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U. S. DEPARTMENT OF COMMERCE
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Lyman J. Briggs,
Director.

CURRENT HYDRAULIC LABORATORY RESEARCH IN THE UNITED STATES.

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WASHINGTON.

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DIRECTORY.

CURRENT HYDRAULIC LABORATORY RESEARCH IN THE UNITED STATES.

Compiled by the National Bureau of Standards,
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Volume III, Number 1. January 1, 1935.

INTRODUCTION.

It may be of interest to those who are cooperating in furnishing information for these bulletins that the circulation is now in excess of 500 copies. This includes only bulletins which are sent as the result of a direct request.

A number of foreign papers on hydraulic and hydrologic subjects have been received and are in the files of the Hydraulic Laboratory Section of the National Bureau of Standards. A list of these accessions, since July 1, 1934, is given in this bulletin. The papers will be loaned upon request.

A revision of the bulletin, "Hydraulic Laboratories in the United States," which contains a description of the various hydraulic laboratories, is planned and will probably appear during July or August, 1935. At present it seems advisable to request that any revisions of the descriptions in the first bulletin issued on July 1, 1932, or descriptions of any laboratories not included in the first bulletin, be furnished not later than June 15, 1935, at the time when the next reports on current hydraulic laboratory research will be due. Several laboratory descriptions have been furnished in the form of projects in current hydraulic research. These descriptions will be reserved for publication in the revised bulletin.

Your attention is called to the fact that as a rule the Hydraulic Laboratory Section of the National Bureau of Standards does not have detailed information or copies of publications relating to the projects listed in these bulletins. For information always apply to the "Correspondent" whose name is listed under paragraph (e) for each project.

CURRENT PROJECTS IN HYDRAULIC LABORATORIES.

(Key)

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

CALIFORNIA INSTITUTE OF TECHNOLOGY.

(102) (a) INVESTIGATION OF VELOCITY DISTRIBUTION IN THE VOLUTE OF A CENTRIFUGAL PUMP IN THE NEIGHBORHOOD OF THE IMPELLER.
(b) Laboratory problem.
(c) General research for theses for M.S. degree.
(d) R. C. Binder.
(e) Professor R. L. Daugherty, or Professor Robert T. Knapp.
(f) By a special instrument the magnitude and direction of the velocity of the water is measured at a number of points within the volute, thus supplying experimental information that has long been desired.
(g) As in (f)
(h) Continued. A preliminary report has been presented by Mr. R. C. Binder and information concerning it can be obtained from him or from Professor Knapp.

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(267) (a) A STUDY OF THE BALLONA CREEK OUTLET.
(b) The Los Angeles County Flood Control District.
(c) Model study to solve a particular problem.
(d) Professor Robert T. Knapp with Vito A. Vanoni and Warren E. Wilson as assistants.
(e) Professor Robert T. Knapp and Professor R. L. Daugherty.
(f) To determine the most advantageous construction of the new flood control channel of the Ballona Creek to discharge into the Pacific Ocean, together with the length and form of jetties if any prove necessary.
This small creek is the outlet of a densely populated drainage area which has an extremely high percentage of the surface composed of roofs, paved streets and other non-porous covering. The creek is, therefore, subject to sudden floods of much larger

magnitude than the area would normally indicate. The new channel is being constructed to straighten the course, increase the hydraulic gradient, and protect the lowlands adjacent to the ocean from flood damage. The beaches in the neighborhood of the outlet are heavily used for recreational purposes and, therefore, these changes must be so made as to protect and if possible help build up these beaches.

(g) Model is being constructed in the basin used for Project 100. The general technique is to be the same as for the older project. An automatic tide machine has been constructed to facilitate operations. Since the basin is too large to permit the use of a variable displacement plunger, the tides are produced by regulating inflow and outflow. A plunger type wave machine has also been constructed the full width of the model; i.e. 40 ft. and provided with mechanism for varying both the amplitude and the frequency of the waves. It is also possible to change the angle of the machine with the coast and thus produce waves of any desired degree of inclination.

(h) Project commenced June, 1934. Work on this model will probably be completed about February, 1935.

(i) This work is being done under a cooperative arrangement with the Los Angeles County Flood Control District through the Chief Engineer, Mr. S. M. Fisher, Col. Charles T.Leeds, consulting engineer, is also actively cooperating.

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UNIVERSITY OF CALIFORNIA, College of Agriculture.

(270)(a) THE EFFECT OF DEPTH TO WATER TABLE UPON THE LOSS OF WATER FROM THE SOIL SURFACE. (Part of project on principles of soil moisture in relation to irrigation.)

(b) California Agricultural Experiment Station.

(c) Experiment Station project.

(d) M. R. Huberty and F. J. Veihmeyer.

(e) F. J. Veihmeyer.

(f) This study is part of a larger project to determine losses of water through plant transpiration and surface evaporation.

(g) Twenty-five tanks holding more than one ton of soil, equipped with Mariott constant water-level regulating devices, are being used. The amount of water evaporated is determined volumetrically and gravimetrically. The investigations have been under way for several years. The experiments have been conducted in such a way that a statistical analysis of the results of evaporation from the surface of the soils with the water table a constant distance below the surface can be obtained.

(h) The experiments will be continued for several additional years.

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(271)(a) MOVEMENT OF MOISTURE THROUGH SOILS. (Part of project on principles of soil moisture in relation to irrigation.)
(b) California Agricultural Experiment Station.
(c) Experiment Station project.
(d) N. E. Edlefsen and F. J. Veihmeyer.
(e) F. J. Veihmeyer.
(f) This study is part of a general project to study movement of water in soils, both under saturated and unsaturated conditions. It also involved the movement of water to roots of plants, the energy relations involved by extraction of water by plants and the factors affecting availability of water to plants.
(g) Extensive equipment of plant containers with suitable arrangements for determining water use ranging from small cans to tanks containing over one ton of soil are being used. In addition, numerous field plots with permanently rooted and annual plants, together with a specially equipped laboratory for the study of different phases of soil moisture movement, are in use.
(h) In progress.

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(272)(a) CHARACTERISTICS OF SPRINKLERS AND SPRINKLER SYSTEMS FOR IRRIGATION.(Part of larger project on farm irrigation structures and systems.)
(b) California Agricultural Experiment Station.
(c) Experiment Station Project.
(d) J. E. Christiansen.
(e) F. J. Veihmeyer.
(f) Determination of factors affecting uniformity of distribution, evaporation losses, and frictional losses in pipe lines with multiple outlets.
(g) Approximately 100 tests have been made on sprinklers of different makes and types to determine the distribution of water under varying conditions. Water is caught in a large number of cans (rain gages) and evaporation losses estimated from average depth caught as compared with water discharged. Effect of wind, pressure, speed of rotation of sprinkler, temperature, humidity, and various combinations of nozzles on performance of sprinklers studied. A large number of tests have been made on portable sprinkler pipe with sprinklers spaced at definite intervals to determine net pressure losses.
(h) In progress.

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UNIVERSITY OF CALIFORNIA, College of Engineering and U. S. Tidal Model Laboratory.

(16)(a) EFFECT ON EVAPORATION FROM STANDARD PANS DUE TO CHARACTER OF SURFACE OF PAN.
(c) Laboratory project.
(d) Hickox.
(e) Professor M. P. O'Brien.

.....

(17)(a) TRANSPORTATION OF BED LOAD BY STREAMS.
(c) Laboratory project.
(d) Lieut Hoeffer.
(e) Professor M. P. O'Brien.
(g) Studies to be continued in a tilting flume 3 feet wide and 18 inches deep.

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(172)(a) HYDRAULIC JUMP.
(c) Laboratory project.
(d) Rindlaub.
(e) Professor J. N. LeConte.
(g) Experiments on the hydraulic jump in a sloping channel.

.....

(269)(a) PROPELLER PUMPS.
(c) Laboratory project.
(d) Miller and Folsom.
(e) Professor M. P. O'Brien.
(h) Theory developed by O'Brien and Folsom is being extended to computation of characteristics of propeller fans.

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(273)(a) EFFECT OF VISCOSITY ON WEIR DISCHARGE.
(c) Laboratory project.
(d) Carson.
(e) Professor M. P. O'Brien.
(g) Tests will be made on triangular weirs using oils of different viscosities.
(h) Equipment being installed.

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(274)(a) SURFACE PROFILES NEAR INLET TRANSITIONS.
(c) Undergraduate thesis.
(d) Douma and Tarr.
(e) Professor M. P. O'Brien.
(f) To analyze the draw-down curve at transition from canal to flume.
(g) Models of actual field installations will be constructed. Surface profiles and velocity distributions are to be carefully measured.
(i) Thesis to be completed in May.

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(275)(a) CAPILLARY RISE IN MANOMETERS
(c) Laboratory project.
(d) Folsom.
(e) Professor M. P. O'Brien.
(g) Theoretical investigations and laboratory tests.

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(276)(a) DISCHARGE COEFFICIENTS OF SHARP-CRESTED WEIRS, IRREGULAR IN PLAN.
(c) Undergraduate thesis.
(d) Peters and Watters.
(e) Professor M. P. O'Brien.
(g) Laboratory tests on weirs with straight, curved, and broken crest traces to determine effect on coefficient of discharge.
(i) Thesis to be completed in May.

.....

(277)(a) CONTRACTION WORKS IN RIVERS.
(c) Graduate thesis.
(d) Lieut. Jones.
(e) Professor M. P. O'Brien.
(f) To determine the effect of contractions in streams with movable bottoms on the scour and the surface slope.
(g) Laboratory tests.
(i) Thesis to be completed in May.

.....

(278)(a) CHARACTERISTICS OF DISC-FRICTION PUMPS.
(c) Laboratory project.
(d) Folsom.
(e) Professor M. P. O'Brien.
(f) To develop a theory of the performance of the turbulence type of pump.
(g) Tests of Westco and Burke type of pumps.

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(279)(a) SCOUR BELOW DAMS.
(c) Graduate thesis.
(d) Lieut. Bengtson.
(e) Professor M. P. O'Brien.
(g) Study of scour below scale models of Moulton, Tisdale and Fremont weirs of Sacramento River flood control system.
(i) Thesis to be completed in May.

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(280)(a) ORIFICES FOR MEASURING DISCHARGE AT END OF PIPE-LINE.
(c) Laboratory project.
(d) O'Brien and Folsom.
(e) Professor M. P O'Brien.
(f) To standardize a set of orifice plates for field measurement of pump discharge. Design is a modification of the International Standard Orifice.

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(281)(a) MODEL OF ESTUARY OF COLUMBIA RIVER.
(b) U. S. Engineer Department.
(d) M. P. O'Brien, B. D. Rindlaub.
(e) Lieut. B. D. Rindlaub.
(f) To investigate channel regulation in the Columbia River estuary.
(g) Investigations to be undertaken on movable bed model with horizontal scale of 1:5600 and vertical scale of 1:64. Tides and waves will be reproduced.

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(282)(a) TRANSPORTATION OF SAND THROUGH PIPE LINES.
(b) U. S. Engineer Department.
(d) M. P. O'Brien, B. D. Rindlaub.
(e) Lieut. B. D. Rindlaub.
(f) To determine the relative power required to move five different river and harbor sands through dredge pipes.
(g) Laboratory tests made by pumping sand and water through 2-inch pipe.
(h) First series of tests completed and partial report prepared.
Second series of tests under way.

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(283)(a) FRICTION COEFFICIENT OF FLAT PLATES ON SAND UNDER WATER.
(b) U. S. Engineer Department.
(d) M. P. O'Brien, B. D. Rindlaub.
(e) Lieut. B. D. Rindlaub.
(f) To determine the coefficient of friction of flat metal surfaces resting on sandy bottoms. (Drag-head of a suction dredge).
(g) Laboratory tests.
(n) Equipment partially ready.

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CARNEGIE INSTITUTE OF TECHNOLOGY.

(243)(a) MODEL STUDY OF SPILLWAY ACTION AT PROPOSED DAM ON TYGART RIVER AT GRAFTON, W. VA.
(b) U. S. War Department.
(c) Laboratory investigation on a model dam.
(d) E. P. Schuleen and H. A. Thomas.
(e) Prof. H. A. Thomas.
(f) Improvement of design of structure for river regulation and flood control.
(g) Model studies of energy dissipation of discharge from flood gates, to obtain best design for deflecting apron at foot of this spillway and similar spillways.

(h) Tests are still in progress, and comprise detailed studies of the design of cushion pools and notched spillway aprons for dissipation of the energy of spillway and conduit discharge.
(i) Height of free fall in prototype is 215 feet. Investigation includes study of the effects of large conduits discharging through dam near toe of spillway.

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(244)(a) MODEL STUDY TO DETERMINE METHODS OF CONTROLLING CURRENTS IN ALLEGHENY RIVER NEAR PROPOSED LOCK AND DAM NO. 9, NEAR EAST BRADY, PA.
(b) U. S. War Department.
(c) Laboratory investigation on a river model.
(d) E. P. Schuleen and H. A. Thomas.
(e) Prof. H. A. Thomas.
(f) Improvement of river navigation.
(g) Investigation will study effect of various structures and dredging operation intended to control the direction and strength of the river currents in the vicinity of the proposed lock.
(h) Tests are still in progress and comprise studies of the directions and velocities of currents in the vicinity of the lock entrances, and of the effect of these currents on model barges entering the lock.
(i) This is a fixed-bed model having a natural scale of 1:180.

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(284)(a) CONSTRUCTION OF A MODEL OF THE ALLEGHENY-MONONGAHELA-UPPER OHIO RIVER SYSTEM FOR USE AS AN INTEGRATING MACHINE FOR SOLVING PROBLEMS OF FLOOD-WAVE MOVEMENTS IN THIS RIVER SYSTEM.
(b) Carnegie Institute of Technology.
(c) Pure research.
(d) H. A. Thomas and J. W. Hackney, with the assistance of engineers furnished by the Works Division.
(e) Professor H. A. Thomas.
(f) To investigate the feasibility of obtaining accurate 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 various problems arising in connection with flood protection by proposed reservoirs in the Allegheny-Monongahela river basin
(g) The model is about 80 feet long by 10 feet high. It represents several hundred miles of the main river channels, all controlled tributaries below proposed reservoir sites, and numerous other tributaries. Vertical longitudinal and transverse scales are unequal.

(g) (Continued.)
Profiles and cross sections are reproduced to scale, but curves are not reproduced. Hydraulic friction effect is produced by transverse metal fins, designed to duplicate the prototype rating curves. The flood-wave from each tributary is introduced from an individual tank with a float-controlled orifice designed to reproduce the prototype hydrograph. Maximum flood stages of about 7 inches in the main model channels are read with precision on inclined gages.
(h) Preliminary tests and calibrations of typical sections of model channel and control orifices completed. Work just starting on construction of main model.
(i) The model channels are designed to satisfy the general differential equation for flood-wave movement, velocity-head and acceleration-head effects being included in the representation.

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CASE SCHOOL OF APPLIED SCIENCE.

(285)(a) HYDRAULIC MODEL STUDIES FOR THE SPILLWAYS AND OUTLET WORKS OF THE SEVERAL DAMS FOR THE MUSKINGUM WATERSHED PROJECT.
(b) Zanesville, Ohio, District Office, U. S. Engineer Department.
(c) Laboratory project.
(d) Under general direction of the District Engineer, supervised by Professor George E Barnes, Head of the Department of Civil Engineering, with laboratory aids.
(e) Professor George E. Barnes.
(f) To establish proper hydraulic features of design for structures proposed, and to formulate operating schedule for outlet works.
(g) Conferences on design, succeeded by fabrication, erection, and testing of models, recommendations, revisions, final acceptance tests. Structures reproduced in wood, steel, and concrete in River Flume, and Testing Flume (Glass) to scales varying from 1/40 to 1/20, with channel conditions reproduced upstream and down. Determine hydraulic gradients, losses, distribution of velocities, scour.
(h) Studies completed for the Wills Creek Dam and the Charles Mill Dam. Studies scheduled and in progress for the Beach City, Tappan, Dover and Mohawk Dams.

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(286)(a) HYDRAULIC STUDIES ON A MODEL OF ONE UNIT OF THE MANHATTAN NEW YORK CITY GRIT CHAMBERS.
(b) Undergraduate thesis for bachelor's degree in Civil Engineering.
(c) Laboratory project.
(d) Thesis advisor, Professor George E. Barnes.
(e) Professor George E. Barnes.

(f) To establish velocity control in grit chamber by restricted outlet based on critical depth principle.
(g) Construction of model on scale of 1/6, determining hydraulic gradient by piezometers, and velocities at a point.
(h) Completed 1934.

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(287)(a) HYDRAULIC STUDIES ON A MODEL OF THE OUTLET WORKS OF THE GERMANTOWN DAM OF THE MIAMI CONSERVANCY DISTRICT.
(b) Undergraduate thesis for bachelor's degree in Civil Engineering.
(c) Laboratory project.
(d) Thesis advisor, Professor George E. Barnes.
(e) Professor George E. Barnes.
(f) To establish hydraulic profiles for floods reproduced to scale.
(g) Construction of model on scale of 1/20, determining hydraulic gradient and height of jump.
(h) Completed 1934.

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CORNELL UNIVERSITY.

(288)(a) LOSS OF HEAD DUE TO BENDS, TEES, AND CROSSES AS USED IN WATER WORKS PRACTICE.
(b) Sectional Committee on Specifications for Cast Iron Pipe (Thos. H. Wiggin, Chairman) organized in 1926 under the procedure of the American Standards Association, the Sponsor Societies being Am. Gas Assoc., Am. Soc. for Testing Materials, Am. Water Works Assoc., New England Water Works Assoc.
(c) Engineering Standards Research.
(d) Experiments by E. W. Schoder and A. N. Vanderlip; Analyses of results with respect to economics involved by A. T. Ricketts and T. H. Wiggin.
(e) A. V. Ruggles, A.W.W.A., 29 W. 39th St., New York; or Professor E. W. Schoder, Cornell University.
(f) To determine the advantages or disadvantages in using proposed short-turn fittings rather than the present A.W.W.A. standard types.
(g) Fittings of 6- and 12-inch diameters were tested. The bends, 45-deg. and 90-deg., were of the present A.W.W.A. and of the proposed short-turn patterns. The tees and crosses were of four types, having inner corners with sharp edges, and radii of 1 in., 2 1/2 in.(= short-turn), and 6 in. (= A.W.W.A.)
Tees were placed (1) normally, on run with branch, three conditions of flow: all water straight through; all turned 90 deg. into branch; half into each run and branch; (2) bullhead setting, two conditions of flow:

(g) (Continued)
all water turned 90 deg. into one branch; half 90 deg. into each branch.

Crosses had five conditions of flow: all water straight through; all turned 90 deg.; half straight, half 90 deg.; half 90 deg. to left, half to right; one third each way.

Total flows were measured by a calibrated Venturi meter, and partial flows by orifices in end plates. All pipes in experimental sections were tested as portions of straight pipe lines using same piezometers as when the specials were under test. The pipes differed markedly as to indicated loss of head. Inlet velocities ranged from 3 to 10 ft. per sec.

(h) Tests completed, report made to Sectional Committee.

(i) Five other studies on engineering phases of the proposed change of standards other than the hydraulics involved have been made at other universities. All results are being prepared for publication, both separately by the several universities, and in combined form by the A.W.W.A.

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(239)(a) DIFFERENTIAL, TWO-LIQUID, U-TUBE GAGES.
(b) Departmental research.
(c) Graduate Thesis.
(d) H.C.Eagle and W.E.Wilson.
(e) Professor E.W.Schoder.
(f) To determine to what extent surface tension interfers with indications according to specific gravities of the two (or three) liquids involved.
(h) An abstract of the thesis is in Civil Engineering, Jan., 1934, p. 30-34; comment in May, 1934, p. 266; and the complete thesis is on file in the Engineering Societies Library.
(i) Before relying on the usual formulas for reducing gage differences to differences of pressure heads, investigators should consider carefully the results of this investigation.

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HARVARD UNIVERSITY.

(106)(a) HYDRAULICS OF FLOW OF WATER THROUGH SAND.
(b) Research in water supply and purification.
(c) Departmental research.
(d) G.M.Fair and L.P.Hatch.
(e) Professor G. M. Fair.
(f) Rational formulation of flow of clean water through clean sand and evaluation of factors controlling flow.
(g) Laboratory studies conducted on small-size tubes containing sand beds of different structure.
(h) Results being worked up for publication.

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HORTON HYDRAULIC AND HYDROLOGIC LABORATORY.

(290)(a) VELOCITY DISTRIBUTION IN STREAM CHANNELS.
(b) Scientific research.
(c) Scientific research.
(d) Robert E. Horton, C. W. Force and Laboratory staff.
(g) Investigation comprises two parts: (1) A mathematical investigation of the form of velocity curves in open channels called for by the Manning formula; (2) An analysis and study of several hundred vertical velocity curves obtained in natural river channels, with a view to comparing the actual and theoretical curves.
(h) Investigation nearly completed and publication expected within a few months. See Abstract.

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(291)(a) BACK-WATER BY THE MANNING FORMULA.
(b) Scientific research.
(c) Scientific research.
(d) Robert E. Horton and Laboratory staff.
(f) Improvement in methods of analysis of problems of non-uniform flow.
(g) An integral of the back-water function in terms of the Manning formula has been obtained and tables of back-water functions have been computed therefrom for rectangular channels. It is believed that the method has important advantages because of the fact that where, as is ordinarily the case, back-water calculations are based on the Chezy formula, with a constant coefficient, serious errors are involved when the depth varies because the coefficient is itself a function of the depth.
(h) Investigation completed but results not yet written up in form for publication.

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(292)(a) DISPERSION CURVES OF MANNING'S COEFFICIENT OF ROUGHNESS,
(b) Scientific research.
(c) Scientific research.
(d) Robert E. Horton and Laboratory staff.
(f) The purpose is to provide a means of presentation of experimental values of the coefficient of roughness n in such a manner that the percentage of cases in which the observed coefficient has been found to be greater or less than a given value can at once be determined, thus leading to a more direct and certain method of selection by judgment of values of the coefficient of roughness applicable to a given case.
(g) All available values of the coefficient n for certain particular types of channels have been collated and plotted in the form of frequency curves. The analysis does not, however, cover all types of channels and covers only a limited number of classes of pipe surface.

(292)(h) Investigation completed but results not yet written up in form for publication.

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(293)(a) FLOOD WAVES SUBJECT TO FRICTION CONTROL.
(b) Scientific research.
(c) Scientific research.
(d) Robert E. Horton and laboratory staff.
(f) To provide a basis for practical determination of the crest velocity and change of form of natural flood waves in large rivers.
(g) This research relates to the theoretical aspects of the subject. It is founded on an experimental investigation conducted some years ago at the same laboratory, using a slope table 120 feet in length, for the purpose of determining experimental forms of flood wave crests. The experimental research was conducted in part for the Sanitary District of Chicago. The present research relates mainly to the analysis of the results and is predicated on the idea that the movement of a flood wave in rivers is not, on the one hand amenable purely to momentum control, like waves in still water; neither is it, on the other hand, subject solely to friction control, as in the case of non-uniform flow in channels.
(h) Experimental investigation completed; theoretical investigation in progress. Suggestions are desired from other laboratories interested in this same problem. See Abstract.

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(294)(a) RELATION OF CARRYING CAPACITY OF CAST IRON PIPE CONDUITS TO AGE IN SERVICE.
(b) Scientific research.
(c) Scientific research.
(d) Robert E. Horton.
(f) Contribution to knowledge of the variation with age of the carrying capacity of water supply conduits and distribution mains.
(g) This investigation comprises mainly an analysis of continuous records covering five periods averaging one to three years each of variation in discharge coefficient with length of time in service since cleaning of a 24-inch water supply conduit at Utica, N.Y. It is shown that in this case the carrying capacity after cleaning decreases as an inverse exponential function of the time in service but does not approach zero as a limiting value. Causes of this are discussed and a comparison is made with other experimental data on the decrease in carrying capacity of pipe with age in service.

(h) Investigation completed and it is expected that the results will be published within a few months in the Journal of the New England Water Works Association.

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(295)(a) RAINFALL DURATION.
(b) Scientific research.
(c) Scientific research.
(d) Robert E. Horton and office staff.
(f) To determine the relation between variations in rainfall duration and rainfall amount, both at an individual station and at different stations in the same region. The practical purpose of the investigation is to provide data for the determination of actual rainfall intensity and duration and hence to provide a better basis for the study and determination of surface erosion, infiltration, surface runoff and other phenomena, which are dependent more directly on rainfall intensity and duration than on total rainfall amount.
(g) An analysis has been made for the purpose of determining the actual duration of rain, in hours per month and per season, at all stations having recording rain gages in England, and at a considerable number of such stations in the United States.

Semi-empirical formulas are developed which are rational in form, since they agree with known limiting conditions, giving the relation of rainfall intensity and duration to rainfall amount, both with reference to individual stations and with reference to different stations in the same region.

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UNIVERSITY OF ILLINOIS.

(300)(a) MEASURING THE DISCHARGE BY MEANS OF DIFFERENCE OF HEAD BETWEEN OUTSIDE AND INSIDE OF A BEND.
(b) Research.
(c) Laboratory problem.
(d) W. M. Lansford, L. S. Butler, W. C. Root.
(e) M. L. Enger.
(h) Tests have been made on 1-in. and 4-in. short and long turn elbows, and on 8-in. and 12-in. short turn elbows. A paper entitled "Use of an Elbow in a Pipe Line as a Means of Measuring the Flow of Water," by W. M. Lansford was published in the April Bulletin of the Associated State Engineering Societies. Further results of this investigation are given by Mr. Lansford in his discussion, published in the November 1934 Proceedings of the American Society of Civil Engineers, of a paper by David L. Yarnell and Floyd A. Nagler entitled "Flow of Water Around Bends in Pipes."
(i) The work was begun as a result of a suggestion made by

the late Professor Nagler, of the Iowa Institute of Hydraulic Research. The difference in head between the outside and inside of a given bend is a constant times the velocity head in the pipe for velocities exceeding about 1 ft. per sec.

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(301)(a) STUDY OF THE FLOW OF WATER IN A GLASS PIPE BY THE USE OF MOTION PICTURES.
(b) Scientific research.
(c) Laboratory project.
(d) Edgar E. Ambrosius, John C. Reed.
(e) M. L. Enger.
(g) Fine drops of an insoluble liquid of the same density as water, in suspension in water flowing in a 1 3/4 in. glass pipe, are photographed by a motion picture camera as they move through a thin, broad field intensely illuminated from the two sides of the pipe.
(h) A paper entitled "Study of the Flow of Water Through a Glass Pipe", by Edgar E. Ambrosius, John C. Reed and Henry F. Irving, was presented before the 1934 Summer Meeting of the Aeronautic and Hydraulic Divisions, American Society of Mechanical Engineers, at Berkeley, California, and published by the George Reproduction Company, San Francisco, California.
(i) This investigation is being continued with a more elaborate set-up and has some refinements not found on the old, such as maintaining a constant head, a smooth belled entrance to the pipe in which the analysis is being made, and a provision for determining the loss of head in the pipe. The existing apparatus with its new and improved lighting equipment will permit the study of water velocities up to 1 1/4 ft. per sec. in a 1 3/4 in. (internal diameter) glass pipe. The pipe also is of sufficient length, 40 feet made up of two 20 ft. sections, to insure a complete normal velocity distribution at low velocities. By the use of streak pictures (time exposures) it is anticipated that some information relative to mixing distances, and related phenomena found in turbulent flow, may be found.

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(302)(a) A STUDY OF THE PHENOMENA ACCOMPANYING RADIAL FLOW BETWEEN DISKS WHICH ARE FREE TO MOVE.
(b) Scientific research.
(c) Laboratory project and graduate thesis.
(d) Paul E. Mohn.
(e) M. L. Enger.
(g) Pressures, discharges, and movements of disks were measured.
(h) A paper is being prepared for publication.

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(303)(a) EFFECT OF PULSATIONS OF FLOW ON THE COEFFICIENT OF DISCHARGE OF A PIPE ORIFICE.
(b) Research.
(c) Laboratory problem in graduate course.
(d) Gene Edwards.
(e) M. L. Enger.
(g) Pulsation near an orifice in a 3-inch pipe line were controlled by means of an accurate butterfly valve operated by a variable speed motor. Graphical records were made of the pulsations.

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(304)(a) DISCHARGE COEFFICIENTS FOR ORIFICES IN A PIPE WALL FOR VARIOUS VELOCITIES OF FLOW PAST THE OPENINGS.
(b) Scientific research.
(c) Laboratory problem.
(d) W. M. Lansford.
(e) M. L. Enger.
(g) The discharge from orifice of various diameters in the walls of a 3-inch brass pipe have been investigated. The velocities in the pipe past the orifices has varied from 1 ft./sec. to 15 ft./sec.
(h) Not completed.

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IOWA INSTITUTE OF HYDRAULIC RESEARCH.

(107)(a) HYDRAULIC TEST ON MODEL OF MISSISSIPPI RIVER BELOW KEOKUK DAM.
(b) Corps of Engineers, U.S.A., Rock Island District.
(c) Institute projects.
(d) U. S. Engineer Department Staff.
(e) Martin E. Nelson, Associate Engineer.
(f) To determine, (1) remedy for diagonal currents below lock, (2) effect of wing dams and old cofferdam on tail water of Keokuk plant, and (3) possible power benefits of excavation in power plant tail race.
(g) Tests were made in a fixed-bed model of the river built 1/125th actual size.
(h) Tests are completed and a final report is being prepared.

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(108)(a) MISSISSIPPI RIVER, LOCK AND DAM NO. 4, GENERAL MODEL.
(b) Corps of Engineers, U.S.A. St. Paul District.
(c) Institute project.
(d) U. S. Engineer Department Staff.
(e) Martin E. Nelson, Associate Engineer.
(f) To determine hydraulic conditions at the lock approaches and to study the effect of flood spillways in the earth dam section.
(g) Tests were made in a distorted, fixed bed model built on a 1/300 horizontal scale and a 1/100 vertical scale.

(108)(h) Tests are complete and a final report is being prepared.

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(109)(a) STUDY TO IMPROVE HYDRAULIC SYSTEM OF NAVIGATION LOCKS, GENERAL MODEL.
(b) Corps of Engineers, U. S. A.
(c) Institute project and graduate thesis.
(d) U. S. Engineer Department Staff.
(e) Martin E. Nelson, Associate Engineer.
(f) To eliminate as many as possible of the features now found to be unsatisfactory in river navigation locks and to increase the efficiency of the hydraulic system of such locks.
(g) A typical barge lock was constructed 1/15th full size and has subsequently been altered to meet requirements developed by the tests. This model includes the complete hydraulic system for the lock.
(h) Improvements in the design of ports which connect the side-wall culverts with the lock chamber have increased the rate of filling and emptying without increasing turbulence in the chamber. Some studies have been made of the entrapment of air at culvert valve wells.
(i) Tests to date demonstrate an improvement in conditions at tainter valves in the side-wall culverts when the valve is faced down instead of upstream.

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(159)(a) TAINTER GATE COEFFICIENTS.
(c) Graduate thesis.
(d) Ross N. Brudenell.
(e) Prof. F. T. Mavis and Prof. J. W. Howe.
(f) To determine discharge coefficients for model installations.
(h) Tests to be resumed.

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(208)(a) A STUDY OF VORTEX MOTION.
(c) Graduate thesis.
(d) G. F Djang.
(e) Prof. F T. Mavis.
(f) To determine the effect of vortices on the sediment carrying power of streams.
(g) Problem approached from both mathematical and experimental standpoints.

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(211)(a) RELATION OF TAIL RACE FLOOR TO BOTTOM OF DRAFT TUBES.
(c) Graduate thesis.
(d) Andreas Lukesch.
(e) Prof. F. T. Mavis.
(f) To determine the effect of location of tail race floor upon draft tube efficiency with and without spiral flow.

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(213)(a) MISSISSIPPI RIVER, DAM NO. 26, GENERAL MODEL.
(b) Corps of Engineers, U.S.A., St. Louis District.
(c) Institute project.
(d) U. S. Engineer Department Staff.
(e) Martin E. Nelson, Associate Engineer.
(f) To design control works necessary to maintain a satisfactory navigation channel from the dam to the mouth of the Missouri river and to study the effect of spillway discharge on the river bed at piers of the railway and highway bridges about 800 ft. below the dam.
(g) Movable bed models were built and tested; one with horizontal scale 1/250 and vertical scale 1/60, and the other with horizontal scale 1/400 and vertical scale 1/60.
(h) Preliminary reports have been prepared covering these tests which are now complete.

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(214)(a) MISSISSIPPI RIVER, DAM NO. 26, 1/25th SIZE MODEL.
(b) Corps of Engineers, U.S.A., St. Louis District.
(c) Institute project.
(d) U. S. Engineer Department Staff.
(e) Martin E. Nelson, Associate Engineer.
(f) To study the effect of spillway discharge on the river bed below the dam and to design protection for the railway and highway bridge piers.
(g) Tests were made in a model which represented 400 ft. of dam and bridges on a scale of 1/25. The model was equipped with a movable bed.
(h) Tests are complete and have been covered by a preliminary report.

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(215)(a) MISSISSIPPI RIVER, DAM NO. 20, STILLING BASIN DESIGN.
(b) Corps of Engineers, U.S.A., Rock Island District.
(c) Institute project.
(d) U. S. Engineer Department Staff.
(e) Martin E. Nelson. Associate Engineer.
(f) To determine (1) general criteria for design of stilling basins for this and other low-head dams on erodible foundations, (2) discharge coefficients for tainter and roller gates, and (3) a schedule of operation at Dam No. 20.
(g) Tests were made on a model of a single tainter gate built 1/20th full size and on a model of a single roller gate built 1/30th full size. These models were placed in a glass-sided flume where the action of flow through stilling basins and erosion on a sand bed could be observed and photographed.

(h) Tests were completed in March, 1934, and are covered by a final report now nearly complete.

(i) The following empirical equations have been found to provide length of stilling basin with and without rip-rap downstream:

(1) For smooth aprons with no end sill,

$$\frac{D_2}{H_o} = \frac{1}{(L_A/V_2^2)^{0.5}}$$

(2) For aprons equipped with two rows of baffle piers and an end sill,

$$\frac{D_2}{H_o} = \frac{1}{(L_A/V_2^2)^{0.7}}$$

The terms in the above have the following meanings:

D_2 = Depth of water on the floor of the stilling basin, feet.

H_o = Head upstream from dam above apron floor, feet.

L_A = Length of apron measured from the crest of the gate sill to the downstream edge of the apron, feet.

V_2 = Mean velocity on the apron after hydraulic jump occurs, feet per second.

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(216)(a) MISSISSIPPI RIVER, LOCK & DAM NO. 5.

(b) Corps of Engineers, U.S.A., St. Paul District.

(c) Institute project.

(d) U. S. Engineer Department Staff.

(e) Martin E. Nelson, Associate Engineer.

(f) To determine (1) possible erosion of sand dam adjacent to spillways, (2) currents at the locks, (3) backwater caused by the dam, (4) the effectiveness of auxiliary spillways over the sand dam in reducing flood backwater, (5) certain specific effects of a freshet which damaged the construction railway in April, 1934, and (6) indicate possible damages to a railway fill along the right bank.

(g) The tests are being made in a fixed-bed model 1/500th full size in horizontal and 1/100th full size in vertical dimensions. Model water surface profiles were made to conform to open river profiles by roughening the main channel. Timber was simulated by scattered crushed rock.

(216)(h) Open river tests are complete. The project structures are now being installed.

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(217)(a) THE EFFECT OF TRANSVERSAL VELOCITY ON DISCHARGE COEFFICIENTS OF ORIFICES AND SHORT TUBES.
(b) Corps of Engineers, U. S. A.
(c) Institute project.
(d) U. S. Engineer Department Staff.
(e) Martin E. Nelson, Associate Engineer.
(f) To determine the effect on orifice and short tube discharge of flow past the entrances. This is being done to determine coefficients which may be used in the design of lock filling and emptying systems.
(g) Apparatus consists of a rectangular, galvanized iron pipe 6 inches by 8 inches in cross-section, 30 feet long with a 4-foot mid-section of pyrolin. Standard orifices or short tubes can be inserted in the side of the pyrolin section of the pipe. Velocities past the orifice can be varied from 0 to 9 ft./sec. Orifices can be submerged from 0 to 3.5 ft. The set-up is equipped to measure the hydraulic gradient and velocity in the pipe, submergence of orifice, and discharge through the orifice.
(h) Calibration of a standard 2-in. orifice has been made. Eight variations of lock ports have been partially calibrated.
(i) The latest port design tested in this apparatus had a cross-sectional area at the smallest section 31 per cent of the area of the 2-in. orifice but discharged 120 per cent as much water.

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(218)(a) MISSISSIPPI RIVER LOCK & DAM NO. 4, STILLING BASIN MODEL.
(b) Corps of Engineers, U.S.A., St. Paul District.
(c) Institute project.
(d) U. S. Engineer Department Staff.
(e) Martin E. Nelson, Associate Engineer.
(f) To determine whether stilling basins designed for roller gate and tainter gate spillways would provide adequate protection against erosion at the toe of the dam.
(g) Tests were made in a glass flume on a single tainter gate 1/15th full size and a single roller gate 1/30th full size.
(h) Tests are completed and a final report is in preparation.

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(220)(a) HYDROSTATIC PRESSURES ON ROLLER GATES.
(b) Corps of Engineers, U.S.A.
(c) Institute project.
(d) U. S. Engineer Department Staff aided by Rock Island District Office.
(e) Martin E. Nelson, Associate Engineer.
(f) To determine distribution of hydrostatic pressure on model and full size roller gates under various conditions of operations.
(g) Tests were made on a model gate 1/22.53 times full size in which the head on piezometers spaced around the gate was measured. Similar measurements have been made on gate No. 9, Dam No. 15, at Rock Island, Mississippi river.
(h) Model tests are complete, a report is in preparation. Three conditions of gate opening have been tested at Rock Island.

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(221)(a) TESTS ON SAND DAMS.
(b) Corps of Engineers, U.S.A., St. Paul District.
(c) Institute project.
(d) U. S. Engineer Department Staff.
(e) Martin E. Nelson, Associate Engineer.
(f) To design crests which will permit discharge of flood waters over sand dams and to study seepage through the dams under various amounts of submergence.
(g) Tests on a 1/5th size model in a glass flume have been made. A 1/2 size model will be built embodying the results of the small-scale study.
(h) A report has been prepared on the 1/5th size model tests.

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(305)(a) AN ANALYTICAL AND EXPERIMENTAL STUDY OF THE FLOW OF WATER THROUGH SANDS.
(c) Graduate theses.
(d) E. F. Wilsey and C. C. Wang.
(e) Prof. F. T. Mavis.
(f) Additional experiments on uni-granular sands and mixtures.

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(306)(a) DISCHARGE COEFFICIENTS FOR SUBMERGED MODEL SPILLWAYS.
(e) Prof. F. T. Mavis.
(h) Preliminary tests completed. To be resumed during spring semester.

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(307)(a) STABILITY OF EMBANKMENTS IN WATER.
(c) Graduate thesis.
(d) Prof. A. F. Meyer and F. R. Hoehl.
(e) Prof. F. T. Mavis.
(f) To investigate load-settlement relations for model embankments under different saturation conditions.

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(308)(a) THE HYDRAULICS OF A TYPICAL DETENTION BASIN PROPOSED FOR CONTROL OF FLOODS IN NORTH CHINA.
(c) Graduate thesis.
(d) Wen Hsi Huang.
(e) Prof. F. T. Mavis.
(f) Analysis of reservoir effects on the basis of data for outlet works to be studied in model.

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(309)(a) A STUDY OF THE FORMATION OF VORTICES ABOVE OUTLETS.
(c) Graduate thesis.
(d) Prof. C. J Posey and P. C. King.
(e) Prof. F. T. Mavis.
(f) To study the similarity of vortices.

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(310)(a) STILLING POOLS FOR SPILLWAYS.
(c) Graduate thesis.
(d) C. W Kinney.
(e) Prof. F. T. Mavis.
(f) Compilation and analysis of data from model tests. Additional tests in progress.

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(311)(a) THE MOVEMENT OF WATER AND DETRITUS IN OPEN CHANNEL BENDS.
(c) Graduate thesis.
(d) T. Y. Liu.
(e) Prof. F. T. Mavis.
(f) To study the capacity for traction in curved channels.

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(312)(a) A LABORATORY INVESTIGATION OF OVERFLOW SECTIONS WITH SAND CORE.
(c) Graduate thesis.
(d) Prof. A. F Meyer and H. J. Skidmore.
(e) Prof. F. T. Mavis.
(f) Model study of certain proposed paving and stabilizing structures.

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(313)(a) THE SOLUTION OF CERTAIN TWO-DIMENSIONAL FLOW PROBLEMS BY MEANS OF AN ELECTRICAL ANALOGY.
(c) Graduate thesis.
(d) H. F. Sykes.
(e) Prof. F. T. Mavis.
(f) The third of a series of theses dealing with the applications and limitations of the electrical analogy. Intended to complete certain aspects of a program of study begun in 1928.

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(314)(a) SEEPAGE FLOW THROUGH EARTH DAMS AND FOUNDATIONS.
(c) Graduate thesis.
(d) T. P. Tsui.
(e) Prof. F. T. Mavis.

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(315)(a) ANALYSIS OF PRECIPITATION AND FLOOD RECORDS FOR IOWA.
(b) Iowa State Planning Board.
(c) Cooperative project. - R. H. Matson, coordinator.
(d) F. T. Mavis, Edward Soucek, and staff.
(e) Prof. F. T. Mavis.
(h) Frequency-intensity studies for precipitation virtually completed to date. Duration tables for flow and flood studies in progress.

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(316)(a) HYDROLOGIC STUDIES, - RALSTON CREEK WATERSHED.
(c) Cooperative project, - Bureau of Agricultural Engineering, U. S. Dept. of Agriculture, and U. S. Geological Survey.
(d) D. L. Yarnell, R. G. Kasel, and C. W. Kinney.
(e) Prof. F. T. Mavis.
(h) Continuous records, since 1924, of precipitation, run-off, ground water levels, and cover. Drainage area of 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.
(c) Cooperative project, - U. S. Geological Survey.
(d) R. G. Kasel and staff.
(e) Prof. F. T. Mavis.
(h) Stream gaging stations are maintained cooperatively at 39 stations on 9 major watersheds in Iowa. Report on surface water resources of Iowa is being prepared.

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(318)(a) HYDRAULICS OF SAND FILTERS.
(c) Graduate theses.
(d) Prof. E. L. Waterman, R. J. Schlickelman and G. C. Ahrens.
(e) Prof. F. T. Mavis.
(f) To study the hydraulic characteristics of filter sands in tubular sections of a filter.

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(319)(a) TENNESSEE RIVER, PICKWICK DAM.
(b) Corps of Engineers, U.S.A., Nashville District.
(c) Institute project.
(d) U. S. Engineer Department Staff.
(e) Martin E. Nelson, Associate Engineer.
(f) To determine the best layout for the main units of the project and to establish the locations of operating gates in the dam.
(g) Tests are made in a fixed-bed model built on a horizontal scale 1/450th and a vertical scale 1/150th full size. The projects structures consist of a long earth dam, a lock, a spillway section of dam, and a powerhouse.
(h) Tests on this model are about half done.

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(320)(a) TENNESSEE RIVER, PICKWICK LOCK HYDRAULIC SYSTEM, GENERAL MODEL.
(b) Corps of Engineers, U. S. A., Nashville District.
(c) Institute project.
(d) U. S. Engineer Department Staff.
(e) Martin E. Nelson, Associate Engineer.
(f) To make a thorough study of all features of the hydraulic system for the Pickwick project lock.
(g) The side-culvert intakes and outlets, culvert control valves, emptying and filling ports, and the culverts themselves are to be set up as part of the lock model which has been under investigation for some time. The scale ratio has been made 1/30 for these tests because of the unusual size of the Pickwick lock.
(h) The model is still under construction.

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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, La. 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 five 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) FCTORS AFFECTING THE EVAPORATION FROM A LAND PAN.
(b) Cooperative between the U. S. Geological Survey and the College of Engineering, La. State Univ.
(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) Records of evaporation are taken on a standard U. S. Weather Bureau Land Pan, and meteorological data are obtained from a nearby station maintained by the Geology Dept. 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, La. State Univ.
(c) General scientific research.
(d) E. L. Green.
(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 temperature and of wind movement may be obtained.
(h) Records have been taken since October, 1933.

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(226)(a) TILE AND OPEN DITCH DRAINAGE.
(b) Cooperative between the U. S. Department of Agriculture and the College of Engineering, La. State Univ.
(c) General scientific research.

(d) B. O. Childs and Glen N. Cox.
(e) B. O Childs, Howme, Ln., or Dr. Glen N. Cox.
(f) Study of rainfall, runoff, effectiveness, water-holding power, etc.
(g) Records of rainfall have been kept on a tiled and on an open ditch area for about three years. All runoff is pumped and measured. Watertable readings have been taken at a large number of places daily.
(h) Records have been kept for four years and a paper is now being prepared for publication.

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MASSACHUSETTS INSTITUTE OF TECHNOLOGY.

(36)(a) EXPERIMENTAL INVESTIGATION OF THE CAVITATION PHENOMENON.
(b) Massachusetts Institute of Technology.
(c) General scientific research.
(d) H. Peters, J. K. Vennard, M. W. Libbey.
(e) Above staff.
(f) To study the cavitation phenomenon in all its details and to determine in a quantitative way the factors influencing it. To study the basic nature of the phenomenon rather than its destructive effects upon a large number of materials. The program for the immediate future is as follows:
1. Study of cavitation severity.
2. Forces acting which cause pitting.
3. Effect of profile shape on frequency of collapse.
4. Movement of the pressure wave set up by the collapse.
(g) Work has been carried forward on frequency measurement using the stroboscope and visual observation on a large two-dimensional venturi section having throat of 4" x 2" and on a geometrically similar one (in two dimensions), having a throat of 3/4" x 3/4". Where frequencies have been too high for visual work, the stroboscopic camera of Professor H. E. Edgerton has been used for pictures at the rate of 2000 per second.
(h) Results from the above two units have been correlated and show preliminarily that the dimensionless figure fl/V is a constant for profiles of the same downstream divergence angle (f is frequency of collapse, l is length of cavitation, V is velocity at throat). Results from tests on the relation ofcavitation severity to air content, carried out in the early summer, showed that cavitation severity increased with decreasing air content of the water, showing that the existence of air in the water cushioned the collapse and hence lessened its effect.

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(184)(a) EXPERIMENTAL STUDY OF FLOW OVER DAM WITH PIERS.
(b) River Hydraulic Laboratory, M.I.T.
(c) Graduate research for Master's degree.
(d) R. Boucher.
(e) Professor K. C. Reynolds.
(f) To study coefficient of discharge for a dam with and without piers of various designs.
(h) Thesis presented August, 1934. Title, "The Determination, by Model Study, of the Effect of Piers on the Discharge over a Spillway Dam."
(i) From these experiments it was found that the Creager pier nose is more efficient than the semi-circular nose. Stop-log and gate slots were found to have a slight effect on the discharge.

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(185)(a) EXPERIMENTAL STUDY OF THE FLOW OF WATER THROUGH SLUICE GATES.
(b) River Hydraulic Laboratory, M. I. T.
(c) Graduate research for Master's degree.
(d) F. W. Blaisdell.
(e) Professor K. C. Reynolds.
(f) To compare the discharge coefficients for a model sluice gate and its prototype.
(g) A 1:15 model of the Tremont Gates at Lowell, Mass., was constructed and the results compared with observations by James B. Francis.
(h) Thesis submitted July, 1934. Title, "The Coefficient of Discharge of Sluice Gates."

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(321)(a) EXPERIMENTAL INVESTIGATION OF THE TRANSPORTATION OF SAND BY RUNNING WATER.
(b) River Hydraulic Laboratory, M.I.T.
(c) Graduate research for Master's degree.
(d) S. Chyn.
(e) Professor K. C. Reynolds.
(f) To determine the relationship between the transportation of the sandy bed of a miniature river and the grainsize composition of the sand forming the bed.
(g) Synthetic sands of various sand modulus and mean grain diameter will be used.

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(322)(a) EXPERIMENTAL DETERMINATION OF HYDRAULIC CHARACTERISTICS OF WATER CLOSET BOWLS.
(b) Massachusetts State Association of Master Plumbers and Sanitary Engineering Laboratory, M. I. T.
(c) Research for benefit of plumbing industry.
(d) Professor Thomas R. Camp, E. C. Roche, R. B. Thompson, Gerald Putnam.
(e) Professor Thomas R. Camp.
(f) To develop method of "rating" water closet bowls which will show their minimum requirements as to total quantity and rate of supply for an adequate flush. The data given

by such a rating will be useful to sanitary engineers and plumbers in selecting bowls and appropriate flushing devices, and to the manufacturers in improving the design of bowls and flushing devices.

(g) Rim and jet calibrated as orifices separately and operating together from which orifice constants are computed. Position of water surface in bowl observed with steady siphon action and steady weir action for various rates of flow through bowl. Minimum rate of flow for steady siphon action observed. Time required for siphon to draw water surface to bottom of bowl observed for various constant rates of flush. From these data, rate of flush and amount of water for "safe economic flush" are established. Trial flushes are made from which rate curves of bowl discharge are measured.

(h) Experimental work completed. Report will probably be published within a year.

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(323)(a) STUDY OF THEORY OF FILTRATION OF WATER THROUGH SAND.

(b) Sanitary Engineering Laboratory, M.I.T.

(c) Graduate research for Doctor's thesis.

(d) R. Eliassen.

(e) Professor Thomas R. Camp.

(f) To develop a rational theory for the time rate of "clogging" of sand filters.

(g) Sectional glass tube filter operated in parallel with other filters at Providence (R.I.) Water Purification Plant. Observations of head loss and floc removal made during run at small intervals of depth in filter. Observations of accumulated deposit in small intervals of depth made at end of run. It is hoped to obtain sufficient data to determine which of the quantities of the Fair-Hatch sand flow formula are variable with time in the filtration process, the manner in which they vary, and to correlate these variables with the rate of deposit of sediment within the filter.

(h) Experimental filter is in operation and observations are being made.

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(324)(a) STUDY OF FLOW OF WATER TO WELLS AND PITS.

(b) Soil Mechanics Laboratory, M.I.T.

(c) Graduate Thesis.

(d) Nicholas H. Kuchn, Jr.

(e) Professor Glennon Gilboy.

(f) To obtain further information on the characteristics of flow toward wells and pits in pervious soil, particularly to aid in the development of rational methods of determining the average permeability of a natural soil from measurements of quantities pumped out of wells and pits below ground water.

(324)(g) Model studies on semi-circular sections. Observations on flow lines and seepage quantities. Correlation with electrical analogy and mathematical treatment.
(h) Preliminary.

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(325)(a) STUDY OF SEEPAGE THROUGH EARTH DAMS ON PERVIOUS FOUNDATIONS.
(b) Soil Mechanics Laboratory, M.I.T.
(c) Graduate thesis.
(d) Lieutenants Besson, Kumpe, Lincoln, Powers, C. E., U.S.A.
(e) Professor Glennon Gilboy.
(f) To provide means for estimating seepage through and under earth dams for cases in which the permeability of dam and underground are of a comparable order of magnitude.
(g) Model studies in glass-sided flume, 2.5 feet high and 20 feet long. Observations on flow lines and discharge quantities. Correlation with mathematical analyses.
(h) Preliminary.

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UNIVERSITY OF MICHIGAN.

(326)(a) EXPERIMENTS ON RECTANGULAR ORIFICES WITH PARTIALLY SUPPRESSED CONTRACTIONS.
(b) H. W. King.
(d) K. A. MacKichan and J. Whitford.
(f) To determine coefficients of discharge.
(h) In early stages.

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UNIVERSITY OF MINNESOTA.

(94)(a) TRANSPORTATION OF SEDIMENT.
(b) University of Minnesota Engineering Experiment Station.
(c) University hydraulics research project.
(d) Lorenz G. Straub and graduate assistants.
(e) Lorenz G. Straub.
(f) Investigations of transportation of bed sediment in alluvial rivers and the effect of contraction works on the river channel.
(g) Preliminary experiments were conducted in a wooden flume about 35 feet long, 12 inches wide, and 18 inches deep, sediment being added at the entrance to the flume and collected and weighed at the point of discharge. Water discharge was measured by means of a weir located at the entrance to the flume. Additional experiments are in progress using a specially designed steel tiltable flume about 60 feet long, 3 feet wide, and 15 inches deep. Sediments of various mechanical compositions are being used; some of the materials have been taken directly from

the beds of midwestern rivers. Observations are made of the rate of sediment transportation for various flow conditions, the character of the riffle formations, the effect of channel contraction works on the regimen of the stream bottom, etc.

(h) Investigations in progress.

(i) Progress reports are contained in Transactions of the American Geophysical Union for 1932 and 1934, "Hydraulic and Sedimentary Characteristics of Rivers," and "Effect of Channel-Contraction Works upon Regimen of Movable Bed-Streams."

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(95)(a) BROAD-CRESTED WEIRS.

(b) University of Minnesota Engineering Experiment Station.

(c) University hydraulics research project.

(d) Lorenz G. Straub, H. A. Doeringsfeld, C. L. Barker.

(e) Lorenz G. Straub.

(f) Characteristics of broad-crested weirs, experimentally establishing the pressure-momentum relations.

(g) Flat-crested weirs of various heights were constructed into a large glass flume, observations being made of the pressure distribution, and headwater and tailwater elevations. Analytical studies were made to determine the limitations of the pressure-momentum relations.

(h) Experimental work is completed.

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(96)(a) EXPERIMENTAL DESIGN OF DROP-CULVERT SPILLWAYS.

(b) University of Minnesota Engineering Experiment Station.

(c) Joint research project, Hydraulic Department and Agricultural Engineering Dept., U. of M.

(d) Harry B. Roe and Lorenz G. Straub.

(e) Lorenz G. Straub.

(f) Design of drop-culvert spillways by means of models.

(g) A basin approximately 20 feet long, 3 feet wide, and 2 1/2 feet deep was so arranged that models of various types of drop-culverts could be inserted and tested for a variety of headwater and tailwater elevations. The models consisted of cylindrical tubes, bell-mouthed tubes, and siphon tubes. Models of the cylindrical tubes were constructed to 3 different sizes in order to ascertain the scale effects (the deviation of flow conditions from Froude's Model Law); those of bell-mouthed shape and siphon arrangement were constructed to 2 different sizes. It was observed that for low heads (small difference in elevation of headwater and tailwater) the scale effect became appreciable.

(h) Investigations have been completed.

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(97)(a) MODEL TESTS OF SAND DAMS.
(b) United States Engineer Department.
(c) Cooperative project of University Hydraulics Department and United States Engineer Department.
(d) Lorenz G. Straub, H. M. Hill.
(e) Lorenz G. Straub.
(f) Determination of the most economical type of sand dam for low head canalization development on the Upper Mississippi River.
(g) Various types of models of proposed sections for sand dams were constructed and investigated to determine relative merits of the designs. Models were constructed of sand of the type proposed for use in the prototype; they were constructed to two different scales. Observations were made of the flow lines through the structure, also the seepage rate, for various headwater and tailwater conditions. Equipotential lines were determined by making numerous observations of the hydrostatic pressure at various points within the dam. Piping conditions were investigated and means of overcoming instability because of piping studied. Various supplementary studies were made of the permeability of the sand, etc.
(h) An experimental series has been completed; report is in progress.

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(98)(a) PERMEABILITY OF GRANULAR MATERIALS.
(b) University of Minnesota Engineering Experiment Station.
(c) University hydraulics research project.
(d) Lorenz G. Straub and graduate assistants.
(e) Lorenz G. Straub.
(f) Investigation of the permeability of granular material subject to high liquid pressures.
(g) Investigation of a number of grades of sand to determine their permeability under various conditions was made using several methods and types of apparatus. The principal experiments were made by means of a steel cylindrical permeameter 1¼ inches in diameter and about 4 feet long. Pressure gradients through the sand were varied from a minimum of a fraction of an inch in 3 feet length to about 500 feet in the same length of specimen.
(h) A preliminary set of experiments have been completed; work has been temporarily discontinued.

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(99)(a) LAWS OF HYDRAULIC SIMILITUDE.
(b) University of Minnesota Engineering Experiment Station.
(c) University hydraulics research project.
(d) Lorenz G. Straub and graduate assistants.
(e) Lorenz G. Straub.
(f) Investigations of the limitations of the laws of hydraulic similitude.

(g) In connection with various research projects of the hydraulics laboratory in which models are used, wherever possible studies are being made on models of several different scales. The results recorded are being generalized to develop numerical limitations of the various laws of hydraulic similitude.
(h) In progress.

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(189)(a) VISCOUS FLOW THROUGH PIPE LINES.
(b) University of Minnesota Engineering Experiment Station.
(c) Graduate research project.
(e) Lorenz G. Straub.
(f) Checked experimental data previously presented on limitation of laminar and turbulent flow.
(g) Flow through glass tube is observed, the condition of flow noted by means of dye lines, head loss recorded.
(h) Experiments completed.

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(190)(a) FLOW CONDITIONS IN OPEN CHANNELS.
(b) University of Minnesota Engineering Experiment Station.
(c) University hydraulics research project.
(e) Lorenz G. Straub.
(f) To determine conditions of laminar and turbulent flow in open channels.
(g) Flow conditions are observed in a small tiltable flume.
(h) Preliminary set of experiments completed; further studies are being undertaken with an improved type of apparatus.

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(261)(a) FLOW OVER SPILLWAYS.
(b) Northern States Power Company.
(c) Cooperative research with Northern States Power Company.
(d) Lorenz G. Straub and George E. Loughland.
(e) Lorenz G. Straub.
(f) Determination of spillway capacity and coefficients of discharge for flood relief on hydroelectric development at Menomonie, Wisconsin.
(g) Experiments conducted on small-scale wooden models built into glass flume.
(h) Experimental series completed; project under construction.

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(262)(a) LAMINAR FLOW THROUGH ORIFICES.
(b) University of Minnesota Engineering Experiment Station.
(c) Graduate research project.
(d) S. H. Anderson.
(e) Lorenz G. Straub.
(f) To determine the variation in coefficients of discharge for low velocities through orifices in pipe lines.
(g) Orifices of relatively large diameter were arranged in glass tubes to make possible observation of nature of turbulence by means of dye lines.
(h) Experimental series completed.

(327)(a) EXPERIMENTAL STUDY OF FLUSH VALVES FOR WATER-CLOSETS.
(b) Minnesota State Board of Health.
(c) Cooperative research project with Sanitary Division of Minnesota State Board of Health and the Hydraulics Department of the University.
(d) Lorenz G. Straub, H. A. Whittaker, Jack J. Handy.
(e) Lorenz G. Straub.
(f) Investigation of the suitability of various types of flush valves particularly with the view of determining possibilities of back siphoning into fresh water lines.
(g) A standard water-closet bowl is so arranged that the discharge variation may be recorded graphically. The set-up permits using various types of flush valves. Wide variations in pressure are possible on the feed water line.
(h) Experiment set-up is partially complete: no experiments have been performed.

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(328)(a) EXPERIMENTAL STUDY OF SEDIMENTATION BASINS.
(b) University of Minnesota Engineering Experiment Station.
(c) Graduate research project.
(d) Alvin Anderson.
(e) Lorenz G. Straub.
(f) Determination of flow conditions in waterworks sedimentation reservoirs by means of models.
(g) Models of entrance and exit structures are built into a glass-sided channel in such a manner that flow conditions can be controlled. Finely divided solid material of low specific gravity is added to the water at the entrance to the model basin so that sedimentation and flow conditions can be observed.
(h) In progress.

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(329)(a) STUDIES OF HYDRAULIC JUMP.
(b) University of Minnesota Engineering Experiment Station.
(c) Graduate research project.
(d) Harold Flinsch.
(e) Lorenz G. Straub.
(f) Experimental study of mechanical occurrences within hydraulic jump.
(g) A glass flume 20 inches wide and 27 inches deep is arranged to provide various conditions of shooting and streaming flow. Measurements are made of the velocities, pressures, etc., within the jump.
(h) Experiment is in progress.

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PENNSYLVANIA STATE COLLEGE.

(137)(a) A STUDY OF VARIOUS TYPES AND KINDS OF STILLING DEVICES FOR USE IN CHANNELS OF APPROACH TO WEIRS AND FOR OTHER PURPOSES.
(b) The Pennsylvania State College.
(c) Research.
(d) Professors Elton D. Walker and H K. Kistler.
(e) Either of above.
(f) The development of a standard stilling device, or possibly more than one device.
(g) Water is admitted to one end of a tank from a pipe, under such conditions as to produce a high velocity and considerable turbulence. The discharge is measured at the other end of the tank by means of a standard weir which has been calibrated Velocity measurements are made at a number of points in a cross section about four feet downstream from the inlet both with and without any stilling devices in place. When stilling devices are tested, they are inserted about two feet below the inlet. Each device is tested with a number of different velocities, average velocities being determined by means of the weir readings and the cross section of the channel. We seek to relate the relative effectiveness of the various stilling devices to the magnitude and distribution of velocities in the cross section.
(h) Data covering a large number of experiments are being tabulated and studied, and a progress report in the form of a bulletin is under preparation.
(g) Further investigation that may be suggested by the results found will be undertaken as soon as the current preliminary studies are completed.

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PENNSYLVANIA WATER & POWER COMPANY.

(228)(a) RESISTANCE OF WELDING MATERIALS TO CAVITATION: HIGH HEAD TESTS AT HOLTWOOD.
(b) Pennsylvania Water & Power Company and Safe Harbor Water Power Corporation.
(c) Commercial research.
(d) J. M. Mousson and W. B Hess.
(e) C. F Merriam.
(f) Determination of resistance of various materials to pitting. Selection of best materials and method of application for repairs to turbines damaged by action of cavitation. Determination of most suitable material for new turbine installations.
(g) Exposure of test plates to cavitation formed by a special weir profile under a head of 1100 ft. Materials to be tested include welded, sprayed, cast, forged, and

rolled plates of various steels, bronzes and other alloys. Quantitative measurement of severity of damage is made by weighing specimens for amount of material lost. All materials are also to be subjected to erosion by a water jet at the laboratories of Westinghouse Electric & Manufacturing Company. Correlation of results of these tests with analysis of chemical and physical properties will be made.

(h) Preliminary tests of apparatus made and 113 (Nov. 19,'34) specimens tested, mainly cast, forged or built up by welding. Sufficient information has been secured to select a material for prewelding of turbine blades combining corrosion resistance and machinability. Tests have indicated a fairly distinct correlation between Brinell hardness and resistance to corrosion.

(i) Due to the greatly accelerated nature of these tests, the physical action resulting from cavitation is accentuated very much more, proportionally, than the chemical action.

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(229)(a) RESISTANCE OF MATERIALS TO CAVITATION, LOW HEAD TESTS AT SAFE HARBOR.

(b) Pennsylvania Water & Power Company and Safe Harbor Water Power Corporation.

(c) Commercial research.

(d) C. F. Merriam and assistants.

(e) C. F. Merriam.

(f) Determination of resistance to pitting of various materials and protective coatings, and study of nature of pitting by microscopic examination of damage.

(g) Exposure of test plates to cavitation formed in a rectangular venturi passage. Materials tested include various steels, cast iron, copper, lead, aluminum, rubber and rubber paints, and other protective paints.

(h) Interesting observations of the progress of pitting have been made showing the boring action in the pit after it has once gained a foothold.

(i) It has been found that with the head available, the damaging action is not sufficiently severe to give greatly accelerated results.

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(230)(a) TURBINE MODEL TESTS.

(b) Safe Harbor Water Power Corporation.

(c) Commercial testing.

(d) L. M. Davis and assistants.

(e) C. F. Merriam.

(f) Determination of the effect of alteration of the shapes of blades for a Kaplan turbine and study of efficiency and cavitation characteristics of model runners.

(g) Routine efficiency and cavitation tests at the Holtwood Hydraulic Laboratory.
(h) Much information which has proved of practical value has been obtained and further research will be continued on completion of similar work now being carried on for an outside concern.

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(330)(a) EFFECT OF SEASONAL CHANGES IN RIVER WATER ON CORROSION OF SPECIMENS SUBJECTED TO CAVITATION.
(b) Pennsylvania Water & Power Company and the Safe Harbor Water Power Corporation.
(c) Commercial research.
(d) L. M. Davis and J. M. Mousson.
(e) C. F. Merriam.
(f) To determine whether there is greater danger of damage from cavitation in summer than in winter.
(g) Interspersed with test specimens under Project 228; specimens of standard analysis are tested weekly. Loss of weight is taken as a measure of extent of the damage. This is being correlated with river water temperature.
(h) As yet only a limited range in river temperatures has been covered, and it will take a year to get a complete cycle. Results so far indicate a decreasing amount of damage with approach of winter. It is planned to have the water artificially heated for some tests.
(i) This research is to follow up some of the results of Project 36 which indicated that the amount of air dissolved in water had considerable effect upon lessening the damage done by cavitation.

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PURDUE UNIVERSITY.

(47) (a) FLOW OF FLUIDS THROUGH CIRCULAR ORIFICES.
(b) Purdue Engineering Experiment Station.
(c) General Scientific Research.
(d) F. W. Greve.
(e) Professor F. W. Greve, School of Civil Engineering, Purdue University, West Lafayette, Indiana.
(f) To determine experimentally the effects of density, surface tension, viscosity, and temperature upon the rate of discharge through small circular orifices.
(g) The liquids under investigation were water, three sucrose solutions of different densities, furnace oil, engine oil, and a mixture of furnace and engine oil. Flow was maintained by a small pumping unit discharging directly into an open orifice tank that was approximately 15 in. in its three dimensions.

The nominal diameters of the thin-edge orifices, cut in 1/4-in. brass plates, were 1/4, 3/8, 1/2, 5/8, 3/4, and 7/8 in. respectively. The discharge from each orifice was directed into either a weighing tank or into the reservoir which supplied the pump. The discharge was weighed to within one ounce. A telescope and micrometer scale attached to a piezometer of 2-in. diameter permitted readings of the head to be noted to within 1/1000 in. Time was indicated on a stopwatch. The tests were made at room temperature. An Engler viscometer, a Cenco-De Novgy tensiometer, and a Jolly balance were employed to measure the respective viscosities, surface tensions, and densities.

(h) Installation has been completed of the larger and more extensive equipment. Experimental work will be begun upon completion of a steam heating system for control of liquid temperatures.

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RENSSELAER POLYTECHNIC INSTITUTE.

(331)(a) AN INVESTIGATION OF THE PERFORMANCE OF LARGE CENTRIFUGAL PUMPS, USING AIR AS A MEDIUM.

(b) General scientific research.

(c) Graduate work for thesis and advanced degree.

(d) Miguel A. Quinones, B.S. in C. E.

(e) Professor Grant K. Palsgrove.

(f) This investigation was carried on with the idea of finding a method by which the performance of large centrifugal pumps could be obtained at the manufacturer's laboratories where water requirements were inadequate.

(g) Certain conclusions were arrived at through theoretical considerations and then checked by data obtained from runs at different speeds on a Gould's six inch, double suction, low head centrifugal pump, Both water and air was used.

(h) Completed.

(i) Will be available as Bulletin No. 48 of the Rensselaer Polytechnic Institute Engineering and Science series, publication about January 1935.

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(332)(a) AN ANALYSIS OF THE EFFECT OF SPEED ON THE PERFORMANCE OF GEAR PUMPS.

(b) General scientific research.

(c) Graduate work for thesis and advanced degree.

(d) J. Anthony Ciccolella, Jr., M.E.

(e) Professor Grant K. Palsgrove.

(f) To supplement the rather meager amount of published information relative to rotary pumps.
(g) Theoretical development of various equations necessary to quantitatively analyze the performance; 1.- turbulent flow 2.- stream-line or viscous flow, 3.- constant discharge head, 4.- combinations of preceding cases. Developed equations were verified experimentally by use of a Worthington Type 10C, rotary gear pump.
(h) Work completed for above type of pump.

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(333)(a) INVESTIGATION OF THE THEORY OF THE PITOT TUBE.
(b) General scientific research.
(c) Undergraduate thesis.
(d) William H Dailey, Jr.
(e) Professors Grant K. Palsgrove and William J. Moreland.
(f) To investigate conditions of flow at and near the pitot tube, and thereby obtain a true basis for the derivation of the well known pitot tube equation.
(g) Flow was investigated by means of pressure and velocity measurements, photographs of jets of dye in the water, and by visual observation.
(h) Incomplete.

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S. MORGAN SMITH CO.

(334)(a) KAPLAN TURBINE EFFICIENCY AND HORSE POWER TESTS.
(b) Sanitary District of Chicago, Lockport Power Plant, Rehabilitation, Division "A". 8500 Horse Power Turbine.
(c) Guarantee Tests.
(d) R. Sahle and J. D. Scoville for S. Morgan Smith Co., L W Hall for Sanitary District of Chicago.
(e) Engineering Department, George A. Jessop, Chief Engineer.
(f) To determine the horse power and efficiency of the full size turbines in their permanent field setting. To get complete information so that the turbines can be most efficiently operated over the entire range of head from 28 to 44 feet. To determine the best blade and gate relationship under all heads so that the control mechanism can be correctly designed.
(g) An exact model was made of the full size runner, its gate case, scroll case, flume, intake and draft tube. This complete model of the entire hydraulic installation was used for each of the whole series of tests. The runner blades were carefully set and locked in a series of six positions or angles covering the full stroke. At each position a series of tests was made with a sufficient number of gate openings so that a curve can be drawn to determine the exact opening to produce

maximum efficiency at the particular blade angle under test. After all of the blade angles are tested envelope curves can be drawn showing the correct blade angle-gate opening relationship throughout the entire range of operation.

Since the full size turbines will drive generators, the actual speed must be constant at all heads. The proportional speed varies with the head, being high at the low heads and low at the high heads. In the testing laboratory, the head is practically constant and the speed is varied for each test to cover the required range of proportional speed as determined by the field head conditions. Information was obtained to construct correct blade angle-gate opening curves for all heads under which the turbines will operate.

The power was measured by an Alden absorption dynamometer and precision beam scale, the head by differential float gauges, and the water by a weir. The distribution of the water at the draft tube outlet was determined.

(h) Tests are completed.

(i) The data secured are much more comprehensive than is practicable in a field test.

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(335)(a) PRESSURE REGULATORS (RELIEF VALVE - SYNCHRONOUS BYPASS). Discharge and Operation Characteristics Tests.

(b) Boulder Dam Project, 115,000 Horse Power Turbines.

(c) Research preparatory to final design and manufacture.

(d) R. Sahle, H.I. Hartman, A. G. Smith, J. D. Scoville, D. J. McCormack, George A. Jessop.

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

(f) Determination of size and design to secure proper discharge values at all openings and under all conditions of operation. To secure the best and smoothest absorption of energy. To check the hydraulic control of the main piston under all heads and discharges.

(g) An exact model was made of the full size valve, including the entrance and discharge passages. Two different designs of discharge tubes were tested. The energy absorber was thoroughly investigated as to shape and areas of passageways, location of disc, etc. For better observation, some runs were made with the discharge tube removed. Careful measurements of pressure above and below the main piston were taken; where desirable, continuous data being recorded on pressure-time charts. Reactions due to the discharge

were determined.

The forces required to balance the main piston and to raise and lower it withvarious time elements were carefully studied.

The effects of variable head and variable back pressure were thoroughly investigated.

(h) Tests are completed.

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(336)(a) AXIAL FLOW PUMP TESTS.
(b) S. Morgan Smith Co.,
(c) Commercial research.
(d) H. Deglon, J. D. Scoville, R. Sahle.
(e) Engineering Dept., J. D. Scoville, Hydraulic Engineer.
(f) To determine the characteristics of adjustable blade axial flow pumps. To secure design data.
(g) Two and four blade pumps were tested to determine discharge, horse power and efficiency at wide range of speeds. Axial flow and several types of elbow discharge tubes were used. The number and location of guide vanes was investigated. Various shapes of intakes were tested with the pump.
(h) Tests are completed.

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STANFORD UNIVERSITY.

(239)(a) CALIBRATION OF HYDRAULIC ROUGHNESS.
(b) Self.
(c) Research.
(d) John Hedberg.
(e) John Hedberg.
(f) Continuation of project to establish an absolute scale of roughness for use in establishing similarity with models.
(g) Models to various scales of open channel sections, lined with sandpaper of various grades and with material of standard smoothnesses will be tested at various slopes; and the results will be correlated with past experiments.
(h) Search of literature and design of models is halted by the absence of Mr. Hedberg on leave to serve Denver Office of Reclamation Bureau.

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(337)(a) HYDRAULIC MODEL EXPERIMENTS FOR THE DESIGN OF SPILLWAY OF SAN FRANCISQUITO DAM.
(b) Stanford University.
(c) A laboratory investigation of physical works being designed for immediate future construction.
(d) J. G. Rawhauser.

(e) Comptroller's Office, Stanford University, California.
(f) To develop best form of spillway applicable to local conditions.
(g) Model of chute type of spillway on scale of 1:50 tested, using various forms and profiles.
(h) Experimental data completed.
(i) The spillway is to be built in conjunction with a 100 ft. earth dam w ich will develop a reservoir of 5,000 acre feet capacity. Plans are subject to the approval of the Department of Dam Inspection, California State Division of Water Resources.

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U. S. BUREAU OF AGRICULTURAL ENGINEERING.

(192)(a) FLOW OF WATER IN IRRIGATION CHANNELS.
(b) Division of Irrigation, Bureau of Agricultural Engineering, U. S. Department of Agriculture.
(c) Conducted by Division of Irrigation with informal cooperation with U. S. Bureau of Reclamation, irrigation enterprises, hydro-electric companies and municipal water departments.
(d) Fred C. Scobey, Assistance as needed.
(e) Fred C. Scobey, Senior Irrigation Engineer, Division of Irrigation, Bureau of Agricultural Engineering, Berkeley, California.
(f) Revision, U.S.D.A. Bull. 194, "The Flow of Water in Irrigation Channels." (Experimental determinations of the value of 'n' for different kinds of channels and the preparation of estimation charts; originally published in 1915).
(g) Complete field tests are made in channels of all variations of surface that can be located under conditions where experimentation is feasible. They are made in all sizes of channel from small lateral ditches to the largest of canals.
The United States Bureau of Reclamation has agreed to allow access to its files of experimentation made along the lines laid down in our Bulletin 194 and ordered shortly after that publication appeared.
(h) In progress.
(i) See II-2 for parts of (g) and (h)

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(246)(a) SAND AND SILT REMOVAL INVESTIGATION, P.W.A. PROJECT NO.F.P.99.
(b) The Bureau of Agricultural Engineering, U. S. Department of Agriculture, and the Bureau of Reclamation, U. S. Department of the Interior.
(c) The investigations are being conducted cooperatively between the two above mentioned bureaus.
(d) R.L.Parshall, Senior Irrigation Engineer, Division of Irrigation, Bureau of Agricultural Engineering, in charge of the investigations; Carl Rohwer, Associate Irrigation Engineer,

Division of Irrigation, Bureau of Agricultural Engineering, and E. W Lane, Research Engineer, Bureau of Reclamation, as collaborators.

(f) The purpose of this work is to test the vortex and grating types of sand traps, previously investigated at the Bellvue hydraulic laboratory near Fort Collins, Colorado, with a view of applying these devices on an enlarged scale in the attempt to remove fine sand and silt from Colorado River water.

(h) In progress.

(i) See II-2 for (g) and part of (h).

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U.S. CORPS OF ENGINEERS.

(259)(a) MODEL STUDIES OF BONNEVILLE DAM, A NAVIGATION AND POWER PROJECT ON COLUMBIA RIVER.

(b) U. S. Engineer Corps, Portland District - Major C. F. Williams, District Engineer.

(c) A research problem to furnish data for design and subsequent operation of the Bonneville Project.

(d) J. C. Stevens, Consulting Engineer, A. J. Gilardi, Engineer in direct charge of laboratory work, C. I. Grimm, Head Engineer in charge of Bonneville Dam Project.

(e) U. S. District Engineer, Portland, Oregon.

(f) To determine (1) the best profile of the dam, aprons and baffles to hold the head water at predetermined levels for power and navigation purposes and also to safely pass floods of over a million cfs. and (2) the best method of operating the structures.

(g) An outdoor laboratory has been constructed at Government Moorings in the City of Portland. Water is pumped from Willamette River and circulated through the models. Two models have been constructed.

No. 1. A 1:36 scale model of 180 feet of the total crest length of 900 feet of the dam. The model includes 3 of the 18 50-foot gates to be installed, 2 piers, and 2 half piers.

No. 2. A 1:100 scale model of nearly 5 miles of Columbia River from the head of Cascade Rapids to well below the foot of Bradford Island. The study on this model will include the behavior of the river as to backwater conditions before and after construction of the dam. In it will be included the dam with 18 50-foot crest gates, power house, a single lift lock for sea-going vessels, fishways, and all other features germane to the project.

(h) Both models have been completed and tests are under way. The tests on No. 1 have been to determine the best type of overflow structure and baffles to absorb the energy without scouring the river channel below the dam. Nearly 100 tests on a great variety of baffle types have been completed. Additional tests are in

progress. On model No. 2 tests have been made for the effect of cofferdams in the main river that are to be used during the construction of the dam.

(i) The work is being paid from the PWA appropriation for the Bonneville Dam.

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U. S. GEOLOGICAL SURVEY.

(26)(a) PERMEABILITY TESTS CONDUCTED UNDER VERY LOW HYDRAULIC GRADIENTS.

(b) United States Geological Survey, Water Resources Branch.

(c) General scientific research.

(d) O. E. Meinzer, V. C. Fishel.

(e) O. E. Meinzer.

(f) The purpose of this experiment is to find out if there is a flow of liquids through porous material with hydraulic gradients as low as one foot per mile or less, and if there is a flow at such low gradients, to ascertain if it follows Darcy's law which states that the flow of water through a given porous material varies directly as the hydraulic gradient.

(g) The present investigation is conducted with a U-shaped non-discharging type of apparatus having a column of material two meters in length. An initial hydraulic gradient is established by adjusting the water levels so that the level in one column is slightly higher than in the other. Observations are then made on the rate of change of the water levels.

(h) The results obtained in these tests confirm Darcy's law for hydraulic gradients of one foot per mile and indicate that the law probably holds to at least half a foot per mile. There was a definite movement of water for gradients as low as 0.05 foot per mile. These results were presented in a paper at the fifteenth annual meeting of the American Geophysical Union and were published in the Transactions of the Union for 1934, Part 2, pp. 405-409. Further tests are in progress.

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(27)(a) THIEM'S METHOD FOR DETERMINING PERMEABILITY OF WATER-BEARING MATERIALS.

(b) The U. S. Geological Survey in cooperation with the Conservation and Survey Department of the University of Nebraska.

(c) General scientific research.

(d) L. K. Wenzel.

(e) L. K. Wenzel, U. S. Geological Survey, Washington, D. C.

(f) Pumping tests were conducted near Grand Island, Nebraska, during the summer of 1931 as a part of a cooperative investigation of the ground-water resources of the Platte

Valley to determine the practicability of Thiem's method for determining permeability of water-bearing materials. Two additional pumping tests were made during 1933, one at Gothenburg and the other at Kearney, using a modified method of procedure that was determined by the test near Grand Island to give the most accurate results. See Bulletin II-1 for further details.

(1) The results of the pumping tests near Grand Island will be published by the United States Geological Survey as Contribution to the Hydrology of the United States and the results of the other two tests will be published ultimately in a report on the ground-water resources of the Platte Valley.

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(265)(a) STUDY OF THE SIZE OF INTAKE OPENINGS OF WELL SCREENS IN RELATION TO THE YIELD OF WELLS AND THE PERMEABILITY OF WATER-BEARING FORMATIONS.

(b) United States Geological Survey, Water Resources Branch.

(c) General scientific research.

(d) A. G. Fiedler, M. A. Pentz.

(e) A. G. Fiedler, U. S. Geological Survey, Washington, D. C.

(f) The purpose of this study is to determine the effect of the size of intake openings of well screens upon the yield of wells and also to determine the relationship between the yield of a well of a definite type to the permeability of the water-bearing formation.

(g) The permeability of the water-bearing formation will be determined by field pumping tests in accordance with the method suggested by Thiem as modified by L. K. Wenzel as the result of tests made in the Platte Valley, Nebraska. Laboratory tests of permeability will also be made. Wells finished with screens having different sizes of intake openings, but otherwise of identical construction, will be drilled in a selected area. The wells will be pumped at different rates and observations of the drawdown of the pumped well, and the lowering of the water-table in other observation wells will be made, and the relationship between yield, size of screen slot and permeability will be determined.

(h) Field work has been completed.

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U. S. BUREAU OF RECLAMATION.

(248)(a) SPILLWAY TESTS, GRAND COULEE DAM.

(b) U. S. Bureau of Reclamation.

(c) Routine laboratory study.

(d) Hydraulic Studies Section of U. S. Bureau of Reclamation.

(e) U. S. Bureau of Reclamation.

(f) Purpose: an aid to, and check on, the design of proposed structures.

(g) 1:184 model, testing completed.
1:120 full size model now under construction.
1:30 sectional model, testing under way.
1:15 sectional model at Montrose, Colorado, laboratory of Bureau of Reclamation.
(h) Tests under way.

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(249)(a) SPILLWAY TESTS, HYRUM DAM.
(b) U. S. Bureau of Reclamation.
(c) Routine laboratory study.
(d) Hydraulic Studies Section of U. S. Bureau of Reclamation.
(e) U. S. Bureau of Reclamation, Denver, Colorado.
(f) Purpose: an aid to, and check on, the design of proposed structures.
(g) Tests of 1:48 model of spillway chute and stilling pool.
(h) Studies completed.
(i) Report available for loan.

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(250)(a) SPILLWAY TESTS, AGENCY VALLEY DAM.
(b) U. S. Bureau of Reclamation.
(c) Routine Laboratory Study.
(d) Hydraulic Studies Section of U. S. Bureau of Reclamation.
(e) U. S. Bureau of Reclamation, Denver, Colorado.
(f) Purpose: an aid to, and check on, the design of proposed structures.
(g) Tests made of 1:30 model of entire spillway.
(h) Studies completed.
(i) Report available for loan about March, 1935.

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(251)(a) SPILLWAY TESTS, PINEVIEW DAM.
(b) U. S. Bureau of Reclamation.
(c) Routine laboratory study.
(d) Hydraulic Studies Section of U. S. Bureau of Reclamation
(e) U. S. Bureau of Reclamation, Denver, Colorado.
(f) Purpose: an aid to, and check on, the design of proposed structures.
(g) Tests made of 1:30 model of entire spillway.
(h) Studies finished.
(i) Report available for loan.

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(338)(a) RYE PATCH DAM SPILLWAY TESTS.
(b) U. S. Bureau of Reclamation.
(c) Routine laboratory study.
(d) Hydraulic Studies Section of U. S. Bureau of Reclamation.
(e) U. S. Bureau of Reclamation, Denver, Colorado.
(f) Purpose: an aid to, and check on, the design of proposed structures.
(g) 1:50 scale model tested at all flows.
(h) Studies complete.
(i) Report available for loan.

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(339)(a) MOON LAKE DAM SPILLWAY TESTS.
(b) U. S. Bureau of Reclamation.
(c) Routine laboratory study.
(d) Hydraulic Studies Section of U. S. Bureau of Reclamation.
(e) U. S. Bureau of Reclamation, Denver, Colorado.
(f) Purpose: an aid to, and check on, the design of proposed structures.
(g) 1:40 model tested under various conditions.
(h) Studies complete.
(i) Report available for loan.

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(340)(a) STUDY OF PERCOLATION THROUGH, AND STABILITY OF, EARTH DAMS UNDER A CHANGING HEAD.
(b) U. S. Bureau of Reclamation.
(c) Routine laboratory study.
(d) Hydraulic Studies Section of U. S. Bureau of Reclamation.
(e) U S. Bureau of Reclamation, Denver, Colorado.
(f) Purpose: an aid to, and check on the design of proposed structures.
(g) Arbitrary models tested in a glass-faced flume, under a varying water head.
(h) Work under way.

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(350)(a) IMPERIAL DAM SPILLWAY MODEL TESTS.
(b) U. S. Bureau of Reclamation.
(c) Routine laboratory study.
(d) Hydraulic Studies Section of U. S. Bureau of Reclamation.
(e) U. S. Bureau of Reclamation, Denver, Colorado.
(f) Purpose: an aid to, and check on, the design of proposed structures.
(g) 1:30 model of a section of the dam tested for prevention of scour.
(h) Tests under way.

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U. S. NATIONAL BUREAU OF STANDARDS.

(129)(a) TRANSPORTATION OF SEDIMENT, COLORADO RIVER.
(b) U. S. Bureau of Reclamation.
(c) General research.
(d) C. A. Wright, R. H. Monish and C. W. Elliot.
(e) The Director, National Bureau of Standards.
(f) To determine the relative scouring action on a bed of fine sand of clear water and of water containing a considerable amount of fine silt and clay.
(g) The apparatus and method described in Report II-2, July 1, 1934, are being utilized for continued experiments on the relative scouring action of clear water and muddy water. Georgia kaolin was added to the supply basin and a concentration of 0.5% was obtained in the water over the sand bed. An impact Pitot tube was made for measuring the velocities. The water-surface slopes were measured only with the point gage mounted on top of the flume. Determination of concentration of the clay in suspension, clay in the bed, mechanical analyses of the sand, density and viscosity of the water were made in the sediment laboratory.
(h) Experiments were continued using the same slope and same bed as before. Due to the roughening of the bed during the experiments the slope of the water surface was found to change progressively during the experiment. The bed load scoured up from the bed and caught in the trap was found to be proportional to the 10th power of the mean velocity. The experiments with the muddy water have not as yet yielded any conclusive results. Scouring of the bed started more easily with muddy water and when once started tended to progress more readily.

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(171)(a) INVESTIGATION OF THE PRESSURE VARIATION IN THE UPSTREAM AND DOWNSTREAM SIDES OF AN ORIFICE PLATE.
(b) Scientific Data, National Bureau of Standards.
(c) National Bureau of Standards research.
(d) H. S. Bean, E. Buckingham, C. D. Shepard.
(e) The Director, U. S. Bureau of Standards.
(f) To obtain more complete data than is now at hand on the variations of pressure in the vicinity of an orifice plate, which will assist in better correlation of orifice coefficient data.
(g) Water from a constant head tank will be discharged through the orifice section of the line into either a weighing or calibrated tank. Simultaneous readings will be made of the pressure at 45 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.

(171) (h) Set-up in progress of erection.
(i) It is possible the same set-up will be used later for similar tests using air in place of water.

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(43)(a) INVESTIGATION OF PIPE BENDS.
(b) U. S. Bureau of Reclamation.
(c) General research.
(d) K. H Beij, G. H. Keulegan, G. E. Golden.
(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 of engineers; and to extend the results to include flow of other fluids, such as oils, steam, etc.
(g) Laboratory tests will be made on pipe of various materials and various degrees of roughness; on sizes up to 20 inch diameter if funds permit; on bends of various central angles and on miter bends and cast fittings. Transparent pipes and bends will be used to investigate the nature of flow.
(h) Tests on a line of 4-inch steel tubing with 90 degree bends of radii varying from 6 inches to 16 feet are in progress. Tests have been completed on bends of 3/8 inch brass tubing of central angles varying from 5 to 180 degrees and constant arc length of 2 meters. The results are being prepared for publication. Apparatus for testing fittings on 1 inch copper tubing is being installed.

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(195)(a) LAWS OF SEDIMENT TRANSPORTATION.
(b) Proposed by U. S. Corps of Engineers and U. S. Bureau of Reclamation.
(c) General research.
(d) C. A. Wright, B. H. Monish, C. W. Elliot.
(e) The Director, National Bureau of Standards.
(f) Study of the laws of transportation of bed load by flowing water.
(g) The following studies are planned: validity of Du Boys' law of tractive force as a criterion for the movement of bed load, taking account of the wall effect and the vertical velocity distribution curve; relation of bed load movement to mean and bottom velocities of water; critical tractive force for spheres of different sizes and specific gravities, for sand grains of uniform size, for various sand mixtures and different degrees of sharpness; effect on critical tractive force of fine silt or clay particles mixed with the sand; comparison of values of critical tractive force as determined by different criteria; tests of Kramer's sand uniformity factor; range of tractive force over which various sand mixtures are suitable for use in models, roughness coefficients for flume with sand bed; with non-movement of sand and with various degrees of sand movement and riffling.

(195)(h) Experiments in the flume of Project 129 indicate that the tractive force is not a suitable criterion for movement of bed load when no material is fed in and the water surface slope is variable. Studies of the ratio of bed velocity (0.02 feet above the bed) to mean velocity and of bed load to bed velocity have as yet yielded no conclusive results. A slight change in the bed velocity results in a large change in the bed load. Fine clay particles mixed in the sand bed increase by 10% the tractive force (measured at the beginning of the experiment) necessary to cause riffle formation. The prosonce of fine clay particles in the water does not measurably affect the vertical velocity distribution curve above the sand bed.

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(196)(a) MODES OF TRANSPORTATION OF SAND BY FLOWING WATER.
(b) Proposed by U. S. Geological Survey.
(c) General research.
(d) C. A. Wright, H. N. Eaton, B. H. Monish, C. W. Elliot.
(e) The Director, National Bureau of Standards.
(f) Study of the various modes of transportation of bed and suspended load by flowing water.
(g) Study of the formation, dimensions and motion of riffles and traveling banks under different conditions; quantity of bed load as related to depth, slope, velocity, etc.; velocity of travel of uniform sand grains and sand mixtures using colored grains; mechanism of suspension and laws of suspended load.
(h) Experiments in the flume of Project 129 indicate that a sand bed of average diameter of 385 microns has a definite critical velocity (1 fps) at which the mode of transportation of the sand changes from a thin sheet to small riffles or dunes. The presence of clay in the bed raises this critical velocity 20%. With clay in the bed and with muddy water the depressions scoured out of the bed are sharp edged rather than rounded, and the riffles are larger and less numerous.

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(258)(a) STUDY OF DIVISORS FOR SOIL EROSION INVESTIGATION.
(b) Soil Erosion service, U. S. Department of the Interior.
(c) Data for calibration and for design.
(d) H. L. Cook, D. A. Parsons.
(e) The Director, Soil Erosion Service,
(f) To determine the relative accuracy of divisors now in use; and to develop improved form of divisor, if necessary.
(g) Tests will be made with clear water and water containing various concentrations of soil and debris to determine accuracy and relative advantages of divisors now in use. If these tests demonstrate the necessity, an attempt will be made to develop an improved divisor.

(258)(h) Most of the divisors now in field use have been tested with clear water, and tests with water containing soil are about to be started. Several new types of divisors have been constructed and subjected to preliminary tests.

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(341)(a) STUDY OF MEASURING FLUMES OF THE VENTURI TYPE.
(b) Soil Erosion Service, U. S. Dept. of the Interior.
(c) Data for calibration and design.
(d) H. L. Cook, D. A. Parsons.
(e) The Director, Soil Erosion Service.
(f) To develop better devices for the measurement of rates of runoff from experimental plots used in the study of soil erosion.
(g) Tests are to be made of venturi-type flumes and control meters of very small to moderately large capacities. A special objective will be to develop self-cleaning flumes having parabolic or trapezoidal throat sections.
(h) The design of the essential equipment has been completed and tests will start in the near future.

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(342)(a) STUDIES OF ARTIFICIAL CONTROLS FOR STREAM-FLOW MEASUREMENT.
(b) U. S. Geological Survey, Water Resources Branch.
(c) Cooperative project with U. S. Geological Survey for comparative performance tests and general scientific research.
(d) W. S. Eisenlohr, Jr., (Geological Survey)
R. B. Hunter and C. W. Elliot (National Bureau of Standards).
(e) C. H. Pierce, U. S. Geological Survey, Washington, D. C.
(f) To study the relative merits of the various designs of artificial controls developed in recent years by the several district offices of the Survey, with a view to standardizing on a few selected types.
(g) Full size models are being tested in the 12-foot flume with flows ranging from 0.1 to 18.0 second-feet. Nine or more controls are to be tested including V-notch and trapezoidal-notch weir crest plates and various forms of concrete notches, inclined crests, and horizontal crests. Tests include calibration with free fall and submerged conditions and study of the effects of filling the channel above the control.
(h) Tests have been completed on the first three controls and the others will be finished as rapidly as possible.

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(343)(a) ROUGHNESS IN PIPES.
(b) National Hydraulic Laboratory.
(c) General research.
(d) K. H. Beij, G. E. Golden.
(e) The Director, National Bureau of Standards.

(343)(f) Study of hydraulic roughness in pipes.
(g) Correlation of friction losses with surface of pipes.
(h) Data have been obtained on a 4-inch galvanized iron pipe line, about 65 feet long, with screwed couplings.
(i) This investigation is carried on in connection with other projects as opportunity offers.

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(344)(a) EFFICIENCY OF WELL SCREENS.
(b) U. S. Geological Survey.
(c) General research.
(d) R. B. Hunter, B. H. Monish (National Bureau of Standards), and A. G. Fiedler (Geological Survey).
.....(e) A. G. Fiedler, U. S. Geological Survey.
(f) To determine the losses through well screens of a certain type.
(h) Experimental work will be started as soon as the necessary apparatus can be designed, purchased and installed.

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(345)(a) BIBLIOGRAPHY ON DRAFT TUBES.
(b) Tennessee Valley Authority.
(d) G. H. Keulegan, E. Buckingham, H. N. Eaton.
(e) Carl A. Bock, Asst. Chief Engineer, Tennessee Valley Authority, Knoxville, Tennessee.
(f) To make a study of the literature on the subject of draft tubes for large water wheels published during the last twenty years and to prepare a report which will include an annotated bibliography.
(h) Abstracts have been prepared of the pertinent articles included in the bibliography, and the report is being written.
(i) In connection with this project, a paper by Fritz Krisam entitled, "Investigation of a new form of draft tube for high-speed turbine runners" published in Mitt. des Inst. für Strömungsmaschinen der Tech. Hoch. Karlsruhe, Vol. 2, 1932, is being translated.

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U. S. WATERWAYS EXPERIMENT STATION

(51)(a) SUSPENDED LOAD INVESTIGATIONS.
(b) Mississippi River and Tributaries.
(c) All experiments are prosecuted to the end of aiding in the development of plans for flood control, harbor improvement, navigation, etc. All have a direct practical application to the work of the Corps of Engineers, U. S. Army, in its administration of the Rivers and Harbors of the Nation. The U. S. Waterways Experiment Station holds as an unvarying principle the maintenance of the closest contact with the field in all experimental work. This contact is kept both by Station personnel visiting the prototype and by engineers from the field visiting the Station while any particular model study is in progress.

(d) All experiments are conducted at the U. S. Waterways Experiment Station by personnel of the Station under the direction of Lieut. Francis H. Fallmer, Director of the Station.
(e) The Director, U. S. Waterways Experiment Station.
(f) Study of suspended load carried by the Mississippi River, Atchafalaya River and their tributaries - silting of reservoirs - study of the behavior of different sediment traps. Design of new traps.
(g) Field and laboratory investigations, analyses of samples, compilation of curves, comparison of results obtained from different traps.
(h) Studies for 1930-31 reported on, other studies still in progress.
(i) See list of publications, U S. Waterways Experiment Station.

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(52)(a) SOIL INVESTIGATIONS.
(b) Navigable Waterways, U.S.A.
(c) (d) and (e) See (51).
(f) Study physical properties of soils, especially as they pertain to levee construction.
(g) Mechanical Analyses, Atterberg Limits, permeability determinations, microscopic examinations, specific gravity determinations, shear and compression tests of samples undisturbed and otherwise, obtained under the supervision of the Station. Study of subsidences by use of pre-set plates established throughout the compressible strata at critical points for measuring the progress of consolidation in the strata. Checking observed results against anticipated settlement determined from study of undisturbed samples of foundation material.
(h) Studies in progress continually.

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(59)(a) LEVEE SEEPAGE.
(b) Mississippi River Commission.
(c) (d) and (e) See (51).
(f) Study and observe hydraulic gradient and flow lines in levees and models of levees of standard sections of various materials placed by various methods.
(g) Loop of levees, standard section, 10 feet high, of various materials and placed in various ways, kept full; measurements taken.
(h) First phases of experimental work complete. Report being prepared.

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(74)(a) TRACTIVE FORCE.
(b) Mississippi River Commission.
(c) (d) and (e) See (51).
(f) To determine relation between physical properties of bed-load materials and tractive force required to move them. Also to determine laws governing rate of bed-load movement.

(g) Tests in special tilting flume checked by special runs in models.
(h) Initial phases of experimental work complete. Tests are to be continued, using artificial mixtures, in glass-sided flume. Range of sizes to be extended to include small gravels.
(i) Results of initial tests will be contained in Paper 17, now being prepared for publication.

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(77)(a) ISLAND NO. 35, MISSISSIPPI RIVER.
(b) Mississippi River Commission.
(c) (d) and (e) See (51)
(f) Develop methods of improving navigation.
(g) Movable bed model from Mile 181.4 to 204.0 below Cairo. Model scales are 1:600 horizontal and 1:150 vertical.
(h) Original experiment completed. Additional studies now in progress.
(i) Reports of original experiment included in Technical Memoranda Nos. 29-2, 3, 4, 5, 6, 7, U. S. Waterways Experiment Station.

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(91)(a) MISSISSIPPI RIVER MODEL NO. 4 - INCLUDING THE RIVER FROM MILE 560 TO MILE 655 BELOW CAIRO.
(b) Mississippi River Commission.
(c) (d) and (e) See (51).
(f) Miscellaneous problems involving flood control and channel stabilization between the limits specified in (a). Reaches studied: Millikens Bend, King's Point, Racetrack Towhead, Diamond Point Cut-off, Buckridge Crossing, and Yucatan Point Cut-off.
(g) Model scales: 1 to 1000 and 1 to 100; movable bed.
(h) In progress.
(i) Results of these studies are described in Technical Memoranda Nos. 34, 34-2, 38-1, 47-1, 47-2, 47-3, 47-4, 47-5, 58-1, 58-2, 58-3.

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(92)(a) MISSISSIPPI RIVER MODEL NO. 5 - INCLUDING THE MISSISSIPPI RIVER FROM MILE 650 TO MILE 762.5 BELOW CAIRO.
(b) Mississippi River Commission.
(c) (d) and (e) See (51).
(f) Miscellaneous problems involving flood control and channel stabilization within the limits specified in (a). Reaches studies: Waterproof Cut-off, Cowpen Point Cut-off, Bondurant Towhead, Esperance Point - Morville Landing, Glasscock Point Cut-off.
(g) Model scales: 1 to 1000 and 1 to 100; movable bed.
(h) In progress.
(i) Results of these studies are described in Technical Memoranda Nos. 32-1, 32-2, 32-3, 34-2, 42-1, 42-2, 42-3, 42-4, 42-5, 60-1.

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(148)(a) WINYAH BAY, SOUTH CAROLINA COAST.
(b) Division Engineer, South Atlantic Division.
(c) (d) and (e) See (51).
(f) Study means of increasing navigable depths in the harbor.
(g) Tidal Study. Model scales 1 to 500 horizontal and 1 to 100 vertical. Using a reversing flow of water through the model to simulate tidal fluctuations, and sawdust moving over a concrete bed to simulate movement of bed material, the effect of different systems of training walls and dredge cuts, is tested.
(h) Original experiment and additional requested studies completed.
(i) Results of original experiment included in Technical Memoranda Nos. 37-1, 2, 3, 4, and final report. Results of additional studies included in Technical Memoranda Nos. 37-5, and 6.

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(150)(a) ISLAND NO. 20, MISSISSIPPI RIVER.
(b) Mississippi River Commission.
(c) (d) and (e) See (51).
(f) Study of effects of proposed regulating works on channel location and depths.
(g) Movable bed model from Mile 118 to Mile 135 below Cairo. Model scales are: 1:1000 horizontal and 1:125 vertical.
(h) Completed.
(i) Report included in Technical Memoranda Nos. 43-1, 2. U.S. Waterways Experiment Station.

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(151)(a) ATCHAFALAYA RIVER BASIN.
(b) Mississippi River Commission.
(c) (d) and (e) See (51).
(f) Study of the effects of changes in the regimen of the affluents of the Atchafalaya.
(g) Model scales 1 to 1500 and 1 to 100; fixed bed.
(h) Completed.
(i) Results of this study are described in Technical Memoranda Nos. 40-1, 40-2, 40-3.

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(152)(a) ROBINSON CRUSOE ISLAND, MISSISSIPPI RIVER.
(b) District Engineer, Memphis, Tenn.
(c) (d) and (e) See (51).
(f) Study of proposed regulating works.
(g) Movable bed model from Mile 208 to Mile 250.9 below Cairo. Model scales are: 1:1000 horizontal and 1:125 vertical.
(h) Experiment in progress.
(i) Partial report included in Technical Memoranda Nos. 44-1, 2, 3, 4. U. S. Waterways Experiment Station.

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(153)(a) ARTICULATED CONCRETE MATTRESS STUDY.
(b) U. S District Engineer, Memphis, Tenn.
(c) (d) and (e) See (51).
(f) Relative protection afforded banks by two types of articulated concrete mattress.
(g) Installation of full size mattress units on the banks of the creek from which Station water supply is derived. Observations of erosion from floods will be made.
(h) In progress.

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(163)(a) MISSISSIPPI RIVER MODEL NO. 1, INCLUDING THE MISSISSIPPI RIVER FROM MILE 390 TO MILE 810 BELOW CAIRO, THE RED RIVER FROM ITS MOUTH TO MILE 33 ABOVE BARDRE LANDING, AND THE ATCHAFALAYA RIVER FROM ITS HEAD TO MILE 35 BELOW BARBRE LANDING.
(b) Mississippi River Commission.
(c) (d) and (e) See (51).
(f) Miscellaneous problems affecting water surface elevations within the limits specified in (a). Problems studied: Ten proposed Cut-offs, Leland and Tarpley Neck Cut-offs, Brunswick Levee Extensions, Natchez Levee Set-back, and Enlargement of the Atchafalaya River.
(g) Model scales 1 to 2400 and 1 to 120; fixed bed.
(h) In progress.
(i) Results of several studies are described in Technical Memoranda Nos. 25, 25-A, 25-B, 25-C, 25-D, 34, 34-2, 50-1.

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(165)(a) MISSISSIPPI RIVER BED MATERIAL SURVEY.
(b) Mississippi River Commission.
(c) (d) and (e) See (51).
(f) To determine characteristics of material composing the bed of the Mississippi River and its principal tributaries.
(g) Samples taken from bed of Mississippi River at about one-mile intervals from Cairo to Gulf of Mexico, and from beds of Ohio, Old, Red, Black, and Atchafalaya Rivers and the Atchafalaya Basin. Supplementary samples later taken from Arkansas, White, Ouachita, Yazoo, St. Francis, Ohio, Tennessee, Cumberland, Wabash, Missouri, and Illinois Rivers. Special trap used for procuring samples. Mechanical and hydrometer analysis, specific gravity test, and microscopic examination were made of each sample. Petrographic study is being made.
(h) Analysis of samples from Mississippi, Ohio, Atchafalaya, Red, Black, and Old Rivers completed and tabulated. Analyses of other tributary samples completed and being tabulated. Petrographic study in progress.
(i) Paper 17 (now being prepared for publication) includes results of analyses of Mississippi, Ohio, Atchafalaya, Red, and Old River samples.

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(166)(a) U. S. INTRA-COASTAL WATERWAYS CROSSING WITH BRAZOS RIVER, NEAR FREEPORT, TEXAS.
(b) U. S. District Engineer, Galveston, Texas.
(c) (d) and (e) See (51).
(f) Study to eliminate shoaling of canal by Brazos River.
(g) Scale 1 to 200 horizontal and 1 to 45 vertical. A silt-laden discharge of water, and bed material added to the stream, are used in simulating Brazos River. Different improvement plans are tested.
(h) In progress.

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(167)(a) ST. JOHNS RIVER, JACKSONVILLE, FLORIDA.
(b) U. S. District Engineer, Jacksonville, Florida.
(c) (d) and (e) See (51).
(f) Study to determine effects of blocking off one entrance to tidal area in order to improve channel conditions in other entrance; also to determine the effect of a cut-off in the main channel.
(g) Tidal Model. Scale of model 1 to 1000 horizontal and 1 to 50 vertical. A reversible flow of water simulates tidal fluctuations; a movable bed was employed.
(h) Completed.
(i) Results of experiment are in Technical Memorandum No. 55-1.

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(168)(a) HEAD OF PASSES, MISSISSIPPI RIVER.
(b) U. S. District Engineer, 1st New Orleans District, New Orleans, La.
(c) (d) and (e) See (51).
(f) Determine methods of improving navigation conditions at Head of Passes.
(g) Movable bed model extending from 8 miles above to 6 miles below, Head of Passes. Model scales 1:600 horizontal and 1:150 vertical.
(h) Experiment completed.
(i) Reports included in Technical Memoranda Nos. 46-1, 2, 3, 4.

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(169)(a) SOUTHWEST PASS, MISSISSIPPI RIVER.
(b) District Engineer, 1st New Orleans District, New Orleans, La.
(c) (d) and (e) See (51).
(f) Determine methods of improving channel conditions in Southwest Pass.
(g) Movable bed model from Mile 8.8 below Head of Passes to Gulf of Mexico. Model scales: 1:1000 horizontal and 1:125 vertical.
(h) Experiment completed.
(i) Report included in Technical Memoranda Nos. 45-1, 2, 3, 4. U. S. Waterways Experiment Station.

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(170)(a) MISSISSIPPI RIVER MODEL NO. 2, INCLUDING THE MISSISSIPPI RIVER FROM MILE 370 TO MILE 445 BELOW CAIRO, 60 MILES OF THE ARKANSAS RIVER, AND 16 MILES OF THE WHITE RIVER.
(b) Mississippi River Commission.
(c) (d) and (e) See (51).
(f) Determine effects of separating mouths of Arkansas and White Rivers; also effects of cut-offs on these rivers upstream from mouth.
(g) Model scales 1 to 1000 and 1 to 100; fixed bed.
(h) In progress.
(i) Partial results of thisstudy are described in Technical Memorandum No. 51-1.

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(198)(a) FITLER BEND, MISSISSIPPI RIVER.
(b) Mississippi River Commission.
(c) (d) and (e) See (51).
(f) Study for Improvement of Navigation.
(g) Model scales 1 to 500 and 1 to 150. movable bed.
(h) In progress.
(i) Results to date of this study are described in Technical Memorandum No. 56-1.

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(199)(a) ARANSAS PASS, GULF OF MEXICO.
(b) The Division Engineer, Gulf of Mexico Division.
(c) (d) and (e) See (51).
(f) To determine best improvement for navigation channel through pass.
(g) Tidal Study. Scale of model, 1 to 500 horizontal and 1 to 100 vertical. A reversible flow of water simulating tidal action, and a movable bed, is used to test proposed improvement works.
(h) In progress.

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(200) (a) FORT CHARTRES, MISSISSIPPI RIVER.
(b) District Engineer, St. Louis, Mo.
(c)(d) and (e) See (51).
(f) Develop dike system to improve depths over crossings in vicinity of Ste. Genevieve.
(g) Movable bed model from Mile 137 to Mile 112 above Cairo. Model scales: 1:1000 horizontal and 1:125 vertical.
(h) In progress.
(i) This experiment supplements previous study of the river between Miles 137 and 120 above Cairo. (See (83) Report No. 1-3, Oct. 1, 1933). Present study has been partly reported in Technical Memoranda Nos. 49-1, 2, 3, and 4.

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(201)(a) TETRAHEDRAL BLOCK REVETMENT.
(b) Mississippi River Commission.
(c) (d) and (e) See (51).
(f) Study to determine effect of slope of bank on stability of Tetrahedral Blocks.
(g) Installation of full size tetrahedral blocks on the banks of the creek from which Station water supply is derived. Observation of effects of floods will be made.
(h) Completed.
(i) Tests indicated blocks would stand on slope of 1:2 1/2. No report contemplated.

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(202)(a) INVESTIGATION OF MATERIAL FOR CORE OF FORT PECK DAM.
(b) Fort Peck, Missouri District.
(c) (d) and (e) See (51).
(f) Determine physical properties of soil that may be used for core material of hydraulic fill dam.
(g) Separation of coarse and fine particles into groups for special study of such.
1. Removed particles coarser than fine sand (0.20 m.m.)
2. Removed particles coarser than very fine sand (0.10 m.m.)
3. Removed particles coarser than very fine silt (0.01 m.m.)
4. Removed particles coarser than very fine sand and finer than very fine silt and clay.
(h) Completed.
(i) Report rendered to the District Engineer, U. S. Engineer Office, Fort Peck, Montana.

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(252)(a) SOUTH PASS, MISSISSIPPI RIVER.
(b) U. S. District Engineer, 1st New Orleans District, New Orleans, La.
(c) (d) and (e) See (51).
(f) Determine methods for eliminating scour below sill near entrance to pass.
(g) Movable bed model extending from entrance to pass to 1.5 miles below Head of Passes. Model scales: 1:300 horizontal and 1:75 vertical.
(h) Completed.
(i) This model study is an auxiliary to the Head of Passes study.

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(253)(a) CAT ISLAND, MISSISSIPPI RIVER.
(b) U. S. District Engineer, Memphis, Tenn.
(c) (d) and (e) See (51).
(f) Study of proposed regulating works.
(g) Movable bed model from Mile 241-2 to Mile 275.0 below Cairo. Model scales: 1:1000 horizontal and 1:125 vertical.
(h) Experiment in progress.

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(254)(a) SAVANNAH RIVER, GEORGIA.
(b) U. S. District Engineer, Savannah, Ga.
(c) (d) and (e) See (51).
(f) Determine methods of improving navigation conditions in Savannah River.
(g) Movable bed model from Mile 188 to Mile 178.5 above Savannah. Model scales: 1:200 horizontal and 1:30 vertical.
(h) Experiment in progress.
(i) Partial report included in Technical Memorandum 57-1.

(255)(a) COney ISLAND DIKE MODEL.
(b) District Engineer, Cincinnati, Ohio.
(c) (d) and (e) See (51).
(f) Determine method of improving the navigability of the Ohio River below Dam No. 36.
(g) Model scales: 1 to 250 and 1 to 60; fixed bed.
(h) First phase of experimental work completed.
(i) Results of this phase of the experiment are included in Technical Memorandum No. 64-1.

(256)(a) MISSISSIPPI RIVER MODEL NO. 3 - INCLUDING THE MISSISSIPPI RIVER FROM MILE 486 TO MILE 531 BELOW CAIRO.
(b) Mississippi River Commission.
(c) (d) and (e) See (51).
(f) Miscellaneous problems involving the river within the limits specified in (a).
(g) Model scales 1 to 1000 and 1 to 100; movable bed.
(h) In progress.
(i) Results of one study are described in Technical Memorandum No. 59-1.

(257)(a) DIRECTIONAL ENERGY STUDY.
(b) Mississippi River Commission.
(c) (d) and (e) See (51).
(f) Experiments to determine relations between length of tangent, length of pool, total length, slope, and bed material of rivers.
(g) Outdoor flume, 50 feet x 15 feet with movable bed, being used.
(h) In progress.

(346)(a) INVESTIGATION OF THE LEVEE AND BORROW PIT MATERIAL IN THE VICINITY IMMEDIATELY EAST OF THE BIG LAKE RESERVATION IN ARKANSAS.
(b) U. S. District Engineer, U. S. Engineer Office, Memphis, Tenn.
(c) (d) and (e) See (51).
(f) To determine the differences between the soil in the present levee and that obtained from the proposed new line. Also, to determine the cause and the means of preventing the numerous slides in the present levee or new levee if constructed.

(g) Mechanical Analyses, Atterberg Limits, Moisture Contents.
(h) Completed.
(i) Report rendered to the District Engineer, U. S. Engineer Office, Memphis, Tenn.

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(347)(a) AN INVESTIGATION OF THE SOIL AVAILABLE FOR THE CONSTRUCTION OF A LEVEE IN THE MAUVAIS TERRE LEVEE AND DRAINAGE DISTRICT, SCOTT COUNTY, ILLINOIS.
(b) U. S. District Engineer, U. S. Engineer Office, St. Louis, Mo.
(c) (d) and (e) See (51).
(f) To determine by the application of known theoretical methods, the most efficient cross-section for this levee unit, knowing the physical properties and characteristics of the material available for its construction.
(g) Mechanical Analyses, Atterberg Limits, Specific Gravity Determination, Shear Tests, Permeability Determinations.
(h) Completed.
(i) Report rendered to the District Engineer, U. S. Engineer Office, St. Louis, Mo.

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(348)(a) SEDIMENT INVESTIGATION IN THE ATCHAFALAYA BASIN.
(b) U. S. District Engineer, Second New Orleans District, New Orleans, La.
(c) (d) and (e) See (51).
(f) To determine the quantity, nature and source of the material, both sediment and bed material, being transported by the Atchafalaya River and some of its branches.
(g) Mechanical Analyses, Sediment Analyses, Microscopic Examinations.
(h) Completed.
(i) Report rendered to the District Engineer, Second New Orleans District, New Orleans, La.

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WEST VIRGINIA UNIVERSITY.

(50)(a) DISCHARGE THROUGH THIN PLATE ORIFICES IN PIPE LINES.
(b) West Virginia University.
(c) General scientific research.
(d) L. V. Carpenter assisted by students.
(e) L. V. Carpenter, College of Engineering, West Virginia University, Morgantown, West Virginia.
(f) To study coefficients of various sizes of circular thin plate orifices in pipe lines with a view to the determination of the relations existing between the coefficients of large and small orifices by principles of similarity.
(g) A series of six different size circular orifices have been tested in a 2-inch pipe line. The section of pipe line as well as the thin plate orifice are smooth brass. It is proposed to make a number of similar tests on orifices in 3, 4, and 6 inch pipe lines.

(h) Work is being continued on this project and an article is now being prepared for publication.

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WORCESTER POLYTECHNIC INSTITUTE.

(205)(a) SALT VELOCITY METHOD OF WATER MEASUREMENT.
(b) Alden Hydraulic Laboratory.
(c) Research.
(d) C. M. Allen, and L. J. Hooper, and C. W. Hubbard.
(e) Professor C. M. Allen.
(f) To establish limits of accuracy in short test sections.
(g) By comparing the discharges as determined by the Salt Velocity Method for varying flows directly by the Weighing Tank Method or weirs calibrated by the Weighing Tank Method.
(h) In progress.

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(206)(a) PITOMETER SHIP LOG.
(b) The Pitometer Ship Log Corporation, New York City.
(c) Commercial research.
(d) L. J. Hooper and Shaw Cole.
(e) E. S. Cole.
(f) To determine the coefficient of the pitometer log and effect of angularity.
(g) Stillwater tests made on revolving boom, moving water tests made in throat of venturi meter.

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(349)(a) HARTFORD METROPOLITAN WATER WORKS DAM AND SPILLWAY.
(b) Hartford Metropolitan Water Works.
(c) Commercial Research.
(d) C. W. Hubbard.
(e) Professor C. M. Allen.
(f) Model test to determine the proper shape of the spillway and waste channel and to insure a most economical design for probable maximum flood conditions.

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NEW YORK UNIVERSITY.

(130)(a) DURATION CURVES OF STREAM FLOW.
(c) General scientific research and in connection with theses for Master's degrees.
(d) Thorndike Saville, graduate students, and assistants.
(e) Professor Thorndike Saville.
(f) To determine regional characteristics of stream flow and the applicability of statistical methods to its analysis.
(g) Construction of duration curves of weekly stream flow in terms of mean flow. Deviations of curves from one another as influenced by drainage area and regional characteristics and

length of record. Construction of composite curve applicable to a region. Statistical analysis of curves and data.

(h) Study of five North Carolina streams completed and published: "An investigation of the flow-duration curves of North Carolina streams," by Thorndike Saville and John D. Watson, Trans. American Geophysical Union, National Research Council, Washington, D. C., 1933, pp. 406-425. Studies in progress covering streams in New Jersey, New York, Tennessee and North Carolina.

(i) The investigation is intended to cover the entire country, and the results will be presented in a series of papers dealing with different regions.

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(131)(a) ESTIMATING FLOOD FLOWS.

(b) General scientific research and in connection with theses for Master's degrees.

(d) Thorndike Saville, graduate students, and assistants.

(e) Professor Thorndike Saville.

(f) (g) To compare all the various methods which have been proposed by applying them to streams having long periods of flow, and to develop if found desirable, improved methods.

(h) Comparison of several methods to 57 year daily record of Tennessee River in Master's thesis (1933) by H. Thielhelm. Results indicate marked diversity. Subsequent studies indicate period of record has marked influence upon extrapolated values, and that estimates of extreme floods in terms of the mean flood differ for different stations on same streams even when same (30 year) period is used.

A report entitled, "A Study of Methods of Estimating Flood Flows Applied to the Tennessee River", has been circulated in mimeograph form by the U. S. Geological Survey in connection with its flood study being prosecuted under the auspices of the Mississippi Valley Committee and Water Resources Section of the National Resources Board. This manuscript will probably later be published with other material in a water supply paper dealing with floods.

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(132)(a) RAINFALL, RUNOFF, EVAPORATION, SILTING ON FLAT RIVER, N. C.

(b) N. C. Department of Conservation and Development and City of Durham, N. C.

(c) Project to improve operation of water supply and water power development of City of Durham, and as general research.

(d) Thorndike Saville and Charles E. Ray, Jr.

(e) Professor Thorndike Saville.

(f) To determine hydrological characteristics of Flat River drainage Basin.

(g) Records collected from numerous stream flow and rainfall stations; floating evaporation pan and meteorological instruments. Measurement of silt deposits in reservoir. Forest and vegetation survey. Analysis of data collected.

(h) Records available since 1929. Preliminary report in 1931.

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(133)(a) COASTAL EROSION IN NORTH CAROLINA.
(b) North Carolina Department of Conservation and Development and U. S Beach Erosion Board.
(c) Research in conservation of natural resources.
(d) Thorndike Saville and Charles E. Ray, Jr.
(e) Professor Thorndike Saville.
(f) To determine nature and extent of coastal erosion at selected points and propose control measures.
(g) Historical study of coast from charts. Annual or more frequent surveys by land and air. Studies of sediments, currents, storms, etc. Plans for protecting beaches and inlest.
(h) Report on Wrightsville Beach, 1930. Report on Fort Fisher Beach by U. S. Beach Erosion Board, H. Doc. 204, 72nd Congress, 1st Session, 1931.

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COMPLETED PROJECTS

ABSTRACTS AND REFERENCES.

CALIFORNIA INSTITUTE OF TECHNOLOGY.

(100) MODEL INVESTIGATIONS OF SILTING PROBLEMS AT SEAL BEACH.
"Solving a Flood and Beach Protection Problem with an Hydraulic Model - A Study of San Gabriel River Mouth at Alamitos Bay Inlet, California," by Charles T. Leeds, Vito A. Vanoni and Robert T. Knapp. Trans. Amer. Geophysical Union, Part II, June, 1934, pp. 579-593.

(101) THE CHARACTERISTICS OF A CENTRIFUGAL PUMP WHEN OPERATED UNDER ABNORMAL CONDITIONS.
"Complete Characteristics of Centrifugal Pumps and their Use in the Prediction of Transient Behavior," by Robert T. Knapp. Preprinted Papers and Program, Aeronautic and Hydraulic Divisions, Amer. Soc. Mech. Eng., Berkeley, Calif., June, 1934, pp. 60-64.

(104) FURTHER MODIFICATION OF THE THEORY OF CENTRIFUGAL PUMP DESIGN.
"Cavitation and Separation in Pumps and Turbines", by George F. Wislicenus. Thesis available from Library of California Institute of Technology.

"Separation in Pumps and Turbines", by George F. Wislicenus. Preprinted Papers and Program, Aeronautic and Hydraulic Divisions, Amer. Soc. Mech. Eng., Berkeley, Calif., June, 1934, pp. 71-74.

UNIVERSITY OF CALIFORNIA - COLLEGE OF ENGINEERING.

(12) JET PUMPS.

"Mixing of Fluid Streams", by Lowell A. Ledgett. Preprinted Papers and Program, Aeronautic and Hydraulic Divisions, Amer. Soc. Mech. Eng., Berkeley, Calif., June, 1934, pp. 90-96.

(14) STREAMLINE AND TURBULENT FLOW THROUGH GRANULAR MATERIALS.

"Flow through Granular Materials", by G. H. Hickox. Trans. Amer. Geophysical Union, Part II, June, 1934, pp. 567-572.

(17) TRANSPORTATION OF BED LOAD BY STREAMS.

"The Transportation of Bed Load by Streams", by Morrough P. O'Brien and Bruce D. Rindlaub. Trans. Amer. Geophysical Union, Part II, June, 1934, pp 593-603.

(Project being continued.)

(172) HYDRAULIC JUMP.

"Graphical solution for hydraulic jump", by G. H. Hickox, Civil Engineering, Vol. 4, No. 5, May, 1934, p. 270. (letter) (Project being continued.)

(173) RATING A MODIFIED PARSHALL FLUME.

Thesis available on loan.
(See also Abstract in II-2.)

(174) AERATION OF SHARP-CRESTED WEIRS.

Thesis available on loan.
(See also Abstract in II-2.)

(268) WATER HAMMER.

"Some Experiments and Calculations on the Resurge Phase of Water Hammer", by Joseph H. Le Conte. Preprinted Papers and Program, Aeronautic and Hydraulic Divisions, Amer. Soc. Mech. Eng., Berkeley, Calif., June. 1934, pp. 45-49.

(269) PROPELLER PUMPS.

"Propeller Pumps", by Morrough P. O'Brien and Richard G. Folsom. Preprinted Papers and Program, Aeronautic and Hydraulic Divisions, Amer. Soc. Mech. Eng., Berkeley, Calif., June, 1934, pp. 65-70.
(Project being continued.)

CORNELL UNIVERSITY.

(289) DIFFERENTIAL, TWO-LIQUID, U-TUBE GAGES.

"Differential Manometers Investigated", by Henry C. Eagle, and Warren E. Wilson. Civil Engineering, Vol. 4, No. 1, Jan., 1934, pp. 30-32.

Complete thesis on file in the Engineering Societies Library.

See also: "Differential two-liquid gages and specific gravities," by Ernest W. Schoder, Civil Engineering, Vol. 4, No. 5, May, 1934, p. 266. (letter)

HARVARD UNIVERSITY.

(106) THE STUDY OF THE FLOW OF WATER THROUGH SAND.

"Fundamental factors governing the streamline flow of water through sand," by Gordon M. Fair and Lorenzo P. Hatch. Jour. Amer. Water Works Assoc., Vol. 25, No. 11, Nov., 1933, pp. 1551-1563. (Project being continued.)

HORTON HYDRAULIC AND HYDROLOGIC LABORATORY.

(290) VELOCITY DISTRIBUTION IN STREAM CHANNELS.
Preliminary abstract.

It is shown that in wide channels the velocity distribution curve which is derived from and meets the requirements of the Manning formula differs materially from the actual vertical velocity curve because of the presence in the stream of what may be called latent eddy energy, which does not contribute to movement of translation.

It is shown that in wide channels there is an upward current due to eddies and an equal downward current, or return flow. The effect of the latter is important in relation to fixing the bottom velocity, which has not heretofore been taken into account. Allowing for energy distribution, a correction is obtained for the theoretical velocity curve given by Manning's formula. The result is an expression for velocity distribution in terms of bottom and surface velocities, containing two parabolic terms, which gives excellent agreement with observed velocity distribution.

Three criteria are developed for testing the validity of the velocity distribution equation;

1. It must give the same mean velocity as that given by Manning's formula for the same slope, depth and roughness.

2. It must give the correct velocities at the .2 and .8 depth points.

3. The computed value of the energy ratio, or Coriolis coefficient, must agree with the actual coefficient derived from an observed velocity curve. A rational expression for the Coriolis coefficient in a wide channel is derived, showing that the Coriolis coefficient for such a channel is about 1.02 to 1.04. This is in good agreement with the results obtained directly from vertical velocity curves. It is contrary to the generally accepted view, derived mainly from pipes and small channels, that the Coriolis coefficient is about 1.11.

Mathematical functions are developed which permit the application of the same theory and results to narrow channels, where the side walls exert an important influence.

It is shown that the rule that the mean of the .2 and .8 depth velocities equals the mean velocity has a rational foundation and its validity depends on the simple fact that the area of a parabola with a given exponent bears a constant ratio to the area of the enclosing rectangle.

(293) FLOOD WAVES SUBJECT TO FRICTION CONTROL.
Preliminary abstract.

This far it has been shown that it is possible for the entire upstream slope of a flood wave to travel downstream at a uniform velocity equal to the initial velocity of the stream before the wave was superposed. This results from the fact that the energy consumed in friction per unit of channel bottom can, with a suitable upstream slope profile, decrease at the same rate at which the surface slope decreases. This result is new in hydraulics. The accomplishment of this requires that the downstream end of the portion of the wave moving at a uniform velocity must have support. Actually the support is only partial and, as a result, the wave flattens out as it travels downstream. An analysis of the mechanics of the flattening out of the wave is in progress, the underlying idea being that approximate results can be obtained more readily by subdividing the wave into two parts, treating each part separately along simple mathematical lines rather than to attempt a solution of the complicated differential equations covering the wave motion as a whole, hitherto often undertaken but never satisfactorily attained.

(Project being continued.)

(296) DISCHARGE COEFFICIENTS FOR TAINTER GATES.

An analytical formula for flow through tainter gates and sluice gates is derived by a method similar to that used by Koch and Carstanjen. It is found that a coefficient 1.03 must be applied to the formula as originally developed by Koch and Carstanjen. The reason for this coefficient is because the velocity distribution in the channel of approach is not uniform, and the value of this coefficient has been independently derived from the investigation of velocity distribution in channels (see Project 290, page 12).

The theoretical formula is compared with experiments by

Robert E. Horton and staff at the Hydraulic Laboratory of the University of Iowa and with experiments by Theron M. Ripley. The results, with diagram for determining coefficients, are given in abbreviated form in Engineering News-Record, January 4, 1934. Reprint copies of this paper will be furnished to other laboratories in exchange for reports of their work.

(297) SEPARATE ROUGHNESS COEFFICIENTS FOR CHANNEL BOTTOM AND SIDES.

An analysis was made of the flow in channels having different degrees of roughness of the bottom and sides. A result is obtained which gives the variation in apparent coefficient of roughness taken over the entire perimeter, with varying depth. Theoretical results are compared with experiments of the U. S. Department of Agriculture on streams in Illinois.

The results of this investigation have been published in Engineering News-Record, November 30, 1933. Reprint copies of this paper will be furnished to other laboratories in exchange for reports of their work.

(298) LAMINAR SHEET FLOW.

This investigation, by Robert E. Horton, H R. Leach and R. Van Vliet, included laboratory experiments to determine the actual velocity of flow of very thin sheets of water on a smooth inclined surface. The results are compared with the theoretical velocities for laminar flow and found to be in good agreement therewith for conditions such that the flow remains laminar.

A study was also made of the conditions under which the flow changes from laminar to turbulent, and an expression is obtained for the lower critical velocity at which the change takes place from laminar to turbulent flow,

$$v_H = \frac{.206\,\nu}{n^2\,D^{2/3}} .$$

Horton's criterion above given differs from Reynolds' criterion for pipes in that the former contains the coefficient of roughness, and the depth enters with the two-thirds power instead of with the first power.

The results of this investigation have been published in the Transactions of the American Geophysical Union, 1934, Part 2, pp. 393-404. Reprint copies of this paper will be furnished to other laboratories in exchange for reports of their work.

(299) POSITION AND MIGRATION OF GROUND-WATER DIVIDES IN PERMEABLE DEPOSITS.

The purpose of this investigation was to determine the position of the ground-water divide between two streams which have cut the water-table to different depths in a generally uniform permeable deposit, under conditions where there is a continuous accretion to the water-table by infiltration.

It is shown that the position of the divide is a definite function of the distance L between streams, the heights h_1 and h_2 of adjacent streams above an impervious base plane, and of the ratio $\frac{k}{\alpha}$ of the transmission capacity (k) of the material comprising the aquifer, and α the average net rate of accretion of water to the aquifer by infiltration of rainfall.

The distance l_1 from the lower stream to the ground-water divide is given by the equation

$$\frac{l_1}{L} = \frac{1}{2} + \frac{k}{\alpha} \cdot \frac{h_2^2 - h_1^2}{2L^2} .$$

It is shown that the ground-water divide is neither stationary nor does it necessarily coincide with the topographic divide between the streams. It is shown that the phreatic drainage basin of the lower-lying stream expands at the expense of the adjacent higher-level streams when ground-water depletion is long continued. The results of the analysis are applied to certain Illinois streams to explain observed differences of yield of adjacent streams with similar soil and nearly identical rainfall. The practical application of the method to tracing the position of ground-water divides is described.

The investigation is completed in form for publication.

UNIVERSITY OF ILLINOIS.

(300) MEASURING THE DISCHARGE BY MEANS OF DIFFERENCE OF HEAD BETWEEN OUTSIDE AND INSIDE OF A BEND.

"Use of an elbow in a pipe line as a means of measuring the flow of water", by W. M. Lansford. Bulletin of the Associated State Engineering Societies, April, 1934.

See also: "Flow of water around bends in pipes" Discussion by W. M. Lansford, Proc. Amer. Soc. Civ. Eng., Nov., 1934, pp.1392-1395.

(301) STUDY OF THE FLOW OF WATER IN A GLASS PIPE BY THE USE OF MOTION PICTURES.

"Study of the flow of water through a glass pipe," by Edgar E. Ambrosius, John C. Reed and Henry F. Irving. Preprinted Papers and Program, Aeronautic and Hydraulic Divisions, Amer. Soc. Mech. Eng., Berkeley, Calif., June, 1934, pp. 83-89.

(Project being continued.)

IOWA INSTITUTE OF HYDRAULIC RESEARCH.

(112) FLOW OF WATER AROUND BENDS IN OPEN AND CLOSED CHANNELS.

"Flow of water around bends in pipes," by D. L. Yarnell and F. A. Nagler, Proc.Amer. Soc. Civ. Eng., Vol. 60, No. 6, Aug., 1934, pp. 783-797.

LOUISIANA STATE UNIVERSITY AND AGRICULTURAL AND MECHANICAL COLLEGE.

(227) FLOW PAST SQUARE CORNERED CONTRACTIONS IN AN OPEN CHANNEL.

This project has for the present been completed and the results included in a dissertation which is on file in the library of the Louisiana State University, Baton Rouge, La.

Abstract:

Due to lack of experimental data, the loss of head which occurs as water flows past sudden contractions in open channels has been assumed to follow the same laws as govern in the case of pipes. The purpose of this thesis was to study these losses for varying conditions and to either prove or disprove the above assumption. A wide range of channel conditions was not possible due to laboratory limitations.

The velocity distribution at a number of sections both above and below the contractions was taken by means of a Pitot tube.

The following conclusions were made:

1. The head loss caused by a sudden contraction in an open channel was found to vary as $K V^{2.65}$
2. "K_c", in the equation $H_c = K_c V^2/2g$, increases when the velocity increases with A_2/A_1 remaining constant.
3. "K_c", decreases when A_2/A_1 increases with the velocity remaining constant.
4. The coefficients for open channels with sudden contractions do not agree with those for pipes with sudden contractions. The open channel coefficients are increasingly larger for an increase in A_2/A_1 for a constant velocity than those for pipes.
5. The contraction caused a very irregular velocity distribution. At a distance of ten widths below the contraction, the velocity distribution was about normal again.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY.

(29) EXPERIMENTAL STUDY OF SEA-WALL DESIGN.

"Investigation of wave action on sea-walls by the use of models," by Kenneth C. Reynolds, Trans. Amer. Geophysical Union, Reports and Papers, Hydrology, 1933, pp. 512-516.

(184) EXPERIMENTAL STUDY OF FLOW OVER DAM WITH PIERS.

"The determination, by model study, of the effect of piers on the discharge over a spillway dam," by R. Boucher. Thesis presented August, 1934.

(185) EXPERIMENTAL STUDY OF THE FLOW OF WATER THROUGH SLUICE GATES.

"The coefficient of discharge of sluice gates," by F. W. Blaisdell. Thesis presented July, 1934.

(187) EXPERIMENTAL INVESTIGATION OF FLOW OVER VARIOUS SHAPED DAM CRESTS AS USED IN EASTERN UNITED STATES.

"A study of different shaped spillways with reference to their effect upon the coefficients of discharge and upon the distribution of pressure on their downstream faces." Thesis available.

(188) EXPERIMENTAL INVESTIGATION OF ANCHORS.

"Determination of anchor holding power for model test." Thesis available.

UNIVERSITY OF MINNESOTA.

(94) TRANSPORTATION OF SEDIMENT.

"Hydraulic and sedimentary characteristics of rivers," by L. G. Straub, Trans. Amer. Geophysical Union, 1932, pp. 375-382.

"Effect of channel-contraction works upon regimen of movable-bed streams," by Lorenz G. Straub, Trans. Amer. Geophysical Union, 1934, Part II, pp. 454-463.

(Project being continued.)

OKLAHOMA AGRICULTURAL AND MECHANICAL COLLEGE.

(232) THE NEW THEORY OF A BROAD-CRESTED WEIR.

"The new theory of a broad-crested weir," by Nicholas M. Oboukhoff, Oklahoma Engineering Experiment Station, Oklahoma City, Oklahoma.
Part I in Publication No. 19, Sept. 1933.
Part II in Publication No. 20, Jan 1934.

RENSSELAER POLYTECHNIC INSTITUTE.

(331) AN INVESTIGATION OF THE PERFORMANCE OF LARGE CENTRIFUGAL PUMPS, USING AIR AS A MEDIUM.

"An investigation of the performance of large centrifugal pumps, using air as a medium," by Miguel A. Quinones. Rensselaer Polytechnic Institute Bulletin, Engineering and Science Series, No. 43, Sept., 1934, 48 pp.

U. S. GEOLOGICAL SURVEY.

(26) PERMEABILITY TESTS CONDUCTED UNDER VERY LOW HYDRAULIC GRADIENTS.

"Tests of permeability with low hydraulic gradients," by O. E. Meinzer and V. C. Fishell. Trans. Amer. Geophysical Union, 1934, Part II, pp. 405-409.

U. S. BUREAU OF RECLAMATION.

Reports on the following projects are available for loan at U. S. Bureau of Reclamation, Denver, Colorado.

(249) Spillway tests, Hyrum Dam.

(250) Spillway tests, Agency Valley Dam (About Mar. 1, 1935.)

(251) Spillway tests, Pineview Dam.

(338) Rye Patch Dam Spillway tests.

(339) Moon Lake Dam spillway tests.

U. S. WATERWAYS EXPERIMENT STATION.

See list of published reports in Bulletin II-2. Technical Memoranda and Research Memoranda have been prepared for all completed studies, and for all completed phases of any study now listed as "in progress". Loan copies of these papers may be obtained by writing to the Director, U. S. Waterways Experiment Station, Vicksburg, Miss.

To be printed in near future:
Paper 17 - Studies of river bed materials and their movement with special reference to the lower Mississippi River.

WEST VIRGINIA UNIVERSITY.

(49) SEDIMENTATION OF SMALL PARTICLES SUSPENDED IN WATER. Thesis available for loan.

PUBLICATIONS OF AERONAUTIC AND HYDRAULIC DIVISIONS, A. S. M. E.

Preprinted Papers and Program, Aeronautic and Hydraulic Divisions, Amer. Soc. Mech. Eng., 1934, Berkeley, Calif. 197 pp.
Obtainable from George Reproduction Company, 500 Sansome St., San Francisco, Calif. Price $1.50 per copy.

PUBLICATIONS OF AMERICAN GEOPHYSICAL UNION.

Transactions, 1932. Out of print.
Transactions, Papers and Reports, Hydrology, 1933. 184 pp.
Obtainable from K. H. Beij, National Bureau of Standards, Washington, D. C. Price $1.00 per copy.

Transactions, 1934, Part II (Hydrology). 374 pp.
Obtainable from The General Secretary, American Geophysical Union, 5241 Broad Branch Road, Washington, D. C. Price $1.50 per copy.

TRANSLATIONS.

The American Society of Mechanical Engineers, 29 West 39th Street, New York, has announced the forthcoming publication of a translation of Bulletin No. 3 of the Mitteilungen des Hydraulischen Instituts des Technischen Hochschule München. Publication is expected in March, 1935, the price not to exceed $3.00. The bulletin contains papers on errors in weir measurements, Thoma counter-flow brake, 90 degree pipe bends, miter-bends, oblique angle pipe branches, loss in circumferential lap jointed pipes, loss in smooth and rough surface bends, new machine for testing lubricating oil, energy transformation in expanding orifices similar to draft tubes, and influences of viscosity on efficiency of small turbine models.

The following translations have been received from Professor M. P. O'Brien of the University of California and are available at the National Hydraulic Laboratory, National Bureau of Standards, Washington, D. C., for loan.

Weinel, "Contribution to the rational hydrodynamics of series flow." From Ingenieur Archiv, April, 1934.
Nemenyi, "Movement of bedload." From Wasserbauliche Strömungslehre.
Bubendey, "Movement of bedload." From Wasserbau.
Stach, "The coefficients of standard nozzles and standard orifices at entrance and discharge." From Zeitschrift des VDI, Feb. 18, 1934.

FOREIGN PAMPHLETS RECEIVED BY THE NATIONAL BUREAU OF STANDARDS AND IN FILES OF NATIONAL HYDRAULIC LABORATORY.

EGYPT.

Civil Engineering Society Year Book, 1934, Royal School of Engineering Union, Egypt. (in English and Arabic)
In English: "Calibration of Regulators and Weirs", "Dynamical Similarity", "Application of Earth Pressure Theory to Sheet Piling."

ENGLAND.

A. H. Gibson and W. Cowen.
A Comparison of the results of observations on surge tank installations and on their scale models with an investigation of the dead-beat surge tank, and of surge tanks of non-uniform cross section. Min. Proc. Inst. Civ. Eng., Vol. 235, 1932-33, Part 1, pages 327-351.

P. Davies.
The laws of siphon flow. Min. Proc. Inst. Civ. Eng., Vol. 235. 1932-33, Part 1, pages 352-506.

A. H. Gibson, T. H. Aspey and F. Tattersall.
Experiments on siphon spillways. Min. Proc. Inst. Civ. Eng., Vol. 231, 1930-31, Part 1, pages 203-282.

J. Allen and D. L. Deshpande.
The design of piers for a bridge or sluice dam: an investigation with the aid of model experiments. Selected Papers of the Institution of Civil Engineers, No. 151, 1934. 26 pages.

J. Allen.
Streamline and turbulent flow in open channels. Phil. Mag., Ser. 7, Vol. XVII, June, 1934, pages 1081-1112.

A. H. Gibson.
The problem of tidal estuaries: forecasting by working models. 23 pages.

J. Allen.
Experiments on a model sluice gate of the tilting flap design. Abstract of Communication No. 4965, The Institution of Civil Engineers, 1933-34. 3 pages.

ITALY

Corrado Ruggiero.
Contributo al calcolo dei canali di fognatura. (Contribution to the computation of drainage channels) (In Italian) Reprint from Annali dei Lavori (gia Giornale del Genio Civile), 1934, Fasc. 3.

Corrado Ruggiero.

Il colpo d'ariete nelle condotte elevatorie. Problemi particulari e verifiche sperimentali. (Water hammer in high head conduits) (In Italian) Reprint from L'Energia Elettrica, Vol.XI, Fasc. V, May 1934 - XII.

Guido Ferro.

Considerazioni sulle formule per il calcolo della portata massima dei colatori di bonifica. (Consideration of the formulas for the maximum capacity of drainage ditches) (In Italian) Reprint from L'Energia Elettrica Vol. XI, April 1934 - XII.

Alessandro Veronese.

Ricerche sulla relazione che intercede tra l'altezza di adescamento dei sifone autolivellatori sperimentati in modello e quella dell'originale. (Investigation of the relations which connect the suction lift of automatic siphons in model tests with that of the prototype) (In Italian) Reprint from L'Energia Elettrica, Vol. XI, Fasc. VII, July 1934 - XII.

Franco Liceni.

Sul fenomeno della turbulenza. (On the phenomenon of turbulence) (In Italian) Reprint from L'Energia Elettrica, Vol. XI, Fasc. VII, July 1934 - XII.

Mario Marchetti.

Determinazioni sperimentali relative al moto uniforme nelle condotte forzate per forza motrice. (Experimental investigation of uniform flow in pressure conduits for power plants) (In Italian) Reprint from L'Energia Elettrica, Vol. XI, Fasc. V, VI, VIII, May, June, August, 1934,-XII.

Giulio de Marchi.

Saggio di teoria del funzionamente degli stramazzi laterali. (Statement of the theory of operation of side channel spillways) (in Italian) Reprint from L'Energia Elettrica, Vol. XI, Fasc. XI, Nov. 1934 - XII.

NORWAY.

Norges Vassdrags- og Elektisitetsvesen.

Vannstandsiakttagelser i Norge, 1932 (Stream gage records in Norway for 1932) (In Norwegian)

Same for 1933.

RUSSIA.

Transactions of the Scientific Research Institute of Hydrotechnics, Leningrad, Vol. XI, 1934 (In Russian, English abstracts except for titles 12 and 14 below.)

Contents:

Transactions of the Scientific Research Institute of Hydrotechnics, Leningrad, Vol. XII, 1934. (In Russian, English abstracts of first 8 titles below)

Contents:

Velocity formulas, roughness coefficients.

The following information is furnished by Mr. O. C. Merrill, Chairman of the American Committee of the World Power Conference;

> "At the 1926 meeting of the World Power Conference in Basle, it was proposed that studies be undertaken on methods of determining the value of roughness in water conduits. In consequence of this resolution a report on velocity formulae was presented to the 1930 meeting by Dr. Strickler of Switzerland and to the 1933 meeting by Captain Lindquist of Sweden. These two reports, while interesting and valuable in themselves, did not carry out the actual proposals adopted in 1926, and the matter was again brought up before the National Committees of the World Power Conference in connection with the distribution of the Lindquist report. This report, a translation of the discussions and resolution of the Basle meeting, and a paper by Parry of England, which had given rise to the resolution, were sent out by the American Committee of the World Power Conference to a considerable number of individuals in the United States engaged in hydraulic research with request for their comments and such suggestions as they might have with respect to undertaking the research in the United States."

"The matter under consideration was manifestly one for those engaged in technical research and not for the World Power Conference itself. The correspondence which followed evidenced a very considerable interest in the subject as well as a desire that a committee be formed in the United States to draw up a plan of research and to put it into effect. Such a committee has, accordingly, been constituted under the auspices of the American Committee of the World Power Conference and all further activity will be in the hands of that committee. Dr. Theodor von Karman, Director, Guggenheim Graduate School of Aeronautics, California Institute of Technology, Pasadena, California, has agreed to be Chairman of such a committee. Professor Boris A Bakhmeteff, Professor of Civil Engineering, Columbia University is vice-chairman, and Professor Morrough P. O'Brien of the University of California is Secretary. Other members of the Committee are:

Dr. Lyman J. Briggs, Director,
National Bureau of Standards,
Washington, D. C.

Capt. Hugh J. Casey, Director,
U. S. Waterways Experimental Station,
Vicksburgh, Miss.

Mr. E. W. Lane, Hydraulic Engineer,
U. S. Bureau of Reclamation,
Customhouse, Denver, Colorado.

Professor Lewis F. Moody,
Princeton University.

Mr. Fred C. Scobey,
Senior Irrigation Engineer,
U. S. Dept. of Agriculture,
Berkeley, Calif.

"Suggestions or inquiries respecting the work of the Committee should be addressed to Professor O'Brien."

Water Resources in the United States.

The U. S. Geological Survey is cooperating with the Mississippi Valley Committee and the National Resources Board in two projects bearing on water resources.

The first comprises a study of flood flows in the United States. The results will probably be presented as a water supply paper in the late spring of 1935. In connection with this work a special cooperating committee has been appointed by the American Society of Civil Engineers.

The second project deals with rainfall-runoff-groundwater relationships. A special committee of the American Geophysical Union has been

appointed to assist in this work.

An "Inventory of Water Resources in the United States" will form the larger part of Section II of the report of the Water Resources Section of the National Resources Board. This report will be released about January 10.

INDEX OF PROJECTS.