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

CURRENT HYDRAULIC LABORATORY RESEARCH IN THE UNITED STATES.

REPORT NO. II-1
January 1, 1934.

WASHINGTON.

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DIRECTORY

REPORT ON CURRENT HYDRAULIC LABORATORY RESEARCH IN THE UNITED STATES

Compiled by the Bureau of Standards
U. S. Department of Commerce
Washington, D. C.

Volume II, Number 1. January 1, 1934.

INTRODUCTION.

Commencing with this number, the Bureau of Standards will issue its bulletins on current hydraulic laboratory research semi-annually, on January 1 and July 1. The decision to do this was reached after returns were received from a questionnaire which was sent out with the October 1, 1933, report. These dates appear to be the most satisfactory, on the whole, for the college laboratories and do not appear to cause inconvenience to the other laboratories.

It is now planned to issue bi-annually the report describing the hydraulic laboratories in the United States. The next report of this nature will be issued in 1935. If any descriptions of important laboratories should be received in the meantime, this information will be distributed in the form of addenda to the semi-annual reports.

A limited distribution of the reports will be made in foreign countries from now on, and it is hoped that the foreign laboratories will cooperate by furnishing information as to their work and reprints of papers which they publish.

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.

(100) (a) MODEL INVESTIGATIONS OF SILTING PROBLEMS AT SEAL BEACH.
(b) The Los Angeles Gas & Electric Corporation and the Los Angeles County Flood Control District jointly.
(c) General scientific research to solve a particular problem.
(d) Dr. Robert T. Knapp and V. A. Vanoni with Major Charles T. Leeds as consultant.
(e) Professor R. L. Daugherty, or Professor Robert T. Knapp.
(f) To determine the probable effect of a change in the channel of the San Gabriel River, which now discharges into Alamitos Bay some distance from the point where the bay is connected with the ocean. This causes the bay to silt up. The Flood Control engineers propose to cut a new river channel so that it will discharge into the channel connecting the bay with the ocean. But the Seal Beach steam plant of the Los Angeles Gas & Electric Corporation is located along this channel and draws condensing water from it. It is feared that the change will cause this channel to silt up and thus interfere with the supply of condensing water.
(g) A model basin has been constructed. In it there has been reproduced to scale a portion of the bay, the ocean, the connecting channel and the present outlet of the river. The river will be caused to discharge its various rates of flow while the ocean will reproduce its tide cycles. The effects will be observed both for the present river course and with the proposed new channel.
(h) Model is completed and work is now under way.
(i) This work has been financed by the Los Angeles Gas & Electric Corporation and the Los Angeles County Flood Control District. H. L. Masser and J. G. Rollow of the former and E. C. Eaton, Chief Engineer of the latter together with Major C. T. Leeds have made the work possible.

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(101) (a) THE CHARACTERISTICS OF A CENTRIFUGAL PUMP WHEN OPERATED UNDER ABNORMAL CONDITIONS.
(b) Laboratory problem only.
(c) General scientific research and thesis for Haynes.
(d) Dr. R. T. Knapp and B. C. Haynes, and others as assistants.
(e) Professor R. L. Daugherty, or Professor Robert T. Knapp.
(f) To investigate characteristics when a centrifugal runs in both directions, with water being pumped and also with water flowing down backwards through the pump. This study is of interest for cases where the power suddenly fails for a centrifugal pump with a high lift and a long discharge line in which the flow will reverse.
(g) The method is the usual one of testing a pump, save for the new conditions, which are brought about in the laboratory by a second pump which can pump water into the discharge line of the first pump.
(h) Work has been under way for the past year and is to continue.

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(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 thesis 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) Work has been under way for more than a year. Much has been accomplished and it will be continued this year.

(104) (a) FURTHER MODIFICATION OF THE THEORY OF CENTRIFUGAL PUMP DESIGN.
(b) College problem.
(c) For thesis.
(d) George F. Wislicenus.
(e) Professor R. L. Daugherty, or Professor Robert T. Knapp.
(f) To place the method of design on a sounder basis.
(g) Theoretical studies based on actual test data.
(h) Work has been under way for some time and is continuing.

(105) (a) INVESTIGATION OF TRANSPORTING VELOCITIES OF SAND FOR USE IN MODELS.
(b) The laboratory.
(c) Thesis for Master's degree.
(d) W. F. Pruden and J. Sheffet.
(e) Professor R. L. Daugherty, or Professor Robert T. Knapp.
(f) As indicated by title.
(h) Work done during the past school year.

UNIVERSITY OF CALIFORNIA.

(12) (a) JET PUMPS.
(c) Laboratory project.
(d) Ledgett and Folsom.
(e) Professor M. P. O'Brien.
(f) Continuation of project on water jet pumps, by O'Brien and Gosline reported at Pacific Coast Applied Mechanics meeting of the A.S.M.E., January 20-21, 1933.
(g) Studies are being made on an air jet pumping air. The mixing process is receiving particular study in a special model.

(14) (a) STREAMLINE AND TURBULENT FLOW THROUGH GRANULAR MATERIALS.
(c) Laboratory project.
(d) Givan and Hickox.
(e) Professor M. P. O'Brien.
(f) Determination of laws of flow through soils, sands and gravels.
(h) Preliminary study of (1) flow through lead shot and (2) effect of size of container, has been completed by Givan.
(i) Report may be borrowed from laboratory director.

(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) Rindlaub.
(e) Professor M. P. O'Brien.
(f) Continuation of work begun by Cothran, Rindlaub, Wilson, Kurilow.
(h) Preliminary report on method of obtaining and representing data completed in May, 1933.
(i) Report may be borrowed from laboratory director. See "Abstracts and References." (Report I-3)

(172) (a) HYDRAULIC JUMP.
(c) Laboratory project.
(d) Hickox and Rose.
(e) Professor M. P. O'Brien.
(f) Experiments on circular and trapezoidal channels, rectangular channels with flaring sides or with sloping bottoms.

(173) (a) RATING A MODIFIED PARSHALL FLUME.
(c) Undergraduate thesis.
(d) Gilden and Taylor.
(e) Professor M. P. O'Brien.
(f) Determination of rating of modified Parshall flume for use where standard flume fills with sediment. In cooperation with U. S. Forest Service.
(h) To be completed in May, 1934.

(174) (a) AERATION OF SHARP-CRESTED WEIRS.
(c) Graduate thesis.
(d) Johnson.
(e) Professor M. P. O'Brien.
(f) Determine supply of air necessary to insure complete aeration of nappe. Effect of incomplete aeration on discharge.
(h) To be completed in May, 1934.

(175) (a) COMPARISON OF MODELS AND PROTOTYPES.
(c) Laboratory project.
(d) Jameson.
(e) Professor M. P. O'Brien.
(f) To determine the limits of correspondence of model and prototype.
(g) Tests are being made on models of dams, tunnels, and river bends. The model scale is being reduced until the model fails to correspond to the prototype.

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CORNELL UNIVERSITY.

(176) (a) A PHYSICAL VIEW OF THE NATURE OF MOLECULAR AGGREGATION IN LIQUIDS AND OF THE MECHANISM OF FLOW.
(c) Graduate thesis.
(d) Gwon-fan Djang.
(e) Professor E. W. Schoder.
(f) An attempt to find a basic explanation of the chief properties of liquids so as to explain viscous and turbulent flows.
(g) From certain assumptions as to molecular motions and fields an equation for the value of the coefficient of absolute viscosity is derived, and computed values are compared with experimentally found values. There is some discussion of "The Origin of Turbulence"; "The Entry Effect; and "The Region of Peculiar Disturbance" (found between one-and two-fifths of the radius in from the walls of a pipe).
(h) Thesis completed Feb., 1933.

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(177) (a) AN EXPERIMENT TO DETERMINE GESCHIEBE ACTION AT A RIVER FORK.
(c) Graduate thesis.
(d) Lieutenants C. D. Curran and K. D. Nichols.
(f) A check on and an extension of work done by the investigators at the Vicksburg U. S. Waterways Experiment Station in the summer of 1932. See (85), Report I-3.
(g) The flumes were 2 ft. wide with a fork at 30 degrees. The fork did not rejoin the straight stretch. Various percentages of the total flow were run through the fork. A tiny current meter was used to study velocities of the water.
(h) Thesis completed May, 1933.
(i) Conclusions include:- (a) For all divisions of the flow a greater percentage of geschiebe than the percentage of flow will be moved into the channel making an angle with the approach channel, and for more than 30 percent of the flow moving through the side channel over half of the geschiebe will be deviated. (b) The movement of such a great proportion of geschiebe down the side channel is caused by the fact that bottom currents move down this side channel.

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(178) (a) THE BACKWATER SUPPRESSOR.
(c) Graduate thesis.
(d) Ahmed M. Sijan.
(f) Check model studies of the Thurlow Backwater Suppressor.
(g) An Ogee dam 2 ft. high in a flume 2 ft. wide had two rectangular passageways built through its base to simulate draft tubes. Two midstream piers on top of the dam and three sliding gates permitted control of the overflow.
(h) Thesis completed June, 1931.
(i) The maximum efficiency of the device was 7.8 per cent. The maximum head gained was 0.89 ft. when the head without the suppressor was 1.84 ft. Certain changes made in the draft tube outlets at the toe of the dam gave better results than the original design.

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(179) (a) FLOW OF WATER OVER SHARP-CRESTED WEIR NOTCHES; RECTANGULAR, TRIANGULAR, AND TRAPEZOIDAL.
(c) Graduate thesis.
(d) Chitty Ho and Sze-ling Wu.
(f) To check results by Barr, Cone, and others.
(g) A total of 454 runs, all volumetric measurements. All notches set in a channel 6 ft. wide with water 7.6 ft. deep below crests. Maximum heads ranged from 2.1 to 3.4 ft. The triangular notches included three cut in galvanized sheet iron; 90 degree, 60 degree, and 1 to 4 side slopes; and five with edges of 6" x 1/8" brass plates; 90 degree, 60 degree, 1 to 3, 1 to 4, 1 to 6. There were eight brass rectangular notches ranging from 0.5 to 4 ft. wide; also nine brass trapezoidal notches with crest widths of 0.5, 1.5, and 2.5 ft., and side slopes 1 to 3, 1 to 4, and 1 to 6. Current meter measurements were made in the channel of approach.
(h) Thesis completed Nov., 1931.

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(180) (a) DISCHARGE MEASUREMENTS BY TRAJECTORY AND EXIT DEPTH, RESPECTIVELY, FOR JETS FROM FILLED AND PARTLY-FILLED HORIZONTAL PIPES.
(c) Graduate thesis.
(d) Richard S. Jones and Yun-Chen Tu.
(f) To check previous experimental results and assumptions frequently made.
(g) Volumetric measurements. Steel pipes 2, 3, 4, and 6 inches in diameter; and brass pipes 2, 3, and 5 inches were used.
(h) Thesis completed Aug., 1932.

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HARVARD UNIVERSITY.

(106) (a) A STUDY OF THE FLOW OF WATER THROUGH SAND.
(b) Conducted as departmental research.
(c) Conducted as general scientific research.
(d) Gordon M. Fair and Lorarus P. Hatch, Associate Professor of Sanitary Engineering and Research Fellow in Sanitary Engineering, respectively.
(e) Professor Gordon M. Fair.
(f) To determine the filtration and expansion characteristics of sands used in purification and, if possible, to aid in the study of the flow of water through the soil.
(g) Laboratory investigations consisting of a study of the characteristics of sands and of their behavior when subjected to flowing water.
(h) Study has been under way for three years and is almost completed and ready for publication.

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HYDROLOGICAL LABORATORY, U. S. GEOLOGICAL SURVEY, WATER RESOURCES BRANCH, DEPARTMENT OF THE INTERIOR.

(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 materials 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 ground water through a given material varies directly as the hydraulic gradient.
(g) The permeability tests have been made with a simple apparatus which permits an inflow of water at the bottom of a column of material of known height and outflow at the top. The difference in head of water at the top and bottom is regulated by an adjustable supply tank and is indicated by two pressure gages. Observations are made on the rate of discharge and the temperature of the water. Satisfactory results have been obtained for gradients as low as 5 feet per mile by using a column of sand one meter in length. A new U-shaped apparatus has been designed having a column of sand two meters in length. A hydraulic gradient is set up by having the water level in one column slightly higher than in the other. Observations are made on the rate of change of the water levels and the temperature.
(h) The results of the tests with the former apparatus are given in U. S. Geological Survey Water-Supply Paper 596 by N. D. Stearns. The new apparatus has just recently been started and no satisfactory results can yet be given out.

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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) Under the supervision of 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, to attempt to determine the practicability of Thiem's method for determining permeability of water-bearing materials as a part of a cooperative investigation of the ground-water resources of the Platte Valley, Nebraska.

About 80 small observation wells were driven into the saturated sands and gravels of the valley on lines radiating from the pumped wells. The depths to water in these wells were measured at frequent intervals before pumping started, during pumping, and after pumping stopped. The distances of the observation wells from the pumped wells were carefully measured and the altitudes of the measuring points were obtained by instrumental levels. The discharge of the pumped well and the drawdown in it were measured every 30 minutes. The well was pumped continuously at nearly a constant rate for 48 hours and measurements of the depths to water in the observation wells were continued for an additional 24 hours after pumping stopped.

Darcy's law essentially states that the quantity of water discharged through any water-bearing material is equivalent to the product of the cross-sectional area through which movement takes place multiplied by the hydraulic gradient and a constant. This constant is called the coefficient of permeability. The cross-sectional area and hydraulic gradient usually can be obtained in the field but the coefficient of permeability is more difficult to ascertain. Thiem, a German hydrologist, developed a formula for obtaining this coefficient from measuring the drawdowns in two observation wells located at different distances from a pumped well. His formula, however, strictly applies only to a region where there is no hydraulic gradient before pumping begins and it was to determine the effect of an initial hydraulic gradient that this investigation was made.

It has been possible to plot the drawdown and recovery curves of each observation well from the measurements made of the depths of water in the wells. The initial hydraulic gradient has been determined from a contour map of the water table before pumping started. The cone of depression has been determined for several time intervals and sections have been drawn across the cone. Many coefficients of permeability have been computed because the drawdowns in only two observation wells are needed in Thiem's equation. The coefficients thus computed have varied through a wide range depending upon where the two observation wells used in Thiem's formula were located in reference to the pumped well. This variation in the coefficient is probably due to an initial hydraulic gradient, too short a pumping period, and local variations in the permability of the formation. Before conclusive results can be obtained, additional tests and a further study of the data already collected will have to be made.

UNIVERSITY OF ILLINOIS.

(181) (a) MEASURING DISCHARGE BY MEANS OF DIFFERENCE OF HEAD BETWEEN OUTSIDE AND INSIDE OF A BEND.
(c) Laboratory problem.
(d) W. M. Lansford, L. S. Butler, W. C. Root.
(e) Professor M. L. Enger.
(h) Tests have been made on 1-in. and 4-in. short and long turn elbows, and on 2-in. and 12-in. short turn elbows.
(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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(182) (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, Henry F. Irving.
(e) Professor M. L. Enger.
(g) Fine drops of an insoluble liquid of the same density as water, in suspension in water flowing in a 2-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 has been prepared for publication.

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(183) (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) Professor M. L. Enger.
(g) Pressures, discharges, and movements of disks were measured.
(h) A paper has been prepared for publication.

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LOUISIANA STATE UNIVERSITY AND AGRICULTURAL AND MECHANICAL COLLEGE.

(28) (a) HYDROLOGICAL STUDY OF CITY PARK LAKE DRAINAGE AREA.
(b) Cooperative between the U. S. Geological Survey and the College of Engineering, Louisiana State University.
(c) Graduate work for advanced degree as well as general scientific research.
(d) T. Smart and A. Lambert.
(e) Dr. Glen E. Cox, Assoc. Prof. of Mech. & Hydr.
(f) Study of rainfall, runoff, and evaporation.
(g) The rainfall will be measured at a number of different points in standard rainfall cans and in one Weighing Recording Gage. The discharge will be measured over a concrete spillway by means of a Stevens automatic water level recorder. The evaporation will be measured in both a land and a water pan. Wind velocities, humidity and temperature to be taken at a nearby University Weather Station. An attempt will be made to determine the effect of these different variables upon the evaporation and run-off from the area.
(h) The gage house is under construction at the present time.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY.

(29) (a) EXPERIMENTAL STUDY OF SEA-WALL DESIGN.
(b) River Hydraulic Laboratory, M.I.T.
(c) Graduate research for Doctor's degree.
(d) Professor K. C. Reynolds.
(e) Professor K. C. Reynolds.
(f) Improvement of sea wall design.
(g) A plunger at one end of a concrete basin 6 ft. x 20 ft. creates waves which run the length of the basin, break on a sandy beach and strike a vertical sea wall.
(h) Preliminary observations of the sand and water carried over the wall indicate that a possible criterion of the relative effectiveness of various types of sea walls may be judged by measuring the amount of sand carried over the wall in a minute. The effect of the height of wall, and of the height and slope of beach on this amount is not under investigation to determine the conditions for maximum sand movement. Paper entitled "Investigation of Wave Action on Sea Walls by the Use of Models" published in Transactions of the American Geophysical Union, National Research Council, Washington, D. C., June, 1953, pp. 512-516.

(30) (a) EXPERIMENTAL INVESTIGATION OF THE TRANSPORTATION OF SAND BY RUNNING WATER.
(b) River Hydraulic Laboratory, M.I.T.
(c) General scientific research.
(d) C.H.MacDougall of laboratory staff.
(e) C. H. MacDougall.

(f) To investigate the factors which influence the movement of sand and the attendant phenomena.
(g) Very flexible and complete apparatus will permit accurate measurements of the quantity of sand moved at various conditions of slope and depth in a channel 32 feet long, 2 feet wide and having a maximum discharge of 3 sec. feet. Arbitrarily graded sands will be used.
(h) Paper entitled "An Experimental Investigation of Bed Sediment Transportation" by C. H. MacDougall recently prepared but not yet in published form. It is expected that this paper will be published in the spring of 1934.

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(36) (a) EXPERIMENTAL INVESTIGATION OF THE CAVITATION PHENOMENA.
(b) Massachusetts Institute of Technology.
(c) General scientific research.
(d) E. W. Spannhake, J. K. Vennard, H. N. Halberg.
(e) Above staff.
(f) To study the cavitation phenomena in all its details, to determine as far as possible in a quantitative way the factors influencing the phenomena, and to correlate its effect upon metals and various materials with their physical and chemical properties (mainly microstructive, resistance to fatigue, and resistance to corrosion).
(g) Visual observation, observation with high speed movie camera (1000 pictures per second), record of vibrations with sound and vibration recorder, measurements of pressure distributions and maximum pressures, systematic tests on various materials of varying physical and corrosive properties. A small test unit is being designed to give better control of conditions for endurance tests.
(h) Preliminary tests on blade profile have been run to determine the factors affecting cavitation in the gap between the end of the blade and the wall. Tests hae been carried out to obtain a relation between the air content of the water and the point at which the hydraulic similitude relations break down at the inception of cavitation.

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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 thesis.
(d) R. Boucher.
(e) Professor K. C. Reynolds.
(f) To study coefficient of discharge for a dam with and without piers of various designs.
(g) The discharge over a dam will be observed without piers and then the effect of various shapes of piers on the flow and on the discharge coefficient will be observed.
(h) Dam completed and abutments ready.

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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 thesis.
(d) F.W.Blaisdell.
(e) Professor K. C. Reynolds.

(f) To study the flow of water through sluice gates by means of models, observing the flow conditions and determining the discharge coefficients.
(g) A model of a spillway section with several sluice gates will be constructed and the flow through them studied for various conditions of operation.
(h) Model being constructed.

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(186) (a) EXPERIMENTAL INVESTIGATION OF THE FLOW CONDITIONS PAST BAFFLE PLATES.
(c) Graduate research for Master's thesis.
(d) A. T. Dempster
(e) Professor T. R. Camp.
(f) To observe flow conditions after water has passed through various types of baffle plates.
(g) Various types of baffle plates will be set into the 50-cm. wide glass channel. Flow conditions will be observed by means of dyes. The work will be related to water treatment processes in which baffle plates are used.
(h) Experimental work will be begun soon.

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(187) (a) EXPERIMENTAL INVESTIGATION OF FLOW OVER VARIOUS SHAPED DAM CRESTS AS USED IN EASTERN UNITED STATES.
(b) River Hydraulic Laboratory, M.I.T.
(c) Undergraduate thesis.
(d) D. D. Knox.
(e) Professor K. C. Reynolds.
(f) To study effect of changing shape of dam crests on discharge coefficient and on distribution of pressure on downstream face.
(g) Flow over various typical spillway sections will be studied in a glass channel 1 foot wide.
(h) Models will be ready soon.

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(188) (a) EXPERIMENTAL INVESTIGATION OF ANCHORS.
(b) Graduate research for Master's thesis.
(d) Lt. W. H. Leahy, U.S.N. and Lt. J. M. Farrin, U.S.N.
(e) Professor H. E. Rossell, Commander, U.S.N.
(f) To study various types of anchors to determine effect of weight, fluke area, shank angle, etc., on holding ability.
(g) A series of commercial anchors of various weights will be investigated in a glass front channel 2 feet wide and 20 feet long. Also other types of anchors will be studied - some by means of models.
(h) One series of anchors already studied.

UNIVERSITY OF MINNESOTA.

(94) (a) TRANSPORTATION OF SEDIMENT.
(e) Professor Lorenz G. Straub.
(f) Investigations of the transportation of bed sediment in alluvial rivers and the effect of contraction works on the river channel.
(g) In progress.

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(95) (a) BROAD-CRESTED WEIRS.
(e) Professor Lorenz G. Straub.
(f) Characteristics of broad-crested weirs, experimentally establishing the pressure-momentum relations.
(h) In progress.

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(96) (a) EXPERIMENTAL DESIGN OF DROP-CULVERT SPILLWAYS.
(e) Professor Lorenz G. Straub.
(h) In progress.

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(97) (a) MODEL TESTS OF SAND DAMS.
(e) Professor Lorenz G. Straub.
(h) In progress.

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(98) (a) PERMEABILITY OF GRANULAR MATERIALS.
(e) Professor Lorenz G. Straub.
(f) Investigation of the permeability of granular materials when subjected to high liquid pressures.
(h) In progress.

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(99) (a) LAWS OF HYDRAULIC SIMILITUDE.
(e) Professor Lorenz G. Straub.
(f) Investigation of the limitations of the laws of hydraulic similitude.
(h) In progress.

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(189)(a) VISCOUS FLOW THROUGH PIPE LINES.
(e) Lorenz G. Straub.
(f) To check experimental data previously presented on limits of laminar and turbulent flow.
(g) Flow through glass tubes is observed, the condition of flow noted by means of dye lines, head loss recorded.
(h) In progress.

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(190) (a) FLOW CONDITIONS IN OPEN CHANNELS.
(e) Lorenz G. Straub.
(f) To determine the conditions of laminar and turbulent flow in open channels.
(g) Flow conditions are observed in a small tiltable flume.
(h) In progress.

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MICHIGAN STATE COLLEGE OF AGRICULTURE AND APPLIED SCIENCE.

(128) (a) INVESTIGATION OF THE HEAT CONDUCTIVITY OF THE BOUNDARY FILM SURROUNDING HOT BODIES.
(b) Physics Department, Michigan State College.
(c) Graduate Thesis work for M.S. degree.
(d) William G. Keck.
(e) William G. Keck.
(f) To determine heat transfer from solids to gases, especially surface resistance. Air flow incidental to problem but proved to be a major problem.
(g) Air flow measured by hot wire anemometer with extreme accuracy.
(h) Complete, as far as air flow is concerned.

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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, pg. 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 records 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.

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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 inlets.
(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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OHIO STATE UNIVERSITY, ROBINSON LABORATORY.

(134) (a) A DETERMINATION OF THE COEFFICIENTS OF COMMERCIAL METERING ELEMENTS FOR STEAM AND WATER.
(b) Ohio State Engineering Experiment Station and the Bailey Meter Company.
(c) General scientific research.
(d) S. R. Beitler and T. C. Barnes.
(e) S. R. Beitler.
(f) To determine the effect of temperature, viscosity, and expansibility of commercial metering elements (orifices, nozzles, and Venturi tubes.)

(g) Orifices, nozzles, and Venturi tubes for 3" and 6" lines were calibrated, using water and steam at various pressures and temperatures.
(h) The experimental work is completed but the results have not been completely analyzed. A partial report has been made in a paper t· the A.S.M.E., "The Flow of Fluids Through Orifices in Six-inch Pipes" (Hyd. 52-7A-1929) and "A Study of Primary Metering Elements in Three-Inch Pipe." (R.P. 54-3, 1931.)

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(135) (a) A STUDY OF THE FLOW OF WATER THROUGH ORIFICES IN VARIOUS SIZED PIPES.
(b) Ohio State Engineering Experiment Station, The American Gas Association, and the American Society of Mechanical Engineers.
(c) General scientific research.
(d) S. R. Beitler.
(e) S. R. Beitler.
(f) To determine the variation of orifice coefficients with pipe size and orifice size and to get comparative values for the various location of pressure taps at present used.
(g) Orifices have been calibrated in 1", 1-1/2", 2", 3", 6", 10", and 15" pipe lines using water as the calibrating fluid. Coefficients have been determined for the so-called corner taps, flange taps, Vena Contracta taps, , pipe taps and throat taps for a wide range of orifice diameters, in all the pipe sizes.
(h) The projected experimental work is practically completed and partial reports were made to a joint sub-committee of the A.G.A., A.S.M.E., who are attempting to standardize orifice coefficients.

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(136) (a) AN INVESTIGATION OF THE EFFECT OF FLANGE FORM ON ORIFICE COEFFICIENTS.
(b) Ohio State Engineering Experiment Station, The American Gas Association, and the American Society of Mechanical Engineers.
(c) General scientific research.
(d) S. R. Beitler, S. E. Overbeck.
(e) S. R. Beitler.
(f) To determine the effect of the various commercial orifice flanges now in use with the gas industry upon the coefficient of discharge of the orifice.
(g) Gas is measured passing through two orifices in series, one orifice being in a standard setting and the other clamped between various commercial cored flanges. The effect of the flange on the meter reading has been determined for both flange and pipe taps.
(h) Projected experimental work is practically completed.

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(191) (a) A STUDY OF METHODS OF FAN TESTING.
(c) Graduate thesis for the Master of Science Degree.
(d) A. G. Allen.
(e) Professor A. I. Brown.
(f) The purpose of this investigation was to determine the comparative accuracy of measurements of air flow made by means of the pitot tube, the thin-plate orifice, and the flow nozzle.
(g) The air flow in the discharge pipe of a centrifugal fan was measured by pitot-tube traverses and compared with determinations made by the orifice or flow nozzle located on an enlarged section of the pipe at the outlet of the air stream. Tests were conducted both with the fan operating under normal conditions and with parts of the fan wheel blocked so as to produce pulsating flow.
(h) Tests have not yet been completed.
(i) The results to date indicate that disagreement in measurement of air flow by the various devices used in fan testing are due to turbulence rather than to the effect of pulsations.

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PACIFIC HYDROLOGIC LABORATORY.

(45) (a) RELATION OF PERMEABILITY OF GRANULAR MATERIALS TO PARTICLE SIZE.
(b) Water Conservation Committee, Irrigation Division, American Society of Civil Engineers.
(c) General scientific research.
(d) Charles H. Lee.
(e) Charles H. Lee, Consulting Engineer, 58 Sutter Street, San Francisco, California.
(f) To provide a more accurate basis for preliminary classification of soil and earth materials as to permeability.
(g) Permeability coefficient of natural undisturbed material determined by means of permeameter. Also complete mechanical analysis of material made by means of hydrometer (Bouyoucos) method for which improvements have been developed. Mechanical analysis curves plotted by groups within fixed limits of permeability, data being obtained for as wide a variety of earthy materials as possible.
(h) With data published in W.S.P. 596-F, U.S.G.S., pp. 164-169 as a nucleus, other materials are being tested and results tabulated as rapidly as opportunity affords.

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(46) (a) RELATION OF HEAD TO FLOW OF WATER THROUGH PARTIALLY SATURATED GRANULAR MATERIALS.
(c) General scientific research.
(d) Charles H. Lee.
(e) Charles H. Lee, Consulting Engineer, 58 Sutter Street, San Francisco, California.

(f) To ascertain more definitely the relation of flood flow in streams to seepage from their beds.
(g) Loss of head determined under various conditions of partial saturation as well as complete saturation with downward flow through undisturbed columns of various types of natural soils and earthy materials. It is proposed to extend the scope of observations to include capillary back pressure.
(h) Preliminary results obtained on beach sand indicate capillary back pressure is of prime importance in controlling the net head available for percolation through submerged and partially saturated soil columns.

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THE PENNSYLVANIA STATE COLLEGE.

(137) (a) A STUDY OF VARIOUS TYPES AND KINDS OF STILLING DEVICES FOR USE IN CHANNELS OF 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) It is hoped that a bulletin of the Pennsylvania State College may be issued sometime during the next calendar year giving the results of the work.

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PRINCETON UNIVERSITY.

(138) (a) LOSS DUE TO SUDDEN ENLARGEMENTS IN OPEN CHANNELS.
(b) Scientific research.
(c) Graduate work for thesis and advanced degree.
(d) Lieut. J. A. Ostrand, Jr., U.S.A.
(e) Professor L. F. Moody.
(f), (g) To compare actual results with theoretical calculation following a rational method based on the impulse-reaction principle or "momentum" principle. Applied to flow in a glass

flume of 12" x 12" section, with two ratios of sudden enlargement in addition to uniform section. Results show good agreement with theory.

(h) Work completed.

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(139) (a) INVESTIGATION OF A "FREE" AND "DROWNED" HYDRAULIC JUMP. Or COMPARISON OF FREE JUMP WITH SUBMERGED DISCHARGE.

(b) Scientific research.

(c) Graduate work for thesis and advanced degree.

(d) Lieut. T. E. Raestow, U.S.A.

(e) Professor L. F. Moody.

(f) (g) To compare actual results with theoretical calculation following a rational method based on the "momentum principle". Particularly directed to the "drowned" or partially submerged jump, or the transition stage between the complete or free jump and completely submerged discharge from an orifice. Applied to experiments in a 12" x 12" glass-sided flume about 8 ft. long. Results show good agreement with theory.

(h) Work completed.

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(140) (a) INVESTIGATION OF RAINFALL AND RUNOFF IN CERTAIN WATERSHEDS.

(b) Scientific research.

(c) Graduate work for thesis and advanced degree.

(d) Lieut. C. Van B. Sowin, U.S.A.

(e) Professor L. F. Moody.

(f) An analytical and statistical investigation of typical eastern watersheds. A comparison of different methods of graphical analysis of runoff-duration curves, using "probability scales", or scales based on the probability integral. Also analysis of functional effect of certain variables on mean annual runoff.

(g) Analysis based on published records, (not experimental). Results have verified a theoretical conclusion that plotting duration curves on "probability paper" is a valuable method and that arithmetic scale of ordinates results in close approximation to a straight line for large discharges, and logarithmic ordinate scale has same result for small discharges; so that use of both scales gives a means of extrapolation and prediction at both ends of curve.

(h) Work nearing completion.

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(141) (a) EFFECT OF TURBULENCE ON CURRENT METER MEASUREMENTS. AN INVESTIGATION.

(b) Scientific research.

(c) Graduate work for thesis and advanced degree.

(d) Lewis F. Moody, Jr.

(e) Professor L. F. Moody.

(f) To investigate experimentally the error due to turbulence in applying still-water ratings to moving water measurements. Comparison of actual results with calculations by the two-meter "angular" method, based on oblique still-water ratings, to determine whether this method is reliable with a particular kind and degree of turbulence.
(g) Lateral turbulence produced in rating flume by introducing lateral jets of water in plane of meters. Four Ott meters tested: two of "spoke" or "paddle" type (right and left hand meters), and two of "screw" type (right and left hand).
(h) Work completed.

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(142) (a) EFFECT OF LONGITUDINAL VELOCITY OSCILLATIONS ON CURRENT METER PERFORMANCE.
(b) Scientific research.
(c) Graduate work for thesis and advanced degree.
(d) Robert S. Hackett.
(e) Professor L. F. Moody.
(f) To determine whether, or to what degree, variations or pulsations in the magnitude of velocity affect the recording of a current meter. Involves the effect of that factor in ordinary flowing water which results in variation of magnitude of velocity, as a result of turbulence or eddies, as separated from variations in direction or angularity.
(g) Four meters investigated, Ott meters, two (right and left-hand) of "spoke" or "paddle" type, and two (right and left-hand) of "screw" type. Meters suspended on rod mounted on horizontal axis on rating car, so that meters are oscillated in direction of motion during a still-water rating in the rating flume. Oscillation produced mechanically.
(h) Work nearing completion.
(i) Meters are all of type having helical generating lines in the blade surfaces. Results show that longitudinal velocity variations of uniform character have no measureable effect on the meter performance, within limits of accuracy of measurement.

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(143) (a) INVESTIGATION OF TRIANGULAR WEIRS OF VARIOUS VERTEX ANGLES.
(b) Scientific research.
(c) Graduate work for thesis and advanced degree.
(d) John Campbell, Jr.
(e) Professor L. F. Moody.
(f) Continuation of program of previous years, extending measurements from 90 degree to 30 degree vertex angle, and covering a coordination and partial formulation of results.
(g) Weirs calibrated by volumetric measurement of discharge. Deflecting chute used with a calibrated tank receiving the discharge. Coefficients determined and plotted, and variation of coefficients with head and angle investigated as to functional characteristics.
(h) Work nearing completion as to one stage in program.
(i) Some attention given to dimensional analysis of problem considering effects of viscous and capillary forces (surface tension.)

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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 and J. A. Oakey.
(e) Professor F. W. Greve.
(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 orifice, 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 stop-watch. The tests were made at room temperature. An Engler viscometer, a Cenco-de Novay tensiometer, and a Jolly balance were employed to measure the respective viscosities, surface tensions and densities.
(h) The investigation to date has been in the nature of a preliminary survey, the results being indicative rather than qualitative. Larger and more extensive equipment is being installed to permit greater ranges in head, discharge and temperature. Actual tests will probably not be resumed for several months.

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STEVENS INSTITUTE OF TECHNOLOGY.

(146) (a) CORRELATION BETWEEN SMALL MODEL RESISTANCE AND RESISTANCE OF FULL SIZE RACING SAILING YACHT.
(c) General scientific research.
(d) Professor Kenneth Davidson.
(e) Professor Kenneth Davidson.
(f) A check on the variations of skin friction, wave-making and eddy making with change in size between full size and a model ordinarily running in the transition region.
(g) Towing of full size yacht and small scale model.
(h) Preliminary testing of both sizes completed and correlation under way.

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TEXAS ENGINEERING EXPERIMENT STATION.

(147) (a) THE LOSS OF HEAD IN CAST IRON TEES.
(b) Texas Engineering Experiment Station in cooperation with the Research Laboratory of the American Society of Heating and Ventilating Engineers.
(c) General scientific research.
(d) F. E. Giesecke, W. H. Badgett, and J.R.D.Eddy.
(e) The Director, Texas Engineering Experiment Station, A. and M. College of Texas, College Station, Texas.
(f) To determine a means of calculating the loss of head for the flow of water through cast iron tees.
(g) The investigation included all possible combinations of flow in 3/4 in., 1-in., and 1-1/2 in. standard cast iron tees, and for one combination of flow in 1-1/2 x 1-1/4 x 1-in. standard cast iron tees with water for all the tests at 70 degrees F. and under a constant head. The percentage of water flowing through the outlets of the tee under investigation was controlled by gate valves and the discharge was measured by the volumetric method. Pressure drops were measured by piezometer rings and water column manometers.
(h) The work as described above has been completed and published as Bulletin 41 of the Texas Engineering Experiment Station.
(i) It is planned to continue the investigation of the loss of head in tees in the near future to include other sizes of tees, particularly the larger sizes, and tees with different sizes of outlets, as 2 x 1-1/2 x 1-in. tees. The effect of temperature will also be studied.

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U.S.DEPARTMENT OF AGRICULTURE, 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 as a major project of 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, 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)
Corresponding with interested engineers all over the world; receive contributions in the way of capacity tests as made by their organizations.
All elements of hydraulic design of open channels are matters of office and field dimensions except the element evaluating the retardation of flow due to the hydraulic friction between the moving prism of water and the surface of the containing channel plus the internal friction set up by undulations of surface, constructional irregularities and so on, over and above the asperity of local surface. This element is wholly

empirical. It has a direct influence on the carrying capacity and hence on the size and the cost of any water conduit. For the many combinations of original and acquired surfaces and conditions a great many field experiments with precision apparatus are necessary. "Flow of water in Irrigation Channels" was published in 1915. Since then many new tests on other materials of construction and newer variations of old materials of construction have been made and may be assembled and coordinated into related data.

(g) Laboratory tests are believed worthless in comparison with well-conducted field measurements for the reason that similitude of surfaces cannot be expanded from model to prototype. Commercial surfaces in concrete, enamels and some paints are of such order that no known surface has been developed which will be a MODEL of the original, in terms of asperity of surface.

Complete field tests, developing all the necessary details of local elements to be expanded to average values over a long reach of conduit, are made in channels of all variations of surface that can be located under conditions where experimentation is feasible. These tests are made throughout a wide range of locality, in the whole irrigated West. They are made in all sizes of channel from small lateral ditches to the largest of canals. Farmers are not interested in small ditches alone. Irrigation districts, managed by farmer boards of direction, operate some of the largest canals in the country.

The United States Bureau of Reclamation has agreed to allow access to their files of experimentation made along the lines laid down in our Bulletin 194 and ordered shortly after that publication appeared.

(h) Where feasible all the tests to be listed in the revised publication should be studied in terms of Kutter's n and also of "Reynold's number" which had no standing whatever twenty years ago as a basis of consideration of relative capacities; - also in terms of Manning's formula - newly accepted.

Much of the older publication will require rewriting to include new ideas and still hold the size of the publication to reasonable limits. A few tests should be made on surfaces not adequately covered in the data now available. This field work will require some addition to personnel and some expenses that are not considered warranted under the present conditions. The material will not be ready for publication for another year at least.

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U. S. BUREAU OF RECLAMATION.

(193) (a) HYDRAULIC MODEL EXPERIMENTS FOR THE DESIGN OF THE NORRIS AND No. 3 DAMS.
(b) Tennessee Valley Authority.
(c) For data for design.
(d) U. S. Bureau of Reclamation staff.
(e) U. S. Bureau of Reclamation.
(h) Tests under way.

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(194) (a) HYDRAULIC MODEL EXPERIMENTS FOR THE DESIGN OF THE SPILLWAY FOR THE COLUMBIA RIVER DAM.
(c) For data for design.
(d) U. S. Bureau of Reclamation Staff.
(e) U. S. Bureau of Reclamation.
(h) Tests under way.

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U. S. BUREAU OF STANDARDS.

(42) (a) INVESTIGATION OF THE PHYSICS OF PLUMBING.
(b) The Subcommittee on Plumbing of the U. S. Department of Commerce Building and Code Committee.
(c) General research.
(d) R. B. Hunter.
(e) The Director, U. S. Bureau of Standards.
(f) To obtain data on which to base logical estimates of the capacities of various sizes of drain pipes, vertical and sloping, in plumbing systems.
(g) It is proposed: - (1) To determine the capacities of various sizes of cast iron drains at slopes from 1/8 inch to 1 inch fall per foot with steady flow and full pipes: (2) To study the flow in the same drains or in drains constructed of the same class of pipe with the flow built up to a capacity load by discharges from plumbing fixtures and tanks simulating plumbing fixtures, to obtain an approximate relation between the average capacity load under surging conditions and the capacity load of the same drain with a full pipe under steady conditions: (3) to study the effect of temporary peaks formed by overlapping of discharges from two or more fixtures and the relation of these peaks to the average flow: and (4) to establish if possible an approximate relation between the number of fixtures and the average and peak loads to be expected in actual service.
(h) An installation of 6" pipe, which for a part of the work will be of glass, has been made for continuing the study, and several runs have been made. Work has been suspended temporarily on this project.

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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, U. S. 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) The first work will be on a 4 inch line of steel tubing with special joints to provide accurate alignment. The first bends will be commercial, seamless, 90 degree bends of various radii. Especially long upstream and downstream tangents will be used. Later the work will be extended to smooth (copper and brass) pipe with special bends of accurate dimensions; to sizes up to about 20 inch diameter; to bends of various central angles and radii; to miter bends and cast fittings; and to pipe of various materials and various degrees of roughness. Transparent pipes and bends will be used to investigate the nature of flow.

(h) Tests are under way on 3/8 inch smooth brass tubing and on 4 inch steel pipe with special joints.

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(44) (a) STUDY OF "DEEP WELL" CURRENT METERS.

(b) U. S. Geological Survey.

(c) General research.

(d) R. B. Hunter, W. F. Stutz.

(e) The Director, U. S. Bureau of Standards.

(f) To study the characteristics of current meters developed by the U. S. Geological Survey for explorations in artesian wells; to calibrate these meters in various sizes of well casings from 4" to 15" diameters; and to examine their reliability for detecting the location and extent of leaks in the casing.

(g) An 8-inch supply line fed by a constant level tank with a capacity of 5 c.f.s. and a total head of 47 feet has been provided for the work. The well casings in which the study is to be made will extend vertically from the lower end of the supply line. Two venturi meters, one 4" and one 8" have been installed in parallel in the supply line for measuring the flow and a measuring basin is to be provided for additional measurements. It is proposed to calibrate the meters directly against the mean velocity in the vertical sections of well casing.

(h) The calibration of one 1.5 inch meter in 2,3 and 4-inch casings with several different combinations of meter fittings and of two 3-inch meters in 3,4,6,8, and 12-inch casings has been completed. In addition, lateral traverse readings with the 3-inch meters have been made over a range of velocities in the 6,8 and 12-inch casings, and vertical traverse ratings with and without artificial leaks in the casings have been made in the 4,6 and 8 inch casings. As it has been found that the calibration of the 3-inch meters for other sizes of casings can be interpolated and extrapolated from the data for the 3,4,6,8 and 12-inch casings with approximately the same accuracy as direct calibrations in the casings, it is believed that data necessary for a complete calibration of the 3-inch meters for all sizes of steel casings has been obtained. The report for the U. S. Geological Survey is now being prepared.

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(129) (a) TRANSPORTATION OF SEDIMENT, COLORADO RIVER.
(b) U. S. Bureau of Reclamation.
(c) General research.
(d) C.A.W right, B.H.Monish and C.W.Elliot.
(e) The Director, U. S. 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) A tilting flume 40 ft. long, 20 inches wide and 17 inches high has been built for this work. The circulatory system is entirely independent of the other systems in the laboratory, so that muddy water can be used without requiring too large quantities of clay and silt. A sandtrap which will catch all but the finest sand will be mounted at the lower end of the flume. The return channel is designed to act as a settling basin, so that the fine sand will be removed from the water, while the clay will remain in suspension and pass over the weir at the exit end. Water profiles will be measured with a bank of manometers, and hook gage wells will be connected to the ends of the test section for more accurate measurements. Determinations of critical tractive force and amount ofmaterial scoured will be made, first with clear water, then with clay-laden water. The sands used for the bed will be relatively fine, and the final tests will be made with bed sand from the Colorado River. In some of the tests the sand bed will be laid down in a clean condition, while in other tests it will be laid down in water containing a considerable amount of silt or clay. A supply of several grades of fine sand, including a quantity from the Colorado River at Yuma, has been obtained. Facilities for drying and sieving large quantities of sand are being installed. The testing equipment is ready for use, except for the sandtrap and the brass rails on which the point gage for contouring the bed will slide. A special laboratory is being equipped for making sieve analyses of sand, silt size and concentration determinations, and measurements of specific gravity, voids andgrain shapes.

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(171) (a) INVESTIGATION OF THE PRESSURE VARIATION IN THE UPSTREAM AND DOWNSTREAM SIDES OF AN ORIFICE PLATE.
(b) Scientific Data, Bureau of Standards.
(c) 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 48 pressure openings extending from the orifice plate face to about 4 pipe diameters upstream and 10 pipe diameters downstream. It is planned to vary the ratio of orifice to pipe diameter from about 0.05 to over 0.8, and to vary the Reynolds number over at least a 1 to 10 range for each orifice.

(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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(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, H.N.Eaton, B.H.Monish, C.W.Elliot.
(e) The Director, U.S.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.
(h) The flume described in 129(g), together with a glass-walled flume 40 ft. long and 18 inches wide, will be used for these tests.

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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, U.S.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) The flumes described in 129(g) and 195(h) will be used for these tests, together with other special equipment which will be built as required.

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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 s tudy 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. H. D. Vogel, Director of the Station.
(e) The Director, U. S. Waterways Experiment Station.
(f) Study of suspended load carried by the Mississippi River and its tributaries - silting of reservoirs.
(g) Field and laboratory investigations, analysis of samples, compilation of curves.
(h) Studies for 1930-31 reported on; otherstudies still in progress.
(i) See list of Publications, U. S. Waterways Experiment Station (Page).

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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, microscopic examination, specific gravity determination, shear and compression tests of samples undistrubed 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. Preliminary 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) In progress.
(i) Research Memorandum I-I and Technical Memorandum 28-2, U.S.W.E.S. available for loan.

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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) Experiment continued.
(i) Preliminary report being prepared for publication.

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(81) (a) ST. CLAIR RIVER COMPENSATING WEIRS.
(b) Great Lakes Division.
(c) (d) and (e) See (51).
(f) Determine kind, number and placing of submerged sills to raise level of Lake Huron.
(g) Model scales horizontal 1/100, vertical 1/30, and undistorted model 1/100, also flume tests.
(h) Completed.
(i) Report being prepared for publication.

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(87) (a) BRAZOS SANTIAGO PASS, GULF OF MEXICO.
(b) Gulf of Mexico Division.
(c) (d) and (e) See (51).
(f) Effects of jetties on present channel.
(g) Tidal study. Model scales 1 to 300 horizontal; vertical scale first adopted, 1 to 150, - This abandoned, and a vertical scale of 1 to 75 was used throughout the experiment. Using a reversing flow of water through the pass simulating tidal fluctuations and a movable bed of sand, the effect on the channel of different jetty extension layouts were tested.
(h) Completed.
(i) Results of this experiment, details of construction and methods of operation are covered in a report from the U.S.Waterways Experiment Station, to the District Engineer, U. S. Engineer Office, Galveston, Texas, available for loan.

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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 the river between the limits specified in (a).
(g) Model scales 1 to 1000 and 1 to 100; movable bed.
(h) In progress.

(92) (a) MISSISSIPPI RIVER MODEL NO. 5 - INCLUDING THE RIVER FROM MILE 650 TO MILE 740 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.

(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) In progress. Design of model and method of operation with partial results covered in memoranda to the District Engineer, U. S. Engineer Office, Charleston, S.C.

(150) (a) ISLAND NO. 20, MISSISSIPPI RIVER.
(b) Mississippi River Commission.
(c) (d) and (e) See (51).
(f) Study of effects of regulating works on channel location and depths.
(g) Movable bed model from Mile 118 to Mile 135 below Cairo Model scales; 1:1000 horizontal and 1:125 vertical.
(h) Experiment in progress.

(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 effluents of the Atchafalaya.
(g) Model scales 1 to 1500 and 1 to 100; fixed bed.
(h) In progress.

(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 218 to Mile 241.2 below Cairo Model scales: 1:1000 horizontal and 1:125 vertical.
(h) Experiment in progress.
(i) Model to be extended in future for purpose of studying regulating works in vicinity of Cow Island.

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(153) (a) ARTICULATED CONCRETE MATTRESS STUDY.
(b) District Engineer, Memphis, Tennessee.
(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 RIVER FROM MILE 390 TO MILE 810 BELOW CAIRO, AND THE ATCHAFALAYA RIVER 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).
(g) Model scales 1 to 2400 and 1 to 120; fixed bed.
(h) In progress.

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(165) (a) MISSISSIPPI RIVER BED LOAD SURVEY.
(b) Mississippi River Commission.
(c) (d) and (e) See (51).
(f) Mechanical analyses of samples taken from bed of Mississippi River, half-mile intervals, Cairo to New Orleans; also includes the Atchafalaya River survey.
(g) Analyses equipment.
(h) In progress.

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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 silting of canal by Brazos River.
(g) Scale 1 to 200 horizontal and 1 to 40 vertical. A silt-laden discharge of water will simulate the Brazos River, and different improvement schemes will be 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. A reversible flow of water will simulate tidal fluctuations; a movable bed will be employed.
(h) In progress.

(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 and 1:150.
(h) Experiment in progress.

(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 in progress.

(170) (a) MISSISSIPPI RIVER MODEL NO. 2 - INCLUDING THE MISSISSIPPI RIVER FROM MILE 370 to MILE 445 BELOW CAIRO, AND 60 MILES OF THE ARKANSAS RIVER, and 20 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 in the rivers upstream from mouth.
(g) Model scales 1 to 1000 and 1 to 100; movable bed.
(h) In progress.

(198) (a) FITLER BEND, MISSISSIPPI RIVER.
(b) Mississippi River Commission.
(c) (d) and (e) See (51) Report I-3, Oct. 1, 1933.
(f) Navigation study. See (51) Report I-3, Oct. 1, 1933.
(g) Model scales 1 to 500 and 1 to 150 movable bed.
(h) In progress.

(199) (a) ARANSAS PASS, GULF OF MEXICO.
(b) The Division Engineer, Gulf of Mexico Division.
(c) (d) and (e) See (51).
(f) To determine improvement works 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 sand bed, will be 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) Experiment in initial stage.
(i) This experiment supplements previous study made between Miles 137 and 120 below Cairo. (See (83) Report No. I-3, Oct. 1, 1933.)

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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 supplies is derived: observation of effects of floods will be made.
(h) In progress.

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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) 80% complete.

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WEST VIRGINIA UNIVERSITY.

(49) (a) SEDIMENTATION OF SMALL PARTICLES SUSPENDED IN WATER.
(b) West Virginia University.
(c) Graduate work for advanced degree.
(d) H. W. Speiden and L. V. Carpenter.
(e) L. V. Carpenter College of Engineering, West Virginia University,
(f) To study the laws governing the rate of settling of small particles in model basins.
(g) It is proposed to construct a series of basins making use of the principles of similarity, and investigate the effect of various types of inlet and outlet arrangement; work out the similarity laws governing the flow of water in basins and try to determine some of the theoretical laws governing the rate of settling of small particles.
(h) Experimental work has been started on a basin 4 ft. by 6 ft. in cross section and 10 ft. long. Other basins will be constructed in the near future.

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(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) Experiments on the 2-inch pipe lines are completed, and preparations are being made to start experimental work on the 3-inch pipe line.

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UNIVERSITY OF WISCONSIN.

(154) (a) EXPERIMENTAL STUDY OF THE HYDRAULICS AND PNEUMATICS OF THE PLUMBING SYSTEM.
(b) Laboratory project.
(d) F. M. Dawson, L. H. Kessler, H. Ruf, H. Pommerenck, S. E. Kotz.
(f) To determine by experimental study and show by apparatus the following features:
(1) Friction loss in small house water supply installations, including losses in copper, lead, iron pipes, valves, water meters, and in hot and cold water fixtures.

(2) Water hammer developed in piping layouts and methods of relief of this pressure in the plumbing water supply system.
(3) Proper venting of vertical stacks and horizontal waste and soil pipes.
(4) Self-siphonage of various types of traps.
(5) Heating of hot water by oil and gas and increase of pressure due to expansion of water and best method of control of this pressure.
(6) Construction of brazed, wiped, and soldered joints in copper and lead piping, and strength of these joints.
(7) Adequate water supply to a battery of closets operated by flushometer valves.
(8) Chemical solvents for cleaning of stoppages in waste pipes.
(9) Experimental investigation of grease traps.

(h) Most of the work was completed in June, 1933.

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(155) (a) STUDY OF FLOW OVER TRIANGULAR OR V-NOTCH WEIRS.
(b) Laboratory project.
(c) F. M. Dawson and A. T. Lenz.
(f) To collect data already published and make new tests on the triangular weir for the purpose of producing working tables for triangular weirs good for any viscosity and angle of notch.
(h) Material collected and studies made. Should be ready for publication within a year.

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(156) (a) DISCHARGE OVER WEIRS IN SIDE OF CHANNEL.
(b) Laboratory project.
(f) To determine the discharge over a rectangular weir which is placed in the side of a flowing channel.

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(157) (a) DISCHARGE THROUGH ORIFICES ON END OF PIPE LINE.
(b) Laboratory project.
(f) To determine the coefficient of discharge for orifice openings having various ratios of area to that of approach pipe. Velocity of approach and partial suppression of contraction affects discharge from these orifices.

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(158) (a) RESISTANCE TO FLOW THROUGH LOCOMOTIVE WATER HYDRANTS AND RELIEF FROM WATER HAMMER PRESSURES DUE TO THE CLOSURE OF CYLINDRICAL VALVES.
(b) Laboratory project.
(d) L. H. Kessler.
(f) To determine the loss of head in valve, riser in spout of locomotive water column, and study relief valves, and regulation of valve travel and the effects on the control of water hammer pressures within limits that are not destructive to water service installations.

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WORCESTER POLYTECHNIC INSTITUTE.

(203) (a) HOW WATER FLOWS IN A PIPE LINE.
(b) Alden Hydraulic Laboratory.
(c) Research.
(d) C. M.Allen and L.J.Hooper.
(e) C. M. Allen.
(f) General information.
(g) By injecting a small jet of salt solution in various points in the line and by a system of individual electrodes for determining the dispersion or spread due to turbulence.
(h) Presented at A.S.M.E. meeting in New York, December 5, 1933. To appear in A.S.M.E. Journal, January, 1934.

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(204) (a) TRAVELLING SCREEN METHOD OF WATER MEASUREMENT.
(b) Alden Hydraulic Laboratory.
(c) Research.
(d) C. W. Hubbard.
(e) C. M. Allen.
(f) General information.
(g) To compare the accuracy of Travelling Screen Method with weirs calibrated by Weighing Tank Method.
(h) In Progress.

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(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) 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) Still water tests made on revolving boom, moving water tests made in throat of venturi meter.

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IOWA INSTITUTE OF HYDRAULIC RESEARCH.

(107) (a) HYDRAULIC TEST ON MODEL OF MISSISSIPPI RIVER BELOW KEOKUK DAM.
(b) U.S.Engineer Department.
(c) Institute Project.
(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 tailwater of Keokuk plant, and (3) to determine possible power benefits of excavation in powerplant tailrace.
(g) Investigation on fixed-bed model of river built to scale of 125 to 1.
(h) Investigations completed in November, Final Report being prepared.

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(108) (a) HYDRAULIC INVESTIGATION OF GENERAL MODEL OF LOCK AND DAM No. 4, MISSISSIPPI RIVER AT ALMA, WISCONSIN.
(b) U.S.Engineer Department.
(c) Institute Project.
(d) U. S. Engineer Department Staff.
(e) Martin E. Nelson, Associate Engineer.
(f) To determine hydraulic characteristics of the proposed structure and navigation conditions near the locks.
(g) Investigation on fixed-bed model of river to horizontal scale of 300 to 1 and vertical scale of 100 to 1.
(h) Construction of model completed in November, 1933, and calibration of open channel now under way.

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(109) (a) HYDRAULIC STUDIES TO IMPROVE FILLING AND EMPTYING SYSTEM FOR RIVER NAVIGATION LOCKS.....
(b) U. S. Engineer Department.
(c) Institute Project and Graduate Thesis.
(d) U. S. Engineer Department Staff.
(e) Martin E. Nelson, Associate Engineer.
(f) To increase the efficiency of filling and emptying systems and to eliminate disturbances in the lock chamber during lockage.
(g) Investigation on lock model on scale of 15 to 1 with many adjustable and variable features under control.
(h) Model under observation about 9 months. Preliminary report made in July, 1933. Investigations will continue indefinitely.

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(112) (a) FLOW OF WATER AROUND BENDS IN OPEN AND CLOSED CHANNELS.
(b) Bureau of Agricultural Engineering, U.S.Department of Agriculture.
(c) Cooperative Government and Iowa Institute of Hydraulic Research Project.
(d) U.S.Department of Agriculture staff.
(e) David L. Yarnell, Senior Engineer.
(f) To determine losses, changes in pressure, velocity and direction of current flowing around both open and closed bends of various curvatures.

(g) Investigations have been made on 6-inch transparent Pyralin pipe bend, standard curvature, three angles of 45, 90, 180, and 270 degrees and for four bends of irregular section.
(h) General study in progress since 1926; report completed on transparent conduits of square and rectangular section. Tests made on nine pipe bends.
(i) The tests show that pipe bends may be used as flow meters; merely measuring the difference in pressure between the inside and outside of the bend, preferably at a point 22 1/2° from the beginning of the bend. The experiments revealed that it is possible to have conditions of flow such that the resitance to flow may be very small or unusually large in the same bend carrying identical quantities of water; the loss in one case being several times that with a different velocity distribution approaching the bend. The amount and distribution of the loss within the bend and on the discharge tangent was also determined for each bend. Usually in pipe bends of circular cross-section the pressure in the inside of the bend is less than on the outside. It is possible to change the shape of the bend so that the pressure on the inside of the bend is greater than on either of the two tangents adjacent to the bend. The complete report will be finished this summer.

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(117) (a) TRANSPORTATION OF SEDIMENT BY FLOWING WATER.
(c) Graduate thesis.
(d) Yun-Cheng Tu.
(e) Professors S. M. Woodward and F. T. Mavis.
(f) To determine critical velocity for bed load movement.

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(119) (a) THE HYDRAULICS OF THE MIXTURE OF STREAMS OF WATER AND ITS APPLICATION TO HEAD INCREASES.
(c) Graduate thesis.
(d) J. Stuart Meyers.
(e) Professor F. T. Mavis.
(f) To investigate phenomenon of pressure recovery and loss attendant upon alteration of velocity distribution in conduits.

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(159) (a) TAINTER GATE COEFFICIENTS.
(c) Graduate thesis.
(d) Ross N. Brudenell.
(e) Professor F. T. Mavis.
(f) To determine discharge coefficients for various model Tainter gate installations.

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(207) (a) INVESTIGATION OF EARTH DAMS.
(c) Graduate thesis.
(d) O. J. Baldwin.
(e) Professor F. T. Mavis.
(f) To determine the permeability and capillarity of various materials and to study their behavior in model earth dams.

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(208) (a) A STUDY OF VORTEX MOTION.
(c) Graduate thesis.
(d) G. F. Djang.
(e) Professor 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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(209) (a) A STUDY OF THE MORE RECENT DEVELOPMENTS IN LOCKS.
(c) Graduate thesis.
(d) Arthur Th. Ippen.
(e) Professor F. T. Mavis.
(f) Critical comparison of American and foreign practice in the hydraulic design of locks.

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(210) (a) SEEPAGE FLOW THROUGH SAND DAMS.
(c) Graduate thesis.
(d) Lieut. R. L. Jewett.
(e) Professor F. T. Mavis.
(f) To determine the effect of changes in design upon seepage and capillary flow.

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

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(212) (a) HYDRAULIC STUDY OF MODEL OF LOCK AND DAM NO. 26, MISSISSIPPI RIVER AT ALTON, ILLINOIS. (Site 8300 feet upstream from R.R.bridge.)
(b) U.S.Engineer Department.
(c) Institute project.
(d) U. S. Engineer Department Staff.
(e) Martin E. Nelson, Associate Engineer.
(f) To investigate the possibility of maintaining a satisfactory navigation channel below the proposed locks by regulation of spillway discharge.

(g) Investigations on moveable-bed model of river built to horizontal scale of 250 to 1 and vertical scale of 60 to 1.
(h) Alternate locations for locks and dam 800 feet above R.R. bridge chosen as better site and tests on this model were discontinued. Report being prepared.

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(213) (a) HYDRAULIC STUDY OF MODEL OF LOCK AND DAM NO. 26, MISSISSIPPI RIVER AT ALTON, ILLINOIS. (Site 800 feet upstream from R. R. bridge.)
(b) U. S. Engineer Department.
(c) Institute Project.
(d) U. S. Engineer Department Staff.
(e) Martin E. Nelson, Associate Engineer.
(f) To design control works necessary to maintain satisfactory navigation channel from the dam to mouth of Missouri river and to study effect of spillway discharge on erosion around piers of railroad and highway bridges. (See also following project.)
(g) Investigation on movable bed model of river on a horizontal scale of 400 to 1 and vertical scale of 60 to 1.
(h) Construction of model completed Jan. 1, 1934, and tests will continue about 4 months.

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(214) (a) HYDRAULIC STUDY OF MODEL OF LOCK AND DAM NO. 26, MISSISSIPPI RIVER AT ALTON, ILLINOIS. (site 800 feet upstream from R.R. bridge.)
(b) U. S. Engineer Department.
(c) Institute Project.
(d) U. S. Engineer Department Staff.
(e) Martin E. Nelson, Associate Engineer.
(f) To study effect of spillway discharge on erosion around piers of railroad and highway bridges and to design protection if necessary.
(g) Investigation on movable-bod model representing 400 feet of spillway and bridge section on scale of 25 to 1. Model includes 8 tainter gates.
(h) Construction of model completed Dec. 15th, 1933. Tests will continue about 2 months.

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(215) (a) HYDRAULIC STUDY OF MODEL OF LOCK AND DAM NO. 20, MISSISSIPPI RIVER AT CANTON, MISSOURI.
(b) U. S. Engineer Department.
(c) Institute Project.
(d) U. S. Engineer Department Staff.
(e) Martin E. Nelson, Associate Engineer.
(f) To determine (1) principles and rules to follow in design of stilling basin for dam No. 20 and for other dams to be built on erodible foundations, (2) to determine discharge coefficients for tainter gates, and (3) to determine schedule of tainter gate operation to maintain required pool levels at Dam No. 20, and at other similar dams on Mississippi river.

(g) Investigation on a model of a single tainter gate on a scale of 25 to 1 built in a glass-sided flume. Results will be checked in 25 to 1 scale model of 8 Dam No. 26 tainter gates. Tests approximately 50% completed.

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(216) (a) HYDRAULIC INVESTIGATION OF GENERAL MODEL OF LOCK AND DAM NO. 5, MISSISSIPPI RIVER AT FOUNTAIN CITY, WISCONSIN.
(b) U. S. Engineer Department.
(c) Institute Project.
(d) U. S. Engineer Department Staff.
(e) Martin E. Nelson, Associate Engineer.
(f) To determine hydraulic characteristics of the structure, its effect on flood stages and to study navigation conditions near the locks.
(g) Construction of fixed-bed model will be started about Jan. 15, 1934. Tentative scale ratios, horizontal 400 to 1 and vertical 100 to 1.

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SOME RECENT RESEARCH IN FOREIGN LABORATORIES.

During the summer of 1933, Dr. C. A. Wright of the National Hydraulic Laboratory staff made a study tour of the different European hydraulic laboratories as listed below. With grateful acknowledgment for the courteous way in which the members of the laboratory staffs discussed their work, a brief summary of their current and completed research work is presented here. Specific information as to the individual investigations in progress at each of the laboratories is not given, since this would involve writing to each laboratory for permission to do this.

PLACES VISITED.

Germany: Wilhelmshaven, Hanover, Göttingen, Brunswick, Hamburg, