940.

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(936) (a) STUDY OF THE EFFECT OF RAINFALL IMPACT ON INFILTRATION AND WATER EROSION.
(b) Hydrologic Division, Soil Conservation Service, U. S. Department of Agriculture.
(c) Research in mechanics of erosion.
(d) J. O. Laws, N. L. Stoltenberg.
(e) Chief, Hydrologic Division, Soil Conservation Service (attention: D. A. Parsons).
(f) To investigate the roles of the size and velocity of raindrops in the water-erosion process.
(g) Studies are being made of the velocity and energy of water-drops of various sizes, of the effect of rain energy on the erosion from elementary areas of soil and of the characteristics of natural raindrops.
(h) A study of the velocity of water-drops falling through various distances has been completed, and a paper entitled "Measurements of the Fall-velocities of Water-drops and Raindrops" has been submitted to the American Geophysical Union for publication. Fall velocities and drop-sizes in natural rainfall have been measured. High-speed motion pictures were obtained of water-drops striking soil surfaces. Preliminary tests have shown that rain characteristics have a profound effect upon infiltration and rate of erosion. An initial paper describing the general aspects of the study entitled "Recent Studies in Raindrops and Erosion" was published in the November 1940 issue of Agricultural Engineering.
(i) The work on this study was transferred from the National Hydraulic Laboratory, National Bureau of Standards, to Auburn, Alabama, in July 1940.

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(1267) (a) STUDY OF THE FLOW OF WATER AT SMALL DEPTHS OVER SOIL SURFACES AND THE RESULTANT SCOUR.
(b) Hydrologic Division, Soil Conservation Service, U. S. Department of Agriculture.
(c) Research in the mechanics of erosion.
(d) D. A. Parsons, J. O. Laws, N. L. Stoltenberg.
(e) Chief, Hydrologic Division, Soil Conservation Service (attention: D. A. Parsons).
(f) (1) To determine the hydraulic principles involved in the flow of water in thin sheets and (2) the pertinent factors and their inter-relationship that are involved in the scour and transportation of soil by water, flowing in thin sheets.

(g) The tests are to be made in a tilting flume approximately two feet in width and will be confined to depths of water less than one-tenth foot. Slope, bed material, and depth of water will be controlled variables for the first experiments, but, if the study appears to warrant expansion, the tests may be repeated in part with the application of a spray of known qualities, or with different surface and roughness conditions.
(i) It is intended that the work shall begin in the Spring of 1941.

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U.S. WATERWAYS EXPERIMENT STATION

The following two projects, inadvertently omitted from the list of projects submitted for the U. S. Waterways Experiment Station (see notes on pages 83 and 87, this bulletin), are given here with apologies for their earlier omission.

(1230)
(a) MODEL STUDY OF SALEM COVE DIKE, DELAWARE RIVER.
(b) The District Engineer, U. S. Engineer Office, Philadelphia, Pa.
(c) Model study of shoaling conditions.
(d) and (e) See (415).
(f) To determine effects of the proposed Salem Cove Dike on the shoaling conditions and flow lines in the Delaware River and the Chesapeake and Delaware Canal.
(g) The Chesapeake and Delaware Canal model (see No. 970) was used in the accomplishment of this study. A detailed current and silt investigation, with and without the Salem Cove Dike installed, was made.
(h) The testing program has been completed.
(i) A report of tests results has been submitted to the District Engineer.

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(1231)
(a) MODEL STUDY OF PLANS FOR ELIMINATION OF SHOALING IN WILMINGTON HARBOR, CHRISTINA RIVER, DELAWARE.
(b) The District Engineer, U. S. Engineer Office, Philadelphia, Pa.
(c) Model study of shoaling elimination.
(d) and (e) See (415).
(f) To develop a plan which will eliminate or reduce shoaling in Wilmington Harbor, Delaware.
(g) Wilmington Harbor consists of a channel 400 ft wide by 30 ft deep in the Christina River near its mouth. Flood tides bring silt from the Delaware River into the Christina River at Wilmington Harbor, where the silt is deposited.

Subsequent ebb tides create currents of such small magnitude that the silt is not carried back into the Delaware. Therefore extensive dredging is necessary to maintain project dimensions in the Christina River. The model was an extension of the Chesapeake and Delaware model (see No. 970) and included the Delaware River from 5 miles above Wilmington to Artificial Island, the Christina River from its mouth to the head of tidewater, and the Brandywine River from its confluence with the Christina to the head of tidewater. Tides and currents were reproduced by automatic tide gages - one at Artificial Island, and the other about 5 miles above Wilmington.

(h) Design, construction, and operation of the model are complete.

(i) A report of tests results has been submitted to the District Engineer.

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HYDRAULIC RESEARCH IN CANADA.

ECOLE POLYTECHNIQUE DE MONTREAL.

(639) (a) HYDRAULIC MODEL STUDIES OF DIFFERENT SPILLWAY PROFILES.
(b) Hydraulic Laboratory, Ecole Polytechnique de Montréal.
(c) General scientific research.
(d) Professor Raymond Boucher and assistant.
(e) Professor Raymond Boucher.
(f) To establish a comparison between the discharge capacities of different spillway designs.
(g) Studies are made on concrete models of existing and recommended spillway profiles. Pressure distribution on spillway crests and coefficients of discharge are determined for various heads up to the designed head. The effect of gate piers of various designs is also investigated.
(h) Six different profiles have been studied. The experimental work was interrupted for nearly one year, it is again in progress.

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(1156) (a) THE DETERMINATION BY MODEL STUDY OF THE EFFECT OF CHANNEL DEPTHS ON WEIR COEFFICIENTS.
(b) The Shawinigan Engineering Co., Ltd.
(c) Model tests to determine the discharge of a spillway dam.
(d) Professor Raymond Boucher and assistants.
(e) Professor Raymond Boucher.
(f) To determine the effect of channel depths on the discharge coefficients of a spillway.

(g) Tests are made on a concrete model (scale 1:60) of a spillway crest with two gate piers. On the upstream side of the weir an adjustable wooden false bottom provides various depths of channel of approach. For different channel depths the coefficients of discharge are determined for various heads up to the designed head.
(h) Project completed.
(i) Results of investigation published under the title: "Model Tests of Large Sluice Gates at High Velocities of Approach and with Different Pier Noses", by Jeffrey B. Macphail and Raymond Boucher, Civil Engineering, September 1940, pp. 592 - 594.

ABSTRACTS OF COMPLETED PROJECTS AND REFERENCES TO PUBLICATIONS.

UNIVERSITY OF CALIFORNIA.

(726) PUMP TESTING LABORATORY.

The following publications are available:

1. "The axial adjustment of deep-well turbine pumps." University of California Press, 1940.

2. "Suction requirements for a propeller pump." Submitted to U. C. Press. Single copies may be obtained from Pump Testing Laboratory, University of California.

3. "Some performance characteristics of deep-well turbine pumps." Presented by R. G. Folsom to Fall Meeting, Spokane, Washington, of the American Society of Mechanical Engineers, to appear in Trans. A.S.M.E., 1941.

4. Technical Memorandum V, "Testing centrifugal pumps", presented at Rural Electrification Conference, College of Agriculture, University of California, Davis, California. January 16, 1940.

(800) PRE-ROTATION IN PROPELLER PUMPS.

Present theoretical design of propeller pumps assumes no pre-rotation and uniform velocity distribution before the propeller. To check the validity of this assumption, direction and velocity traverses were made before the propeller of a typical propeller pump. This pump was designed according to the method based on airfoil theory presented in O'Brien and Folsom, "The design of propeller pumps and fans" (1)* and was used for a sample design in the paper.

Traverses were made at two speeds, 960 and 1160 rpm, and at various capacities.

