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HYDRAULIC LABORATORY BULLETIN
SERIES A

CURRENT HYDRAULIC LABORATORY RESEARCH IN THE UNITED STATES

BULLETIN VII
January 1939

WASHINGTON

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CURRENT HYDRAULIC LABORATORY RESEARCH IN THE UNITED STATES

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INTRODUCTION

The following issues of National Bureau of Standards Hydraulic Laboratory Bulletins, Series A and Series B, are still available:

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

Bulletin IV-1, January 1936.
" IV-2, July 1936.
" V-1, January 1937.
" VI , January 1938.

Series B. Hydraulic Laboratories in the United States.
First revision, 1935.

The growing extent of hydrological research and the close relation that much of it bears to the design of hydraulic structures brought about the decision to broaden the scope of this Bulletin to include such research. This decision was stated in the notice sent to hydraulic laboratories in November 1938, and consequently a large number of research projects in hydrology were reported for the present bulletin.

It has been suggested that considerable time is wasted through the translation of foreign papers that have already been translated or are in process of translation at other laboratories and that some definite steps should be taken to prevent this.

It seems advisable to emphasize again that the National Bureau of Standards does not have in its files reports or detailed information regarding the projects conducted by other laboratories. Any person seeking 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.

Attention is again called to the fact that this Bulletin is now being issued annually, instead of semiannually, as was the case up to 1938. It will be issued as early in the year as possible.

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.

POLYTECHNIC INSTITUTE OF BROOKLYN.

(798) (a) STUDY OF CRITICAL DEPTH WEIR.
(c) Senior thesis.
(d) Walter J. Meditz and Ralph W. Gunwaldson.
(e) Prof. Chilton A. Wright.
(f) To design a small rounded weir which will maintain critical depth on its top for a wide range of conditions.
(g) A parabolic small wooden dam 6 inches high has been constructed in the10-inch glass-walled flume. Flows up to one cfs will be set by means of a Venturi meter, and the water surface and pressure will be measured with the submergence ranging up to 100 per cent.
(h) Experiments started.

.....

UNIVERSITY OF CALIFORNIA.

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

.....

(634) (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 bedslope, roughness, shape, size.
(g) Tests on 6" 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.

.....

(720) (a) MODEL STUDY OF WAVE ACTION ON CABRILLO BEACH, CALIFORNIA.
(b) Cooperation with Los Angeles Playground and Recreation Department.
(c) Master's Thesis.
(d) C. M. McAfee, M. P. O'Brien.
(e) Professor M. P. O'Brien.
(f) To determine what, if any, is the proper alignment of Cabrillo Beach to prevent erosion.
(g) Five runs to be made to check results obtained in 1937-38, and to investigate the effectiveness of jetties placed at various positions along the beach.
(h) Model constructed, continuation of work started by H. C. Gee in 1937.

.....

(723) (a) RECOVERY EFFICIENCY OF VARIOUS TYPES OF SLOWLY MOVING FLUID INTERFACES.
(b) Standard Oil Co. of California Research Fellowship.
(c) Laboratory project.
(d) D. R. Rankin.
(e) Professor M. P. O'Brien.
(f) To determine the most efficient type of repressuring media for oil recovery.
(g) Measure recovery of oil from a cylinder of oil-saturated sand for water and gas drives.
(h) Equipment complete, and several runs have been made with oils, sands, and rates of recovery.

.....

(726) (a) PUMP TESTING LABORATORY.
(b) Laboratory investigations in cooperation with the College of Agriculture.
(d) H. E. Burrier, R. G. Folsom, L. Jue.
(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. A complete description of the laboratory has been published in MECHANICAL ENGINEERING for April 1938.

.....

(799) (a) EFFECT OF VISCOSITY UPON THE CHARACTERISTICS OF A CENTRIFUGAL PUMP.
(b) Laboratory project.
(c) Master's thesis.
(d) H. E. Burrier.
(e) Prof. M. P. O'Brien.
(f) To be able to predict the performance of a centrifugal pump pumping viscous fluids after obtaining the performance of the pump using water.
(g) Testing a 2" centrifugal pump using water and using two oils of different viscosity.
(h) Equipment assembled and calibration about complete. Experimental work ready to start.

.....

(800) (a) PRE-ROTATION IN PROPELLER PUMPS.
(b) University of California, Hydraulic Laboratory.
(c) Master's thesis.
(d) Lawrence Sinclair Jue.
(e) Prof. M. P. O'Brien.
(f) To study the magnitude and direction of the water stream fore and aft of the runner in a propeller pump.
(g) A transverse pitometer with remote control will be used.
(h) Pitometer being designed.

.....

(801) (a) FRICTION LOSSES IN ANGULAR CONTACT THRUST BEARINGS.
(b) Laboratory investigation.
(c) Master's thesis.
(d) I. Levy and W. Johnson.
(e) Prof. 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) Friction test equipment being assembled.

.....

(802) (a) THE DESIGN OF A PROPELLER TURBINE.
(b) Laboratory project.
(c) Master's thesis.
(d) F. Jonassen.
(e) Prof. M. P. O'Brien.
(f) To predict the characteristics of a propeller turbine having airfoil-section blade shapes.
(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 being assembled.

.....

(803) (a) MIXING OF STREAMS IN CLOSED CIRCULAR CONDUITS.
(b) In cooperation with Special Committee on Hydraulic Research, American Society of Civil Engineers.
(c) Undergraduate thesis.
(d) E. H. Taylor, J. Kempton and O. Hoefler.
(e) Prof. M. P. O'Brien.
(f) To determine energy losses which result from the convergence or divergence of closed circular conduits.
(g) Tests will include determinations for angles of convergence or divergence of 30°, 45°, 60°, 90°, 135° and 150°. Test set up consists of 2", 4" and 6" branch pipe joining a 6" diameter main line.
(h) Equipment is complete and testing is in progress.

.....

(804) (a) DISCHARGE CHARACTERISTICS OF RECTANGULAR SLUICE GATES.
(b) Laboratory project.
(c) Undergraduate thesis.
(d) E. H. Taylor, R. Hoolhorst.
(e) Prof. M. P. O'Brien.
(f) To determine optimum shape and type of inlet transition for undershot sluice gates.
(g) Tests will be made upon rectangular gates 6" and 1 ft in width and of varying height. Circular inlet transitions of varying radii of curvature will be tested to determine the arrangement for maximum discharge coefficient.
(h) Equipment is complete and testing is in progress.

.....

(805) (a) EQUILIBRIUM SLOPES OF SEA BEACHES.
(b) Laboratory project.
(c) Master's thesis.
(d) C. H. Waters.
(e) Prof. M. P. O'Brien.
(f) To investigate the influence of wave characteristics and of sand characteristics upon the stable slope of beaches, and to study the general phenomena of wave action upon beaches.
(g) A wave tank 50 ft in length, 3 ft in depth and 1 ft wide is employed. At one end, waves are generated by a motor-driven flap. These waves break on a beach constructed at the other end of the tank. Runs are made subjecting beach to wave attack for a time of sufficient duration to establish stable conditions. Data are taken relating slope of beach to settling velocity, median diameter and fineness modulus of sands and to height and length of waves.
(h) All necessary equipment has now been set up and tested. This includes apparatus for measuring waves and analyzing sand. Experimental data will be taken beginning about Jan. 9, 1939.

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(806) (a) OSCILLATING WAVES
(b) Laboratory project.
(c) Master's thesis.
(d) Charles F. Mitchim.
(e) Prof. M. P. O'Brien.
(f) To make an experimental check of oscillatory wave theory.
(g) Investigation to cover only deep water waves of lengths from 2 to 5 ft. Amplitude, crest velocity, and period to be measured directly. Wave length to be computed from crest velocity and period. Particle orbits to be traced by photography, introducing into the water colored particles of the same specific gravity as water.
(h) Research 60% complete. Development of equipment, 100% complete. Development of technique of observations including photography, 100% complete. Experimental data, 50% complete.

.....

(807) (a) TRANSPORTATION OF SAND IN PIPE LINES.
(b) Laboratory project.
(c) Master's thesis.
(d) R. G. Folsom, W. A. Falks.
(e) Prof. M. P. O'Brien.
(f) To determine the friction characteristics of pipe lines when carrying sand-water mixtures, and to be able to predict these characteristics from the known properties of the pipe and sand.
(g) Runs will be made with mixtures of various concentrations and rates of discharge. Sand characteristics and friction factors will be measured.
(h) Equipment complete.

.....

(808) (a) MODEL STUDY OF PROPOSED TIDAL CANAL BETWEEN SUISUN BAY AND SACRAMENTO CALIFORNIA.
(b) Laboratory project.
(c) Master's thesis.
(d) M. P. O'Brien, D. A. Elligat.
(e) Prof. M. P. O'Brien.
(f) To predict tidal effects in the proposed canalby a combination of experimental and theoretical studies.
(g) Model to be constructed of sheet metal to a scale of 1:500 horizontally and 1:100 vertically. Runs will be with various tidal amplitudes and heights, and velocities of the resultant waves will be measured.
(h) Model under construction.

.....

(809)(a) CHARACTERISTICS OF SAND PUMPS.
(b) Laboratory project.
(c) Master's thesis.
(d) R. G. Folsom, C. K. Bagby.
(e) Prof. M. P. O'Brien.
(f) To predict head-discharge characteristics of centrifugal pumps when pumping sand mixtures from the known characteristics when pumping water.
(g) A series of runs will be made using sand-water mixtures of various types of sand.
.....(h).Equipment.complete.and.experimental.work.started.....

CALIFORNIA INSTITUTE OF TECHNOLOGY, COOPERATIVE LABORATORY, SOIL CONSERVATION SERVICE.

(657) (a) INVESTIGATION OF RELIABILITY OF SAND AND GRAVEL SAMPLE SPLITTERS AND SUGGESTED IMPROVEMENTS IN DESIGN.
(b) Section of Sedimentation Studies, Soil Conservation Service, U. S. Department of Agriculture.
(c) Cooperative research program with Soil Conservation Service.
(d) George H. Otto and assistants.
(e) Prof. Robert T. Knapp, Vito A. Vanoni, Project Manager George H. Otto
(f) To determine the degree of reliability of the common laboratory sample splitter under normal condition of use; to investigate causes of bias, if any are found to exist; and to attempt to eliminate them by changes of design.
(g) Extensive series of duplicate sample splitting on samples of known composition, analysis of results by statistical methods.
(h) Project completed and results published in paper, "The Use of Statistical Methods in Effecting Improvements on a Jones type Sample Splitter", by George H. Otto, Journal of Sedimentary Petrology, Vol.7, No. 3, December, 1937.

.....

(658) (a) THE USE OF PROBABILITY GRAPHS IN THE INTERPRETATION OF MECHANICAL ANALYSES OF SEDIMENTS.
(b) Section of Watershed Studies, Soil Conservation Service, U. S. Department of Agriculture.
(c) Cooperative research program with Soil Conservation Service.
(d) George H. Otto.
(e) Prof. Robt. T. Knapp, Vito A. Vanoni, Geo. H. Otto.
(f) To set forth efficient graphical methods and systematical procedure for critical study of a series of related mechanical analyses of sediments.
(g) A modified logarithmic probability graph was developed and tested with actual field sediments.
(h) A paper entitled "The Use of a Modified Logarithmic Probability Graph for Interpretation of Mechanical Analyses of Sediments" is now awaiting publication.
(i) Abstract furnished. See completed Projects, Abstracts.

.....

(659) (a) MECHANICS OF SUSPENDED LOAD TRANSPORTATION.
(b) Section of Sedimentation Studies, Soil Conservation Service, U. S. Department of Agriculture.
(c) Cooperative research program with Soil Conservation Service.
(d) Prof. Robert T. Knapp, Vito A. Vanoni.
(e) Prof. Robert T. Knapp, Vito A. Vanoni.
(f) To investigate the internal mechanics of transportation of a suspended load; the effects of the material in suspension upon the velocity distribution of the flow; the concentration gradient of the suspended material, etc.
(g) Closed circuit flume has been designed and constructed, capable of circulating mixtures of sediment and water at any rate of flow up to 5 cubic feet per second. The slope of the open channel portion can be adjusted to any desired value up to 1:60.
(h) Experiments are now in progress but no reports of the work have been made.

.....

(660) (a) DEVELOPMENT OF A HOT WIRE VELOCITY METER FOR USE IN WATER.
(b) Section of Sedimentation Studies, Soil Conservation Service, U. S. Department of Agriculture.
(c) Cooperative research program with Soil Conservation Service.
(d) Vito A. Vanoni, E. L. Simmons.
(e) Professor Robert T. Knapp, 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 being continued on part time basis. No reports made to date.

.....

(661) (a) THE DEVELOPMENT OF A GRAB SAMPLER FOR SUSPENDED LOAD.
(b) Section of Watershed Studies, Soil Conservation Service, U. S. Department of Agriculture.
(c) Cooperative research program of Soil Conservation Service.
(d) Vito A. Vanoni, J. Pat O'Neill.
(e) Professor Robert T. Knapp, Vito A. Vanoni.
(f) The development of a sampler for suspended load for conditions in which the particles have fall velocities of appreciable magnitude.
(g) & (h) In flows carrying large particles in suspension the local concentration of sediment is affected by disturbances in the flow. To be unbiased, a sampler must therefore take an undisturbed sample. Various sampler designs have been studied under flow conditions in a glass wall flume using dye jets and other means to determine their effect on the flow. Preliminary designs of samplers have been made which appear to cause no measurable disturbance in the flow entering the sampler. Nine single-unit Eakin-type samplers have been built and are now being used in the field. Designs have been prepared for improved single unit samplers and multiple unit samplers which will take several samples simultaneously. Reports and design drawings are available for loan.

.....

(662) (a) THE DEVELOPMENT OF A METHOD FOR MEASURING RATE OF FLOW IN STEEP CHANNELS CARRYING SUSPENDED LOAD.
(b) Section of Watershed and Hydrologic Studies, Soil Conservation Service, U. S. Department of Agriculture.
(c) Cooperative research program with Soil Conservation Service.
(d) Hunter Rouse.
(e) Vito A. Vanoni, Project Manager, Robert T. Knapp, Hunter Rouse.
(f) Measurement of flow in the rapid state, without appreciable deceleration and accompanying deposition of sediment.
(g) After preliminary experiments described in previous bulletins, a special tilting flume was built for more extensive tests; new equipment consists of closed-circuit pumping system with 5 second-foot capacity, pressure tank, two-dimensional nozzle depth control, and 20 feet of brass flume 18 inches wide and 14 inches deep; velocities as high as 30 feet per second may be produced on any slope up to 5%. Meter under investigation consists of vertical pier making small abrupt angle at one channel wall;

superelevation of water surface along pier is studied as a function of the Froude number of the approaching flow.

(h) An extensive series of clear-water runs has been completed, including slopes of 0, 1½, and 3%, Froude numbers, $(V/\sqrt{gd})$ from 3 to 7, and three different pier angles. Depths were determined piezometrically as well as by surface readings. Results indicate that a pier angle having a tangent of 0.2 is most satisfactory, and that the depth change may be measured in piezometer wells with slot inlets, one located just upstream from and the other near the downstream end of the pier. With a pier of sufficient length to produce parallel flow at the higher elevation, the resulting depth ratio may be found from the equation

$$V_1/\sqrt{gd_1} = 3.1 \; d_2/d_1 - 2.3 ,$$

regardless of slope.

.....

(663) (a) MECHANICS OF SEDIMENT SUSPENSION.

(h) Research completed. Paper presented before Fifth International Congress for Applied Mechanics, Cambridge, September 1938, and will be published in Congress Proceedings in 1939. Abstract furnished. See Completed Projects, Abstracts.

.....

(810) (a) THE STUDY OF SEDIMENT-LADEN FLOWS IN RESERVOIRS.

(b) Section of Sedimentation Studies, Soil Conservation Service, U. S. Department of Agriculture.

(c) Cooperative research program with Soil Conservation Service.

(d) Professor Robert T. Knapp, Hugh Stevens Bell.

(e) Professor Robert T. Knapp, Vito A. Vanoni, Project Manager, Hugh Stevens Bell.

(f) To investigate sediment-laden flows in reservoirs and attempt to establish principles governing their behavior.

(g) Experiments conducted in glass-walled tank 3-inches wide by 10-inches deep by 5-ft. long, using a suspension of clay in water to represent the sediment laden flow. Observations made largely with still and motion pictures.

(h) A systematic set of experiments have been made to study the effect of slope, relative density of the fluids and the viscosities of the fluids on the behavior of the flows and upon their tendency to mix. Experiments to determine the effect of barriers, structures and other channel characteristics upon the flows have also been made. The study is being continued.

.....

(811) (a) DEVELOPMENT OF A CENTRIFUGAL TYPE SEDIMENT SEPARATOR.
(b) Section of Sedimentation Studies, Soil Conservation Service, U. S. Department of Agriculture.
(c) Cooperative Research Program with Soil Conservation Service.
(d) N. A. Christensen.
(e) Professor Robert T. Knapp, Vito A. Vanoni, Project Manager.
(f) To develop a device suitable for separating the sediment from samples of water pumped from a natural stream. In the field installation discharges up to 20 cu. ft. per second are to be handled.
(g) The device is based on the principle employed in the "Cyclone" used to remove dust, wood shavings or other sediments from air. The general features of design and performance were determined from experiments on a 7-inch diameter model. The final design was determined by tests on 20-inch and 26-inch diameter models.
(h) Work completed; results not published.

.....

(812) (a) HYDRAULIC DESIGN OF EROSION CONTROL STRUCTURES BY MEANS OF MODEL TESTS.
(b) Section of Watershed and Hydrologic Studies, Soil Conservation Service, U. S. Department of Agriculture.
(c) Cooperative research program with Soil Conservation Service.
(d) N. A. Christensen, Vito A. Vanoni.
(e) Professor Robert T. Knapp, Vito A. Vanoni Project Manager.
(f) To improve existing designs and develop new designs for erosion control structures used in field operations.
(g) Proposed designs of specific structures made by field engineers are tested and modified through hydraulic tests in the laboratory. Typical structures to take care of a range of field conditions are also tested with a view to perfecting design standards. Close cooperation is maintained between the field and laboratory on this work.
(h) Dams of the contracted overfall type and of the chute drop type have been tested and recommended designs submitted. An extensive series of tests to develop standard designs for dams of the contracted overfall type has been started. The work is being continued.

.....

(813) (a) THE STUDY OF FIELD SAMPLING METHODS IN THE LIGHT OF SEDIMENTATION PROCESSES.
(b) Section of Sedimentation Studies, Soil Conservation Service, U. S. Department of Agriculture.
(c) Cooperative research program with Soil Conservation Service.
(d) George H. Otto and assistants.
(e) Professor Robert T. Knapp, Vito A. Vanoni, Project Manager, George H. Otto.
(f) To develop principles upon which to base field environmental sampling.
(g) Ideas developed from analysis checked by field and laboratory tests.
(h) Project completed and results published in paper entitled, "The Sedimentation Unit and its Use in Field Sampling" by George H. Otto, Journal of Geology, Vol. XLVI, No. 4, May-June, 1938.

.....

(814) (a) WIND-TUNNEL CLASSIFIER FOR SAND AND SILT.
(b) Section of Sedimentation Studies, Soil Conservation Service, U. S. Department of Agriculture.
(c) Cooperative research program with Soil Conservation Service.
(d) Hunter Rouse and George H. Otto.
(e) Professor Robert T. Knapp, Vito A. Vanoni, Project Manager, Hunter Rouse.
(f) Development of apparatus for the hydraulic separation of sediment to be used in routine experiments.
(g) Wind tunnel is 15 feet in length, and has flow section 2'-6" high and 2'-3" wide, bell entrance, and 1/10 HP duct fan at downstream end with diaphragm throttle. Entire bottom consists of grid, below which are located 20 pans of various widths. External hopper permits continuous feed (60 to 100 lbs. per hour) in uniform sheet extending across flow section.
(h) To date approximately 3 tons of white Nevada foundry sand (99% silica) have been separated into 30 sizes varying from 0.6 to 0.02 millimeters nominal diameter. Control tests run on all separates indicate very satisfactory sorting well past the sieve range. A paper on apparatus and technique has been prepared for publication.

.....

(815) (a) FIELD SAMPLING EXPERIMENTS ON BEACH SAND FROM MUSTANG ISLAND, TEXAS.
(b) Section of Sedimentation Studies, Soil Conservation Service, U. S. Department of Agriculture.
(c) Cooperative research program with Soil Conservation Service.
(d) George H. Otto.
(e) Professor Robert T. Knapp, Vito A. Vanoni, Project Manager, George H. Otto.
(f) To ascertain the relative significance which may be attached to the parameters and mathematical form of a single mechanical analysis of a natural sediment as illustrated by a beach sand. The outer beach at Mustang Island, Texas was chosen because of its uniformity and relative freedom from local disturbing effects.
(g) Four samples were collected at each of 22 stations along the beach of Mustang Island. The four samples were collected alongside each other but by somewhat different methods. All come from the same sedimentation unit. At one locality two sets, each consisting of 24 closely spaced samples, were collected using two of the four methods. All 136 samples were collected from the same part of the beach and from layers which appeared strictly comparable. Quantitative comparisons of average size, sorting and skewness are made by means of parameters based on logarithmic moments of the sieve analyses following the method of Krumbein. The mathematical type of each analysis is determined by a modified logarithmic probability graph. The influence of the shell content on the mechanical analysis will be investigated for many of the samples. The quantitative results are then interpreted in terms of the field conditions and the environment of deposition.
(h) The analytical work is 80% complete and the calculations are over 50% complete. The results have been most encouraging.

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CALIFORNIA INSTITUTE OF TECHNOLOGY. HYDRAULIC MACHINERY LABORATORY.

(816) (a) COMPLETE PRESSURE-DISCHARGE CHARACTERISTICS FOR CENTRIFUGAL PUMP WITH PLUG TYPE VALVE INSTALLED AT DISCHARGE FLANGE.
(b) Metropolitan Water District of Southern California.
(c) Cooperative Research Program.
(d) Hydraulic Machinery Laboratory Staff.
(e) Professors R. T. Knapp, R. L. Daugherty, and Th. von Kármán.
(f) To determine for the combined setup the pressure-discharge characteristics necessary for the calculation of water hammer and other transient phenomena.
(g) Information obtained in form of steady state Complete Characteristic Diagrams of pump and valve combination for several valve settings. For description of such diagrams see 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".
(h) Investigations complete and report submitted. Not available for distribution.

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(817) (a) VARIATION OF RESISTANCE TO FLOW WITH THE AMOUNT OF OPENING OF CONICAL-PORT, CONICAL-PLUG VALVE.
(b) Metropolitan Water District of Southern California.
(c) Cooperative Research Program.
(d) James W. Daily, John Konecnik.
(e) Professors R. T. Knapp, R. L. Daugherty, and Th. von Kármán.
(f) Flow resistance study for use in analyzing transient behavior of pump together with pipe line and control valves.
(g) Tested under carefully standardized conditions. Upstream and downstream flow conditions investigated at regularly spaced piezometer stations. Range covered includes Reynolds numbers up to 2 million based on mean diameter of valve.
(h) Investigation completed and report submitted. Not available for distribution.

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(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 and Mr. D. P. Barnes.
(f) (See (a)).
(g) Tests covering a wide specific speed range are made on large scale model pumps. Cavitation performance and head-capacity characteristics determined from precise dynamometer tests are 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 partially completed. Information not available for distribution.

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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, R. L. Daugherty, and Mr. D. P. Barnes.
(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 furnish data necessary for comparison of such items as cavitation performance, head-capacity-power characteristics, and unbalanced radial forces.

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(820) (a) STUDY OF ENERGY LOSSES IN DIFFUSORS 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 diffusors is necessary for the proper evaluation of pump and line loss characteristics.
(g) Precision tests of pumps with diffusors of various angles of divergence provide data used in this analysis. Accurate comparisons are possible from measured overall losses and measured pressure distributions along the diffusors.

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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.

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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, and Mr. D. P. Barnes.
(f) To determine effect of dissolved air on cavitation performance.
(g) Investigation of the validity of bubble point as cavitation parameter. An apparatus is being constructed for the purpose of accurately determining the bubble point pressure as a function of temperature. Bubble point measurements will be correlated with the cavitation limits determined from precise dynamometer tests.

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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) James W. Daily, C. A. Gongwer.
(e) Professors R. T. Knapp, R. L. Daugherty and Th. von Kármán, and Mr. D. P. Barnes.
(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 has been constructed to permit the cylindrical tube to be inserted in high-velocity streams at known angles of yaw. Characteristics will be determined in the form of measured pressure distributions around the cylinder.

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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 Karman, R. T. Knapp, and R. L. Daugherty, and Mr. D. P. Barnes.
(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 has been constructed for controlling the velocity distribution at the inlet flange. With this device a wide range of symmetrical velocity distribution can be obtained. Cylindrical direction-finding pitot tubes are used for traversing the plane. Both the magnitude and the direction of the velocities are determined. These velocity and pressure distributions are then correlated with the cavitation limits determined from precise dynamometer tests.

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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) James W. Daily, Brooks T. Morris.
(e) Professors Th. von Kármán, R. T. Knapp, and R. L. Daugherty, and Mr. D. P. Barnes.
(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 under construction. Power is available for developing Reynold's numbers up to approximately one million based on 2-ft throat diameter. Pitot traverses at different cross sections of the inlet will furnish information required for the analysis.

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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, and Mr. D. P. Barnes.
(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.

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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, and 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.

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(828) (a) A STUDY OF THE RELATION BETWEEN INCIPIENT AND FULLY DEVELOPED CAVITATION PERFORMANCE OF HYDRAULIC MACHINES BY MEANS OF DIMENSIONLESS PARAMETERS.
(b) U. S. Bureau of Reclamation.
(c) Cooperative Research Program with U. S. Bureau of Reclamation.
(d) C. A. Gongwer.
(e) Professors Th. von Kármán, R. T. Knapp, and R. L. Daugherty.
(f) and (g) Mechanical deterioration caused by cavitation at the surfaces of the rotating elements of hydraulic machines often occurs under conditions of normal operation. The existence of such incipient cavitation may be measured by its effect on head (in case of pumps) and power (in case of turbines). A correlation of the results by means of dimensionless parameters furnishes a basis for readily comparing impeller performance.

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(829) (a) COMPILATION OF COMPLETE CHARACTERISTIC PERFORMANCE OF CENTRIFUGAL PUMPS OF VARIOUS TYPES OF 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". It is expected that complete report and analysis will be prepared for publication.

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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 Investigation.
(d) James W. Daily, Brooks T. Morris.
(e) Professors Th. von Kármán, R. T. Knapp and R. L. Daugherty.
(f) Refinements in testing equipment and technique require 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 description of methods is being prepared for distribution.

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CALIFORNIA INSTITUTE OF TECHNOLOGY, HYDRAULIC STRUCTURES LABORATORY.

(656) (a) INVESTIGATION OF HIGH VELOCITY FLOW AROUND BENDS IN OPEN CHANNELS.
(b) Los Angeles County Flood Control District.
(c) Cooperative study with Los Angeles County Flood Control District.
(d) Prof. Robert T. Knapp and Dr. Arthur T. Ippen.
(e) Prof. Robert T. Knapp.
(f) On the basis of the results of Project 357 to investigate designs and methods of changing the direction of flow in open channels without excessive superelevation in the curve or in the downstream tangent under condition of shooting flow.
(g) Extensive series of designs were tested and alternate methods of construction were developed to reduce the disturbance in and below the curves.

(h) Project completed and results submitted to the Los Angeles County Flood Control District. An abstract of the results and suggestions was presented as a paper at the Fifth International Congress for Applied Mechanics, which met in Cambridge, Massachusetts, September, 1938, and will appear in the Proceedings of the Congress.
(i) Abstract furnished. See Completed Projects, Abstracts.

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(831) (a) AN EXPERIMENTAL STUDY OF THE VELOCITY FLUCTUATIONS IN TURBULENT FLOW IN OPEN CHANNELS.
(b) Laboratory project.
(c) Research for thesis for Ph. D. degree.
(d) E. R. Van Driest.
(e) Prof. Robert T. Knapp, E. R. Van Driest.
(f) To correlate direct measurements of velocity fluctuations, path lengths, etc., with the corresponding quantities arising from the modern theories of turbulent flow.
(g) The first attack is being made by use of optical methods of measuring the diffusion of globules in the flow in a rectangular channel, as outlined in the paper of Malinshe and Van Driest presented at the Fifth International Congress for Applied Mechanics.

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(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 557 and 656 to study additional methods of control for high velocity channels.
(g) The equipment used in Project 656 and a short variable slope flume of the same cross section are being used for the experimental work. The lines of investigation are being drawn on the basis of the analysis of the mechanism of flow developed in the previous projects.

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CARNEGIE INSTITUTE OF TECHNOLOGY.

(490) (a) INVESTIGATION OF TRAVELLING WAVES IN STEEP CHANNELS.
(b) Pure Research. This is an authorized project of the American Society of Civil Engineers' Special Committee on Hydraulic Research. During the past three years the project was carried on in cooperation with the thesis work of R. F. Schnake, F. A. Morrison, and J. W. Daugherty, graduate students. It is being continued this year by H. A. Thomas with the assistance of J. W. Laugherty.

(c) Laboratory investigation and theoretical analysis, together with field investigation of travelling waves in steep channels of actual engineering structures.
(d) H. A. Thomas and J. W. Daugherty.
(e) Professor H. A. Thomas.
(f) To investigate the fundamental hydraulic principles governing the formation and propagation of travelling waves and surges in channel of steep slope, and to correlate analytical findings with experimental results. To obtain data which will enable the designer of a steep channel to predict the probable maximum height and velocity of travelling waves which may form in the channel under given conditions.
(g),(h),(i) During the first two years an experimental timber channel of rectangular cross-section, 56 feet long and adjustable in slope was constructed, together with apparatus for introducing trains of travelling waves on bores of various heights and periods into the upper end of this channel. Glass observation windo s were installed in the sides of the channel. Velocities and profiles of travelling waves were studied by photographic methods and by electrical timing devices. A glass-sided rectangular channel of adjustable slope and with moving-belt bed was also constructed to hold the waves stationary for observation and photographing, and was used in numerous experiments to study the profiles and properties of standing waves. During the third year a steel channel of trapezoidal cross-section, 96 feet long and of adjustable slope, was constructed together with a motor-operated gate for introducing waves and bores into the upper end. Numerous experiments were conducted in this channel to determine the height and velocity of travelling waves, and to study the tendency of these waves to increase or diminish in size during their progress downstream.

During the present year the work on this project is being directed toward a study of travelling waves in channels containing a bed of loose material such as sand, gravel or boulders. Under certain conditions the height of a wave may be greatly increased by the presence of such materials. A rectangular timber channel 42 feet long is being used in this study.

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(669) (a) CONSTRUCTION OF A MODEL OF THE ALLEGHENY, MONONGAHELA, AND UPPER OHIO RIVER SYSTEM FOR USE AS AN INTEGRATING MACHINE FOR SOLVING PROBLEMS OF FLOOD WAVE MOVEMENTS IN THIS RIVER SYSTEM.
(b) U. S. War Department.
(c) Laboratory investigation using a distorted scale model.
(d) H. A. Thomas, E. P. Schuleen, W. J. Hopkins and W. S. Hamilton.
(e) Professor H. A. Thomas.
(f) To obtain solutions of flood wave problems by using a special type of model channel as an integrating machine and to apply this method to a study of the effect on flood crests of the proposed reservoirs in the Allegheny-Monongahela River Basin.
(g) A model representing hundreds of miles of main river and tributary channels was constructed to a greatly exaggerated vertical scale so that it occupied a space about 85 feet long and 6 feet wide. The vertical scale was 1:80 and the horizontal scale 1:18000. The model channels were designed to satisfy the general differential equation for unsteady flow in non-uniform channels, velocity and acceleration head and friction losses being given due consideration.

The profiles and cross-sections of the channels were reproduced to scale and the correct stage-discharge relations were maintained by adjustable metal baffles set by trial to give the correct hydraulic friction effect. The model was condensed laterally by making no attempt to reproduce the curvature of the prototype channels or the plan of the river system. Unsteady discharge corresponding to natural or controlled hydrographs was introduced into the model by 21 cam-controlled needle valves located at strategic points. Hydrographs of the flood waves passing down the main channels were read on inclined gages.

(h) Tests on the model have been completed and the final report submitted to the Pittsburgh District Office.

(i) The report deals with the following items pertaining to this type of model:

1. The limitations imposed by basic data.
2. The mathematical requirements.
3. The hydraulic and mechanical requirements of satisfactory design.
4. The use of such a model for flood forecasting. The tests conducted established the mechanical accuracy of the model and indicated the effect of proposed reservoirs on the March 1936 flood.

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(728) (a) INVESTIGATION OF EROSION BELOW DAMS.
(b) Carnegie Institute of Technology.
(c) Library and laboratory investigation. Not a thesis.
(d) H. A. Thomas and B. N. Netzer.
(e) Professor H. A. Thomas.
(f) To obtain systematic and comprehensive information on the effectiveness of various types of spillway aprons or buckets in controlling erosion below dams.
(g) The investigation includes the coordination and classification of a large amount of data secured during model tests on various spillway aprons in this and other laboratories and the making of additional tests in a glass-sided flume to verify or amplify the existing information. Velocities in the turbulent-flow region below the spillway are measured by a specially designed device which records instantaneous velocity peaks. Final results are to be presented in the form of curves which will enable designing engineers to predetermine the exact hydraulic behavior of a large variety of spillway aprons or buckets with or without baffles, sills and stilling basins.
(h) The experimental work accomplished to date consists of the development of special apparatus for measurement of maximum instantaneous velocities in turbulent water and the use of this apparatus in a detailed study of velocity conditions along the river bed below an ogee spillway with plain horizontal apron.

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(729) (a) MODEL STUDIES IN CONNECTION WITH THE PROPOSED TIONESTA CREEK, CROOKED CREEK, AND REDBANK CREEK FLOOD CONTROL DAMS.
(b) U. S. War Department.
(c) Laboratory investigation on a series of models divided into three groups.
(d) H. A. Thomas, E. P. Schuleen, W. J. Hopkins, and W. S. Hamilton.
(e) Professor H. A. Thomas.
(f) To furnish data and recommendations for design.
(g) (h), (i) Investigation includes the construction and testing of ten models up to the present time, as follows:

A. Tionesta Creek Project.

1. A 1:36 scale pyralin model of the intake tower, tunnel, and stilling basin to study overall performance under various methods of operation and to design an adequate stilling basin.
2. A 1:80 scale model of the saddle spillway to study flow characteristics of the spillway channel.
3. A 1:200 scale general model of the entire project to locate areas of scour and deposition caused by operation of the saddle spillway and tunnel outlet.

The tests have been completed and the final report on the Tionesta Creek Project submitted to the Pittsburgh District Office. The recommendations made from studies on this group of models and described in the report include: (a) addition of a tunnel vent shaft, (b) simplification of the tunnel stilling basin, (c) removal of baffles and complete revision of the saddle spillway. The report contains considerable data on the friction losses in the long pyralin conduit and the means of adjusting for the lack of roughness similitude. Manning's formula and not Reynold's Number was used in the analysis.

B. Crooked Creek Project.

4. A 1:72 scale model of the saddle spillway to study flow characteristics in the spillway channel.
5. A 1:180 general model of the entire project to locate areas of scour and deposition caused by operation of the saddle spillway and the outlet tunnel.

The tests on this group of models have been completed and the final report on the Crooked Creek Project submitted to the Pittsburgh District Office. The report contains a comparison of the computed and experimental profiles of the non-uniform flow in the spillway channel.

C. Redbank Creek Project.

6. A 1:30 scale spillway model one gate bay in width installed in a glass-sided flume to compare the merits of various preliminary apron designs.
7. A 1:36 scale spillway model two gate bays wide installed in a glass-sided flume to develop the most satisfactory final apron and pier design and to check the pressures on the spillway.
8. A 1:24 scale model of the sluice outlets and deflectors to develop the most satisfactory method of dissipating the energy of the jets and to study the velocity distribution in the tailwater basin.

9. A 1:72 scale general model of the project to study the size of training walls required and develop the most reasonable system of gate operation.
10. A 1:18 scale cavitation model of a portion of the sluice outlets tested in a vacuum tank apparatus to determine the possibility of cavitation along the entrance curves or near the gate slots.

Tests on all models in this group except number 10 have been completed. The final report is nearly finished. Recommendations include more economical designs for apron and training walls and emphasize the need of a symmetrical arrangement of outlet conduits. Of general interest is the development of a simplified type of jet deflector located at the downstream end of the outlet sluices and entirely within the curve of the spillway face.

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(833) (a) GENERAL STUDY ON THE EFFECT OF DRAINS ON SEEPAGE THROUGH EARTH DAMS.
(b) Carnegie Institute of Technology.
(c) Master's Thesis. Laboratory investigation and analysis using models in a narrow glass-sided flume.
(d) H. A. Thomas and A. E. Allen.
(e) Professor H. A. Thomas.
(f) To study the effect of different types of drains and their location on the direction of flow and the quantity of seepage through a typical earth dam and its foundation.
(g) Studies to be made by means of a porous model and foundation molded between glass plates spaced 1-3/8 inches apart. Flow lines to be traced with dye, and the quantity of seepage to be measured volumetrically.
(h) Apparatus has been constructed and the tests begun.

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(834) (a) MODEL STUDIES IN CONNECTION WITH THE PROPOSED LOYALHANNA CREEK FLOOD CONTROL DAM.
(b) U. S. War Department.
(c) Laboratory investigations on a group of models.
(d) H. A. Thomas, E. P. Schuleen, W. J. Hopkins, and W. S. Hamilton.
(e) Professor H. A. Thomas.
(f) To furnish data and recommendations for design.
(g) Investigation includes the construction and testing of two models at the present time, as follows:
1. A 1:36 scale spillway model two gate bays wide installed in a glass-sided flume to determine the most satisfactory bucket and apron design and to investigate the possibility of negative pressures on the spillway near the crest.
2. A 1:24 scale model of the outlet sluices and deflectors to determine the most satisfactory conduit exit design and the flow distribution in the stilling pool under various conditions.

(h) Construction of model number (1) has been completed and tests are under way. Model number (2) is under construction.

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CASE SCHOOL OF APPLIED SCIENCE.

(730) (a) MAHONING DAM SPILLWAY DESIGN.
(b) U. S. Engineer Office, Pittsburgh, Pennsylvania.
(c) Flood control project.
(d) Professor George E. Barnes and Staff.
(e) Professor George E. Barnes.
(f) To determine negative head on crest with spouting velocities under crest gates; to determine features of conduit portal, and proper design for bucket and apron to dissipate energy from combined spillway and conduit discharge.
(g) 1:48 scale of model O. G. section, crest gates and piers, bucket and apron, conduits through dam. Model of section of spillway in glass flume.
(h) Work completed.
(i) Final report issued by the Pittsburgh District Office (Lt. Col. W.E.R.Covell, District Engineer). This report includes findings for projects 731 and 732 below. See abstract included in this bulletin.

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(731) (a) MAHONING DAM - STUDY OF SLUICES.
(b) U. S. Engineer Office, Pittsburgh, Pennsylvania.
(c) Flood control project.
(d) Professor George E. Barnes and Staff.
(e) Professor George E. Barnes.
(f) To determine proper design for bellmouth intake to sluices, and action of control gates, air vents, etc. under various conditions of operation.
(g) 1:25 scale model, conduit of pyralin, including trash racks.
(h) Work completed.
(i) Final report as above. See abstract in this bulletin.

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(732) (a) MAHONING DAM - CHANNEL MODEL.
(b) U. S. Engineer Office, Pittsburgh, Pennsylvania.
(c) Flood control project.
(d) Professor George E. Barnes and Staff.
(e) Professor George E. Barnes.
(f) To determine overall performance of complete model, including all features developed in the studies above, with particular reference to channel currents and scour.
(g) 1:72 scale model including section of reservoir and channel downstream.
(h) Work completed.
(i) Final report as above. See abstract in this bulletin.
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(835) (a) PRESSURES ON GRAVITY SECTION SPILLWAY FOR A DAM, WITH FREE DISCHARGE AND WITH CREST GATES.
(b) Laboratory study.
(c) Undergraduate thesis project.
(d) R. A. Vanderhoof.
(e) Professor George E. Barnes.
(f) Piezometric observations with 1:48 scale model of spillway.
(g) Same as (f).
(h) Findings partially completed.
(i) The trace of the upper nappe in these experiments will define the boundary layer required for Project 2 below.

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(836) (a) FLOW NET STUDY BY METHOD OF ELECTRICAL ANALOGY, FOR DISCHARGE OVER GRAVITY SPILLWAY.
(b) Laboratory study.
(c) Graduate thesis project.
(d) W. H. McClarran and J. A. Tapleshay.
(e) Professor George E. Barnes.
(f) Tracing of stream lines formed by electrical current in brine solution between fixed boundaries representing upper and lower nappe, in a section model of spillway.
(g) Same as (f).
(h) Measurements under way.
(i) Correlated with Project (835) above.

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(837) (a) STUDY OF VENTURI OUTLET FOR GRIT CHAMBER.
(b) Laboratory study.
(c) Undergraduate thesis project.
(d) C. A. Carlson and H. L. Weiss.
(e) Professor George E. Barnes.
(f) Calibration and velocity distribution.
(g) 1:6 scale model.
(h) Findings near completion.
(i) None.

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(838) (a) DETERMINATION OF HYDRAULIC GRADIENTS IN THE EASTERLY SEWAGE TREATMENT PLANT.
(b) City of Cleveland.
(c) Undergraduate thesis project.
(d) D. L. Snow.
(e) Professor George E. Barnes.
(f) Determining actual water surface elevations in the field, for comparison with elevations computed in design, for the purpose of determining losses in aerated channels.
(g) Field work at the plant.
(h) Measurements under way.
(i) None.

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(839) (a) CHARACTERISTICS OF SHOOTING FLOW ON A SLOPING APRON WITH SEPARATE EFFECTS OF VELOCITY, SLOPE OF THE APRON, AND FLARING SIDEWALLS.
(b) Laboratory study.
(c) Undergraduate thesis project.
(d) J. J. Hunt and B. A. Jackson.
(e) Professor George E. Barnes.
(f) Construction of model and measurement and analysis of results.
(g) Same as (f).
(h) Under construction.
(i) None.

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CORNELL UNIVERSITY.

(587) (a) LARGE A.S.M.E. FLOW NOZZLES WITH WATER.
(b) National Bureau of Standards.
(c) Co-operative research.
(d) F. C. Morey, E. W. Schoder, A. N. Vanderlip.
(e) Professor E. W. Schoder.
(f) Finding of coefficients and loss of head.
(h) Laboratory work completed and data reported to the A.S.M.E. Fluid Meters Committee.
(i) Report for this Bulletin furnished by H. S. Bean, National Bureau of Standards.

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(840) (a) CALIBRATION TESTS ON CONCRETE WALL V-NOTCHES.
(b) U. S. Soil Conservation Service.
(c) Tests of several thicknesses of wall and angle of notch.
(d) Albert N. Huff.
(e) U. S. Soil Conservation Service.
(f) Standardization for normal and abnormal field installations.
(g) Discharges by standard weir and by volume; various backwaters and depths of channel of approach.
(h) About half done.
(i) Weirs for use on small (mostly dry) watercourses.

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HORTON HYDRAULIC AND HYDROLOGIC LABORATORY.

(290) (a) VELOCITY DISTRIBUTION IN STREAM CHANNELS.
(c) Scientific research.
(e) Robert E. Horton.

(Continuation of project reported in earlier bulletins of this series.)

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(291) (a) BACK-WATER BY THE MANNING FORMULA.
(c) Scientific research.
(e) Robert E. Horton.

(Continuation of project reported in earlier bulletins of this series.)

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(292) (a) DISPERSION CURVES OF MANNING'S COEFFICIENT OF ROUGHNESS.
(c) Scientific research.
(e) Robert E. Horton.

(Continuation of project reported in earlier bulletins of this series.)

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(293) (a) FLOOD WAVES SUBJECT TO FRICTION CONTROL.
(c) Scientific research.
(e) Robert E. Horton.
(h) Results of the experiments at the Horton Hydrologic Laboratory on the movement of flood waves in an experimental channel 5-5/8 in. wide and 120 ft long, together with a comparison of these results with those given by different theoretical formulas, are contained in a paper entitled "Channel Waves Subject Chiefly to Momentum Control", Robert E. Horton, Contribution from Division of Research, Soil Conservation Service and Horton Hydrologic Laboratory, Voorheesville, N.Y., (mimeographed). The same paper with some omissions will be published in the Bulletin of the Permanent International Association of Navigation Congresses. Copies may be obtained from the U. S. Soil Conservation Service, Washington, D. C. (SCS-TP-16, May-1938). or from the Horton Hydrologic Laboratory, Voorheesville, N. Y. (50 ¢). See also: "Rain Wave Trains," Robert E. Horton, Trans. American Geophysical Union, 1938, pp. 368-374; "Seddon's and Forchheimer's formulas for crest velocity of flood waves subject to channel friction control," Robert E. Horton, Trans. American Geophysical Union, 1938, pp. 374-382.

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(294) (a) RELATION OF CARRYING CAPACITY OF CAST IRON PIPE CONDUITS TO AGE IN SERVICE.
(c) Scientific research.
(e) Robert E. Horton.

(Continuation of project reported in earlier bulletins of this series.)

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(385) (a) SURFACE RUNOFF PHENOMENA.
(c) Scientific research.
(e) Robert E. Horton.
(h) A complete analysis of the phenomena of surface runoff in accordance with the Horton infiltration theory has been made and will be published shortly by the Horton Hydrologic Laboratory. Excerpts from this paper, covering the questions of depth and velocity of overland flow, were included in a paper on "Interpretation of Runoff Plat Experiments in relation to Soil Erosion," presented before the Soil Science Society of America, Washington, D. C., December 1938, and which will probably be published in the Transactions of that society for 1938.

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(386) (a) WIND VELOCITY NEAR THE GROUND.
(c) Scientific research.
(e) Robert E. Horton.
(b) (d), (f) and (g) Earlier issues of this bulletin contain these details.
(h) In this research an attempt is being made to evaluate the difference between the wind velocity curves above the ground surface for conditions of laminar and turbulent flow, respectively.

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(738) (a) SURFACE RUNOFF PHENOMENA - CHANNEL PHASE.
(b) Scientific research.
(c) Scientific research.
(d) Robert E. Horton and Laboratory staff.
(e) Robert E. Horton.
(g) An application of the Manning formula and the equation of continuity or storage equation to the determination of the transformation of a stream rise in its course through stream channels. The method is based on channel storage, and the research includes:
(1) Development of methods of determining the volume of channel storage from hydrographs, including determination of stream widths and channel storage volumes for rising and receding stages during the passage of a stream rise;
(2) Application of the stream stage-storage relations to the determination of channel-inflow graph from channel-outflow graph;
(3) Effect of various factors, such as volume of channel storage and location of area from which surface runoff is derived on form of channel-outflow graph;
(4) Synthesis of channel-outflow graphs from channel-inflow graph or surface-runoff graph.
(h) This research has reached the point where the results are being worked up for publication. Two papers growing out of this research have been completed and are pending publication, one "A preliminary study of the determination of stream width from the hydrograph," by Robert E. Horton, the other, "Flood volumes," by Robert E. Horton and Richard Van Vliet.

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(841) (a) EVAPORATION FROM WATER SURFACE - AN ANALYTICAL AND EXPERIMENTAL STUDY.
(b) Scientific research.
(c) Scientific research.
(d) Robert E. Horton and Laboratory staff.
(e) Robert E. Horton.
(f) To evaluate the effect of wind movement on evaporation from lakes and water surfaces, with particular reference to the separate conditions existing according as the wind movement is laminar or turbulent; also to supply an analytical basis for determination of area factor or relation of evaporation from lakes and reservoirs to that from evaporation pans.
(g) The method includes an analytical study of the transport of vapor across a water surface by wind action, whether laminar or turbulent, and the removal of vapor from the water surface by diffusion, convection and turbulence, checking the results by comparison with observed data under various conditions.
(h) The investigation has reached a point where the results are ready to be put in final form for publication but work on this project has been temporarily suspended to permit the completion of certain other researches.

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(842) (a) RAINFALL PHENOMENA.
(b) Scientific research.
(c) Scientific research.
(d) Robert E. Horton and Laboratory staff.
(e) Robert E. Horton.
(f) To provide working data and rules for the application of rainfall records to the estimation of surface runoff.
(g) The research is based on detailed analysis of hourly rainfall records at regular U. S. Weather Bureau stations and certain other stations having recording rain gages. The research includes studies to determine the relative rainfall intensity and duration in different parts of a drainage basin during the same storm, and the relation of rainfall intensity and duration to storm conditions, particularly cold and warm fronts. It also includes a detailed study of the quantity of rainfall excess from rain falling at intensities exceeding different infiltration-capacities of the soil, the patterns of rain intensity graphs at different stations and the quantity of rainfall excess on areas where most of the rain gages are of the non-recording type. An attempt is being made to work out various index quantities characterizing the rainfall regime of a given location in terms of average rain intensity.
(h) Some features of this research are nearing completion and results will be published from time to time as they become available.

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UNIVERSITY OF ILLINOIS.

(301) (a) STUDY OF THE FLOW OF WATER IN A CIRCULAR GLASS PIPE BY THE USE OF MOTION PICTURES.
(c) Laboratory investigation.
(e) Prof. F. B. Seely.

(Continuation of a project reported in earlier bulletins of this series.)

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(504) (a) MODEL OF SPILLWAYS OF WATER SUPPLY RESERVOIRS IN ILLINOIS.
(c) Investigation of capacities, use as measuring devices and erosion problems.
(e) Prof. F. B. Seely.
(h) Tests of West Frankfort model are completed and the results published in Circular 20 by the Illinois State Water Survey, Urbana, Illinois.

(Continuation of a project reported in earlier bulletins of this series.)

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(626) (a) VELOCITY DISTRIBUTION IN PIPES AT HIGH REYNOLDS NUMBER.
(c) Research.
(e) Prof. F. B. Seely.
(h) Experiments in progress. Thesis completed and on file in University Library.

(Continuation of project reported in earlier bulletins of this series.)

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(655) (a) THE DEVELOPMENT OF A MAGNETIC INSTRUMENT FOR MEASURING THE FLOW OF FLUIDS IN PIPES.
(c) Research.
(e) Prof. F. B. Seely.
(h) Published in January 1939 issue of Mechanical Engineering, "A Magnetic Flow Meter" by W. M. Lansford.

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(739) (a) EFFECT OF RADIUS OF CURVATURE ON THE FLOW OF WATER AROUND PIPE BENDS.
(c) Research.
(e) Prof. F. B. Seely.
(h) Tests in progress.

(Continuation of project reported in earlier bulletins of this series.)

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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.
(e) Prof. H. E. Babbitt.
(h) Preliminary apparatus completed and at present work is being planned regarding final tests.

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(843) (a) A STUDY OF THE HYDRAULIC CHARACTERISTICS OF VALVES.
(c) Research.
(d) G. B. Lyon, W. M. Lansford.
(e) F. B. Seely.
(f) To study the loss in head due to valves and to improve design of valve.
(g) Tests are being made on 1 1/2-in. gate, globe, and check valves of several designs. The work is being done very carefully, velocities as high as 50 fps being used.
(h) Tests in progress.

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IOWA INSTITUTE OF HYDRAULIC RESEARCH.

(306) (a) HYDRAULIC STUDIES OF A MODEL OF THE UNIVERSITY DAM AT IOWA CITY AND STUDY OF FLOW OVER SUBMERGED DAMS.
(c) Graduate thesis and research.
(d) Edward Soucek and C. L. Morgan.
(e) Edward Soucek.
(f) To study the relation of models and prototypes and to determine the laws of flow over submerged dams.
(g) Report for publication nearing completion.

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(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. E. W. Lane.
(h) Continuous records since 1924 of precipitation, runoff, groundwater levels, and cover. Drainage area 3 sq. mi. of rolling agricultural land near east city limits of Iowa City.

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(317) (a) COOPERATIVE STREAM GAGING IN IOWA.
(b) Iowa Institute of Hydraulic Research.
(c) Cooperative project - U. S. Geological Survey.
(d) R. G. Kasel, District Engineer, and staff.
(e) Prof. E. W. Lane.
(h) Stream gaging stations are maintained cooperatively, at stations on major watersheds in Iowa.

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(595) (a) A STUDY OF THE LAWS OF TRANSPORTATION OF SEDIMENT BY FLOWING WATER.
(b) Cooperative project, Iowa Institute of Hydraulic Research and various government agencies.
(c) Project includes collection and analysis of sediment from a wide variety of streams and the analysis of sediment data obtained by other agencies with a view to developing the laws governing the transportation of material by streams, the manner of deposition in reservoirs and other engineering problems related to sediment transportation.
(d) Iowa Institute of Hydraulic Research and cooperating government agencies.
(e) Prof. E. W. Lane.
(f) The purpose of the investigation is to develop methods by which the engineering problems related to sediment transportation can be solved in a quantitative way.
(g) Sediment samples from a number of streams have been collected and analyzed and deductions on the laws of transportation derived from the results. Laboratory and field studies are planned of the laws governing transportation of material in suspension and along the bed. The method of deposition in reservoirs, the perfection of analysis methods and other engineering aspects will be studied.
(h) The study has been under way about two years and a report is planned during the coming year.

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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) Iowa Institute of Hydraulic Research.
(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 ground water level will be observed and correlated.
(h) Stream flow measurements underway, rainfall and ground water observing stations about to be 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) Prof. E. W. Lane.
(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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(847) (a) THE SHAPE OF STABLE CHANNELS.
(b) Iowa Institute of Hydraulic Research.
(c) Master's Thesis.
(d) E. W. Lane, C. J. Posey, and C. T. Li.
(e) Prof. E. W. Lane.
(f) To develop the laws governing the shape of water-conveying channels in erodible material.
(g) A study will be made of the shape of actual channels covering a wide range of conditions to determine the laws governing both cross section and alignment.
(h) Work just started.

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(848) (a) SPREADING OF A WATER JET ON A FLAT FLOOR.
(b) Iowa Institute of Hydraulic Research.
(c) Master's Thesis.
(d) E. W. Lane and E. M. Muratzade.
(e) Prof. E. W Lane.
(f) To discover the maximum desirable rate of expansion in an open channel carrying water at high velocity.
(g) Studies will be made of rectangular and other shaped jets on horizontal and inclined floors, observation being made of the shape of the water cross section and paths of the currents within the jet.
(h) Apparatus being set up.

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(849) (a) AN INVESTIGATION OF FISHWAYS.
(b) Iowa Conservation Commission.
(c) Research.
(d) E. W. Lane, A. M. McLeod, Dr. Paul Nemenyi.
(e) Prof. E. W. Lane.
(f) To develop more effective and economical fishways.
(g) Models about 8 x 8 inches in cross section and 5 ft in length are being studied both as to their hydraulics and as passes for small fish. Full size fishways are to be installed at the Laboratory dam to compare designs and check results of model tests.

(h) Suitable types of baffles have been found and also some progress has been made in determining practical construction methods for reinforced concrete fishways.

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(743) (a) SIMULTANEOUS FLOW OF AIR AND WATER IN CLOSED CONDUITS.
(b) Cooperative project with Committee on Hydraulic Research, American Society of Civil Engineers.
(c) Laboratory research.
(d) Dean F. M. Dawson and A. A. Kalinske.
(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" used, 50 feet long, with transparent sides. Provisions for air flow measurement will be made at both ends of the conduit. Surface friction between the air and water is one of the important items to be investigated.
(h) The apparatus has been designed and is being built.

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(850) (a) HYDRAULICS AND PNEUMATICS OF PLUMBING DRAINAGE SYSTEM.
(b) Cooperative project with National Association of Master Plumbers.
(c) Laboratory and field research.
(d) Dean F. M. Dawson and A. A. Kalinske.
(e) Dean F. M. Dawson.
(f) To obtain basic data for sizing of drains, stacks, and vents of plumbing drainage system.
(g) Data obtained to be used in preparing tables and charts for use in plumbing codes.
(h) Experimental work complete; report being prepared.

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(851) (a) HYDRAULICS OF VERTICAL DRAIN AND OVERFLOW PIPES.
(b) Cooperative project with National Association of Master Plumbers.
(c) Laboratory research.
(d) Dean F. M. Dawson, A. A. Kalinske, and A. M. McLeod.
(e) 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.

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(852) (a) OPERATION OF ANTI-SIPHON TRAPS IN PLUMBING SYSTEMS.
(b) Cooperative project with National Association of Master Plumbers.
(c) Laboratory investigation.
(d) Dean F. M. Dawson, A. A. Kalinske, and A. M. McLeod.
(e) A. A. Kalinske.
(f) To determine the resistance to siphoning and blowing of so-called commercial anti-siphon traps. Also, to study the hydraulics of flow through these traps.

(g) Four different types of anti-siphon traps were tested, and for obtaining comparative data, ordinary P-traps were also tested.
(h) The report is complete and is available.

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(853) (a) AIR-CHAMBERS FOR WATER-HAMMER RELIEF.
(b) Cooperative project with National Association of Master Plumbers.
(c) Laboratory research.
(d) Dean F. M. Dawson and A. A. Kalinske.
(e) 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. Compound and branched pipes are also to be studied. A high-speed Diesel engine indicator of the cantilever spring type is used to record the pressures.
(h) Tests are in progress.

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(854) (a) FUNDAMENTAL DATA ON TURBULENCE IN FLOWING WATER.
(b) Institute project.
(c) Laboratory Research.
(d) A. A. Kalinske and E. R. Van Driest.
(e) A. A. Kalinske.
(f) To obtain fundamental data on water turbulence by the photographic method and to analyze those data by methods similar to those used for air turbulence.
(g) Two general methods of obtaining turbulence data in flowing water by the photographic method were used. One was that of injecting a stream of color and photographing its fluctuations, and the other that of injecting droplets of carbon-tetrachloride and benzol and photographing their travel. An open channel 12" x 12" was used in these preliminary experiments.
(h) The preliminary experiments have been completed and the results reported in a paper presented by the investigators at the Fifth International Congress of Applied Mechanics at Cambridge, Mass., in September 1937. The paper is entitled "Applications of Statistical Theory of Turbulence to Hydraulic Problems."

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(855) (a) DIFFUSION CHARACTERISTICS OF TURBULENCE IN AN OPEN CHANNEL.
(b) Institute Project.
(c) Master's thesis.
(d) A. A. Kalinske and J. M. Robertson.
(e) A. A. Kalinske.
(f) The purpose of this investigation is to study the variation of the coefficient of turbulent diffusion vertically in an open channel by direct experimental means.
(g) The diffusion coefficient is to be determined from data obtained by means of motion pictures of the spread of immiscible liquid droplets injected into the water stream. The experiments will be made in a 2.5 foot channel with different water depths and with a variation of bottom roughness.
(h) Tests are in progress.

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(507) (a) THE CONVERSION OF KINETIC INTO POTENTIAL ENERGY.
(b) Am. Soc. C. E. Committee on Hydraulic Research.
(c) Independent research.
(d) Prof. F. T. Mavis and A. A. Kalinske.
(e) Prof. F. T. Mavis.
(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.

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(856) (a) HYDRAULICS OF CULVERTS.
(c) Graduate thesis.
(d) A. R. Luecker.
(e) Prof. F. T. Mavis.
(f) To review flow data and test reports, and to study effects of systematic entrance variations.
(g) Tests of transparent model conduit with submerged and free outlets.
(h) Report in progress.

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(857) (a) COEFFICIENT OF DISCHARGE FOR NON-SUBMERGIBLE TAINTER GATE.
(b) Master's thesis.
(c) Analytical.
(d) J. W. Howe and E. S. Pretious.
(e) J. W. Howe.
(f) Determination of relation of discharge coefficient to head, gate opening, and pool levels for particular gate installation.
(g) For free discharge log H/D vs. log C yielded 2 straight lines whose equations were:
(1) $C = .545\ (H_c'/D)^{.18}$ for ratios of H/D less than 3, and

(2) $C = .613\ (H_c'/D)^{.08}$ for ratios of H/D greater than 3.
For submerged discharge log P/H plotted vs. log C/D gave a family of parallel straight lines from which was derived the equation:
(3) $C = .95\ \frac{(D)^{.145}}{(P)^{.22}}$

NOMENCLATURE

H_c' = head to center of gate opening corrected for velocity of approach
D = gate opening
C = coefficient of discharge
P = tailwater depth above gate sill.

(h) Completed.
(i) The average departure of experimental values from equations was 3 per cent for equation (1), 1 per cent for equation (2), and 2 per cent for equation (3).

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(858) (a) COOPERATIVE METEOROLOGICAL OBSERVATIONS.
(b) U. S. Weather Bureau.
(c) Operation of Class A evaporation station.
(d) Staff of Iowa Institute of Hydraulic Research.
(e) J. W. Howe.
(f) Furnishing data on precipitation, wind movement, evaporation, and water content of snow at Iowa City.
(g) Standard Class A station procedure.
(h) Continuous.

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(859) (a) EFFECT OF FREEBOARD UPON EVAPORATION FROM STANDARD 48-inch PAN
(b) Master's thesis.
(c) Experimental.
(d) J. W. Howe and R. W. Revell.
(e) J. W. Howe.
(f) Investigation of variable freeboard upon evaporation rate.
(g) Operation of several standard 48-inch pans with different water levels with other conditions controlled. Losses supplied by small reservoirs to give accurate determination of evaporation in short period.
(h) Beginning.

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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 are being conducted in a model on a scale of 1 to 22.4; observations are made with respect to turbulence, surging, hawser pull, and duration of lockage.
(h) Tests are in progress.

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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 are being conducted in a model on a scale of 1 to 30; observations are made with respect to turbulence, surging, hawser pull, and duration of lockage.

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(862) (a) MISSISSIPPI RIVER, FILLING AND EMPTYING SYSTEM FOR NEW 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) Tests are being conducted in a model on a scale of 1 to 24 simulating the various types of filling systems proposed and observing turbulence, surging, hawser pull, and duration of lockage.
(h) Tests are in progress.

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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) Records have been taken since April 1, 1933.

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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, 1933.

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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) 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.
(i) The original galvanized pan was replaced by a copper one and this change was accompanied by a considerable increase in evaporation.

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(863) (a) STUDY OF FLOW THROUGH A PIPE ORIFICE.
(c) General scientific research for Master's thesis.
(d) F. B. Sessums.
(e) Dr. Glen N. Cox.
(f) To study the flow pattern upstream and downstream from the orifice plate.
(g) An experimental section of glass tubing contains a glass orifice plate. Qualitative and quantitative measurements will be made of the flow condition especially in the jet. Tests will be made with the orifice discharging freely and also with it submerged.
(h) The apparatus is ready to be assembled.

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MASSACHUSETTS INSTITUTE OF TECHNOLOGY, DEPARTMENT OF CIVIL AND SANITARY ENGINEERING.

(747) (a) AN EXPERIMENTAL INVESTIGATION OF THE EFFECTS OF THE APPROACHING SEA DEPTH AND THE DIMENSIONS OF THE ROCK MOUNT FOUNDATION ON THE WAVE ACTION ON VERTICAL BREAKWATERS.
(b) River Hydraulic Laboratory, M. I. T.
(c) Master's thesis.
(d) R. S. Hsu.
(e) Dr. K. C. Reynolds.
(f) Experimental study of distribution and intensity of pressure of waves striking a breakwater.
(g) A plunger at one end of a wave tank created waves which struck a breakwater at the opposite end. By means of specially designed microphones and an oscillograph the pressure diagram was obtained for four different elevations on the breakwater. Models having scales of 1 to 60 and 1 to 90 were used.
(h) Research completed. Thesis with title of (a) submitted in October 1938.
(i) The electrical apparatus for measuring wave pressures was sensitive and reliable. Results were compared with values computed by Sainflou's and Lira's methods. The former gave values in better agreement with those obtained by the models.

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(864) (a) AN EXPERIMENTAL INVESTIGATION OF THE VARIATION IN THE FRICTION FACTOR WITH CHANGES IN REYNOLDS NUMBER IN OPEN CHANNEL FLOW.
(b) River Hydraulic Laboratory, M. I. T.
(c) Master's thesis.
(d) J. A. Downs.
(e) Dr. K. C. Reynolds.
(f) To study variations in the apparent roughness of open channels as Reynolds Number changes.
(g) A wooden flume of rectangular cross-section was used, having a slope of 1 to 250 and a test length of 20 feet. Two series of tests were run: with a width of 24 in. and with a width of 12 in. The walls and bed of the channel were artificially roughened with a uniform-grained sand. The flow was always uniform.
(h) Thesis with title of (a) submitted in October 1938.
(i) Manning's coefficient of roughness was found to be practically constant for different values of Reynolds Number. The coefficient of friction (as used for pipe flow) decreased for increasing values of Reynolds Number. The research is to be continued using narrower channels.

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(865) (a) AN EXPERIMENTAL INVESTIGATION ON THE CAPE COD CANAL MODEL TO STUDY COEFFICIENT OF ROUGHNESS AND EFFECT OF DIKE ON FLOW CONDITIONS
(b) River Hydraulic Laboratory, M. I. T.
(c) Master's thesis.
(d) Lts. A. C. Welling, J. H. Anderson, E. W. Niles, N. M. Martin of Corps of Engineers, U. S. Army.
(e) Dr. K. C. Reynolds.
(f) Using the model of the Cape Cod Canal to study:
(a) the relationship between Manning's coefficient of roughness for open channel flow and the Reynolds' Number; and (b) the effect of a dike in Buzzards Bay on tidal phenomena in the Canal.
(g) The 115-foot concrete model, built several years ago for the Boston office, Corps of Engineers, was used. It has a horizontal scale of 1 to 600 and a vertical scale of 1 to 60. For part (a) the flow through the canal was made steady. A section of canal was used having a length of 584 cm, an average bottom width of 27.7 cm, and a depth of about 17 cm. A Bentzel tube was used to obtain the mean velocity in a cross-section. For part (b) a dike was built in Buzzards Bay and observations made of water surface profiles and velocities for comparison with model data previously collected.
(h) Research completed. Thesis with title of (a) submitted in October 1938.
(i) Manning's coefficient of roughness was found to be a constant of about 0.009 for different values of Reynolds Number. The coefficient of friction (as used for pipe flow) was found to decrease with an increasing value of Reynolds Number.

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(866) (a) AN INVESTIGATION OF THE EFFECT OF ANGULARITY OF APPROACH ON THE DISCHARGE COEFFICIENT FOR A DAM.
(b) River Hydraulic Laboratory, M. I. T.
(c) Master's thesis.
(d) Lts. A. W. Betts and J. P. Buehler of Corps of Engineers, U. S. Army.
(e) Dr. K. C. Reynolds.
(f) To investigate the effect of angularity and depth of approach on the discharge coefficient for a 1 to 60 scale model of a dam.
(g) Angles of approach (with respect to the axis of the dam) of 90°, 60°, 45°, 30° were studied. The depths of approach varied from 9 in. to 0 in. The width of the approach channel was always 15 in.
(h) Research completed. Thesis with title of (a) submitted in October 1938.
(i) If the abutments are perpendicular to the crest of the dam, the coefficient of discharge for the same head and depth of approach, showed little tendency to change with change in angle of approach. If the abutments were an extension of the walls of the approach channel, the coefficient for a given head decreased markedly at all crest heights as the angle of approach became more acute.

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(867) (a) THE DESIGN AND CONSTRUCTION OF AN OPEN CHANNEL FOR DETERMINING UPPER AND LOWER CRITICAL VELOCITIES.
(b) River Hydraulic Laboratory, M. I. T.
(c) Master's thesis.
(d) Lts. B. Card, S. L. Brown, R. M. Sieg of Corps of Engineers, U. S. Army.
(e) Dr. K. C. Reynolds.
(f) See (a)
(g) A tilting glass-walled channel of rectangular cross-section was built 2 in. wide, 6 in. high, and 20 ft. long. The rate of discharge will be determined by weighing.
(h) Experimental equipment completed. Thesis with title of (a) submitted in October 1938.
(i) About February 1939 a Master's thesis will be begun by Mr. J. C Howland to obtain experimental data.

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(868) (a) THE EFFECT OF SHAPE OF SEA WALL ON BEACH EROSION.
(b) River Hydraulic Laboratory, M. I. T.
(c) Master's thesis.
(d) F. R. Klauck.
(e) Dr. K. C. Reynolds.
(f) By the use of models to study the effect of shape of sea walls on the erosion of beaches under various conditions of still-water elevation and beach slope.

(g) A plunger at one end of a wave tank created waves which ran the length of the tank, up a sandy beach, and over a sea wall. Models of a vertical wall using scale ratios of 1 to 40, 1 to 50, and 1 to 60 were studied for comparative purposes. 1 to 50 scale models of six different shapes of wall were investigated. The profile of the beach as well as the rate of movement of beach material over the wall were determined.
(h) Thesis with title of (a) submitted in October 1938.
(i) Further studies will be made.

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(869) (a) AN EXPERIMENTAL INVESTIGATION OF THE COEFFICIENT OF DISCHARGE FOR SHARP-CRESTED OFFSET WEIRS.
(b) River Hydraulic Laboratory, M. I. T.
(c) Master's thesis.
(d) E. Post.
(e) Dr. K. C. Reynolds.
(f) The object of these experiments was the determination of the coefficients of discharge for sharp-crested, suppressed, aerated, offset weirs.
(g) An offset weir was defined as a weir consisting of three straight sections; two sections being perpendicular to the center line of the channel, the sum of their lengths being equal to the width of the channel; the third section being parallel to the axis of the channel and joining the other two sections. 20 different shapes of weir were used, all with a crest height of 15 in.; 5 shapes were used with a crest height of 10 in.; and 1 shape with crest heights of 5 1/2 in., 3 in., and 1 in.
(h) Thesis with title of (a) submitted in October 1938.
(i) Further studies will be made.

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(870) (a) AN EXPERIMENTAL ANALYSIS OF SWIMMING POOL DESIGN.
(b) River Hydraulic Laboratory, M. I. T.
(c) Master's thesis.
(d) T. H. Campbell.
(e) Dr. K. C. Reynolds.
(f) By the use of a model of a swimming pool to investigate numerous problems, including a means of eliminating as rapidly as possible the waves caused by any disturbances.
(g) A 1 to 8 scale model of a pool 82 ft long by 50 ft wide and 13 ft maximum depth was built. One wave of definite magnitude was created at the deep end of the pool and the height of the wave was observed as the time progressed following the creation of the wave. A plot of wave height against time gave a so-called "wave subsidence" curve. Such curves were obtained for different longitudinal profiles for the pool.
(h) Thesis with title of (a) submitted in June 1938.
(i) More favorable "wave subsidence" curves were obtained if the bottom of the pool had a broken longitudinal slope. The shape of gutter and other features of pool design are yet to be investigated.

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(871) (a) A QUANTITATIVE EXPERIMENTAL INVESTIGATION ON NEGATIVE PRESSURES ON A SPILLWAY SECTION OF A DAM.
(b) River Hydraulic Laboratory, M. I. T.
(c) Bachelor's thesis.
(d) T. C. Torrance.
(e) Dr. K. C. Reynolds.
(f) See (a).
(g) A dam was designed for a 2-foot head, following the customary procedure. Two models were built to scales of 1 to 18 and 1 to 36 with 10 piezometer connections on the crest and downstream face at corresponding points. The head on the models was varied to correspond with heads of 2 ft to 12.08 ft in the prototype. The crest height of the prototype was 19 ft 6 in.
(h) Thesis with title of (a) submitted in June 1938.
(i) Further studies are to be made.

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(872) (a) AN EXPERIMENTAL STUDY OF THE FLOW OVER AERATED CIRCULAR WEIRS WITH DIFFERENT DEPTHS OF APPROACH.
(b) River Hydraulic Laboratory, M. I. T.
(c) Bachelor's thesis.
(d) J. R. Suprenant and W. R. Williams.
(e) Dr. K. C. Reynolds.
(f) To investigate the effect of the depth of approach on the discharge-coefficient of a sharp-crested weir, semi-circular in plan.
(g) A sharp-crested semi-circular weir with a diameter of 6-5/8 in. to the upstream face, was used. The four depths of approach were 3 in., 6 in., 12 in., 17-5/16 in. The rate of flow was determined volumetrically.
(h) Research completed. Thesis with title of (a) submitted in June 1938.
(i) If H is the head in feet and D is the diameter in feet to the upstream face, the rate of flow in English units was: for $H/D < 0.237$, $Q = 2.70\ L\ H^{1.385}$, where L is the crest length in feet; for H/D between 0.237 and 0.272, no definite formula; for $H/D > 0.272$, $Q = 2.21\ L\ H^{1.265}$

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(873) (a) HYDRAULIC LOSSES IN PIPE BENDS.
(b) Civil Engineering Department.
(c) Master's thesis.
(d) R. H. Courland.
(e) Prof. George E. Russell.
(f) To determine the excess loss due to curvature in bends of 90° and 180°; also, the variation of f with Reynolds Number in rubber-lined fire hose.
(g) Use was made of 1.50-in. fire hose (rubber-lined) to construct bends of desired radius and angle of curvature. Head losses, with hose in straight position, were determined for velocities varying from 3 to 30 fps and for Reynolds Numbers of from 70,000 to 350,000. Head losses were then measured with hose containing two 90° bends of certain radius. Hose and bends were kept in position with wooden forms. Velocities and values

of Reynolds number varied widely. Losses due to bends computed from data so furnished. Radius of bend varied from 32d to 80d.
(h) Experimental work completed and work progressing on analysis of data.

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(874) (a) EXPERIMENTAL STUDY OF SHORT-CIRCUITING THROUGH MIXING CHAMBERS.
(b) Sanitary Engineering Laboratory, M. I. T.
(c) Bachelor's thesis.
(d) W. Christensen and S. Morabito.
(e) Prof. T. R. Camp.
(f) 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 to be studied to determine if the dye patterns can be duplicated and if the Froude model law is satisfactory.
(h) Apparatus under construction.

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(875) (a) RAINFALL INTENSITY -DURATION CURVES FOR BOSTON, MASS.
(b) Sanitary Engineering Laboratory, M. I. T.
(c) Bachelor's thesis.
(d) H. F. Kennison.
(e) Prof. T. R. Camp.
(f) To check and amend curves prepared by C. W. Sherman. (Trans. A.S.C.E. 1931, pg. 951) for a 50-year rainfall record at Chestnut Hill Reservoir on the basis of the 60-year record now available.
(g) Method same as used by Sherman.
(h) Just started.

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(876) (a) HYDRAULICS OF FLOW OF CLEAN WATER THROUGH CLEAN SAND.
(b) Sanitary Engineering Laboratory, M.I.T.
(c) Staff research.
(d) Prof. T. R. Camp, D. A. Root, and staff.
(e) Prof. T. R. Camp.
(f) Experimental check of validity of Fair-Hatch theory.
(g) Apparatus consists of sectional glass tube filter designed for depth of sand of about 2 ft and with 13 piezometer connections throughout depth for head loss measurements. Distilled water is recirculated downward through sand and is filtered and deaerated on each circuit. When sand is placed, air is removed by agitation and back washing. Overall porosity is controlled by subsidence of bed after expansion by back wash. Six sands are to be studied: (1) uniform sand with round grains, (2) crushed quartz of uniform size, (3) homogeneous non-uniform sand with round grains, (4) homogeneous non-uniform crushed quartz, (5) non-uniform round sand stratified as to grain size, and (6) non-uniform crushed quartz stratified as to grain size.
(h) Work on uniform sand with round grains has been completed.

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(877) (a) ELECTRIC NETWORK ANALYZERS FOR HYDRAULIC ANALYSIS OF WATER DISTRIBUTION SYSTEMS.
(b) Dept. of Civil & Sanitary Engineering and Dept. of Electrical Engineering, M. I. T.
(c) Master's thesis.
(d) H. T. Strandrud.
(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 with which $V = KI^x$ to correspond with analogous pipe friction formula $h = kQ^x$.
(h) In progress.

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S. MORGAN SMITH COMPANY.

(878) (a) ADJUSTABLE BLADE PUMP CAVITATION TESTS.
(b) S. Morgan Smith Company.
(c) Commercial research.
(d) R. Sahle, H. B. Bennett and testing crew for the S. Morgan Smith Company.
(e) Engineering Department, George A. Jessop, Chief Engineer.
(f) To determine the cavitation limits for the full size pumps in their field setting.
(g) A complete model consisting of an adjustable-blade impeller, guide-vane casing, elbow suction tube and elbow pressure tube was used for the cavitation tests. The suction and discharge tubes are each connected to large steel tanks. Movable gates control the water level in each of the tanks. The level in the suction tank can be lowered to a level of approximately 20 ft below the center line of the impeller. Vacuum is created in the suction box in order that the intake is at all times submerged. This cavitation stand is known as an open system since the water used is circulated in an open channel. During tests the whole system was submerged to avoid taking air into it.
Sigma was determined by the usual method - Sigma equals barometer in feet of water minus the vapor pressure in feet of water above 32° F. minus the suction lift in feet divided by the total head.
The discharge was measured by rated piezometers which are located in the suction tube. The pump shaft is direct connected to an electric dynamometer operated as a motor and connected by means of levers to a beam scale. The head is measured by piezometer connections located at the entrance to the suction tube and at the discharge end of the pressure tube.
(h) Tests are now in progress.

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(879) (a) ADJUSTABLE BLADE AXIAL FLOW PUMP EFFICIENCY, HORSE-POWER AND DISCHARGE TESTS.

(b) Canadian & General Finance Company, Ltd., Sao Paulo Tramway, Light and Power Company, Ltd., Traicao Pumping Plant.

(c) Commercial research.

(d) R. Sahle, H. B. Bennett and testing crew for the S. Morgan Smith Company, F. T. Simson, Engineer of the Canadian & General Finance Company, Ltd.

(e) Engineering Department, George A. Jessop, Chief Engineer.

(f) To determine the discharge in cfs, the horse-power, and efficiency of a full-size adjustable-blade axial-flow pump in its permanent field setting. To determine the horse-power and efficiency when operating the pump impeller in the reverse direction as a turbine. To obtain complete information so that the pump can be most efficiently operated over the entire range of head from 4.5 to 7.5 meters. To determine the blade angle where minimum running torque will occur, the runaway speed and the maximum hydraulic thrust. To rate piezometers located at various points in the suction and pressure tubes.

(g) An exact model was made of the prototype impeller, guide-vane casing, elbow suction tube and elbow pressure tube. The tubes were made of plate steel and were built-up in sections and welded together to conform with the prototype design. The impeller blades were carefully set and locked in a series of seven positions or angles covering the full movement. At each position efficiency, horse-power and discharge tests were conducted over a large range of speeds to cover the required proportional speed as determined by the field head conditions. At each position of the blades, running torque was determined by maintaining a constant speed and a constant water level in the discharge pit which was entirely water tight.

The power input and output were measured by an electric dynamometer and a precision beam scale. The head was measured by piezometer connections located at the entrance to the suction tube and at the discharge end of the pressure tube. The discharge was measured by a sharp-crested weir without end contraction.

(h) The test was conducted as an acceptance test for the Canadian & General Finance Company, Ltd. Engineers.

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(880) (a) FRANCIS TURBINE EFFICIENCY AND POWER TESTS.

(b) S. Morgan Smith Company.

(c) Research.

(d) R. Sahle, H. B. Bennett and testing crew for the S. Morgan Smith Company.

(e) Engineering Department, George A. Jessop, Chief Engineer.

(f) To improve the capacity and efficiency of turbines of standard design.

(g) Investigations were carried out in an open flume setting. All tests were conducted over a large range of speed and sufficient number of gate openings so that a curve can be drawn to determine the exact opening to produce the maximum efficiency. Various lengths and tapers of vertical draft tubes were also tested with the above runner and wheel case.
(h) Tests are completed.

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NEW YORK UNIVERSITY, HYDRAULIC LABORATORY.

(750) (a) LOSSES OF HEAD WITH AIR AT LOW PRESSURES.
(h) Experimental work has been completed and graduate student thesis is in preparation.

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(751) (a) HYDRAULICS OF SURFACE FILTER WASH.
(h) Experimental work has been completed and graduate student thesis is in preparation.

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(881) (a) FREE OUTFALL FROM CIRCULAR CONDUITS.
(b) New York University.
(c) Master's thesis.
(d) J. C. Morgan.
(e) John 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 free outfall as a metering device.
(g) Laboratory measurements using 4" to 14" pipes with flows up to 2 cfs.
(h) Experimental work to be started immediately.

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NEW YORK UNIVERSITY, CHEMICAL ENGINEERING LABORATORY.

(884) (a) A STUDY OF STREAMING POTENTIALS.
(b) New York University.
(c) Graduate research for master's degree.
(d) Professor H. J. Masson and Mr. E. Grabowski.
(e) Professor H. J. Masson.
(f) To determine the relationship between Reynolds number, pressure drop and streaming potentials for a wide variety of fluids.
(g) Using the conventional apparatus for determining Re vs. ΔP. The electrostatic potential developed at different points of the system will be determined.
(h) R. E. Treybal, Thesis, New York University Library. "Study of Development of Electrostatic Charges in a Flowing Liquid."

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(885) (a) THE EFFECT OF FLOW OF ELECTROLYTE ON DISTRIBUTION OF METAL DEPOSIT.
(b) New York University.
(c) Undergraduate thesis.
(d) Professor Masson and Messrs. D. Horvath and R. Burdynski.
(e) Professor Masson.
(f) The distribution of metal deposit depends on the nature of the flow - laminar or turbulent of the electrolyte. Conversely the distribution of metal deposit will give an indication of the nature of the flow past a body.
(g) A cylinder is immersed in a motionless copper sulphate bath and the distribution of copper in the surface determined. The electrolyte is now set in motion from anode to cathode and the distribution of the deposit determined at different velocities.
(h) Mason B. Lindsey, Thesis, New York University Library, "A Study of the Effect of Flow of Electrolyte in Metal Deposit."

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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.
(h) All projected experimental work to be completed by Jan. 30,1939. Results submitted to Committee for analysis.

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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 & 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) Considerable data have been taken, but they are as yet incomplete.

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(882) (a) A STUDY OF SMALL ATOMIZING JETS.
(b) Standard Container Corporation.
(c) Cooperative project of Engineering Experiment Station.
(d) R. W. Hursh.
(e) Prof. S. R. Beitler.
(f) To study the hydraulic action of small vaporing jets as used in spray nozzles.

(g) Production spray nozzles are being tested for capacity and effectiveness of atomization by weight and photo processes.
(h) Special machinery designed but no data taken.

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OKLAHOMA AGRICULTURAL AND MECHANICAL COLLEGE.

(883) (a) A SURVEY OF THE MINERAL CONTENT OF THE WATERS OF OKLAHOMA.
(b) Engineering Experiment Station at the Oklahoma Agricultural and Mechanical College, Stillwater, Oklahoma.
(c) Project of Academic Research.
(d) Dr. O. M. Smith, Professor of Chemistry and Head of the Department of Chemistry and Chemical Engineering, in charge;
Mr. H. S. Darcey, C. E., Sanitary Engineer of the Oklahoma State Department of Health;
Mr. R. Dott, Geologist of the Oklahoma State Geological Survey;
Mr. L. Cecil of the International Filter Company.
(e) Dr. N. M. Oboukhoff, Research Professor of Electrical Engineering and Professor of Mathematical Physics.
(f) Determination of the mineral content of waters of Oklahoma in a form of a survey.
(g) Experimental method covering practically all districts and sections of Oklahoma.
(h) Almost completed.
(i) Most probably will be published in January, 1939, as a Bulletin of the Engineering Experiment Station at the Agricultural and Mechanical College.

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OREGON STATE COLLEGE

(681) (a) FLOW AROUND BENDS IN OPEN CHANNELS.
(b) Committee on Hydraulic Research, Am. Soc. C. E.
J. C. Stevens, Chairman, Portland, Oregon.
(c) A research project on flow around bends in open channels.
(d) C. A. Mockmore and Fred Merryfield.
(e) Prof. C. A. Mockmore, Corvallis, Oregon.
(f) An open channel, 18 inches wide and 10 inches deep, with several bend sections of 30-inch central radius have been designed and built to permit varying flow conditions.
(h) Taking of motion pictures now under way. A mathematical analysis based on observed conditions of flow at a section half way around a 180-degree bend has been made. Relative values of acceleration and angular velocity of particles at various points in the section have been computed and plotted for comparison. Preliminary report available.

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PACIFIC HYDROLOGIC LABORATORY.

(370) (a) EARTH DAM INVESTIGATIONS.
(b) 1. Pacheco Pass Water District.
2. The Goldfields Consolidated Mines Company.
(c) Conducted as part of engineering research for design and selection of material for rolled-fill earth dams.
(d) Charles H. Lee.
(e) Charles H. Lee, Consulting Engineer,
58 Sutter Street, San Francisco, California.
(f) Study of physical properties of soils as related to rolled-fill earth dam construction.
(g) Mechanical analysis by hydrometer method, specific gravity determinations, compaction tests, permeability tests, etc.
(h) Completed.
(i) General conclusions from results included in following technical papers:
1. Selection of Materials for Rolled-fill Earth Dams, with discussion, by Charles H. Lee, Trans. A.S.C.E., 1938 (Vol. 103) P.1
2. Some Problems in the Design of Earth Embankments, by Charles H. Lee. Paper read before S. F. Section, A.S.C.E. at meeting of October 18th 1938.
3. Graphical Representation of the Mechanical Analyses of Soils. Discussion by Charles H. Lee, Proc. A.S.C.E. September 1938, P. 1438.

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(752) (a) STUDY OF REMOVAL OF SALT WATER FROM DREDGER-FILL BY DRAINAGE AND LEACHING.
(b) Golden Gate International Exposition, Department of Works, Treasure Island, San Francisco, California.
(c) Laboratory and field research.
(d) Charles H. Lee.
(e) Charles H. Lee, Consulting Engineer,
58 Sutter Street, San Francisco, California.
(f) Determination of an inexpensive and rapid method for reducing groundwater level and salinity in a new dredger-fill to the point where any variety of horticultural vegetation could be planted without injury or retarded growth. The dredger-fill (Treasure Island) is composed of material excavated from the bottom of San Francisco Bay and is largely fine sand with occasional balls of blue marine clay and thin layers of clay. The central portion of the fill was saturated with salt water to within one foot of the surface and all portions were impregnated with salt. Water level was to be lowered to at least 6.5 feet below the surface and chlorine content of the soil was to be reduced from over 5000 p.p.m. to less than 100 p.p.m.

(g) The method as originally outlined was followed essentially as follows:
1. Gravity salt water was removed from the fill to a depth of 10 to 13 feet below ground surface by means of batteries of 1-1/4 inch well points sunk to a depth of 25 feet and connected by suction-headers to pumps discharging into previously constructed storm sewers.
2. Adhesive saline soil moisture in sand was leached out, reducing chlorine from a concentration of 3000 to 5000 p.p.m. to less than 100 p.p.m. This was accomplished by natural rainfall supplemented by sprinkling the surface with fresh water where drainage was incomplete at the time of rainfall.
3. Saline clay balls were removed from backfill around trees and shrubs and beneath lawn and annual plants, and gypsum mixed with the backfill at the rate of 1 lb per cubic foot, to act as a flocculating agency to break up the clay and facilitate leaching by water from garden watering.

(h) Laboratory and field tests have been completed, planting exceeding 3000 trees, many thousand shrubs and 30 acres of lawn and garden have been completed, and after an elapse of from 4 to 6 months have shown no indication of injury from salinity.

(i) Report of laboratory and field tests submitted to Director of Works, Golden Gate International Exposition. Brief description of method and results in Engineering News Record, October 13th 1938, pp.462-463.

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(916) (a) STUDY OF INCREASING THE IMPERMEABILITY OF CLAY MEMBRANE BY USE OF SODIUM CHLORIDE.

(b) Golden Gate International Exposition, Department of Works, San Francisco, California.

(c) Laboratory and field research.

(d) Charles H. Lee.

(e) Charles H. Lee, Consulting Engineer, 58 Sutter Street, San Francisco, California.

(f) To select an inexpensive method for placing an impervious clay lining upon the bottom of the 7-acre fresh-water lagoon at Treasure Island, San Francisco, California. The lagoon basin is excavated in permeable unsaturated sand, and the depth of water is to be 3 feet. Losses by seepage are to be reduced as nearly as possible to zero.

(g) Investigations first included selection of well-graded clayey material capable of a high degree of compaction by use of mechanical rolling equipment. For this purpose mechanical analysis and compaction tests were made. A second line of investigation was to determine the effectiveness of solutions of sodium chloride in rendering more cohesive and impermeable the spread and rolled 10-inch clay layer. For this investigation, tests were made of the chemical content of the clay soil solution, the degree of flocculation in the natural clay, the deflocculating effect of applying sodium chloride solutions of various strengths followed by working with fresh water, and the change in physical properties of the clay, including permeability, as the result of the salt treatment.

(h) Laboratory tests have been completed indicating that the selected clay could be rendered impervious by the use of sea water. Clay has been selected, placed in the lining and rolled, sea water has been pumped into the lagoon and held for a period of 45 days, after which it was pumped out and the lagoon filled with fresh water. The initial rate of fresh water seepage through the rolled clay lining, as determined in a test pool, was 1 inch per day. When salt water was introduced into the lagoon, the rate was reduced to 0.7 inch per day with marked increase in cohesiveness of the clay as compared with that using fresh water. After draining off the salt water and refilling with fresh water, the initial rate during the first four days was reduced to 0.4 inch. It is anticipated that this rate will be greatly reduced within a period of 50 days, after the fresh water has thoroughly penetrated and washed the clay lining.

(i) Report is being prepared in the form of a technical paper for submission to the A.S.C.E.

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THE PENNSYLVANIA STATE COLLEGE.

(137) (a) A STUDY OF VARIOUS TYPES AND KINDS OF STILLING DEVICES FOR USE IN CHANNELS OF APPROACHED WEIRS FOR OTHER PURPOSES.

(c) Research.

(e) Professor Elton D. Walker.

(h) The bulletin is still under preparation, work having been delayed by pressure of other duties of the investigators.

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PRINCETON UNIVERSITY.

(886) (a) AN INVESTIGATION INTO THE ANGULAR CHARACTERISTICS OF AN ADJUSTABLE BLADE CURRENT METER.

(b) Graduate thesis for degree of M. E.

(c) Experimental research.

(d) Marshall C. Long.

(e) Lewis F. Moody, Professor of Hydraulic Engineering.

(f) To determine the characteristics of an axial-flow, adjustable blade current meter in turbulent flow.

(g) The instrument has been described by previous investigators. It was constructed in the Engineering Dept. shop and for this investigation it was rebuilt, with the addition of ball bearings furnished by the Pennsylvania Water and Power Company, and other modifications. The work was a continuation of earlier experiments in this field previously reported. Extensive tests were made, the meter being moved through still water at various angles of obliquity, and with the propeller blades adjusted at various pitch angles.

(h) At a pitch angle of 11.4 degrees the meter registered the true cosine component of the velocity within one-half of one percent accuracy up to thirty degrees of flow obliquity. At pitch angles below ten degrees the meter over-registers, and at pitches above about fifteen degrees it under-registers. The meter thus furnishes in a single instrument means for obtaining in sequence both types of registry; or, for securing results free from turbulence errors for use in the single-meter method of water measurement, with satisfactory accuracy.

(i) The paper was awarded the graduate student prize of the American Society of Mechanical Engineers, December 1938.

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RENSSELAER POLYTECHNIC INSTITUTE.

(887) (a) USE OF A DIAPHRAGM FOR MEASURING FLOW THROUGH A VENTURI FLUME.
(b) General scientific research.
(c) Undergraduate thesis.
(d) Stuart Mason Phelps.
(e) Professor Grant K. Palsgrove.
(f) To determine the characteristics of a flexible diaphragm measuring apparatus used in connection with a Parshall measuring flume.
(g) From a large elevated tank water was allowed to flow through a calibrated Venturi meter into a rectangular concrete flume and thence through a 6" wooden Parshall flume arranged for free-flow condition only. Rate of flow varied from 0.25 cfs to 0.85 cfs. Two shapes, (circular and square), three sizes (1", 3", 4") and two thicknesses (very thin sheet rubber and ordinary automobile tire tubing) of diaphragm were used.
Readings of head in Parshall flume were observed on a glass tube mounted in front of a target and connected to the bottom of a vertical sliding rod which was graduated and capable of vertical motion through a vernier block.
Within range of experiments to date, diaphragm gives very consistent measure of rate of flow (maximum variation found, 3%; within great majority of runs, variation found was less than 1%). The 3" diaphragm seems to be most satisfactory, although size, shape and thickness of diaphragm apparently have no effect on accuracy of readings with above indicating device, hence the possibility of use of flexible material particularly adapted to withstand abrasive or chemical actions. Resulting equation:- $Q = 2.20\ H^{1.60}$; for 6" flume.
(h) Project incomplete; part herein reported available at Rensselaer Polytechnic Institute Library.

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(888) (a) INVESTIGATION OF FLOW CONDITIONS FOR A FIXED AIR BUBBLE IN A WATER CONDUIT.
(b) General scientific research.
(c) Undergraduate thesis.
(d) Peter John Musante, Jr.
(e) Professors Grant K. Palsgrove and James J. Devine.
(f) To determine the water velocity in a tube necessary to hold a limiting size air bubble "Fixed" for angles of inclination of tube from 0 to 90 degrees with horizontal.
(g) Two tubes of the same size were used (3.7 cm. internal diameter). Tube A to approximate a smooth tube with no discontinuity or interference, tube B to approximate a pipe line with a branch taken off at 90° to the longitudinal axis of pipe. Water supply was taken from an overhead tank under constant head. It was found that the maximum velocity in all cases appeared at 45° inclination of tube where a definite break in the curves of velocity vs. inclination occurs.
From 0° to 45°: - $V = \frac{0.86}{\theta - 0.13}$

θ = degrees inclination.

From 45° to 90°: $V = \frac{4.48}{\theta + 0.3}$

(h) Project incomplete; part herein reported available at Rensselaer Polytechnic Institute Library.
(i) This work is a continuation of that by Alessandro Veronese in Milano, Italy.

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STANFORD UNIVERSITY.

(889) (a) CHARACTERISTICS OF BORE WAVES.
(b) Research.
(c) Research.
(d) J. Hedberg.
(e) Prof. J. Hedberg.
(f) To study the details of their transmission especially around bends, into constricted or expanded sections and to find out ways and means of reducing or eliminating a wave after it has once started.
(g) Production of bore waves at the end of a rectangular channel and observing its progress past various channel constructions.
(h) In construction stages.

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(890) (a) VARIABLE DISCHARGE OF A RECTANGULAR CHANNEL.
(b) Research.
(c) Thesis for the Degree of Engineer.
(d) M. MacLain Adams.
(e) J. Hedberg.
(f) Checking of the varied flow equation with particular attention to the nature of the frictional resistance term.
(g) A variable discharge of known character is introduced into a rectangular channel and a complete record of depths obtained along the channel. From these and the known volume discharged, all the flow factors are evaluated and the friction term isolated.
(h) In construction stages.

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SYRACUSE UNIVERSITY.

(891) (a) PROPORTIONAL WEIR STUDIES.
(b) Departmental research project.
(c) To study characteristics of a weir in which the discharge will be proportional to the first power of the head. The weir will consist of a sharp-edged rectangular notch in a wall having a cross-section in the form of a cycloid curve.
(d) Louis Mitchell and Cecil S. Camp.
(e) Prof. Cecil S. Camp.
(f) To determine coefficients and adaptability to practical use.
(h) Construction stage.

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UNION COLLEGE.

(892) (a) FLOW THROUGH SHARP-EDGED RECTANGULAR WEIRS AND VERY NARROW RECTANGULAR SLOTS.
(b) General research.
(c) General research.
(d) Prof. Robert W. Abbett.
(e) Prof. Robert W. Abbett.
(f) To determine causes of variation in weir formula coefficients.
(g) Flow tests on weirs having crest lengths varying from 1/4 inch to 48 inches.
(h) Project completed and results published in Engineering News-Record, October 6, 1937.

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(893) (a) EXPERIMENTS ON THE HYDRAULIC CHARACTERISTICS OF SPRAY NOZZLES.
(b) Union College and The Anthony Co., Long Island City, N. Y.
(c) General research.
(d) Prof. Robert W. Abbett.
(e) Prof. Robert W. Abbett.
(f) To improve the design of spray equipment for concrete curing chambers and moist rooms.
(g) Experiments to develop a spray nozzle operating under hydrostatic pressure which will produce a spray suitable for concrete curing purposes.
(h) Project completed and results published in Engineering News-Record, April 28, 1938. The experimental nozzle produces a satisfactory spray from hydrostatic pressures from 25 lb per sq in. up.

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(894) (a) AN INVESTIGATION OF SPLASH PHENOMENA.
(b) General research.
(c) General research.
(d) Robert W. Abbett.
(e) Prof. Robert W. Abbett.
(f) To define the energy transformations involved in various splash effects.
(g) An attempt is being made to determine the mathematical laws of splash energy from measurements and photographs of splash patterns created by objects of various forms.
(h) Project incomplete and inactive at the present time.

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THE STATE COLLEGE OF WASHINGTON.

(628) (a) RESISTANCE OF SPECIALLY DESIGNED BENDS FOR 6-INCH PIPE.
(b)-(c) Private research in cooperation with Engineering Experiment Station.
(d) E. R. Fosdick.
(e) Professor J. G. Woodburn (now at University of Wisconsin)
(f) To determine loss of head due to specially designed 90-degree bends in 6-inch pipe, as compared to loss due to standard cast-iron bends.
(g) Piezometers on bends and in approach and discharge pipes were used to measure the loss of head. Discharge was measured over a 90-degree V-notch weir.
(h) Tests completed and report available in Engineering Experiment Station Bulletin No. 51, "Diversion Losses in Pipe Bends".

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(895) (a) ACCURACY OF VARIOUS WEIR FORMULAS.
(b)-(c) Department of Civil Engineering and Engineering Experiment Station.
(d) Professor J. G. Woodburn and students.
(e) Professor J. G. Woodburn (now at the University of Wisconsin).
(f) To compare the accuracy of the various weir formulas.
(g) 111 tests on sharp-crested weirs were made at different heads, and the accuracy of the discharges as computed by the various formulas was compared with the measured discharge.
(h) Tests complete and report available as Engineering Experiment Station Bulletin No. 53, "Check List of Weir Formulas".

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(896) (a) APPLICATION OF PRESSURE-MOMENTUM THEORY TO BROADCRESTED WEIRS.
(b)-(c) Dept. of Math. and Mechanics at University of Minnesota and Dept. of Civil Eng'r at Washington State College.
(d) Professors H. A. Doeringsfeld, C. L. Barker.
(e) Professor C. L. Barker.
(f) To develop a formula for determining the flow over a broadcrested weir without the use of empirical coefficients.
(g) Several weirs of various sizes were tested, and the theoretical formulas checked for accuracy against the observed discharge.
(h) Experimental work completed and report being prepared.

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WEST VIRGINIA UNIVERSITY.

(897) (a) EFFICIENCY RATINGS OF SEDIMENTATION BASINS.
(c) Undergraduate thesis.
(d) Esther R. Benford.
(e) H. W. Speiden.
(f) To study the effects of various baffle systems on the efficiency of a model circular sedimentation basin.
(g) A model approximately 1/30th the size of the basin used by the Morgantown Water Co. was built and tested at two rates of flow. Two different systems of baffles were tested. Various methods of measuring the efficiency of volumetric displacement are discussed.

(h) Complete.
(i) Efficiency tests were conducted by the usual method of adding salt to the influent and testing the effluent for chlorides. Some criticism of the method of adding the salt is probably justified. Results were quite erratic.

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UNIVERSITY OF WISCONSIN.

(764) (a) EFFECT OF VISCOSITY AND SURFACE TENSION ON V-NOTCH WEIR COEFFICIENTS.
(b)(c) Doctor's thesis.
(d)(e) Professor Arno T. Lenz.
(f)(g) Discharge coefficients for V-notch weirs with angles from 10 to 90 degrees inclusive were obtained by precise measurements for water and two oils. Temperatures of the liquids were controlled and the corresponding values of viscosity and surface tension determined. These have been correlated by dimensional analysis, and the results are being checked with data from other experimenters.
(h) Bulletin in preparation, probably available in September.

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(768) (a) STANDARD WEIR STUDIES.
(b)(c) Departmental research project in cooperation with the Graduate School.
(d) L. E. Bidwell. (e) Prof. J. G. Woodburn.
( ) Study of the accuracy of 11 international standard weir formulas for heads up to 1 ft; determination of effect of variations in weir design on accuracy of discharge measurements.
(g) A steel flume 20 ft long with a glass-sided section 6 ft long has been built in the Laboratory. The width of the flume is 2 ft and the depth 3 ft. A sharp-crested weir 2 ft high has been installed in the glass-sided section. Flows are measured volumetrically.
The first variation in design which is being studied is the determination of the amount of air required under the nappe in order that the head-discharge relation will not be affected. The amount of air required is measured by number of 1-in. pipes required, as well as by a larger pipe with an air-flow meter. A comparison of accuracy has been made of two methods of reading the head on the weir: (1) Hook gage in stilling well at side of flume connected by pipe with bottom of flume 3 ft upstream from the weir. (2) Point gage in the center of the flume 3 ft upstream from the weir.
(h) Volumetric tests have been made for flows up to 0.8 cfs. Comparison of results is being made with each of the 11 formulas. Preliminary studies have been made of air requirement and of best methods of measuring the air supply required under the nappe.

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(898) (a) TRAVEL OF SURGE WAVES IN OPEN CHANNELS.
(b)(c) Departmental research project.
(d) E. R. Dodge, B. R. Blackwell, E. A. Menuez.
(e) Professor J. G. Woodburn.
(f) To determine the rate of travel of surge waves and the effect of variations in width and depth of channel on this rate of travel.
(g) A rectangular wooden flume 1 ft wide and 80 ft long has been built in the Laboratory. Preliminary tests involve determination of value of n for flow at various depths and at various grades of the flume. The next step will be a study of rate of travel of waves of increasing and decreasing depth to check the general theory on this subject. This preliminary work will be followed by a study of the rate of travel of surges caused by slow opening and closing of head gates. The flume will then be widened in places to determine if possible the effect of these wide places on the rate of travel of the surge wave. The effect of deepening the flume will also be studied. From a small-scale model it is hoped that progress can be made to tests on larger flumes and on natural water courses.
(h) Construction of the flume is completed and experimental work is beginning.

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(899) (a) FLOW OF FLUIDS THROUGH SHARP-EDGED ORIFICES UNDER LOW HEADS.
(b)(c) Master's thesis.
(d) E. A. Menuez.
(e) Professor J. G. Woodburn.
(f) To determine the relations between orifice coefficients and Reynolds and Weber's numbers; also critical velocity in a jet in the atmosphere.
(g) Discharges of orifices from $\frac{1}{8}$-in. to 2-in. diameter are to be measured for fluids of various viscosities and surface tensions, to determine the relation between the various measured quantities and the results obtained by dimensional analysis. By photographic methods it is proposed to determine the distribution of velocity throughout the jet. Photographs will be made under a beam of parallel light 1/8 to 1/4-in. in width parallel to the jet covering both horizontal and vertical traverses of the jet. The photograph will be timed by a moving slit motivated by a falling weight which will control the light beam.
(h) Apparatus has been constructed for accurate determination of viscosity and surface tension in fluids. An orifice tank has been constructed and measurements have been made on discharge coefficients under heads varying from 0.030 to 2.500 ft. Apparatus has been designed for velocity determination.

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(900) (a) WATER APPLICATION EFFICIENCY STUDIES WITH SPECIAL REFERENCE TO UTAH WORK.
(b)(c) Master's thesis.
(d) Wayne D. Criddle.
(e) Professor J. G. Woodburn.
(f) To determine more efficient practical methods of applying irrigation water to the land.
(g) Field studies of existing method of water application now used by irrigators and experiments with new methods developed from a study of the physical characteristics of the various soils, together with a review of the published literature on the subject.
(h) Field studies have been made during the past two summers in Utah County, agriculturally one of the most important counties of Utah. Typical farms throughout the county were seledted for study. Soil types varied from a light sandy soil to a heavy red clay. Crops and methods or types of irrigation were varied. Field studies have been completed and analysis of the results is in progress.

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(901) (a) HYDRAULICS OF HEAD FLUMES, DROP INLETS AND ENERGY DISSIPATORS USED BY THE SOIL CONSERVATION SERVICE.
(b)(c) Undergraduate theses.
(d) E. Bartz, D. Hilgendorf, W. H. Tamm, R. J. Katchera, Mr. & Mrs. J. Huppler.
(e) Professor J. G. Woodburn.
(f) Determination of coefficients of discharge, of variation of pressure, and of methods of dissipating energy in the outlet.
(g) Small-scale models will be constructed and tested in the Laboratory. Three different sizes of models will be teste to determine the effect of variation in scale. The model flows and heads tested will correspond to the flows and heads encountered in small dams used by the Soil Conservation Service for controlling erosion.
(h) The fall semester has been devoted to the study of literature on this subject and planning and designing the models. Testing will start the second semester.

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(902) (a) PERFORMANCE OF SPRING-LOADED WATER-HAMMER RELIEF VALVES.
(b)(c) Master's thesis.
(d) P. S. Davy, E. H. Strand.
(e) Professor L. H. Kessler.
(f) Experimental study of the behavior of flat disc-type spring-loaded relief valves on large pipe lines to determine coefficients which can be used in computing the reduction of water-hammer pressures resulting from the use of such valves.

(g) Five-in. relief valves with springs of various moduli were used in the experiments. The coefficients of discharge for various lifts of valve were determined, and an analytical method was developed for predicting reduction in water-hammer pressures when these valves are used on large pipelines such as those supplying locomotive hydrants. Field tests conducted a number of years ago have been correlated with the laboratory investigation and with the analytical method.

(h) Tests have been completed and thesis has been filed in the University Library. A technical paper setting forth the results of the study is in preparation.

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(903) (a) RELIEF FROM WATER HAMMER IN SMALL COMPOUND PIPES.

(b)(c) Undergraduate thesis.

(d) C. J. Harrison H. R. Panzer, T. B. Prawdzik.

(e) Professor L. H. Kessler.

(f) To study the behavior of air chambers and mechanical-pneumatic arresters in reducing water-hammer pressures on compound pipes in series and to compare the results with previous test data on simple pipes.

(g) Length of the test pipelines in series are varied from 50 to 400 ft. Air chambers and arresters with useful air volumes from 4 to 8000 cu in. are connected just above the quick-closing valve at the discharge end of the line. The smallest diameter in the series is used at the discharge end. Diameters of test pipe are 1/2, 3/4, 1, $1\frac{1}{3}$, and 2 in. Variations in pressure are recorded on chronomatic drums stylus-operated by two different types of high-speed indicators.

(h) The work of the first semester has been directed largely toward learning and improving the technique of making water hammer tests. Tests will start in February.

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(904) (a) MONTHLY VARIATION OF RAINFALL INTENSITIES IN WISCONSIN.

(b) (c) Research in Hydrology.

(d) (e) Professor Arno T. Lenz.

(f) To determine whether extreme rainfall intensities are likely to occur with snow on frozen ground.

(g) Intensity data from six U. S. Weather Bureau records were combined into a single record of 204 station-years and analyzed. Intensity-frequency curves were drawn for each month. From these curves a second set was drawn showing the intensity to be expected for each month for frequencies of 30 and 100 years for periods of 5 through 120 minutes. It is concluded that the intensity to be expected in winter is much less than that expected in mid-summer. For example, April storms of a given frequency will have only about one-third the intensities of July storms of the same frequency.

(h) Project completed and reported in Transactions of the American Geophysical Union, Nineteenth Annual Meeting, 1938, Engineering Reprint No. 66, College of Engineering Experiment Station, University of Wisconsin. Copies available upon application to the writer.

WORCESTER POLYTECHNIC INSTITUTE.

(647) (a) STUDY OF ELECTRODES FOR SALT VELOCITY METHOD.
(b) (c) Alden Hydraulic Laboratory Research.
(d) L. J. Hooper.
(e) Prof. C. M. Allen.
(f) To determine the performance of various electrode designs under various operating conditions.
(g) Tests being made in 40" line, checking discharge measurements with a calibrated Venturi meter and a calibrated weir.
(h) In progress.

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(648) (a) REPRESENTATIVE AMERICAN HYDRAULIC LABORATORIES.
(b) Alden Hydraulic Laboratory and Boston Society of Civil Engineers.
(c) Inspection and report of Hydraulic Laboratories in United States and Canada.
(d) L. J. Hooper.
(e) Prof. C. M. Allen.
(f) To become acquainted with current hydraulic laboratory research in the United States and Canada.
(g) Personal inspection trip.
(h) Report completed.
(i) Report published under above title as Section 2, Number 1, of Vol. XIV, Journal of the Boston Society of Civil Engineers.

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(649) (a) INVESTIGATION OF ERRORS OF PITOT TUBES.
(b) Alden Hydraulic Laboratory.
(c) General research.
(d) C. W. Hubbard.
(e) Prof. C. M. Allen.
(f) To determine the cause of and evaluate the systematic errors in pitot tube measurements, both in smooth and turbulent water.
(g) 1. Continuation of measurements of mean angularity of turbulent flow in 12", 40", and 78" pipes. Tests made with small vane indicator so connected electrically with a chronograph that the percent of time the flow angle is less than or greater than some arbitrary angle could be measured. The results when plotted on probability paper indicated values of mean angle which is also a measure of turbulence.
2. Measurements of pressure pulsations at impact tip and wall piezometer to determine effect on pitot tube. Tests made with small diaphragm so connected electrically to a chronograph that percent of time that piezometer pressure exceeds variabbe reference pressure can be measured. Mean pressure pulsation found by plotting results on probability paper.
3. Tests to determine weather there is dynamic resistance to backflow of surges in manometer connected to pitot tube. Such a resistance would cause surges to be unduly weighted and too great an average manometer reading. Tests made by measuring rate of flow into and out of pitot tip while tip is located in jet from 4" orifice.

4. Study of effect of support rod of pitot tube on reading of piezometer in pipe wall. Tests made by moving different sizes of dummy rod with respect to fixed wall piezometer. Effect of presence of rod on piezometer reading determined by noting change in piezometer reading from initial value when dummy rod was in distant position.
5. Test of effect of pitot tip on wall piezometer reading because of "venturi effect" in causing an increase in the velocity of the water past the tip. Effect appreciable only when pitot tip is large for the pipe.
6. Further tests of the effect of a support rod on the pressure piezometer on the side of a pitot-static tip. A long tip with a side-pressure piezometer was moved longitudinally and angularly with respect to a dummy support rod. The effect of the dummy rod on the piezometer reading was taken as the change in reading from that obtained with the rod in a distant location.

(h) The results of all of the above tests in addition to the calibration of a pitot tip on a rotating boom in still water by balancing the pitot impact head against a centrifugal head which was previously reported were presented in a paper "Investigation of Errors of Pitot Tubes" at the December meeting of the A.S.M.E. in New York, 1938.

(i) 1. Measurements of mean angularity of turbulent flow were found to be less than 3° in normal pipes, too small to affect the reading of a pitot tube. The measured angularity compared well in magnitude with that computed from the Prandtl and Von Kármán theory of turbulent flow. The angularity was found to be nearly constant across the pipe. Angularity in a radial direction and that perpendicular to the radius of the pipe was found to be equal.
2. Pressure pulsations agreed in magnitude with angularity (lateral pulsation) and were found to be too small to affect the true averaging of the velocity from the measured pulsating pressures.
3. No dynamic resistance to the backflow of surges from a pitot tip could be detected, indicating that the true dynamic head would be read by a manometer in which the liquid was surging.
4. The reading of the wall piezometer was found to be affected by the pitot support rod, the amount depending on the size of the rod and the relative position of rod and piezometer.
5. The pitot tip was found to affect the reading of the wall piezometer slightly, even when the piezometer was upstream from the end of the tip. The effect is proportional to the relative size of the tip and pipe.
6. The support rod of a pitot-static tube was found to affect the reading of a single side pressure piezometer on the tip, the amount of this effect depending on the relative position of piezometer and support rod.

The general conclusion was that the impact tip registered the true dynamic head and that the reason for a pitot coefficient different from unity was an error in reading the true pressure head.

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(905) (a) DIVERSION TUNNEL OUTLET MODEL TEST, LACKAWACK DAM.
(b) Board of Water Supply, City of New York, Walter Spear, Ch. Eng.
(c) Check of design by model testing.
(d) C. W. Hubbard and O. L. Brodie.
(e) Prof. C. M. Allen.
(f) To devise a method of reducing the kinetic energy in the water discharging from the proposed diversion tunnel so that the channel leading from the outlet to the river would not be damaged by flood discharges.
(g) Method was to construct a model of the lower end of the tunnel and stilling basin one-sixtieth full scale. Water was measured by calibrated 6" venturi meter. Tunnel proper was represented by 45 ft of six-inch pipe set at the correct slope. Pipe was painted inside with a waterproof paint which when tested showed the value of "n" to be 0.0082, almost the exact roughness to represent a concrete-lined tunnel sixty times as large. Changes were made in the stepped bottom of the diverging stilling basin until the most effective and most economical arrangement was obtained.
(h) Completed.
(i) It was found that by adding stepped projections on the vertical faces of proposed steps that the effectiveness in dissipating kinetic energy in the water flowing from the tunnel and up over the rising steps was considerably increased. The projections on the vertical faces of the steps prevented the water from being all deflected to the diverging side walls and caused a more uniform flow in the channel downstream from the stilling basin.

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(906) (a) MODEL TEST OF INTAKE CONTROL WORKS, DELAWARE AQUEDUCT.
(b) Board of Water Supply, City of New York.
(c) Checking design by model testing.
(d) C. W. Hubbard and Torris Eide.
(e) Prof. C. M. Allen.
(f) & (g) To test two proposed methods of conducting the water from Rondout Reservoir into the tunnel leading to the West Branch Reservoir. The maximum difference in head was 300 ft, full scale. Each of the two designs was tested to determine the effectiveness in safely regulating the flow of water into the tunnel and also in preventing the entrainment of air in the water.
(h) Completed.
(i) Tests were made to determine the effectiveness of a number of types of outlets and energy dissipators, so that the lower stilling chamber into which the drop pipes discharged could be made as small as possible. Tests were made of the pressure at the top and bottom bends in the drop pipes in order that cavitation in the full-size structure might be prevented. Studies were made of the ability to prevent entrainment of air by observing the motion of fine air bubbles injected into the drop pipes. Measurement of the energy in the streams issuing from the various outlets were made by special pitot tubes.

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(907) (a) MEASUREMENT OF FLOW BY PITOT TUBES.
(b) Hydraulic Power Committee of the A.S.M.E.
(c) General research.
(d) Prof. C. M. Allen, C. W. Hubbard, L. J. Hooper.
(e) Prof. C. M. Allen.
(f) and (g) As a continuation of the recent investigation of the errors of pitot tubes, to calibrate various recommended types of pitot tubes in different sizes of pipes with various degrees of turbulence.
(h) Project started.

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(908) (a) UNION VILLAGE DAM, SPILLWAY MODEL TESTS.
(b) U. S. Engineer Office, Providence District, Lt. Col. J. S. Bragdon, District Engineer.
(c) Checking flood control designs.
(d) L. J. Hooper and C. N. Morang.
(e) Prof. C. M. Allen.
(f) The purpose of these tests was to determine whether the designed spillway and channel would safely discharge a flow of 52,000 cfs with the reservoir water level at elevation 567 ft and to effect whatever economies in construction possible in the design. (to determine the discharge capacity of the spillway and channel and to improve the flow conditions where possible)
(g) A 1:60 model of the project was made of concrete and wood. It comprised a section of the reservoir, entire approach channel, spillway crest, discharge chute and the rock surface to the downstream side of Avery Brook. A detailed study of the spillway crest shape was made with 1:16 scale crest sections in a 3-ft glass-sided flume.
(h) Model studies and report completed.
(i) The tests resulted in an increase in the discharge capacity of the spillway, improved flow conditions in the approach channel near the spillway crest, reduction of about 14% in the excavation of the approach channel and a modification of the discharge chute to secure more uniform distribution of the water over the rock surface at the discharge end.

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(909) (a) UNION VILLAGE DAM, TUNNEL OUTLET TESTS.
(b) U. S. Engineer Office, Providence District.
Lt. Col. J. S. Bragdon, District Engineer.
(c) Checking flood control designs.
(d) L. J. Hooper and C. N. Morang.
(e) Prof. C. M. Allen.
(f) To determine the flow and erosion conditions at and beyond the tunnel outlet.
(g) A 1:26 model was built of the project, using wood, concrete and sheet metal as dictated by ease of construction. The model comprised a short section of the tunnel, the outlet portal and about 600 ft of the excavated downstream channel.
(h) Project completed.
(i) It was found that under the conditions existing in the project a stilling pool was naturally formed below the outlet, and further artificial control works were not deemed necessary. Minor improvements were made to the design portal.

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(910) (a) KNIGHTSVILLE DAM, SPILLWAY.
(b) U. S. Engineer Office, Providence District.
Lt. Col. J. S. Bragdon, District Engineer.
(c) Checking flood control designs.
(d) L. J. Hooper and C. N. Morang.
(e) Prof. C. M. Allen.
(f) To determine the spillway capacity and the flow conditions in the spillway channel and river bed due to the spillway and tunnel discharges.
(g) A 1:60 concrete model of the Knightsville Spillway was made, comprising a section of the reservoir and dam, approach channel, spillway, the entire tunnel, the spillway discharge channel, and a portion of the natural river bed.
(h) Project completed.
(i) The discharge capacity of the spillway was determined for a number of lengths and approach conditions. The design was modified to avoid the possibility of scour near the tunnel outlet and near one transition of the approach channel at the spillway.

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(911) (a) SPILLWAY TESTS, SURRY MOUNTAIN DAM.
(b) U. S. Engineer Office, Providence District.
Lt. Col. J. S. Bragdon, District Engineer.
(c) Checking flood control designs.
(d) L. J. Hooper and C. N. Morang.
(e) Prof. C. M. Allen.
(f) To determine the discharge capacity of the spillway and the discharge channel under various conditions of operation.
(g) A 1:60 model of the Surry Mountain side channel spillway discharge channel as far as station 13+00 was made of wood and concrete. Discharges were measured with Venturi meters and the hydraulic gradients with traversing point gages.
(h) Project completed.
(i) The model tests indicated that some saving of rock excavation in the discharge channel and of concrete in the spillway could be effected without reducing the discharge capacity below the design figure. The design of the lower end of the discharge channel was modified to secure improved flow conditions.

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(912) (a) CONDUIT INTAKES.
(b) U.S.Engineer Office, Providence District.
Lt. Col. J. S. Bragdon, District Engineer.
(c) Checking flood control designs.
(d) L. J. Hooper and C. N. Morang.
(e) Prof. C. M. Allen.
(f) To determine a short and simple intake transition for a tunnel roof.
(g) A series of tests of intake shapes was made in a 5-ft test flume. Although only four shapes were tested, the effect of 15 different arrangements was determined by varying the elevation of a false floor in the intake and conduit. The hydraulic gradient was measured for three discharges for each model arrangement.
(h) Project completed. (i) These tests were not made for a specific project but were intended to be of general assistance in design.

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(913) (a) PIEZOMETER STUDIES.
(b)(c) Alden Hydraulic Laboratory research project.
(d) L. J. Hooper.
(e) Prof. C. M. Allen.
(f) To obtain an open flume check of piezometer performance.
(g) An open tilting flume 12" square in cross-section and 22 ft long was set up in a 5-ft test flume. A piezometer section was constructed 5 ft from the downstream end. Water surface checked with a traversing point gage. Water discharge measured with a calibrated 12" x 6" Venturi meter.
(h) Tests completed.
(i) Tests indicated that the piezometers used checked the average water surface within 1% of the mean velocity head of the water flowing. Velocities between 2.5 and 7.5 fps used. Smooth flume walls and walls roughened with galvanized wire screen 1/3" mesh were tried, but the result was unchanged.

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(914) VENTURI METER DESIGN.
(b) & (c) Alden Hydraulic Laboratory Research.
(d) L. J. Hooper.
(e) Prof. C. M. Allen.
(f) To find a reliable, compact design for a Venturi meter.
(g) Designs were made for a 10" x 5" and for a 8" x 4" meter. Two meters of each design were tested, the discharge being checked by a weighing tank.
(h) Work completed, no formal report made.
(i) It was found that a 10" diffuser 3 throat diameters long, followed by a sudden expansion to the normal pipe size, gave a meter with an overall loss of 14% of the measured deflection. This allowed the overall length of the 10" meter to be reduced to 30" and the 8" meter to 24". The 10" meter inlet transition used the A.S.M.E. flow nozzle shape. the 8" meter inlet provided a uniform acceleration of the velocity head in the first half, followed by a uniform deceleration as the throat was approached. The 8" meters had a practically constant coefficient with Reynolds Numbers in excess of about 10^5. The 10" meters gave coefficients which continually increased with the discharge, covering a range of 2% for Reynolds Numbers between 2×10^5 and 10^6.

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(915) (a) DRAFT LOG TESTS.
(b) Pitometer Log Corporation.
(c) Testing various designs.
(d) L. J. Hooper.
(e) Prof. C. M. Allen.
(f) To determine a design of a projecting rod which will allow the draft of a ship to be measured.
(g) Various designs have been tested on the boom, in a pipe line, and on a destroyer.
(h) Work in progress.

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U.S. GOVERNMENT LABORATORIES.

CORPS OF ENGINEERS, BONNEVILLE HYDRAULIC LABORATORY.

Explanatory Note - This laboratory was formerly located at Government Moorings within the city of Portland on the banks of the Willamette River about 1½ miles from Linnton. It has been variously referred to as the Bonneville Hydraulic Laboratory and the Linnton Hydraulic Laboratory.

The laboratory at Government Moorings was dismantled early in 1938 and is now being reconstructed at the site of the Bonneville project, Bonneville, Oregon. At its former location it was devoted largely to studies of the Bonneville project. The results of those studies appear in a 3-volume report under date of June 30, 1937. (See Completed Projects - Abstracts.)

(917) (a) SPILLWAY OF MUD MOUNTAIN DAM.
(b) U. S. Engineer Department, North Pacific Division. Col. C.H.Lee, Division Engineer, C. I. Grimm, Head Engineer.
(c) Mud Mountain Dam is a flood control project on Puyallup River, Washington. Designs are now in progress. The hydraulic features of the spillway and tunnels are to be studied by means of models.
(d) Major T. D. Weaver, District Engineer, with Ben L. Peterson and P. L. Hislop engineers in direct charge of studies and J. C. Stevens as Consulting Engineer.
(e) Division Engineer, U. S. Engineer Office, Portland, Oregon.
(f) To obtain data to aid in design and construction of the project.
(g) Experimental work done by means of models. Water is supplied to a storage tank from which it is circulated by pumps to the various models and returned to the storage tank.
(h) Work is just being started.
(i) See explanatory note above.

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U. S. GEOLOGICAL SURVEY.

(697) (a) STUDY OF INTAKES FOR GAGE WELLS.
(b) United States Geological Survey, Water Resources Branch.
(c) Tests of intakes of various forms in different velocities of flowing water; needed for intake design and for hydraulic research.
(d) W. S. Eisenlohr, Jr.
(e) C. H. Pierce, U. S. Geological Survey, Washington, D. C.
(f) To ascertain the essential factors relating to the design of intakes and to perfect a design that will maintain the water surface in the gage well at the same height above gage datum as the water surface in the river at the outer end of the intake pipe.
(g) Tests will be made of 1/8-scale models in the 20-inch flume at the National Hydraulic Laboratory, National Bureau of Standards, Washington, D. C. Subsequent tests of a few full-size models will be made in the 12-foot flume for comparison with results obtained with the 1/8-scale models.

(h) Tests of 1/8-scale models and a few selected full-size models have been completed. A descriptive report of this investigation giving the results of the laboratory tests is being prepared.

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(918) (a) INVESTIGATION OF THE EFFECT OF REFORESTATION ON STREAMFLOW.
(c) Cooperative between the United States Department of the Interior, Geological Survey, and the New York State Department of Conservation.
(d) Arthur W. Harrington and assistants.
(e) Arthur W. Harrington, District Engineer, Water Resources Branch, Geological Survey, Albany, N. Y.
(g) Complete hydrologic studies will be made of several reforested and nonreforested areas over a long period of time.
(h) Project is still in its preliminary stage, but continuous records of precipitation, runoff, ground-water levels, temperature and humidity are being collected on three small reforested areas in Central New York and one small nonreforested area.

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U.S. BUREAU OF RECLAMATION.

(48) (a) HYDRAULIC MODEL EXPERIMENTS FOR THE DESIGN OF THE BOULDER DAM.
(b) U. S. Bureau of Reclamation.
(c) Specific research.
(d) Hydraulic Research Division, U. S. Bureau of Reclamation, Denver, Colorado.
(e) U. S. Bureau of Reclamation, Denver, Colorado.
(f) Experimental study to aid in the design of the spillways, intake towers, penstocks, and needle valve outlets at Boulder Dam.
(g) An extensive series of tests was made to develop the best form of spillway to discharge 400,000 second-feet with a drop of over 500 feet. Two units of the side channel type were adapted and various forms tested using model scales of 1:100, 1:60, and 1:20, with discharges ranging up to 112 second-feet. An extensive study was also made of the individual losses in the intake towers, penstock bends, tees and branches. The best arrangement for the battery of needle valves in the tunnel plug outlets was worked out with the aid of three different scale models. Another model was used to depict the flow conditions in the river downstream from the dam with the various combinations of outlets discharging. A third study was made of the hydraulics of rounded-crest spillways, including proper shape for rounded section of spillway, coefficients of discharge, vacuum and pressure effects on crest section and drum gates.
(h) All except the later work on rounded-crest spillways have been completed and published.
(i) A complete report of the model studies on the spillways, reported as Technical Memoranda Nos. 322, 335, and 347 in Bulletin V-1 of January 1, 1937, has been condensed and published as Part VI, Bulletin 1 of the Boulder Canyon Project Final Reports. A report covering the model experimentation on the Boulder Dam intake towers, penstocks, tunnel plug outlet works, and predicted

conditions of the river downstream from the dam, reported as Technical Memorandum No. 525 in Bulletin V-1, has been published as Part VI, Bulletin 2 of the Boulder Canyon Project final Reports which are on sale at the U. S. Bureau of Reclamation in Denver, Colorado, or Washington, D. C., or can be obtained on loan from the Denver Public Library.

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(547) (a) HYDRAULIC MODEL EXPERIMENTS FOR THE DESIGN OF THE GRAND COULEE DAM.
(b), (c), (d), (e) - Same as No. 48.
(f) To check and, if possible, improve the various hydraulic features of the dam.
(g) Models of spillway bucket tested on three scales. Model of partially constructed dam at various stages with alternate diversion sequences to determine best procedure for avoiding adverse erosion of the river bed; model tests to determine the best design for the three tiers of sluiceways; model tests for the design of the Grand Coulee turbines, and tests to aid in the design of the entrance and elbow leading to the 1600 second-feet pumps.
(h) Testing has been completed on all except the last two features. Reports are in preparation.

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(548) (a) IMPERIAL DAM AND ALL-AMERICAN CANAL STRUCTURES.
(b), (c), (d), (e) Same as No. 48.
(f) To check and improve the designs of Imperial Dam and its appurtenant works and various structures on the All-American Canal. Also general studies are in progress for the design of small canal chutes and drops.
(g) Model studies.
(h) Testing on the Imperial Dam and All-American Canal structures has been completed. The general work on chutes and drops is still in progress.
(i) This material will be incorporated in one of the final reports on the Boulder Canyon project.

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(699) (a) MARSHALL FORD DAM SPILLWAY.
(b) Colorado River, Texas.
(c), (d), (e). Same as No. 48.
(f) To check designs of overfall section, sluiceways, and stilling pool.
(g) Model tests. To eliminate so far as possible negative pressures in the sluiceways and develop a satisfactory stilling pool.
(h) Completed. Report in preparation.

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(703) (a) VALLECITO DAM SPILLWAY.
(b), (c), (d), (e) - Same as No. 48.
(f) Tests to aid in the design of spillway, stilling pool, and outlet works.
(g) Model of spillway and outlet works on scale of 1:60.
(h) Completed. Report delayed.

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(774) (a) SUN RIVER CANAL HEADWORKS AND CHUTES.
(b), (c), (d), (e) - Same as No. 48.
(f) To revise designs of structures already in operation.
(g) Model studies for eliminating undesirable flow conditions in outlet works, chutes, and stilling pools.
(h) Completed. Report can be obtained on loan.

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(778) (a) DOS BOCAS DAM SPILLWAY.
(b) Rural Electrification Division, Puerto Rico Reconstruction Administration.
(c), (d), (e) - Same as No. 48.
(f) To check design of overfall section and stilling pool.
(g) Model test. Study of flow characteristics throughout structure.
(h) Completed. Report should be obtained through Puerto Rico officials.

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(779) (a) ROZA DIVERSION DAM AND APPURTENANT STRUCTURES.
(b), (c), (d), (e) - Same as No. 48.
(f) To check hydraulic design of roller gates, overflow section, canal intake, and fish ladder on Roza Dam. Also power wasteway No. 2.
(g) Model tests.
(h) Tests on Roza Dam completed. Report in preparation. Testing is in progress on power wasteway No. 2.

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(780) (a) DEER CREEK DAM SPILLWAY AND OUTLET WORKS.
(b), (c), (d), (e). - Same as No. 48.
(f) To check hydraulic design of spillway and outlet works.
(g) Model study.
(h) Completed. Report delayed.

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(919) (a) SHASTA DAM SPILLWAY, SLUICEWAYS, PENSTOCKS, AND OUTLET WORKS.
(b), (c), (d), (e) - Same as No. 48.
(f) To check hydraulic design of spillway and sluiceways and determine best layout for power house and outlet works.
(g) Model studies, two scales used to date.
(h) Testing is in progress.

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(920) (a) FRIANT DAM SPILLWAY AND SLUICEWAYS.
(b),(c), (d), (e) - Same as No. 48.
(f) To check hydraulic design of spillway, sluiceways, and stilling pool.
(g) Model study.
(h) Model is under construction.

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(921) (a) SHOSHONE OUTLET CONTROL WORKS FOR HEART MOUNTAIN DIVISION.
(b), (c), (d), (e) - Same as No. 48.
(f) To check hydraulic design.
(g) Model studies.
(h) Completed. Report in preparation.

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(922) (a) GREEN MOUNTAIN DAM SPILLWAY.
(b), (c), (d), (e) - Same as No. 48.
(f) To check hydraulic design.
(g) Model studies.
(h) Completed. Report in preparation.

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(923) (a) HEADGATE ROCK DAM.
(b) Indian Service.
(c), (d), (e) - Same as No. 48.
(f) To check hydraulic design of overfall section, stilling pool, and outlet works.
(g) Model studies.

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(924) (a) GRAND COULEE POWER PLANTS DRAFT TUBES.
(b) U. S. Bureau of Reclamation.
(c) Model studies of draft tube performance.
(d) Power and pumping plants laboratory staff.
(e) Chief Engineer, U. S. Bureau of Reclamation, Denver, Colorado.
(f) Selection of most favorable draft tube design.
(g) Selection based on the efficiency of an homologous turbine model as affected by various draft tube designs.
(h) Tests practically completed.

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(925) (a) GRAND COULEE PUMPING PLANT INTAKE.
(b) U. S. Bureau of Reclamation.
(c) Study of hydraulic losses and flow conditions from racks to pump impeller eye.
(d) Power and pumping plants laboratory staff.
(e) Chief Engineer, U. S. Bureau of Reclamation, Denver, Colo.
(f) To reduce losses and obtain optimum flow distribution into the pump impeller.
(g) Transparent models for both visual and quantitative study.
(h) Tests nearing completion.

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(926) (a) CIRCULAR SLUICE ENTRANCES.
(b) U. S. Bureau of Reclamation.
(c) Laboratory study for design data.
(d) Power and pumping plants laboratory staff.
(e) Chief Engineer, U. S. Bureau of Reclamation, Denver, Colorado.
(f) To develop a sluice entrance design which will not cavitate when operating under high heads.
(g) The sluice entrance was designed to conform approximately to the outline of a free jet flowing through a circular sharp-edged orifice.
(h) Test completed. Report in process.

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(927) (a) PENSTOCK RELIEF VALVES AS ENERGY ABSORBERS.
(b) U. S. Bureau of Reclamation.
(c) Laboratory study for design data.
(d) Power and pumping plants laboratory staff.
(e) Chief Engineer, U. S. Bureau of Reclamation, Denver, Colo.
(f) To correct defects in designs now in use and to develop new design.
(g) By means of transparent models for visual and quantitative study.
(h) Report on first series completed. Second series of tests now in progress.

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(928) (a) NEEDLE VALVE CAVITATION.
(b) U. S. Bureau of Reclamation.
(c) Cavitation in needle valves.
(d) Power and pumping plants laboratory staff.
(e) Chief Engineer, U. S. Bureau of Reclamation, Denver, Colo.
(f) To design the water passages to give maximum discharge without cavitation.
(g) By means of a bronze model and a transparent sectional model to study the performance both visually and quantitatively.
(h) Tests completed and report in preparation.

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(929) (a) SEALS FOR PENSTOCK HEAD GATES AND SLUICE GATES.
(b) U. S. Bureau of Reclamation.
(c) Tests of various designs of sealing devices.
(d) Power and pumping plants laboratory staff.
(e) Chief Engineer, U. S. Bureau of Reclamation, Denver, Colo.
(f) To develop an effective seal for high-pressure gates.
(g) Full-scale sections of seals operated hydraulically.
(h) Tests in progress.

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(930) (a) BENDS AND ELBOWS IN LARGE PENSTOCKS.
(b) U. S. Bureau of Reclamation.
(c) Laboratory for design data.
(d) Power and pumping plants laboratory staff.
(e) Chief Engineer, U. S. Bureau of Reclamation, Denver, Colo.
(f) To study the hydraulic characteristics of various types of bends.
(g) Transparent models.
(h) Model being designed.

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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, R. L. Burt.
(e) Chief, Soil Conservation Service (Attention H. L. Cook).
(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 STRUCTURES.
(b) Soil Conservation Service, U. S. Department of Agriculture.
(c) Studies in conservation hydraulics.
(d) W. O. Ree, R. L. Burt.
(e) Chief, Soil Conservation Service (Attention H. L. Cook).
(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) One series of tests on rectangular notches of the type used in drop structures has been completed.
(i) For further description see Civil Engineering, October, 1938.

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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, R. L. Burt.
(e) Chief, Soil Conservation Service (Attention H. L. Cook).
(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, R. L. Burt.
(e) Chief, Soil Conservation Service (Attention H. L. Cook).
(f) To obtain data on the protective characteristics of inexpensive artificial channel linings for direct application in the design of the 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, R. L. Burt.
(e) Chief, Soil Conservation Service (Attention H. L. Cook).
(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 will start during the spring of 1939.
(i) For further information see Civil Engineering, October, 1938.

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U. S. SOIL CONSERVATION SERVICE AT THE NATIONAL BUREAU OF STANDARDS.

(258) (a) STUDY OF DIVISORS FOR SOIL EROSION INVESTIGATIONS.
(b) Soil Conservation Service, U. S. Department of Agriculture.
(c) Instrumentation research.
(d) D. A. Parsons, Fred W. Blaisdell, H. L. Cook.
(e) Chief, Soil Conservation Service. (Attention H. L. Cook).
(f) Calibration of divisors now in use; study of relative accuracy of various types; development of new divisors.

(g) Calibrations are being made of divisors as they are developed, both with clear and with muddy water, to determine their effectiveness in splitting off a fixed percentage of the water and soil passing.

(h) Of the several types tested to date, the Geib multislot divisor has proved to be the best. It has been developed for use on areas ranging from one-hundredth to one-half acre.

(i) There is still a great need for devices suitable for larger areas.

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(341) (a) STUDY OF MEASURING FLUMES.
(b) Soil Conservation Service, U. S. Department of Agriculture.
(c) Instrumentation research.
(d) D. A. Parsons, Fred W. Blaisdell, H. L. Cook.
(e) Chief, Soil Conservation Service (attention H. L. Cook).
(f) The development and calibration of more suitable devices for the measurements of rates of runoff from experimental areas.
(g) The study involves the design, construction, and calibration of new types, particularly for maximum flows ranging between twenty-five and one-thousand cubic feet per second. Calibration test of models of some existing controls will also be made.
(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.

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(497) (a) METHODS FOR SAMPLING AND ANALYZING SOIL-WATER MIXTURES.
(b) Soil Conservation Service, U. S. Department of Agriculture.
(c) Instrumentation research.
(d) D. A. Parsons, E. P. Deatrick, J. O. Laws, S. R. Kline, H. L. Cook.
(e) Chief, Soil Conservation Service (attention H. L. Cook)
(f) Determination of the best methods of sampling and analysis from the standpoints of accuracy and efficiency.
(g) The work is confined almost entirely to studies of the methods of sampling retained volumes of runoff and the subsequent analysis of the samples taken.
(h) Tests have been made of a number of sample splitters and of several methods of sampling volumes of mixtures of soil and water. The variables in the sampling tests have been: kind of soil, depth and volume of mixture, and concentration. The submersion, weight-volume, and evaporation methods of analysis have been studied.

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(707) (a) DEVELOPMENT OF ARTIFICIAL RAINFALL APPARATUS.
(b) Soil Conservation Service, U. S. Department of Agriculture.
(c) Instrumentation research.
(d) D. A. Parsons, V. D. Young, J. O. Laws, H. L. Cook.
(e) Chief, Soil Conservation Service (attention H. L. Cook)
(f) Development and study of the methods of use of devices for the production of artificial rain of controlled intensity and spray energy.
(g) The spray characteristics of commercial and laboratory-developed nozzles have been studied. Complete plans for the construction of sprinkler units for field use are being prepared.
(h) Three of the five devices for sprinkling experimental plots are being or have been used in field investigations of soil infiltration rates and erosion.

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(936) (a) STUDY OF THE EFFECT OF THE CHARACTER OF RAIN ON WATER EROSION.
(b) Soil Conservation Service, U. S. Department of Agriculture.
(c) Research in the mechanics of erosion.
(d) D. A. Parsons, J. O. Laws, H. L. Cook.
(e) Chief, Soil Conservation Service (Attention H. L. Cook).
(f) To investigate the roles of the size, velocity and energy 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 is nearing completion. Preliminary tests have shown that rain characteristics have a profound effect on the rate of erosion.

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U. S. SOIL CONSERVATION SERVICE, ENOREE 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) Construction is completed and preliminary tests are now in progress at the station located on Enoree River near Greenville, S. C. Ten recording rain gages have been installed on the drainage area above the station.
(i) To supplement river observations a concrete flume 5 feet wide, 30 inches deep, and 50 feet long, provided with a constant-head tank, a weir, and a sand-feed elevator, has been installed.

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U. S. SOIL CONSERVATION SERVICE, CORNELL UNIVERSITY.

(840) (a) CALIBRATION OF BROAD-CRESTED TRIANGULAR WEIRS WITH TRAPEZOIDAL CRESTS.
(b) Soil Conservation Service.
(c) Hydraulic laboratory tests.
(d) A. N. Huff and D. B. Krimgold.
(e) C. E. Ramser, In Charge, Watershed and Hydrologic Studies, Soil Conservation Service.
(f) To develop rating tables and curves for weirs used in the runoff studies conducted by the Soil Conservation Service.
(g) The flows over 1/2, 1/3, and 1/5 scale models and over full-scale structures of triangular weirs with 2:1, 3:1, and 5:1 side slopes are measured volumetrically and by means of a sharp-crested suppressed weir in a 6' flume and a 16' canal respectively. Upstream and downstream false floors are used to simulate channel conditions encountered in the field. The effect of various degrees of submergence is determined for the several weirs with various channel conditions.
(h) A final report is expected within the next three or four months.
(i) These investigations were preceded by a series of tests of small scale models conducted at the National Hydraulic Laboratory for the purpose of developing the shape of the crest.

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U. S. SOIL CONSERVATION SERVICE, HYDROLOGICAL STUDIES.

(938) (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, In Charge, Watershed and Hydrologic Studies, Soil Conservation Service.
(f) To secure data on runoff resulting from precipitation of various intensities occurring on drainage basins representative of a number of runoff problem areas in the United States.
(g) 82 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 the runoff problem areas in various parts of the United States were established. Rates and amounts of precipitation are measured by means of recording raingages and snow surveys where necessary. Rates and amounts of runoff are obtained by means of triangular weirs with trapezoidal crests equipped with water-level recorders. Topographic, soil and cover, and tillage maps are prepared for each of the drainage basins. All available precipitation and runoff data in each of the runoff problem areas are compiled in order to permit proper and wide application of the resulting data.
(h) The construction of the necessary installations on seventy drainage basins was completed by September 1938. It is expected that the remaining twelve will be completed by the end of 1938. Records of precipitation and runoff and of related information for the Summer of 1938 were secured on thirty-eight of the drainage basins.

(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	Colorado Springs, Colo.	4
Freehold, N. J.	4	Muskogee, Okla.	4
Hagerstown, Md.	5	Safford, Arizona	6
Chatham, Va.	3	Albuquerque, N. M.	3
Americus, Georgia	4	Santa Fe, N. M.	3
Hamilton, Ohio	4	Santa Paula, Calif.	5
Garland, Texas	6	Watsonville, Calif.	4
Bentonville, Ark.	6	Newberg, Oregon.	4
Edwardsville, Ill.	4	Emmett, Idaho	2
Fennimore, Wisc.	4		
Vega, Texas	3		

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TENNESSEE VALLEY AUTHORITY.

A. CURRENT HYDRAULIC LABORATORY RESEARCH PROJECTS

Items (b), (d), and (e) are the same for projects 494 to 948 inclusive. 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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(495) (a) PICKWICK LANDING DAM, COFFERDAMS.
(c) Investigation of effect of cofferdamming and construction operations on river regimen.
(f) To determine the effect of proposed cofferdams and dredging operations during construction on river stages, navigation, and scour; to determine the allowable constriction of the river channel by cofferdams in each of the various stages of construction.

(g) A model of 9000 feet of the Tennessee River including the dam site was built to a scale of 1:100. 3800 feet of the channel at the site was formed in fine sand in order to investigate scouring conditions. Scale models of all proposed construction features such as cofferdams, lock, power house, and spillways were put in place to simulate various proposed phases of construction, and the effects on the river were observed in order to determine the best sequence of operations.
(h) Tests completed.
(i) Report in progress.

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(573) (a) GUNTERSVILLE LOCK, NAVIGATION STUDIES.
(c) Investigation of navigation conditions at entrance to Guntersville Lock.
(f) To determine the proper location of lock, and length and angle of guide walls to give good navigation conditions in the neighborhood of the lock.
(g) Tests were made on a model built to a scale of 1:150. About one and one-half miles of river channel were included. Navigation conditions were studied by observation of the river currents and by operation of model barges through the lock. Conditions during construction were studied, as well as the final design.
(h) Tests completed.
(i) Report completed.

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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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(575) (a) SWAN LAKE MODEL EXPERIMENT.
(c) Study of effect of closing a small bridge in a long embankment crossing a wide river valley.
(f) To investigate the direction and velocity of currents along the embankment of the Southern Railway due to closing the bridge across Swan Lake, near Decatur, Alabama.
(g) A model of the flood plain and river channel of the Tennessee River near Decatur, Alabama, was built to scales of 1:400 horizontal and 1 to 100 vertical. After verification, it was operated with the proposed changes in the railway embankment. The magnitude and direction of the resulting currents were recorded, as well as the changes in water surface elevation.
(h) Tests completed.
(i) Report completed.

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(577) (a) HEAD INCREASER FOR POWER HOUSE.
(c) Investigation of a combined spillway and power house unit whose object is increasing the effective head on the turbines by utilizing the surplus flood waters to reduce the back pressure on the draft tubes.
(f) To determine feasibility of application of the scheme to dams on the Tennessee River.
(g) Tests were made on a 1:50 scale model. Provision was made for changing the proportions and dimensions of the spillway sluices, draft tubes, and tailrace. Transparent sections allowed visual observation of flow conditions.
(h) Tests completed.
(i) Report in progress.

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(708) (a) GUNTERSVILLE DAM SPILLWAY DESIGN.
(c) Investigation of stilling basin for Guntersville Dam spillway.
(f) To determine a satisfactory and economical design of apron below the dam for dissipation of energy and prevention of bed erosion.
(g) Tests were made on a 1:25 scale model of 3 spillway bays. The final design was checked on a 1:100 scale model of the entire spillway.
(h) Tests completed.
(i) Report in progress.

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(709) (a) CHICKAMAUGA DAM, SPILLWAY DESIGN.
(c) Investigation of stilling basin for Chickamauga Dam spillway.
(f) To determine a satisfactory and economical design of apron below the dam for dissipation of energy and prevention of bed erosion.
(g) Tests were made on a 1:25 scale model of 3 spillway bays. The final design was checked on a 1:100 scale model of the entire spillway.
(h) Tests completed.
(i) Report in progress.

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(710) (a) CHICKAMAUGA DAM, COFFERDAM.
(c) Investigation of effect of cofferdamming and construction operations on river regimen.
(f) To determine the effect of proposed cofferdams and dredging operations during construction on river stages, velocities, and scour; to determine the allowable constriction of the river channel by cofferdams in the various stages of construction.
(g) A model of about 2 miles of the Tennessee River at the site of Chickamauga Dam was formed in fine sand at a scale of 1:110 in order to investigate scouring conditions. The bed was paved with concrete to measure velocities and backwater effects. Scale models of proposed construction features such as cofferdams, locks, and spillways, were installed to simulate various phases of construction.
(h) Tests completed.
(i) Report in progress.

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(781) (a) GILBERTSVILLE LOCK, FILLING SYSTEM.
(c) Investigation of various types of filling systems for Gilbertsville Lock.
(f) To develop the simplest, most effective, and most economical scheme of filling system.
(g) Tests are being made on a 1:36.67 scale model of Gilbertsville Lock. Systems tested include the conventional culvert and port system with various spacings of ports, short culverts by-passing the upper miter sill, and a taintor gate which serves to close the lock, as well as to regulate filling. The effectiveness of the various schemes is determined by measuring the hawser stresses required to hold a model barge tow in place during filling. A continuous record of barge motion, water levels, and hawser stresses is obtained.
(h) Tests nearing completion.

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(782) (a) NAVIGATION BELOW PICKWICK LANDING DAM.
(c) Investigation of proposed dredging program on navigability of shoals below Pickwick Landing Dam.
(f) To determine the effectiveness of a proposed dredged channel in facilitating navigation through the shoals below Pickwick Landing Dam.
(g) A model of approximately 11 miles of the Tennessee River below Pickwick Landing Dam was built to a horizontal scale of 1:300 and a vertical scale of 1:80. The proposed dredging was reproduced, and its effect on navigation was determined by observation of currents and operation of a model barge tow.
(h) Tests completed.
(i) Report in progress.

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(783) (a) WILSON DAM, SPILLWAY INVESTIGATION.
(c) Investigation of spillway apron to reduce damage from erosion below apron.
(f) To determine possible corrective measures to reduce erosion below existing apron.
(g) Tests were made on a 1:39.4 scale model of 3 spillway bays in a glass-sided flume so that erosive tendencies could be observed.
(h) Tests completed.
(i) Report completed.

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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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(940) (a) HIWASSEE DAM, EMERGENCY SLUICE GATE.
(c) Investigation of shape of gate as affec ting hydraulic downpull on gate during closure.
(f) To design the gate so as to reduce the hydraulic load during closure, and consequently the hoist capacity, as far as possible.
(g) A 1:15 scale model of the emergency gate was built and tested in place on a model of the sluice entrance. The effectiveness of a number of designs was determined by weighing the hydraulic load. Pressure measurements on the face of the gate and on the gate beams aided in designing for reduced load.
(h) Tests completed.
(i) Report in progress.

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(941) (a) HIWASSEE DAM, EMERGENCY PENSTOCK GATE.
(c) Investigation of shape of gate as affecting hydraulic downpull on gate during closure.
(f) To design the gate so as to reduce the hydraulic load during closure, and consequently the hoist capacity, as far as possible.
(g) A 1:18 scale model of the gate was built and tested in place on a model of the penstock entrance. The effectiveness of a number of designs was determined by weighing the hydraulic load.
(h) Tests completed.
(i) Report completed.

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(942) (a) NORRIS STILLING BASIN PERFORMANCE.
(c) Comparison of model tests on Norris stilling basin with performance of prototype.
(f) To determine degree of correspondence of 1:72 scale model with its prototype.
(g) Observations of the operation of Norris stilling basin were made during the releases of January and February, 1937.
(h) Work completed.
(i) Report completed.

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(945) (a) NORRIS SPILLWAY DISCHARGE COEFFICIENTS.
(c) Determination of Norris Spillway discharge coefficients and comparison with results of tests on 1:72 scale model.
(f) To rate the Norris spillway and to determine the correspondence of the 1:72 scale model with its prototype.
(g) Observations of depth of flow over crest were made during release of January and February, 1937. Discharges were measured at a U.S.G.S. rating station just below the dam.
(h) Work completed.
(i) Report in progress.

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(944) (a) PICKWICK LANDING DAM, NAVIGATION IMPROVEMENT BELOW DAM.
(c) Investigation of methods of improving navigation below the dam.
(f) To discover means of eliminating adverse currents near lower lock approach.
(g) Tests were made on a 1:100 scale model of the river at the dam to study the effects of various proposed dredging schemes.

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

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(945) (a) PICKWICK LANDING DAM, LOCK WALL EXTENSION.
(c) Study of effect of proposed lock wall extensions in quieting waves in lock approach.
(f) To determine the most economical method of reducing wave height in the approach to Pickwick landing lock.
(g) Tests made on guard wall extensions of varying character, solid and permeable, on a 1:100 scale model. Several types of floating boom designed to reduce waves are also being tested at scales of 1:100 and 1:6.4.
(h) Tests in progress.

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(946) (a) GILBERTSVILLE DAM, LOCK LOCATION.
(c) Study of arrangement of structures for Gilbertsville Dam.
(f) To determine the best location of Gilbertsville lock from the standpoint of navigation.
(g) A model of 10,000 feet of the Tennessee River at the dam site was built at a scale of 1:100. The structures were made removable and quickly interchangeable so that the effect of various layouts could be observed. The effects on navigation were determined by measurement of velocities, and by observation of the action of a model barge tow.
(h) Tests completed.
(i) Report completed.

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(947) (a) GILBERTSVILLE DAM, COFFERDAM.
(c) Investigation of effect of cofferdamming and construction operations on river regimen.
(f) To determine the effect of proposed cofferdams and dredging operations during construction on river stages, navigation, and scour; to determine the allowable constriction of the river channel by cofferdams in each of the various stages of construction.
(g) A model of 10,000 feet of the Tennessee River was built at a scale of 1:100. The river bed was molded in fine sand so that scour could be observed. Structures, including lock, powerhouse, spillway, and cofferdams were made removable so that the effects of various arrangements could be tried.
(h) Tests in progress.

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(948) (a) WATTS BAR DAM, NAVIGATION STUDY.
(c) Investigation of navigation conditions below Watts Bar Dam.
(f) To determine the best arrangement of structures for Watts Bar Dam from the standpoint of navigation.
(g) A model of 12,000 feet of the Tennessee River at the dam site was built at a scale of 1:150. Models of structures are removable so that different arrangements can be studied. The effect of spillway and powerhouse operation on boats entering the lock from below are of particular interest.
(h) Tests in progress.

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B. CURRENT HYDROLOGICAL AND HYDRAULIC FIELD INVESTIGATIONS

Items (b) and (e) are the same for projects 949 to 965 inclusive. Their significance is as follows:

(b) Tennessee Valley Authority.
(e) Albert S. Fry, Head Hydraulic Research Engineer, Tennessee Valley Authority.

(949) (a) COPPER BASIN RUNOFF STUDIES.
(d) Hydrology Section, Hydraulic Data Division, under direction of Robert W. Gay.
(f) To compare the runoff rate from a denuded area with that from two adjacent watersheds, one with grass and one with forest cover.
(g) Data from rain and stream gages in North Potato, Brush, and Turtletown Creeks are analyzed to obtain the necessary comparison.
(h) A report is in preparation.

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(950) (a) DETERMINATION OF SILT CARRIED IN SUSPENSION BY TENNESSEE RIVER AND TRIBUTARIES.
(d) Hydrography 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 Robert W. Gay.
(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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(952) (a) FOUNDATION SOIL TESTS - COULTER SHOALS PROJECT.
(c) Laboratory tests of samples from proposed foundation area.
(d) Soil Mechanics Laboratory, Hydraulic Data Division, under direction of B. E. Morriss and E. W. Vaughan.
(f) To determine the suitability of the proposed site as a foundation for the earth fill structure of the dam.

(g) Shear, consolidation, and permeability tests were made of representative undisturbed samples and recommendations made regarding suitability of the soil as foundation material.
(h) Preliminary tests have been made. Other tests will be made when additional design data become available.

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(953) (a) GILBERTSVILLE COFFERDAM STRESSES BY GELATIN MODEL.
(c) Soil Investigation.
(d) Soil Mechanics Laboratory, Hydraulic Data Division, under direction of B. E. Morriss and E. W. Vaughan.
(f) To check the design assumptions and verify the intensities and distribution of the computed internal stresses in the cofferdam structure proposed for Gilbertsville Dam.
(g) Photoelastic determinations of the stress distribution and intensity will be made using a gelatin model and polarized light. Tests will be made for a model loaded hydrostatically to represent three different river stages, for models with three different heights of berm, and for three different depths of flooding the cofferdam.
(h) Equipment is being assembled preparatory to testing.

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(954) (a) GILBERTSVILLE FOUNDATION SOIL TESTS.
(c) Laboratory investigation of soil samples from Gilbertsville Dam site.
(d) Soil Mechanics Laboratory, Hydraulic Data Division, under direction of B. E. Morriss and E. W. Vaughan.
(f) To investigate foundation conditions at Gilbertsville Dam site.
(g) Shear, consolidation, and permeability tests and stress computations were made. An analysis was made to correlate settlements observed in a field loading test with estimated settlements based upon laboratory studies.
(h) Final report is in preparation.

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(955) (a) GROUND WATER INVESTIGATIONS.
(c) Hydrological study.
(d) Hydrography 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, and Wheeler Reservoirs.
(h) Installations are complete and records are being collected. Preliminary reports are being 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 collected on rainfall-runoff and damages during such floods.
(h) Work is in progress.

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(957) (a) HIGHWAY FILL TESTS.
(c) Laboratory investigation of soil materials for proposed highway fills.
(d) Soil Mechanics Laboratory, Hydraulic Data Division, under direction of B. E. Morriss and E. W. Vaughan.
(f) To determine safe slopes and heights that may be used on highway fills or relocated roads across the Pickwick, Guntersville, Chickamauga and Hiwassee Reservoirs where fill is partially submerged by reservoir.
(g) Mechanical analyses, compaction, and shear tests are made, and the stability is determined for various slopes. Consideration is given to the fact that these fills are alternately partially wetted and dried as a result of fluctuating reservoir levels.
(h) Tests are 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 from springs and runs below dam sites before and after construction of dams to determine leakage.
(g) Measuring weirs were constructed and are observed regularly. The records are being analyzed to account for current rainfall. Data are being collected for Norris, Guntersville, Watts Bar, and Wheeler Projects.
(h) Observations are being continued.

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(959) (a) PRECIPITATION IN TENNESSEE RIVER BASIN.
(c) A comprensive study of rainfall and other weather phenomena in and adjacent to the watershed.
(d) Hydrology Section, Hydraulic Data Division, under direction of Robert W. Gay.
(f) To furnish meteorological data for use in planning water control projects, for agricultural and other purposes.
(g) Records from 385 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 and Wheeler Reservoirs are sounded monthly with a resistance thermometer, and readings are taken at every 5 or 10 feet of depth.
(h) Monthly records have been obtained since October 1936 at Norris and since October 1937 at Wheeler. 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) Hydrography Section and Field Investigations Section, Hydraulic Data Division, under direction of G. N. Burrell and J. E. Goddard.
(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) Hydrography Section, Hydraulic Data Division, under direction of 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 Nolichucky River, Andrews Reservoir on the Hiwassee River, and Hales Bar and Wilson Reservoirs on the Tennessee River.
(h) Reports on the above projects are in preparation.

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(963) (a) SILT TRAVERSES - TENNESSEE RIVER TRIBUTARIES.
(c) Hydrographic Research.
(d) Hydrographic Section, Hydraulic Data Division, under 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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(964) (a) SNOWBIRD MOUNTAIN ALTITUDE RAINFALL INVESTIGATION.
(c) Meteorological investigation to study effect of altitude on rainfall.
(d) Field Investigations Section, Hydraulic Data Division, under direction of J. E. Goddard and J. Smallshaw.
(f) To determine the influence of altitude upon the amount of precipitation.
(g) Rain gages are located across a mountain at points having about 200 feet difference in elevation from altitude 1825 feet to altitude 3690 feet. Data collected from these gages are studied and correlated against altitude.
(h) A report is in preparation.

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(965) (a) WATTS BAR DAM SOIL TESTS.
(b) Tennessee Valley Authority.
(c) Laboratory investigation of soil materials to be used in construction of dam.
(d) Soil Mechanics Laboratory, Hydraulic Data Division, under direction of B. E. Morriss and E. W. Vaughan.
(e) Albert S. Fry, Head Hydraulic Research Engineer, Tennessee Valley Authority.
(f) To determine the suitability of the materials proposed for use in the foundation area and earth section of the dam.
(g) Representative samples will be tested for shear, consolidation, and permeability. A settlement analysis, a seepage analysis, and a determination of the allowable height of dam will be made on foundation samples. A stability analysis will be made on borrow pit materials for use in the earth section.
(h) Tests are in progress.

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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.
(c) Model study of flood control plans.
(d) Experiments are conducted at the U. S. Waterways Experiment Station by personnel thereof under the direction of Lieutenant Paul W. Thompson, 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 studies are conducted on a model constructed to a horizontal scale of 1 to 2000 and on a vertical scale of 1 to 100. The model is 1100 feet in length and includes 210 gages and 17 flow inlets. Flood years are represented on schedule, the daily changes in discharge of the main river and tributaries being adjusted by the operators, who also read the model river gages each model day.
(h) Testing of channel improvements is in progress.

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(473) (a) MODEL STUDY FOR CHANNEL IMPROVEMENT AT MARACAIBO OUTER BAR, VENEZUELA.
(b) Standard Shipping Company, New York, N. Y.
(c) Investigation of progressive westward movement of the outer bar with a view to probable future development.
(d) and (e) See (415).
(f) To study outer bar action at the entrance of Lake Maracaibo, Venezuela.
(g) A model of the area in question was constructed to scales of 1 to 300, horizontal, and 1 to 50, vertical. Tides, waves, and other phenomena affecting flow in the area were reproduced in the conduct of the study.
(h) The model study is now complete and the final report is in preparation.

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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) Study of proposed harbor improvements.
(d) and (e) See (415).
(f) The purposes of the study are:
1. To determine the sources of the materials going to make up the shoals in Galveston Channel.
2. To determine the effects of any proposed improvement plan on the Galveston Channel, and corollary to that, to determine 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 model will include the area bounded by the Gulf of Mexico Hanna's Reef in the East Bay, Redfish Bar in Galveston Bay, and Karankawa Reef in West Bay. The model scales are 1 to 800, horizontal, and 1 to 80, vertical. An area approximately 188 feet by 150 feet is covered by the model. Fixed-bed construction is employed in the model, and fine Gilsonite powder is used for simulation of shoal material. Natural tides are reproduced in the model by the action of four automatic tide gates of the type already in successful operation at this Station. To supplement tidal currents, wave action is reproduced in the model by the action of five wave machines. Following adjustment of the model to reproduce shoaling in the Galveston Channel, the various improvement plans proposed by the Galveston Office will be tested and their relative merits determined.

(h) Construction of the model and appurtenances has been completed. Adjustment tests are now in progress.

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(535) (a) MODEL STUDY OF THE CHAIN OF ROCKS REACH, MISSISSIPPI RIVER (MILE 203 TO MILE 183 ABOVE CAIRO, ILLINOIS AND THE MISSOURI RIVER FROM MILE 8 TO THE MOUTH).

(b) The District Engineer, U. S. Engineer Office, St. Louis, Mo.

(c) Model study of plans for channel improvement.

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

(f) To determine the relative effectiveness of several proposed plans for improving navigation conditions in the Chain of Rocks Reach.

(g) The model is of the movable-bed type, using crushed coal as bed material. Model scales are 1 to 600, horizontal, and 1 to 125, vertical.

(h) The series of model tests is essentially complete and the final report is in preparation.

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(536) (a) MODEL STUDY OF PRYORS ISLAND REACH, OHIO RIVER (MILE 899.0 TO MILE 919.4 BELOW PITTSBURGH, PENNSYLVANIA).

(b) The District Engineer, U. S. Engineer Office, Louisville, Kentucky.

(c) Study of proposed channel improvements.

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

(f) To determine the location and type of additional works justified in the Pryors Island Reach for further improvement and stabilization of the navigable channel.

(g) The model is of the movable-bed type, using crushed coal as bed material. Model scales are 1 to 600, horizontal, and 1 to 150, vertical.

(h) All testing has been completed.

(i) The final report, incorporating the results of the tests, is Technical Memorandum No. 107-1, titled, "Model Study of Channel Improvement and Stabilization in the Pryors Island Reach of the Ohio River."

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(538) (a) MODEL STUDY OF DOGTOOTH BEND, MISSISSIPPI RIVER (MILE 32.7 TO MILE 4 BELOW CAIRO, ILLINOIS).
(b) The District Engineer, U. S. Engineer Office, St. Louis, Mo.
(c) Study of proposed channel improvements.
(d) and (e) See (415).
(f) To determine methods for improving navigation conditions in the Dogtooth Bend Reach of the Mississippi River.
(g) The model is of the movable-bed type, using crushed coal as bed material. Model scales are 1 to 600, horizontal, and 1 to 100, vertical.
(h) All testing has been completed.
(i) Results of the tests are incorporated in the final report, Technical Memorandum No. 109-1, titled, "Model Study of Plans for Channel Improvement at Dogtooth Bend, Mississippi River."

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(539) (a) MODEL STUDY OF SWIFTSURE TOWHEAD, MISSISSIPPI RIVER (MILE 51.2 TO MILE 67.3 ABOVE CAIRO, ILLINOIS).
(b) The District Engineer, U. S. Engineer Office, St. Louis, Mo.
(c) Study of proposed channel improvements.
(d) and (e) See (415).
(f) To determine the proper location of dikes and dredging to maintain project dimensions of the Mississippi River channel in the vicinity of Swiftsure Towhead.
(g) The model is of the movable-bed type, using crushed coal as bed material. Model scales are 1 to 600, horizontal, and 1 to 120, vertical.
(h) All testing has been completed.
(i) Results of the tests are incorporated in the final report, Technical Memorandum No. 110-1, titled, "Model Study of Plans for Channel Improvements at Swiftsure Towhead, Mississippi River."

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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) The two Manchester Islands divide the river into three channels, of which only the one on the Kentucky side is navigable. Due to shoaling, the maintenance of the navigation channel has required excessive dredging. The primary purpose of the model studies is to determine the feasibility of procuring a permanent channel by closing the middle channel with a dredged dike in order to increase the velocity of current in the navigable channel. The study also includes a determination of the feasibility of closing the present navigation channel with a dredged dike at the head of the islands and providing a new navigation channel either between the islands or on the Ohio side.
(g) The model is of the movable-bed type, using crushed coal as bed material.
(h) Verification and adjustment have been completed, and most of the model testing of improvement plans has been accomplished.
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(644) (a) MODEL STUDY OF SPILLWAY FOR SARDIS DAM, NEAR SARDIS, MISS.
(b) The District Engineer, U. S. Engineer Office, Vicksburg, Miss.
(c) Study of spillway performance.
(d) and (e) See (415).
(f) To examine the hydraulic performance of the structure, with special reference to the capacity and hydraulic safety of the works as designed.
(g) The study was conducted with a 1 to 70 model of the spillway and adjacent areas.
(h) All testing has been completed.
(i) Results of the study are incorporated in the final report, Technical Memorandum No. 132-1, titled, "Model Study of the Proposed Spillway for Sardis Dam."

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(784) (a) DEBRIS PRESSURE INVESTIGATION.
(b) California Debris Commission.
(c) Study of pressures resulting from impounded debris.
(d) and (e) See (415).
(f) To determine the pressures exerted by material impounded by debris dams.
(g) Tests of pressures exerted by saturated impounded debris were conducted in specially constructed apparatus designed for this purpose.
(h) All testing has been completed.
(i) Results of this study are incorporated in the final report, Technical Memorandum No. 94-2, titled, "Final Report on Laboratory Studies of Lateral Pressures Exerted Against Dams by Submerged Debris."

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(785) (a) SOILS TEST, LOCK AND DAM NO. 2, MISSISSIPPI RIVER.
(b) The District Engineer, U. S. Engineer Office, St. Paul, Minn.
(c) Soils investigation.
(d) and (e) See (415).
(f) To classify and determine the physical properties of the foundation material at the site of the proposed lock.
(g) Classification of foundation samples, mechanical analyses, Atterberg limits, water-control determination, shear tests, consolidation tests, and permeability determinations were made on the samples submitted. Computation of stress distribution in the foundation was made.
(h) All testing has been completed.
(i) A preliminary report, Technical Memorandum No. 117-1, has been rendered. Further work on the study has been suspended pending decision of District Engineer on final design of lock.

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(786) (a) DETERMINATION OF THE TOPMOST FLOW-LINE AND MEASUREMENT OF PRESSURE 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 flow-line 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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(788) (a) INVESTIGATION TO DETERMINE EFFICACY OF ASPHALT REVETMENT, ASPHALT CUT-OFF WALLS AND BENTONITE FOR CONTROLLING SEEPAGE THROUGH AND UNDER LEVEES.
(b) The Mississippi River Commission.
(c) Scientific research.
(d) and (e) See (415).
(f) To determine the efficacy both of the asphalt mattress method and the bentonite method for reducing seepage through and under levees.
(g) Tests were first made to determine effective grouting concentrations and methods. Tests were then conducted on large-scale models to determine the efficacy of bentonite grout, cut-off walls, and blankets for seepage control.
(h) All model tests are completed.
(i) Results of the model tests are presented in Technical Memorandum No. 96-3, titled, "Experiments to Determine the Efficacy of Bentonite in Reducing Seepage Through and Under Levees."

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(791) (a) MODEL STUDY OF OUTLET WORKS, WAPPAPELLO DAM.
(b) The District Engineer, U. S. Engineer Office, Memphis, Tenn.
(c) Model study of performance of outlet structures.
(d) and (e) See (415).
(f) To check the hydraulic characteristics of all points in the design of the outlet works, Wappapello dam, and to develop means of correcting any uneconomic, unsafe, or undesirable conditions.
(g) The model was constructed to a scale of 1 to 25. Tests were made of such features as the approach channel, conservation pool weir, intake structure (including trash racks, curved throat section, gate slots, and vents) transition section, tunnel, stilling basin and exit channel.
(h) All testing has been completed.
(i) Results of the study are incorporated in Technical Memorandum No. 134-1, titled, "Model Study of the Outlet Structures for the Wappapello Dam."

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(792) (a) MODEL STUDY OF SPILLWAY, WAPPAPELLO DAM.
(b) The District Engineer, U. S. Engineer Office, Memphis, Tenn.
(c) Model study of performance of spillway.
(d) and (e) See (415).
(f) To study conditions resulting from operation of the spillway of the Wappapello dam and to develop means of correcting any unsafe or undesirable conditions found to exist.
(g) The model was constructed to a scale of 1 to 100. Observations of spillway characteristics, current directions, velocities, and flow conditions below the ogee section of the spillway were made.
(h) All testing has been completed.
(i) Results of the study are incorporated in Technical Memorandum No. 146-1, titled, "Model Study of the Spillway for the Wappapello Dam."

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(793) (a) MODEL STUDY, FLOOD CONTROL PROJECT, JOHNSTOWN, PENNSYLVANIA.
(b) The District Engineer, U. S. Engineer Office, Pittsburgh, Pa.
(c) Flood control study.
(d) and (e) See (415).
(f) To determine the most feasible plans for increasing the channel capacity of the Conemaugh and Little Conemaugh Rivers and of Stony Creek, at Johnstown, Pa.
(g) A large-scale model, having a horizontal scale of 1 to 200, and a vertical scale of 1 to 80, has been constructed for the study. 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. The model was adjusted to reproduce the hydrography of the floods of 1936-37.
(h) Testing of the proposed improvement plans is in progress.

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(794) (a) SOIL MECHANICS RESEARCH CENTER.
(b) The Engineer Department at Large.
(c) Soils research.
(d) and (e) See (415).
(f) The Soil Mechanics Research Center is an Engineer Department institution established at the U. S. Waterways Experiment Station by authority of the Chief of Engineers. The Center exists to disseminate to the Department at large, data and information on soil mechanics and, further, to conduct such studies in the field of soil mechanics as other offices may request.
(h) The Soils Research Center issues bulletins in which experimental works of general interest are described. However, its main function is that of disseminating information to the Department at large.

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(795) (a) HYDRAULIC RESEARCH CENTER.
(b) The Engineer Department at Large.
(c) Hydraulic research.
(d) and (e) See (415).
(f) The purpose of the Hydraulic Research Center is to assemble and analyze experimental data of importance to the Engineer Department, and to make these data available to all districts of the department.

(h) The Research Center issues bulletins, in which experimental works of general interest are described. However, the Center is chiefly concerned with direct correspondence on specific problems.

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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 is of the movable-bed type, using crushed coal as bed material. Model scales are 1 to 600 for the horizontal and 1 to 100 for the vertical.
(h) Adjustment and verification of the model has been completed; tests of the plans for improvement of the channel are now in progress.

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(967) (a) MODEL STUDY OF SEEPAGE THROUGH LEVEE FOUNDATIONS, MEMPHIS DISTRICT.
(b) The District Engineer, U. S. Engineer Office, Memphis, Tenn.
(c) Model study of seepage through levees.
(d) and (e) See (415).
(f) To obtain information concerning the relief of excess hydrostatic pressure at the landside of levees constructed on foundations consisting of an impervious surface stratum overlying pervious strata.
(g) The model on which this series of tests was conducted was constructed of loess and sand, placed to properly represent the areas of pervious and impervious strata. Various types of drainage systems were investigated during the course of the tests.
(h) All scheduled model tests are completed and preparation of the final report is in progress.

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(968) (a) MODEL STUDY OF SPILLWAY FOR GREAT SALT PLAINS DAM.
(b) The District Engineer, U. S. Engineer Office, Little Rock, Ark.
(c) Model study of spillway performance.
(d) and (e) See (415).
(f) To check the hydraulic characteristics of the spillway and outlet works as designed for Great Salt Plains Dam, and to correct any undesirable conditions which may be found to exist.
(g) The model is constructed to a scale of 1 to 36; the spillway is constructed of concrete, pyralin, and treated wood. A movable sand bed is provided below the spillway for qualitative study of erosion, etc.
(h) All scheduled tests are completed and preparation of the final report is in progress.

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(969) (a) MODEL STUDY OF WAVE FORCE AGAINST BREAKWATERS.
(b) The Division Engineer, Great Lakes Division.
(c) Model study of distribution and intensity of wave forces.
(d) and (e) See (415).
(f) The purpose of the study is to develop a vertical pressure curve showing the pressures developed by waves striking against breakwaters. This vertical pressure curve would be used as a basis for design of breakwaters.

As proposed for the model study, four variables would be investigated on the model and the resulting vertical pressure curves developed. These four variables are:
a. Heights and lengths of waves.
b. Depth of water and slope of bottom.
c. Shape of breakwater.
d. Angle of impingement of waves.
(h) Design of the model is in progress.

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(970) (a) SECOND SERIES, MODEL STUDY OF PLANS FOR THE 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 for study of channel improvement plans.
(d) and (e) See (415).
(f) The purpose of the series of tests is:
a. To determine the effectiveness of the existing jetties under present conditions, with the enlarged canal.
b. To devise a plan for modification of the existing jetties in the event that the existing jetties do not function properly under the conditions of a above.
c. To determine the relative shoaling in the Delaware River Ship Canal under existing and proposed jetty conditions.
(g) The model is of the movable-bed type, using crushed coal for bed material. Model scales are 1 to 800, horizontal, and 1 to 80, vertical.
(h) Preparation of the model for this series of tests is essentially complete.

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(971) (a) MISSISSIPPI RIVER NAVIGATION STUDY.
(b) The President, Mississippi River Commission.
(c) Model study of low-water flow conditions.
(d) and (e) See (415).
(f) The purpose of the investigation is to study low-water phenomena associated with the Mississippi River from Cape Girardeau (Mile 52 above Cairo) to Cottonwood Point (Mile 125 below Cairo) and with the Ohio River from Dam 53 to the mouth.
(g) The model is of the fixed bed (concrete veneer) type constructed to a horizontal scale of 1 to 1000 and a vertical scale of 1 to 100.
(h) Construction of the model is complete.

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(972) (a) MODEL STUDY OF SPILLWAY FOR THE NEW LOCK AND DAM NO. 1, ST. LUCIE CANAL.
(b) The District Engineer, U. S. Engineer Office, Jacksonville, Fla.
(c) Model study of spillway performance.
(d) and (e) See (415).
(f) The purposes of the model study are:
a. The determination of the relative effectiveness of the three proposed spillway designs, or if none of these prove adequate, the development of suitable design.
b. The calibration of the taintor gates and the preparation of a set of discharge curves.
c. The determination of safe discharge quantities corresponding to the various tailwater stages with the view to the formulation of an operating schedule.
(h) The model is now under construction.

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(973) (a) MODEL STUDY OF SEEPAGE THROUGH MISSISSIPPI RIVER LEVEES.
(b) The District Engineer, U. S. Engineer Office, Vicksburg, Miss.
(c) Model study of methods for seepage control.
(d) and (e) See (415).
(f) To find the most economical location for an effective tide drainage system proposed for installation in existing levees and to observe the topmost seepage line.
(h) The model design is in progress.

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(974) (a) MODEL STUDY OF THE STILLING BASIN FOR THE BAYOU DES GLAISES DRAINAGE CULVERT.
(b) The District Engineer, Second New Orleans District.
(c) Study of stilling basin performance.
(d) and (e) See (415).
(f) To determine the effectiveness of two tentative designs and modification thereof for the stilling basin for the outlet of the Bayou Des Glaises.
(g) The model was constructed to a linear scale ratio, model to prototype, of 1 to 12. There were reproduced in the model the outlet of the culvert, the stilling basin structure, and a portion of the outlet channel.
(h) All scheduled model tests have been completed.
(i) The results of the tests are presented in Technical Memorandum No. 147-1, titled, "Model Study of the Stilling Basin for the Outlet of the Bayou Des Glaises Drainage Culvert."

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(975) (a) STUDY OF PERMEABILITY OF ROCK JETTY MODELS.
(b) The District Engineer, U. S. Engineer Office, Philadelphia, Pa.
(c) Study of rates of flow through varied core types.
(d) and (e) See (415).
(f) To determine the relative permeability (under identical conditions of compaction of the core stone) of three general types of jetties. A secondary purpose was to determine the effect - on permeability - of the arrangement of the stones in the cores of each of the jetties.

(g) The jetty models were placed in a flume the dimensions of which were 20 ft by 4.9 ft by 3.6 ft. Seepage through the various models was studied under controlled conditions.
(h) All model tests are complete.
(i) Results of the tests are presented in Technical Memorandum No. 133-1, titled, "Study of Permeability of Rock Jetty Models."

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(976) (a) MODEL STUDY OF EAST RIVER, NEW YORK (SECOND SERIES).
(b) The District Engineer, U. S. Engineer Office, New York.
(c) Study of proposed channel improvements.
(d) and (e) See (415).
(f) To determine the effects of additional proposed improvements in East River.
(g) The model is of the fixed bed (concrete veneer) type constructed to scales of 1 to 480, horizontal, and 1 to 80, vertical. Tides and river flow are simulated in operation of the model.
(h) All scheduled tests are complete and preparation of the report is in progress.

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NATIONAL BUREAU OF STANDARDS.

(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, "Cross-connections in plumbing systems", has been published. See abstract in this Bulletin. A paper, "Methods of estimating demand and sewage loads", is in preparation. The experimental work on building drains is nearing completion.
(i) This project is now being carried on in conjunction with Project 797, also reported in this Bulletin, and future publication of results will probably be combined in one series of papers covering both projects.

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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) A paper on pressure losses in 90° pipe bends was published in July 1938. See abstract in this Bulletin. Experiments on 1-inch smooth pipe coils of one to ten or twelve turns and radii up to about 4 feet are under way.

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(171) (a) INVESTIGATION OF THE PRESSURE VARIATIONS ON THE UPSTREAM AND DOWNSTREAM SIDES OF AN ORIFICE PLATE OR FLOW NOZZLE.
(b) National Bureau of Standards.
(c) Scientific data.
(d) H. S. Bean, F. C. Morey.
(e) The Director, National Bureau of Standards.
(f) To obtain more complete data than are now at hand on the variations of pressure in the vicinity of an orifice plate or flow nozzle, which will assist in better correlation of orifice coefficient data, and the selection of suitable pressure tap locations for use with flow nozzles.
(g) Water from a constant head tank will be discharged through the orifice section of the line into either a weighing or calibrated volumetric tank. Simultaneous readings will be made of the pressure at 48 pressure openings extending from the orifice plate face to about 4 pipe diameters upstream and 10 pipe diameters downstream. It is planned to vary the ratio of orifice to pipe diameter from about 0.05 to over 0.8, and to vary the Reynolds number over at least 1 to 10 range for each orifice.
(h) Work on nozzles practically completed. Similar tests have yet to be made with square-edged thin-plate orifices.

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(342) (a) STUDIES OF ARTIFICIAL CONTROLS FOR STREAM-FLOW MEASUREMENTS.
(b) U. S. Geological Survey, Water Resources Branch.
(c) Cooperative project with the U. S. Geological Survey for comparative performance tests and general scientific research.
(d) M. A. Mason and H. N. Eaton (National Bureau of Standards), W. S. Eisenlohr, Jr. (Geological Survey).
(e) The Director, National Bureau of Standards.
(f) To study the relative merits of the various designs of several district offices of the Survey, with a view to standardizing on a few selected types.
(g) Full-scale sections have been tested in the 12 ft wide flume with flows ranging from 0.1 to 30 cfs. The tests included calibrations under free overfall conditions and with various degrees of submergence, also a study of the effect of the silting-up of the channel above the control.
(h) Final editing of the report is in progress.

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(343) (a) FRICTION LOSSES IN STRAIGHT PIPES.
(b) National Bureau of Standards.
(c) General research.
(d) K. H. Beij, G. H. Keulegan.
(e) The Director, National Bureau of Standards.
(f) Study of hydraulic roughness in pipes.
(g) Correlation of friction losses with surface characteristics of pipes.
(h) A critical review of previous work has been completed. Project is temporarily inactive.
(i) This investigation is carried on in connection with other projects as opportunity offers.

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(384) (a) TESTS OF SPILLWAY FLASHBOARD PINS.
(b) U. S. Forest Service.
(c) Cooperative project with the U. S. Forest Service for testing field designs under simulated field conditions in the laboratory.
(d) C. A. Wright (formerly with National Bureau of Standards), C. A. Betts, (U. S. Forest Service).
(e) The Director, National Bureau of Standards.
(f) To test spillway flashboard pins to failure under pressure due to still and overflowing water and also in a mechanical testing machine.
(h) A report on the results of the investigation has been completed, and a paper has been submitted to the American Society of Civil Engineers for publication.

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(496) (a) DETERMINATION OF DISCHARGE COEFFICIENTS OF FLOW NOZZLES. Cooperative research sponsored by A.S.M.E. Special Research Committee on Fluid Meters.
(b) Factors for use in commercial measurement of fluids.
(c) Cooperative research sponsored by A.S.M.E. Special Research Committee on Fluid Meters, with cooperation of the National Bureau of Standards, University of California (Project 587), Ohio State University (Project 546), University of Oklahoma (Project 617), Cornell University (Project 587), Massachusetts Institute of Technology.
(d) H. S. Bean, F. C. Morey.
(e) The Director, National Bureau of Standards.
(f) To determine discharge coefficients for "long-radius" flow nozzles; to determine the most satisfactory location for pressure holes; to check, compare, and correlate American and European designs and practices.
(g) Tests are being made on nozzles in 2, 3, 4, 8, and 16-inch pipes, with oil, water, steam, and air. Each nozzle used in this project is to be tested with two or more fluids in two or more of the laboratories listed.
(h) Test program 95% completed.
(i) Will require about 1 year to complete the tests and to correlate and publish the results.

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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, B. F. Husten.
(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 and 1938. The next tests will be made in August 1939.

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(564) (a) DENSITY CURRENTS.
(b) National Bureau of Standards.
(c) General research.
(d) G. H. Keulegan, H. N. Eaton.
(e) The Director, National Bureau of Standards.
(f) To determine the laws of currents in miscible stratified fluids.
(g) The mathematical form of a criterion to determine whether or not the moving fluid will mix with the still fluid has been established, and its critical value has been measured in small, closed, rectangular channels of several sizes. In these channels a current of tap water was caused to flow over a heavier salt solution situated in a depression in the floor of the channel. The velocity of the current was increased until the waves set up at the interface of the two liquids commenced to break and so to produce mixing. This velocity was taken as the critical velocity for mixing, and its value was substituted in the criterion. A new channel has been built in which tests will be conducted with liquids having quite different viscosities, but nearly the same difference in density. The purpose of these experiments is to seek the model law for this phenomenon.

A theory is also being developed to obtain the thickness of the laminar layer at the interface of the two liquids and the velocity distribution in it.

(h) A progress report on this investigation was issued in May 1938 giving the derivation of the form of the criterion for mixing, the results of the laboratory experiments, the equation for the flow of bottom currents, and the equation for the lifting of a density current to an intake. A modification of this report has been submitted for publication in the National Bureau of Standards Journal of Research under the title, "The hydrodynamics of current in stratified liquids".

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(616) (a) FLOW IN OPEN CHANNELS.
(b) National Bureau of Standards.
(c) General research.
(d) G. H. Keulegan.
(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 surface, and the depression of the filament of maximum velocity.
(g) The first step has been to review Bazin's work on open channels. This has involved the application of von Kármán's velocity distribution law to wavy and to rough surfaces in open channel flow. It is hoped to conduct experiments on flow in open channels with triangular cross-sections and with different roughnesses.
(h) A paper entitled "The laws of turbulent flow in open channels", by G. H. Keulegan, appeared in the National Bureau of Standards Journal of Research, Vol. 21, No. 6, December 1938 as Research Paper RP1151. See abstract in this Bulletin.

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(705) (a) MODEL STUDIES, SAVAGE RIVER DAM.
(b) The District Engineer, U. S. Engineer Office, Washington, D.C.
(c) Study of the performance of a side-channel spillway around an earth dam.
(d) H. N. Eaton for the National Bureau of Standards, E. P. Fortson, E. P. Tippetts, and B. W. Steele for the U. S. Engineer Office.
(e) The District Engineer, U. S. Engineer Office, Washington, D. C.
(h) Investigation completed. A paper giving the results is being prepared for publication.

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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) The experimental work is nearing completion, and the data are being analyzed for the reports. A paper on methods of estimating demand and sewage loads to be expected in plumbing systems is in preparation.

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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 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 the European and American literature on the mathematical theory of waves having direct application to the phenomena of flood waves.
(g) The results of this review will be coordinated and presented in a series of papers dealing individually with the following subjects: (1) The irrotational flow theory of translation waves, (2) Approximate solutions of wave phenomena involving the friction of the bed, (3) The quasi-permanent regime of rivers, and (4) Recent advances in the unrestricted theory of waves.
(h) The first draft of a paper on the irrotational theory of translation waves has been completed.

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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 undistorted models have been built. Model No. 1, on a scale of 1 to 60, includes the complete spillway weir and channel, tunnel, 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 includes the tunnel with its inlet and outlet works and a small section of the downstream river bed.
(h) Preliminary work on Model No. 1 is completed. Model No. 2 is under test. After completion of tests on Model No. 2, further tests will be made of the spillway channel and tunnel outlet works in Model No. 1.

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(979) (a) MODEL STUDIES, DREDGE SUCTION BOOSTER.
(b) The District Engineer, U. S. Engineer Office, Washington, D. C.
(c) Model tests of a pipe-line dredge-suction line with and without an axial-flow impeller at the suction-line entrance.
(d) L. L. DeFabritis.
(e) The District Engineer, U. S. Engineer Office, Washington, D. C.
(f) To compare the concentration of solids in a model pipe-line dredge-suction line with and without a booster pump at the suction entrance, for different velocities in the line and

dredging from a sand bed that moves relatively to the line, with the view of determining the effect of the booster on the concentration of solids.

(g) A 1:8 scale model of a 24-inch diameter dredge-suction line will be attached to a pump, stationary in position over a long, submerged, sand tank which will be moved under the dredge at any desired constant speed by a motor-propelled carriage. Discharge rates and sand concentrations will be measured in a volumetric weighing tank. A 4-inch diameter, four-bladed, axial-flow impeller, driven by a variable-speed motor, will simulate the booster pump at the suction-line entrance.

(h) Location in the laboratory and set-up of apparatus has been chosen, but construction has not yet begun.

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(980) (a) CALIBRATION OF 36-INCH VENTURI METER.

(b) National Bureau of Standards.

(c) Determination of the characteristics of a 36 x 18 inch Venturi meter.

(d) M. A. Mason.

(e) The Director, National Bureau of Standards.

(f) To determine the characteristics of a venturi meter intended for service as a secondary standard of measurement.

(g) An attempt will be made to employ, for calibration purposes, several methods of water measurement, with emphasis placed on the calibration by pitot tube traverses of the venturi throat. Results of the calibration will be available for studies of the similitude between venturi meters.

(h) A study is being made of all the available literature on venturi meters and their auxiliary equipment, and on the design and use of pitot tubes for the particular purpose envisaged. The possibility of employing simultaneously several methods of measurement is being investigated.

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(981) (a) INSTALLATION REQUIREMENTS FOR HEAD METERS SUCH AS ORIFICE, FLOW NOZZLES, ETC.

(b) Cooperative Research sponsored by A.S.M.E. Special Research Committee on Fluid Meters with the National Bureau of Standards and Washington Gas Light Co.

(c) Laboratory investigation simulating certain possible plant conditions.

(d) A.S.M.E. Fluid Meters Committee, National Bureau of Standards. Washington Gas Light Co.

(e) H. S. Bean, National Bureau of Standards.

(f) To verify and extend previous tests to determine the minimum necessary conditions for 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. Tests will be made with both gas and water.
(h) The undertaking of this work has been authorized by Fluid Meters Committee. Arrangements and plans are being prepared. Tests will be made in Washington during spring and summer of 1939.

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(982) (a) FUNCTIONAL CHARACTERISTICS OF PLUMBING FIXTURES AND FITTINGS.
(b) Cooperative project with Plumbing Manufacturers Association.
(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 towards developing functional and test specifications.
(g) Recording of the variable phenomena that occur in plumbing fixtures will be done by photographic and mechanical means in order to allow more detailed analysis.
(h) Investigation of water-closet characteristics is under way.

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UNIVERSITY OF CALIFORNIA, College of Agriculture, Davis, California.

(270) (a) THE EFFECT OF DEPTH TO WATER TABLE UPON LOSS OF WATER FROM THE SOIL SURFACE.
(c) Experiment Station Project.
(e) Professor F. J. Veihmeyer.
(h) Measurements on 35 water-table tanks recorded each week. See Bulletin V-2, p. 12.

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(271) (a) MOVEMENT OF MOISTURE THROUGH SOILS.
(c) Experiment Station Project.
(e) Professor F. J. Veihmeyer.
(h) Ten field plots, 50' x 100', laid out in 1938 to observe effect of cultural treatment and fertilization of soil surface on rate of entry of water. See Bulletin V-2, p. 12.
(i) Water in Soils and its Movement. F. J. Veihmeyer and N. E. Edlefsen, Union Géodésique et Géophysique Internationale, Bul. 22:355-365, 1936.

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(272) (a) CHARACTERISTICS OF SPRINKLERS AND SPRINKLER SYSTEMS FOR IRRIGATION.
(c) Experiment Station Project.
(h) Tests completed. Bulletin to be prepared.
(i) Irrigation by Sprinkling. J. E. Christiansen, Agricultural Engineering, 18(12):535-538, Dec. 1937; Four New Movable Sprinkler Machines. J. E. Christiansen, Pacific Rural Press, V. 136 (16): 351, 354, 355, Oct. 15, 1938.

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(666) (a) THERMODYNAMIC STUDIES OF EVAPORATION FROM FREE WATER, SOIL, AND PLANTS.
(c) Experiment Station Project.
(e) Professor F. J. Veihmeyer.
(h) Studies continued.
(i) Interpretation of Soil Moisture Problems by Means of Energy Changes. F. J. Veihmeyer and N. E. Edlefsen, Amer. Geophys. Union Trans. Pt. II:302-318, 1937.

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(667) (a) HYDROLOGY OF IRRIGATION WATER SUPPLIES IN CALIFORNIA.
(c) Experiment Station Project.
(e) Professor F. J. Veihmeyer.
(h) Measurements on experimental plots in Shasta County, California, are being continued. See Bulletin V-2, p. 13.
(i) Evaporation from Soils and Transpiration, F. J. Veihmeyer, Amer. Geophys. Union Trans. 613-619, 1938.

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(725) (a) MODIFIED VENTURI SECTION FOR OPEN CHANNELS.
(b) Laboratory project in cooperation with Hydraulic Laboratory, University of California at Berkeley.

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(986) (a) CHARACTERISTICS OF PITOT TUBES USED FOR MEASURING WATER IN PIPE LINES. (Part of larger project on Measurement of Irrigation Water.)
(b) California Agricultural Experiment Station.
(c) Experiment Station Project.
(d) J. E. Christiansen, and O. C. French.
(e) Professor F. J. Veihmeyer.
(f) To determine characteristics and accuracy of different kinds of pitot tubes (including transverse tubes) used for measuring discharge from pumping plants.
(g) Pitot tubes have been tested in a 6-inch discharge pipe of turbine pump in pump laboratory, Division of Agricultural Engineering. Flow measured with calibrated end-cap orifice on end of line. Tests have aimed at determining characteristics of different kinds of pitot tubes, under different flow conditions, rather than simply determining coefficients for the pitot tubes.
(h) Tests to date have included studies of 4 sizes of transverse tubes, from 1/8" to 5/16" diameter, two conventional type pitot tubes made according to suggestion of Ower of the National Physical Laboratory, London, a special transverse tube used by University of Iowa, a commercial flow meter (special form of pitot tube) and other special pitot tubes.
(i) Characteristics of Transverse Pitot Tubes. J. E. Christiansen and O. C. French, Agricultural Engineering, 18(1), Jan. 1937.

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UNIVERSITY OF OKLAHOMA

(617) (a) DETERMINATION OF DISCHARGE COEFFICIENTS FOR FLOW NOZZLES AND SQUARE-EDGED ORIFICES WHEN METERING OIL.
(b) Co-operative research project sponsored by the Special Research Committee on Fluid Meters of the A.S.M.E.
(e) Professor W. H. Carson, Head, Department of Mechanical Engineering.
(h) In progress.
(i) Report for this Bulletin furnished by H. S. Bean, National Bureau of Standards.

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UNIVERSITY OF MINNESOTA.

(94) (a) TRANSPORTATION OF SEDIMENT.
(c) University hydraulics research project.
(e) Dr. Lorenz G. Straub.
(b), (d), (f) and (g) (These details given in earlier bulletins of the series.)

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(99) (a) LAWS OF HYDRAULIC SIMILITUDE.
(c) University hydraulics research project.
(e) Dr. Lorenz G. Straub.
(b), (d) (f) and (g) See complete report of this project 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) and (g)-These details given in earlier bulletins.

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(327) (a) EXPERIMENTAL STUDY OF FLUSH VALVES FOR WATER-CLOSETS.
(c) Cooperative research project with Sanitary Division of Minnesota State Board of Health and the Hydraulics Department of the University.
(e) Dr. Lorenz G. Straub.
(b), (d),(f) and (g) See complete report of this project 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), (d), (f) and (g) (Details given in earlier bulletins.)

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(677) (a) SEDIMENTATION AT THE CONFLUENCE OF RIVERS.
(b) In cooperation with the Special Committee on Hydraulic Research of the American Society of Civil Engineers.
(d) Dr. Lorenz G. Straub and Robert H. Gedney.
(e) Dr. Lorenz G. Straub.
(i) Project has been set up to a larger scale in the recently completed St. Anthony Falls Hydraulic Laboratory.
(f) and (g) See earlier bulletins for these details.

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(678) (a) STUDY OF WIND-GENERATED WAVES.
(e) Dr. Lorenz G. Straub.
(b), (d) and (g) See earlier bulletins for these details.

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(679) (a) STABILITY OF SAND DAMS.
(e) Dr. Lorenz G. Straub.
(b), (d), (f) and (g) See earlier bulletins for these details.

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(983) (a) ST. ANTHONY FALLS NAVIGATION PROJECT.
(b) U. S. Engineer Department.
(c) Design project and operations study.
(d) Staff of U. S. Engineer Department, St. Paul District, Colonel Philip B. Fleming, District Engineer.
(e) Dr. Lorenz G. Straub.
(g) Tests are to be made on a model of the projected development.
(h) Construction of models nearing completion.

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(984) (a) FLOW THROUGH GRANULAR MATERIALS.
(b) Graduate thesis.
(c) Studies of the laws of flow through granular materials.
(d) Robert H. Gedney.
(e) Dr. Lorenz G. Straub.
(g) Various grades of material and fluids of various viscosities are being used.
(h) Apparatus has been set up and a series of experiments performed.

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(985) (a) HIGH-VELOCITY FLOW IN OPEN CHANNELS.
(b) In cooperation with the Special Committee on Hydraulic Research of the American Society of Civil Engineers.
(d) Dr. Lorenz G. Straub, John F. Ripken and Thomas Klingel.
(e) Dr. Lorenz G.Straub.
(f) Experimental study of the laws of flow at extremely high velocities in open channels.

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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 Montreal.
(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) Experimental work in progress. Five different profiles have been studied.

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ABSTRACTS OF COMPLETED PROJECTS AND REFERENCES TO PUBLICATIONS.

UNIVERSITY OF CALIFORNIA.

(423) FLOOD WAVES IN OPEN CHANNELS.

This work is an extension of that reported in a previous bulletin under the same title and numbered 423. The experimental work was carried on in a small channel of variable slope, with a gate at its upper end so arranged that the discharge could be varied through any predetermined cycle. The characteristics of the flood waves generated by the varying discharge were studied. Measurements were taken on the height of the wave, the velocity of propagation and the damping effect of friction. The results were compared with the mathematical theories of flood waves of Airy, Biot, Massé, Deymié and others. It was found that the existing mathematical theory does not agree entirely with the observations, but was of value in attempting to obtain an approval to an empirical solution.

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(424) DIVIDING STREAMS IN OPEN RECTANGULAR CHANNELS.

This work was carried out with open channels six inches in width having one branch in line with the main channel, and the other branch diverging at angles of 45°, 90°and 135° . The following conclusions were reached: There is little difference in the depths in the three channels so long as the major portion of the flow goes down the straight channel; however, to divert a major portion of the flow down the side branch requires that the depth in that branch drop and the depth in the straight branch rise. The drop in the depth of the side branch is a function of the proportion of the discharge it carries, of the kinetic energy of the water entering the intersection, and of the angle of divergence. The rise in depth in the straight branch is a function of the proportion of discharge diverted, and of the kinetic energy of the

water entering the intersection, but is independent of the angle of divergence. If the main channel carries a discharge of low kinetic energy, the head loss is negligible.

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(427) FLOW IN TIDAL CANALS.

The purpose of this study was to test the validity of the theory of Col. E. I. Brown, Corps of Engineers, U. S. Army, as applied to flow in tidal canals, and reported in the Transactions of the American Society of Civil Engineers for 1932. Tides were generated at the mouth of a channel 3" wide and 200 ft long. The amplitude and period of the tide was kept constant and only the friction of the small canal varied. Simultaneous measurements were taken along the canal in order to determine the height of the tidal waves and velocities induced. The observations led to the conclusion that the theory of Col. Brown is correct and that computations of tidal heights and velocities in a canal can be made with sufficient accuracy for practical purposes.

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(719) HYDRAULIC ROUGHNESS IN OPEN CHANNELS.

The channel used in this series of tests was triangular in cross-section, so that the sections would be geometrically similar at different depths. The object was to determine the lower limit of fully developed turbulent flow in open channels. A smooth varnished surface and a surface roughened with uniform sand grains were used. The friction factor "f", the Reynolds number R_e, and the relative roughness e/r were determined for various conditions of depth of flow, bottom slope, and surface roughness. The results are summarized as follows:

(1) Fully developed turbulence occurs in open channels under the same conditions as in circular pipes.

(2) For smooth surfaces, the relation between friction factor and Reynolds number is:

$$\frac{1}{\sqrt{f}} = 2 \log \frac{R_e}{\sqrt{f}} - 0.8$$

which is the same as for circular pipes.

(3) For rough surfaces the equation

$$\frac{1}{\sqrt{f}} = A \log \left(\frac{r}{e}\right) + B$$

relates relative roughness in and friction factor. The quantities A and B may be expected to vary with the geometry of both the roughness and flow cross-section.

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(721) A MODEL STUDY OF BEACH EROSION.

The purpose of this study was to investigate the reliability of small distorted models for the problems of sand movement and beach erosion. A model of a portion of the shore line near Santa Barbara, California, was tested under various conditions of littoral drift and wave action, and the model indications were compared with known occurrences in nature. Runs under identical conditions were carried on to test the ability of the model to reproduce itself. The scales used were 150: 1 horizontally and 49: 1 vertically. The scale ratios for wave period, tidal period, and wave height were determined theoretically and used for the computation of values produced in the model. The sand size could not be reduced to scale. The model gave good qualitative information but failed to reproduce the prototype in all details. When run under identical conditions, the model proved to be entirely consistent within itself.

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(722) SURGING IN HARBORS.

Surges were generated in a long narrow basin by a reciprocating plunger driven at various constant frequencies. The heights and frequencies of the surges, as well as the positions of the nodes, were measured in basins having uniform and variable still-water depths. The purpose was to determine the resonant frequencies of oscillation of the various basins. Agreement with the existing theory was found to be good for those basins in which the still water depth was constant. Here the natural periods of oscillation of the fundamental seiche and the harmonics are:

$$T = \frac{2}{K\sqrt{g}} D$$

when L is the length of the closed basin, D is the constant depth, and K is an integer depending upon the number of nodes present. This equation was verified experimentally. For basins of variable depth the periods are supposed to be:

$$T = \frac{2}{K} \int_0^L \frac{dL}{gD}$$

Agreement with this equation was not found to be good. It was further found that sills placed beneath the surface reduce the amplitude of the surges at the resonant frequencies.

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(725) THE MODIFIED VENTURI SECTION AS AN IRRIGATION METER.

A Venturi Section contracted from the top is placed in a rectangular channel. It is desired to investigate its possibility of use in metering irrigation water under the conditions of a flat energy gradient and low velocities.

The second model investigated has an upstream face 60° with the horizontal and tangent to the radial throat. Below the throat generated by two radii is a diffuser section at 20° with the horizontal. This model, at the throat setting, has a nearly constant coefficient increasing only $1\frac{1}{2}$ per cent when the depth ratio is increased from 5 to 10 per cent.

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

(658) USE OF PROBABILITY GRAPHS IN THE INTERPRETATION OF MECHANICAL ANALYSES OF SEDIMENTS.

In the present state of the theory of sediment transportation, mechanical analyses of sediments are studied by comparing or contrasting them with other analyses. Comparison of mechanical analyses is greatly facilitated if the information they contain can be reduced to a set of numerical values or parameters. Two terms of a Gram-Charlier series, expressed in Krumbein's phi units represent the data for many analyses, thus enabling them to be reduced to three parameters. Graphical methods are given for recognizing such analyses, for obtaining the parameters, and for evaluating the extent to which they summarize the analytical information. A general procedure is then outlined for systematic graphical comparison of mechanical analyses, including analyses not amenable to the above quantitative methods.

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(663) MECHANICS OF SEDIMENT SUSPENSION

To appear in proceedings of Fifth International Congress for Applied Mechanics. Investigator: Hunter Rouse.

Despite its importance to the study of sediment transportation, the theory of sediment suspension through fluid turbulence has not yet been fully verified. This theory presumes a state of equilibrium between the convection due to turbulence and the settling of the sediment, the concentration c at any elevation y then depending upon that at some reference level a, upon the settling velocity w, and upon the distribution of the mixing length l and the velocity of fluctuation v':

$$\ln \frac{c}{c_a} = -\frac{W}{\beta} \int_a^y \frac{dy}{v'l} \qquad (1)$$

In order to test the validity of this fundamental relationship, an apparatus was constructed wherewith the product $E = BV'L$ could be maintained essentially constant throughout a considerable fluid volume, equation (1) then taking the form

$$\frac{c}{c_a} = e^{\frac{-W(y-a)}{\varepsilon}} \qquad (2)$$

The turbulent mixing was produced by means of an electrically driven lattice structure oscillating vertically in a cylindrical glass tank, the amplitude of the agitator remaining constant and the intensity of mixing being governed by the frequency of oscillation. Representative samples of the suspension could be drawn off by pipette at any desired level.

Nearly a hundred distribution curves were determined over a vertical range of 50 cm, using mixtures of water and quartz sands approximately 1/4, 1/8, 1/16, and 1/32 mm in diameter. Concentrations varied from 0.002% to 4% by weight, and the agitator frequency from 0.8 to 5 cycles per second. Since the experiments permitted direct measurement of c/c_a, w, and $y - a$, the quantity E could be computed from equation (2). Plots of E against the agitator frequency yielded almost identical curves for each of the four sediments, regardless of particle size or concentration. A composite dimensionless plot of all data taken in the region of fully developed turbulence evidenced very satisfactory agreement with equation (2), indicating that analysis of the suspended load of streams according to the existing theory is fully justified.

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CALIFORNIA INSTITUTE OF TECHNOLOGY, Hydraulic Structures Laboratory.

(357) and (656) CURVILINEAR FLOW OF LIQUID WITH A FREE SURFACE AT VELOCITIES ABOVE THAT OF WAVE PROPAGATION.

An article with this title will be found in the Proceedings of the Fifth International Congress of Applied Mechanics, published by John Wiley & Sons.

Investigators: Robert T. Knapp and Arthur T. Ippen.

These projects resulted in the development of an analytical method of calculating the free surface of liquids constrained to flow at high velocities between curved boundaries. It is based upon a series of experimental studies of the flow of water in curved channels of rectangular cross-sections It was found that the conventional methods of treating flow around curves in open channels were not generally applicable for cases of gravity waves. The analysis of the curved flow presented is based upon the physical similarity between supercritical open-channel flow and two-dimensional supersonic flow of compressible fluids; (cf. Kármán, Zeitschrift für angewandte Mathematik und Mechanik. Überschallströmung in Gasen u. überkritische Strömung in Gerinnen. Band 18, Heft 1. Februar 1938. 49) The experimental results are analyzed in comparison with this theory.

One of the most serious problems encountered in handling large scale flows of this type is that, even for moderate rates of curvature, very high superelevations are encountered. These disturbances also persist below the curves and thus intensify the difficulty of the problem. The analysis developed not only makes it possible to calculate the magnitude and location of these disturbances, but also indicates means of reducing or eliminating them, based upon the use of the phenomenon of wave-train interference. Experimental verification of typical applications of such treatments are also presented.

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CASE SCHOOL OF APPLIED SCIENCE.

(730) SPILLWAY DESIGN)
(731) STUDY OF SLUICES) - MAHONING DAM
(732) CHANNEL MODEL)

Four models were used in the study; namely, (1) a 1:48 scale model of a section of the spillway, (2) a 1:18 scale model of one sluice, (3) a 1:20 scale model of the stilling weir, and (4) a 1:72 scale general model of the dam and adjacent sections. Findings on the 1:48 scale model included head-discharge curves for free overfall and for crest gates; pressures on the face of the spillway for free and restricted overfall; performance of alternate types of sluice portal sections, with deflectors to give lateral spread to the discharge; performance for alternate designs of the stilling basin including development of a novel type of end sill, performance of stilling basin with and without stilling weir downstream. A stilling weir to artificially raise tailwater depth proved more economical than deep excavation in rock for uncontrolled tailwater. Findings on the 1:18 scale model include trash rack losses, hydraulic gradients through the sluice, and calibration curves. Findings on the 1:20 scale model include rating curves and performance for alternate apron designs, and pressures on the downstream face of the weir. Findings for the 1:72 scale model include calibration curves, performance of stilling basin with various gate and sluice openings, and various heights and lengths of stilling weir. In the structure to be built, piezometer openings will be included as in the model for future correlation of test results.

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HORTON HYDRAULIC AND HYDROLOGIC LABORATORY.

Publications available. Copies of the following publications will be furnished without charge to hydraulic laboratories, upon application: "Hydrologic Research", by R. E. Horton, Science, Vol. 86, No. 2241, Dec. 10, 1937, pp. 527-530. "List of Publications, with Abstracts" by R. E. Horton, Publication No. 112, with Supplement No. 1, Horton Hydrologic Laboratory.

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U. S. ENGINEERS BONNEVILLE HYDRAULIC LABORATORY.

(567) MODEL STUDIES OF THE BONNEVILLE PROJECT ON THE COLUMBIA RIVER.

The results of studies on this project appear in a 3-volume report under date of June 30, 1937, entitled, "A report on model studies made in connection with the Bonneville project", by J. C. Stevens, Consulting Engineer. The contents of this report are as follows:

Letter of Transmittal
Synopsis of the Report
Section I - General Description of the Project and Hydraulic Laboratory
Section II - Scour Prevention
- Appendix A
Section III - Backwater and Channel Improvements.
Section IV - Crest Gates.
Section V - Cofferdams.
Section VI - Fishways and Miscellaneous.

In addition to this there are a number of staff reports on special features, among them one on "Model studies of the Bonneville tailrace for 10 units." by A. J. Gilardi.

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(770) BANK PROTECTION STUDIES.
Report by A. J. Gilardi.

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NATIONAL BUREAU OF STANDARDS, NATIONAL HYDRAULIC LABORATORY.

(42) "Cross-connections in plumbing systems", by Roy B. Hunter, Gene E. Golden, and Herbert N. Eaton. Research Paper RP1086, National Bureau of Standards Journal of Research, Vol. 20, April 1938. Obtainable from the Superintendent of Documents, Government Printing Office, Washington, D. C., 15 cents (stamps not accepted).

This paper deals principally with the technical aspects of the problem of preventing the backflow of water from plumbing fixtures into water-supply systems. It starts with a general review of the subject, including a brief history of previous work on the subject, a classification of cross-connections, and a brief discussion of vacua and siphon action. This is followed by a mathematical and experimental analysis of the conditions tending to produce backflow into a supply line. This analysis makes it possible to determine the worst conditions, as regards backflow, that can occur in any building supply system, and to determine minimum requirements for the positive prevention of backflow under these conditions. Specifically, the minimum pressure that can occur in any system, the maximum rate at which water can be removed from the supply risers under this minimum pressure, the smallest air gap between a faucet and plumbing fixture that can be safely allowed under the worst conditions, and the essential performance characteristics of a siphon-breaker are determined. The effectiveness of various types of siphon-breakers in preventing backflow is discussed, and the operation of one type of flush valve is explained in order to show the essentials of a stable flush valve, that is, one which will not open under any possible reduction in supply pressure. Finally, there is given a brief review of the entire subject of preventing backflow from plumbing fixtures, in which two distinct methods of attack are pointed out, and the merits of each are discussed. The conclusions relate only to the technical aspects of the subject and do not take the form of proposed health or plumbing regulations.

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(43) "Pressure losses for fluid flow in 90° pipe bends", by K. Hilding Beij. Research Paper RP1110, National Bureau of Standards Journal of Research, Vol. 21, July 1938. Obtainable from the Superintendent of Documents, Government Printing Office, Washington, D. C., 10 cents (stamps not accepted).

Pressure losses were determined for nine 4-inch steel, 90° pipe bends of radii from 6 to 80 inches. The results are discussed in relation to those found by previous investigators under comparable test conditions. For bends having radii of four pipe diameters or less, all the results which are discussed may be correlated on the basis of pipe roughness. Further data are needed to establish a working formula. No correlation could be obtained for the bends of larger radii. For such bends the maximum published values should be used in engineering work until more comprehensive data become available.

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(616) "Laws of turbulent flow in open channels", by Garbis H. Keulegan. Research Paper RP1151, National Bureau of Standards Journal of Research, Vol. 21, December 1938. Obtainable from the Superintendent of Documents, Government Printing Office, Washington, D. C., 10 cents (stamps not accepted).

The theoretical investigations of Prandtl and Kármán, and the experimental work of Nikuradse, have led to rational formulas for velocity distribution and hydraulic resistance for turbulent flow in circular pipes. With certain assumptions regarding the effects of secondary currents and of the free surface, and with the adoption of the hydraulic radius as the characteristic length, similar rational formulas are deduced for open channels. The validity and the applications of these formulas are illustrated by a study of Bazin's experiments. In this study the equivalent sand roughnesses of the channels used by Bazin are determined. The criterion for determining the conditions under which a channel with wooden-plank surfaces is to be considered hydrodynamically wavy or hydrodynamically rough is also evaluated. The rational formulas with constants determined from Bazin's experiments are expressed in the form of power laws. It is shown that Manning's empirical formula is a good approximation to the rational formula for rough channels when the relative roughness is large.

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U. S. BUREAU OF AGRICULTURAL ENGINEERING.

(192) "Flow of Water in Irrigation and Similar Canals."

By Fred C. Scobey, Senior Irrigation Engineer. In Bulletin No.II-2 dated July 1, 1934, page 24, it was announced that the Irrigation Division of the U. S. Bureau of Agricultural Engineering would revise Department Bulletin 194, "The Flow of Water in Irrigation Channels", first published in 1915. During the 25-year interval, many new experiments have been made on carrying capacity. Several of these were on canals of materials of construction that have come into general use during the past two decades. All of these tests were conducted on the field channels. Such experiments are the only ones that can bring out

the great differences in capacity as affected by seasonal or permanent changes due to weather, insect larvae, and aquatic growths. The report of this project is in press as a Technical Bulletin of the Department of Agriculture. It will contain about 100 pages, be profusely illustrated, and the recommendations and conclusions are based on 465 listed and described observations.

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UNIVERSITY OF LATVIA, RIGA, LATVIA.

Ist die heutige Lösung des "Überfallproblems einwandfrei?" (Is the present-day solution of the problem of flow over spillways free from objection?), by Prof. Dr.-Ing. A. Vītols.
Zeits. für Wasserkraft und Wasserwirtschaft, Heft 7/8, 1938.

With regard to the overfall problem, we encounter two facts in hydraulics. On the one hand the expression of the flow coefficient in the Polieni formula

$$Q = mb\sqrt{2g}\,h^{3/2}$$ is

governed by formulas of the Bazin type:

$$m = 0.405 + \frac{0.0027}{h},$$

which intrinsically cannot be used outside of the limits of the tests which served to establish them. On the other hand the needs of practical hydraulics are met through model tests, the results of which can be directly transferred to the prototype in which the dimensions of the overfall greatly exceed those of the model. In this procedure the law of geometrical similarity is tacitly assumed, which, however, is not compatible with the so-called "non-homogeneous" term 0.0027/h in the Bazin and related formulas. If we concede the law of geometrical similarity, which, as already stated, is done in practical hydraulics, the laboratory acquires a powerful and fruitful means of solving overfall problems, a solution which is entirely lacking in the present state of hydraulics. The author shows how, with the aid of the law of geometrical similarity, a whole series of overfall problems can be solved, and thereby present-day hydraulics can be enriched with fruitful material.

Furthermore the author seeks to explain the origin of non-homogeneous terms of the Bazin type which do not fit into the concept of geometrical similarity. To this end he utilizes a method of theoretical physics, the dimensionless products of physical and geometrical quantities, upon which the flow process may depend. In this way he comes to the conclusion that the non-homogeneous term of the form c/h, where c is taken as a constant by the author of this formula, is a function of the Reynolds number, from which it follows that c is a function of the temperature. Naturally it may be that the function c(t) is practically constant within the limits of temperature changes of natural streams. However, from the standpoint of physics, it is desirable to establish this function in order to have a universal formula which applies to all fluids and to the entire planetary system. Further it should be settled under

what conditions this non-homogeneous term can be omitted in order to make it possible to achieve the great advantage of having to do with pure geometrical similarity in the field of overfall problems in present day hydraulics.

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(A limited supply of this paper, in French, is available for distribution upon application to the author, c/o National Hydraulic Laboratory).

TRANSLATIONS.

UNIVERSITY OF MINNESOTA

The following translations have been made at the University of Minnesota. Inquiries should be addressed to Lorenz G. Straub, University of Minnesota. Translations have been made with assistance from Works Progress Administration.

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Q. M. SALEH
39 Warwick Road, Earls Court,
London, S. W. 5

The following translations have been made by Mr. Q. M. Saleh, who has kindly placed copies on file with the National Hydraulic Laboratory at the National Bureau of Standards, where they are available for loan upon application.

Meyer-Peter, Beitrag zur Berechnung der Geschiebefthrung und der Normalprofilbreite von Gebirgsflüssen.

Jakuschoff Zur Frage der vereinfachten Schwebestoffuntersuchung nach Gehalt und Zusammensetzung.

The following translations made by Mr. Q. M. Saleh are available for loan with Professors E. W. Lane (State University of Iowa) and with Professor Lorenz G. Straub (University of Minnesota) -

A. Schoklitsch — Der Geschiebetrieb und die Geschiebefracht: Wasserkraft u. Wasserwirtschaft, Heft 4, 1934.

F. Schaffernak — Ein Beitrag zur Morphologie des Flussbettes, Wasserwirtschaft 1929.

The following translations, also made by Mr. Q. M. Saleh, have been made available for loan upon application to the National Hydraulic Laboratory -

E. Meyer-Peter, H. Favre and A. Einstein — New experimental results on the transport of debris - Sch. Bauz. Bd. 105, Nr. 13, 1934.

Donat, Joseph — Ueber Schlangriff und Geschiebetrieb, Die Wasserwirtschaft, Hefte 26 and 27, 1929.

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CALIFORNIA INSTITUTE OF TECHNOLOGY AND U. S. SOIL CONSERVATION SERVICE.

Translations made in cooperation with the Section of Sedimentation Studies, Soil Conservation Service, U. S. Dept. of Agriculture.
See also list under U. S. Soil Conservation Service in which some of the following titles are duplicated.

Papers listed below are either available at the Bureau of Standards, Engineering Societies Library or U. S. Waterways Experiment Station, Vicksburg, Mississippi, or will be made available in a short time.

Dr.-Ing.A.Shields. — Application of Similarity Principles and Turbulence Research to Bed-Load Movement.
Published: "Anwendung der Aehnlichkeitsmechanik und der Turbulenzforschung auf die Geschiebebewegung", Mitteilungen der Preussischen Versuchsanstalt für Wasserbau und Schiffbau, Berlin, 1936.

A. Schoklitsch — Silting of Reservoirs and Scour Prevention.
Published: Stauraumverlandung und Kolkabwehr,
J. Springer, Wien, 1935.

K. H. Grossmann — Theoretical Consideration of Bed Load Movement.
Published: Schweizerische Bauzeitung - Vol. 110,
No. 14, October 2, 1937.

A. H. Einstein — The Hydraulic Radius.
Published: Schweizerische Bauzeitung - Vol. 103,
No. 8, February 24, 1934.

H. Peters — Pressure Measurements.
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Vol. 4 - 1.

A. H. Einstein — Calibrating the Bed-Load Trap as Used in the Rhine.
Published: Schweizerische Bauzeitung - Vol. 110,
No. 14, October 2, 1937.

E. Indri — Transporting Forces of Liquid Current.
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Dec. 1934.

R. Mueller — Re-examination of the Bed-Load Law and Method of Calculation of the Research Institute for Hydraulic Structure at E. T. H., Zurich, with the Aid of Direct Bed-Load Measurements on the Rhine.
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No. 15, October 9, 1937.

J. Ulsamer — The Principles of Measuring Velocity as to Size and Direction with a Hot-wire Instrument.
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T. C. Sen — Experiments with a Hot Wire Instrument.
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U. S. SOIL CONSERVATION SERVICE.

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Giandotti, Mario (French) Contribution to the Study of Bed Loads of Torrents. Congres International de Navigation 15th, Venice, 1931.

Giandotti, Mario Displacements of the Bed of the River Po. Congres International de Navigation 15th Venice, 1931. (French)

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Sensidoni, Francesco. (Italian) Gagings and Measurements of the Suspended Load of the River Reno at Malalbergo. From "Annali dei Lavori Pubblici Fascicule No. 1 January 1938.

Vezzani, Renzo. Studies on the Delta of the Po River. From the Congres International de Navigation 15th, Venice 1931 (French).

Volobuyev, V. R. (Russian) Method of a Continuous Mechanical Analysis with a Siphonic Sedimentometer. "Pedology" New Series XXX Year, No. 1, 1935.

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U. S. BUREAU OF RECLAMATION.

The following translations have been prepared by the Bureau of Reclamation since Bulletin VI, January 1, 1938, was completed. Inquiries should be addressed to the Chief Engineer, U. S. Bureau of Reclamation, Denver, Colorado.

C. Keller — L'Utilisation de L'Air pour les Essais de Machines Hydraulique (Use of Air in Testing Hydraulic Machines) Translated by D. J. Hebert from Genie Civil, April 30, 1938, pp. 371-374.

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NATIONAL BUREAU OF STANDARDS.

The following translations have been made by M. A. Mason of the staff of the National Hydraulic Laboratory. They are available for loan by addressing the Director, National Bureau of Standards.

Henn, W. — Fundamentals of water measurement. Translation of abstract in Zeitschrift des V.D.I., Bd. 82, No. 2, January 8, 1938.

Straus, K. — A ball sounding probe of small diameter for pressure and velocity measurements. Zeitschrift des V.D.I., Bd. 82, No. 2, January 8, 1938.

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HYDRAULIC RESEARCH COMMITTEES.

Committee on Dynamics of Streams, Section of Hydrology. American Geophysical Union.

Chairman: Dr. Lorenz G. Straub,
University of Minnesota,
Minneapolis, Minnesota.

Members.

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H. V. Geib	George W. Musgrave	C. E. Ramser	H.H.Wheaton
C. S. Howard	Martin E. Nelson	William W. Rubey	N. E. Winters

A report of the Committee for 1937-38 was published in the Transactions of the American Geophysical Union, August, 1938, page 349. More recently a new sub-committee was appointed, consisting of Irving B. Crosby, Chairman, E. W. Lane, Gerard H. Matthes, William W. Rubey, and Lorenz G. Straub (ex officio), concerned with the study of "Land Forms" as related to hydrology,

geology and the dynamics of streams. As its initial problem this sub-committee is making studies of the regimen and conformation of river channels. A number of papers concerned with the flow of water in natural and artificial channels have been sponsored by the Committee and published in the Transactions of the American Geophysical Union for 1938, published by the National Research Council.

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Special Committee on Floodwaves, Section of Hydrology.
American Geophysical Union.

Chairman: Dr. Lorenz G. Straub,
University of Minnesota,
Minneapolis, Minnesota.

Merrill Bernard	Ivan E. Houk	F. T. Mavis
H. N. Eaton	W. G. Hoyt	Morrough P. O'Brien
Robert E. Horton	Hans Kramer	Harold A. Thomas

The Special Committee on Floodwaves has set up a program of activity briefly described in the Transactions of the American Geophysical Union for 1938, published by the National Research Council. Supplementing the Committee's preliminary report there have been published "A Report on Activities of Sub-Committee Relating to Governmental Activities of the Special Committee on Flood-waves," by W. G. Hoyt, Sub-Committee Chairman; "Report of Sub-Committee on Bibliography of Special Committee on Floodwaves," by F. T. Mavis, Subcommittee Chairman; "Report of Sub-committee on Current Investigations of Special Committee on Floodwaves," by H. A. Thomas, Sub-Committee Chairman; "Rain Wave-Trains," and "Seddon's and Forchheimer's Formulas for Crest-Velocity of Floodwaves Subject to Channel-Friction Control," by Robert E. Horton; "A Study in the Theory of Flood-waves," by Elmer E. Moots.

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National Research Council Interdivisional Committee on Density Currents.

Chairman: Herbert N. Eaton,
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National Bureau of Standards,
Washington, D. C.

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J. H. Bodine	C. S. Howard	C. S. Scofield
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R. A. Hill	H. Peters	A. H. Wiebe
P. V. Hodges	F. P. Shepard	

*Alternate: G. C. Dobson.

Subcommittee on Elephant Butte Reservoir.

Chairman: C. S. Scofield, Chief
Division of Western Irrigation Agriculture,
Bureau of Plant Industry,
U. S. Department of Agriculture,
Washington, D. C.

Members.

M. M. Ellis — C. S. Howard — C. B. Brown
L. R. Fiock* — M. A. Mason

* Alternate: W. F. Resch.

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.

The Chairman of the Committee presented a brief statement of progress before the Section of Hydrology, American Geophysical Union, in April 1938. See "Progress report of the National Research Council Interdivisional Committee on Density Currents", Trans. Am. Geoph. Union, Nineteenth Annual Meeting, 1938, Part I, p 327. Reprints can be obtained from the Chairman.

The Committee held meetings at Washington, D. C., on June 24 and 25, 1938, at which reports of work during the preceding year were discussed and plans for the coming year were formulated. Copies of the minutes of these meetings can be obtained from the Chairman.

Committee on International Bibliography, Section of Hydrology, American Geophysical Union.

Chairman: K. Hilding Beij,
National Bureau of Standards,
Washington, D. C.

Members

Merrill Bernard — C. S. Howard — Thorndike Saville
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S. T. Harding — C. H. Lee — Lorenz G. Straub
Robert E. Horton — F. E. Matthes — David G. Thompson
F. J. Veihmeyer

As the American contribution to an international bibliography, this Committee, with the cooperation of the American Geophysical Union, has issued: "Bibliography of Hydrology in the United States of America for the Year 1937". Copies are obtainable from the General Secretary, American Geophysical Union, 5241 Broad Branch Road, Washington, D. C., at 30 cents each.

Special Research Committee on Fluid Meters, American Society of Mechanical Engineers.

Chairman: R. J. S. Pigott,
Gulf Research and Development Corp.,
Pittsburgh, Pa.

Members.

H. S. Bean	Louis Gess	Ed S. Smith, Jr.
S. R. Beitler	A. J. Kerr	R. E. Sprenkle
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B. O. Buchland	M. P. O'Brien	T. R. Weymouth
W. W. Frymoyer	W. S. Pardoe	M. J. Zucrow

J. R. Carlton, Secretary.

Subcommittees

(1) Flow Nozzle Research, H. S. Bean, Chairman.

The work sponsored by this subcommittee is being carried on at the following institutions:
Cornell University, Project 587, page 23 of this bulletin,
National Bureau of Standards, Project 171, page 96 of this bulletin, and
Project 496, page 97 of this bulletin,
Ohio State University, Project 526, page 45 of this bulletin,
University of Oklahoma, Project 617, page 104 of this bulletin.

(2) Influence of Installation, J. R. Carlton, Chairman.
(3) Revision of Part I, H. S. Bean, Chairman.
Issued 4th Ed. in October 1937, see A.S.M.E.Council Reports for 1937 under Research. (Mechanical Engineering, Vol. 60, No. 1, Jan.1938,page16)
(4) Research on Volumeters, R.J.S. Pigott, Chairman, H.S.Bean, Coordinator of Research Program.
(5) Oil Measurement in Tulsa Area, A.J.Kerr, Chairman.
(6) Joint A.G.A. -A.S.M.E. Committee, T. H. Kerr, Chairman.
(7) Bibliography, J. R. Carlton, Chairman.
(8) Fund Raising, E.C.M.Stahl, Chairman.

The completion of the flow nozzle research will require additional funds.

For previous reports of the work of this committee, see Bulletin V-1, page 99, Bulletin V-2, page 115, and Bulletin VI, page 73.

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