Results indicated a very nearly uniform velocity// distribution at the point of maximum efficiency, but entrance angles (measured with respect to the pump axis) varied between the hub and case from -6 to +7 degrees. Distribution of entrance angles between hub and case was found to vary with installation conditions in the sump.

To compare with theoretical prediction actual experimental measurements of the change in the head developed by the propeller due to the presence of positive and negative pre-rotation (rotation in the direction of, or opposite to the direction of propeller rotation, respectively) and nonuniform distribution of entrance velocity, the head developed was computed by means of equations presented in the aforc-mentioned paper. Theory indicated that the existing pre-rotation and nonuniform velocity distribution should change the head developed by about 4 percent. Experiment, however, indicated only a change of head of 0.9 per cent.

On the basis of these experiments, the effect on pump performance of pre-rotation, of the magnitude encountered in these tests, should be negligible.

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*Reference in Appendix VI of Thesis.
// In this thesis, "Velocity" means absolute velocity unless designated as otherwise.

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(803) MIXING OF STREAMS IN CLOSED CIRCULAR CONDUITS.

The object of this study was to predict the energy loss occurring at a 90° pipe intersection by use of the equations of momentum, and to compare the predicted values with laboratory measurements. The most important result obtained is that application of the momentum equations is virtually impossible on the basis of simple hydraulic factors such as mean velocities and pressures. Two factors appear to be important. They are:

1. A serious distortion in the velocity pattern in the main pipe just below the junction.

2. The existence of a lateral pressure gradient in the branch pipe which introduces a force in addition to the usual ones considered. This additional force cannot easily be computed a priori.

(809) CHARACTERISTICS OF SAND PUMPS.

The following conclusions are based entirely on observations made in this investigation and should be substantiated by further experiment and research.

1. At a given capacity, the head developed by a centrifugal pump, handling material in suspension, is in general less than that developed for water alone.

2. The drop in the head capacity characteristics varies not only with the concentration but also with the particle size of the material in suspension.

3. The fall velocity of the suspended material is the most important property in predicting the effect on the pump characteristic.

4. The effect on the pump characteristics of very fine particles in suspension, such as colloids, is of a different nature than that of a true suspension.

5. The capacity for maximum efficiency of a centrifugal pump remains constant for all concentrations and sizes of suspended materials.

(1041) CENTRIFUGAL JET PUMP COMBINATION CHARACTERISTICS.

One type of small water-pressure system consists of a normal centrifugal pump connected with a jet pump installed at the bottom of the well. The object of the investigation has been to develop a system for predicting the operating point and efficiency for a given centrifugal pump and a given jet pump when installed in a series of different wells and different type and combinations of interconnecting piping. A performance chart has been developed for all characteristics of the jet pump. Combining the data from this chart with the normal head, capacity, power, and efficiency curves of a centrifugal pump through trial and error methods of calculation developed, it is possible to predict the operating point of the combined system. The results of the analytical development have been checked by laboratory experiments and results may be obtained to about the nearest 3 percent.

(1042) VENTURI METER HANDLING FLUIDS WITH SOLIDS IN SUSPENSION.

In certain operations it is desirable to meter the quantity rate of flow of a fluid containing particles in suspension, a typical example being sand suspended in water. In this investigation a venturi meter formed from two cast-iron reducers has been calibrated using various mixtures of sand and water. The venturi meters, two in number, were placed, one in a horizontal position and one in a vertical position. The calibration coefficient for the

venturi meter was plotted against Reynolds number, the head being expressed in terms of feet of mixture being pumped. The result indicated that as the Reynolds number increased the coefficient more nearly approached that corresponding to water alone. The characteristics at low Reynolds number were different for the horizontal and the vertical venturi meters, demonstrating the dependence of the coefficient on the type of velocity distribution and sediment transport through the meters. The results were practically independent of the sand-particle size and distribution.

(1043) EQUILIBRIUM SAND SLOPES IN FRONT OF SEA WALLS.

Sea walls have been built in many localities with varying results. Sometimes the construction of the wall seems to cause accretion of sand in front of the wall, while at other times it has been held that construction of the wall caused erosion so that the whole beach disappeared. The purpose of this study was to determine whether simple frontal wave attack on a vertical bulkhead or sea wall causes erosion at the toe of the wall. The small number of runs made prevent one from drawing general conclusions, but all indicate that the primary force of wave action alone does not cause scour in front of vertical sea walls. Wave action, however, does place the material in suspension where it may easily be transported by currents which could otherwise cause no damage.

(1044) MODEL STUDY OF WAVE REFRACTION.

The first step in the study was to predict positions of wave crests and height of waves on a model of a sloping beach by the use of the theory as established and clearly presented by Gaillard. The experimental portion of the study consisted of measuring the heights and lengths of waves created in the basin as they moved upon the model and also of photographing the waves vertically from several points at a height about 23 feet above the water surface. The runs were in general agreement with the theory although the basin used was considered too small for good results on models other than a simple sloping beach. This is due to the fact that reflections introduced complicated wave patterns which greatly reduced the value of the results.

(1046) AN INVESTIGATION OF THE HEAD LOSS THROUGH TRAPEZOIDAL-BAR FISH SCREENS.

The following general conclusions were obtained:

1. The head loss varies directly as the sine of the angle of inclination of the screen to the horizontal.

2. Trapezoidal bars are hydraulically equal to, or slightly better than, rectangular flats.

3. The head loss is independent of the depth of water flowing through the screen and is small in comparison with other contributing factors in ordinary channel flow.

STATE UNIVERSITY OF IOWA.

(390) MISSISSIPPI RIVER, LOCK AND DAM NO. 11, DUBUQUE, IOWA.

Part One of this report describes model tests made to indicate the best combination of gates and overflow spillway sections to be included in Dam No. 11, and the most suitable modifications of the piers and approach of the highway bridge immediately downstream. Part Two describes tests made on a hydraulic model of the structure to indicate the most desirable distribution of flows through the gates of the dam as constructed, with the objectives of reducing scour in the river bed which endanger the stability of the structures and of avoiding the deposition of material in the navigation channel.

(397) MISSISSIPPI RIVER, EFFECT OF POOL NO. 5 ON HYDRAULIC CONDITIONS NEAR MINNEISKA, MINN.

The construction of the various locks and dams on the Mississippi River above St. Louis, Missouri, has produced a series of slack-water pools, each of which stands at a higher level than the average elevation of the natural river in the respective reaches. This report presents the results of a model study made to determine the effect of the backwater pool of Lock and Dam No. 5 near Minneiska, Minnesota, on bridges near the mouth of the Whitewater River, and especially its effect on the hydraulic capacity of bridge L-90 of the Chicago, Milwaukee, St. Paul, and Pacific Railroad over the Whitewater River, a small tributary which enters the Mississippi about 4.5 miles upstream from Lock and Dam No. 5. The effect of the backwater pool in particular on the flow profiles and the silting action of Whitewater River floods were studied. The results indicated that the backwater pool of Lock and Dam No. 5 will not affect the normal stages below bridge L-90, nor the silting action of Whitewater River floods.

(448) WEEP HOLES.

(Basic Report) This is a report on experimental studies of four sizes of vertical, cylindrical weep holes filled with two gradations of river gravel. The weep holes were 6 and 10 in. in diameter and 18 and 48 in. long. Fillers were 1/4 in. to 1 in. and 1 in. to 2 in. in size. It was concluded that the maximum safe hydraulic gradient could be computed by the theoretical equation

$$i_m = (1 - P)(s - 1)$$

where i_m = the maximum gradient,

P = ratio of voids to total volume of filler,

and s = specific gravity of the filler,

although individual test results varied considerably from the theoretical in certain cases.
(Appendix A) The appendix presents the results of experiments made on vertical weep holes 4 ft. long forming frustums of cones 6 in. in diameter at the small end and 10, 14, and 18 in. in diameter at the large end. All were tested with flow from the large toward the small end and the 6 x 10-in. cone was tested also with flow passing from the small toward the large end. River gravel in two size gradations and crushed limestone in one size gradation were used as fillers for the weep holes. The large aggregates were better, hydraulically, than the small aggregate. The best weep hole shape was the one diverging in the direction of flow, that is, a frustum of a cone with the large end up.

(849) AN INVESTIGATION OF FISHWAYS

Experimental Investigation

In the introduction the authors give a general outline of the fishway problem on the basis of our present notion of the motivation of fish migration on one hand and with the history of fishway types and fishway research on the other. With this background, the plan of the present research is outlined and the specific local conditions of the site discussed.

The experimental research started with small-scale indoor experiments. A great variety of models were studied as to their hydraulic properties; mainly energy dissipation and stability of the current. In all about 35 models were tested, some of them well known in this country, others copies or modifications of recent European designs: some quite new designs were based upon European investigations, and also new possibilities were tried out.

Some of the more successful designs were reproduced in full scale and installed in an outdoor laboratory setup which made use of the Iowa River fish actually migrating. Two different designs were always used simultaneously for the purpose of comparison. The use of the fishways by the migrants was checked by fish counts. The actual behavior of the fish when negotiating the fishways was directly observed both in the full-scale and small-scale investigations.

The investigation led to a comparative description of the migratory habits and abilities of Iowa fish, to recommendations concerning fishway types and the choice of the slope as a function of the size of the fishway; also to suggestions as to restriction of fishway use to part of the year.

A general program for a second series of experimental investigations is added to the report.

Annotated Bibliography covering also related aspects of fish migration, fish protection, and water-utilization.

About 170 papers are listed, arranged in five sections. For about one-third of these papers abstracts are given. Cross-references and comparative remarks connect the papers listed and abstracted. A few carefully selected illustrations are reproduced.

The work is based in part upon lists and abstracts prepared earlier by Mr. Edward Soucek.

(1024) TRANSITIONS IN RECTANGULAR OPEN CHANNELS WITH SUPER-CRITICAL VELOCITIES.

Experiments involved the measurement of water-surface contours for a considerable range of each of the following variables: depth, width, and velocity of approach; form and relative curvature of diverging side walls; ultimate width of expanded section; slope of channel floor. All data were plotted dimensionlessly, yielding functional relationships between the Froude number and a series of geometrical ratios descriptive of the flow pattern. An effort was then made to correlate these relationships with existing theory of wave phenomena in high-velocity flow. Close correlation was found under certain limiting conditions, but a deviation from the elementary theory was obtained in those cases in which too rapid curvature of the diverging boundaries lead to internal pressures considerably below the hydrostatic. Quantitative analysis of such phenomena apparently requires a refinement of the elementary theory to include the effect of pressure variation in the zones of greatest acceleration.

(1030) SEDIMENT BEHAVIOR IN UPWARD FLOW.

Tests were made in a glass cylinder 12 inches in diameter and 18 inches high, and in a Lucite cylinder 1-3/4 inches in diameter and 54 inches high. Sands investigated ranged from 0.07 to 0.8 mm nominal diameter, having fall velocities in water ranging from 0.02 to 0.35 feet per second; both uniform and graded sands were used. Nominal water velocities varied between the limits of 0.001 and 0.2 feet per second. Total-head traverses were made by means of a movable piezometer tube in the large cylinder and by means of 21 piezometers in the wall of the small cylinder. Sediment concentrations and velocities of fall were determined from samples taken at various elevations.

Preliminary analyses indicated that, once the bed material had begun to expand, the vertical rate of change of total head dH/dz at any point should be a direct measure of the sediment concentration c at that point, the difference in head between any two levels depending only upon the effective weight of material between them. Under such circumstances it was reasoned that the sediment concentration of the individual sizes of a graded material should vary directly with the quantity $(1 - V/w)^{3/2}$, V being the nominal water velocity and w the velocity of fall of the particular sediment grains. For this reason it was believed that means were at

hand for both the quantitative analysis of sediment distribution and the preparation of sand separates of any desired grade.

Experiments proved that the first conclusion was fully justified, the gradient of the total head at any level within the zone of suspension being an accurate measure of the bulk concentration at that level. Moreover, in accord with the preliminary analysis, a graded material was found to stratify once suspension began, the finest sizes being carried to the top and the coarsest remaining near the bottom, the gradient of head - and hence the concentration - varying continuously throughout the vertical column. It was soon noted, however, that large-scale eddies peculiar to such sediment suspensions produced sufficient dispersion of size throughout the stratified zone to permit only a qualitative analysis of size distribution in accordance with the expected function, $dH/dz = c = K(1 - V/w)^{5/2}$. The usefulness of this method must therefore depend upon the success of future studies of the induced turbulence.

(1038) DIVERSION CHANNEL STILLING BASIN, DRY RUN FLOOD CONTROL PROJECT, DECORAH, IOWA.

The Dry Run diversion channel is a proposed project for flood protection at Decorah, Winneshiek County, Iowa. Tests on a model of the diversion channel were made to observe the performance of the channel as designed, and to develop a stilling basin for the outlet. A stilling basin 75 ft. long, 130 ft. wide, with a solid end sill, 9 ft. high, was found to be satisfactory.

This report is the preliminary presentation of the test data and the conclusions drawn from them. It contains the information essential to an understanding of the prototype problem, describes the model arrangement, gives the procedure of the tests, and conclusions with recommendations on hydraulic features of the design.

BEACH EROSION BOARD.

(1155) A MODEL STUDY OF THE EFFECT OF SUBMERGED BREAKWATERS ON WAVE ACTION.

The following general conclusions are indicated:

1. An underwater structure parallel to a shoreline will decrease wave height and wave action on the shore.

2. A vertical wall is the most effective shape for an underwater structure in protecting a beach.

3. The extent to which wave action will be reduced can be controlled by the height of the structure.

4. If protection from storm wave action is desired, the height of the breakwater above the bottom should be not less than 83% of the depth of the water.

The study indicates that submerged breakwaters offer a promising type of protection for harbors.

Copies of this paper, Technical Memorandum No. 1, may be obtained from the Beach Erosion Board.

NATIONAL BUREAU OF STANDARDS.

(797) METHOD OF ESTIMATING LOADS IN PLUMBING SYSTEMS.

This paper describes a method of estimating the demand and sewage loads for which provision should be made in designing plumbing systems in order that the service may be satisfactory. The characteristics of flow through a plumbing system and of the operation of supply valves and plumbing fixtures are described, and their influence on the method of estimating the load to be expected is discussed. The relative load-producing values of different kinds of commonly used plumbing fixtures are analyzed, and a table is developed giving relative load weights in terms of a load factor called the "fixture unit". An estimate curve developed by means of the probability function is given, and its use in conjunction with the table of fixture units is illustrated.

UNIVERSITY OF LATVIA, RIGA, LATVIA.

A Generalized Hydraulics (Psammo-Hydraulics) as an Instrument for the Solution of the Problem of Sediment Transportation and other Problems of the Hydraulics of Mixtures.

Professor Dr. A. Vitols.
Wasserkraft und Wasserwirtschaft, Heft 11/12,
München, 1939.

One of the most difficult problems of hydrology is that of sediment transportation. In spite of all the efforts that have been made for more than half a century (we can take the year 1886, when Du-Boys published his formula, as the mile-stone that marks the beginning of this work), we still have no solution of this problem.

The author has set himself the problem of filling this gap in the field of potamology. The fundamental thought of the author is to fit the solution of this problem into the framework of our ideas and concepts of hydraulics in the hope that this new generalized hydraulics, to which he assigns the name "Psammo-hydraulics", (from the Greek word, "Psammos", meaning sand), will have the same utility as our present-day hydraulics, the latter being only a special case of the former, as the author proves rigorously.

The means of creating this new hydraulics are well known: the knowledge of mechanics, mathematics, and mathematical physics. Many of the principal phenomena of sediment transportation, among these, the formation of riffles, are easily explained in the light of the formula derived. Furthermore, the old Du Boys' formula, which did not rest upon a very firm physical foundation and which has misled investigation of this phenomenon in the past, is clarified.

It is worthy of mention that another branch of hydraulics can be derived from Psammo-hydraulics as a special case; namely, that which pertains to motion of solid bodies (rafts and ships in canals). The name, "Stereo-hydraulics", may be recommended for this.

Also the problem of suspension of sediment is treated by introducing a special suspension coefficient. The transition from suspension to deposition, or vice versa, is specified by the numerical values of several coefficients which can be determined by direct observation.

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(Available for loan.)

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RESEARCH COMMITTEES

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The work of this Committee covers a large number of phases of ground-water hydrology. These include: geologic conditions involving the occurrence of ground water; methods of determining physical characteristics of water-bearing materials, such as porosity, permeability, and transmissibility; the movement of ground waters; problems of ground-water hydrology of dam and reservoir sites, and drainage projects; ground-water problems relating to metalliferous and petroleum deposits; the hydrology of limestone terranes; the hydrology of hot springs and volcanic areas. The activities of the Committee in past years have consisted largely of an annual review of current work on the many phases of the subject, and in the solicitation of papers on selected subjects. In order that the annual review of current work may be as complete as possible the chairman of the Committee will be glad to receive from anyone statements of work in progress or recently completed on any phase of ground-water hydrology.

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Subcommittee on Lake Mead.

Chairman: C. P. Vetter, U. S. Bureau of Reclamation, Customhouse, Denver, Colorado.

Members. M. M. Ellis
C. S. Howard
T. C. Mead.

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The Chairman of the Committee presented a brief progress report to the Division of Geology and Geography of the National Research Council on April 27, 1940. Copies can be obtained from the Chairman.

The Subcommittee on Lake Mead is preparing a comprehensive report on the field observations at Lake Mead during the past few years. These observations show conclusively that bottom currents of water carrying fine sediment in suspension flow through the lake as far as the dam, where the water forms a muddy pool from which the sediment settles slowly. It is anticipated that the report will be issued during the present calendar year.

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HYDRAULIC LABORATORY BULLETIN, SERIES B.

"HYDRAULIC LABORATORIES IN THE UNITED STATES."

The second volume of this bulletin appeared in 1935. It now seems advisable to issue another edition, in order to bring our information as to existing hydraulic laboratory facilities up to date. Numerous inquiries come to the National Hydraulic Laboratory as to where certain types of research can be conducted, or where certain testing facilities exist, and consequently it is a great advantage to have exact information of this nature available.

A mimeographed notice regarding the forthcoming bulletin and specifying the form in which the descriptions are desired will be mailed within the next month to all hydraulic laboratories in the United States of which we have any record. Please do not forward descriptions to us until you have received the notice.

BONNEVILLE HYDRAULIC LABORATORY

The report on current projects at this laboratory was received too late to be included in its entirety in this bulletin. The following are the titles of the projects submitted.

(917) Model study of the spillway of Mud Mountain Dam.
(1106) Model study of the navigation channel conditions on the Columbia River at Bonneville, Oregon.
(1107) Model study of the regulated tunnel of Mud Mountain Dam.
(1108) Model study of Willamette Falls Locks.
(1109) Pressure head investigation on Bonneville Spillway Dam.
( ) Dorena spillway and tunnel model.
See Bulletin VIII, 1940, for descriptions of the first five projects listed.

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INDEX TO PROJECTS

Hydrology.

Machinery - hydraulic.

Page

Meters, orifices, nozzles, current meters, etc.

Miscellaneous.

Open channels.

Percolation, permeability, infiltration.

Page

Pipe and fittings.

Plumbing.

Page

Sediment - transportation, erosion, settling, analysis sampling.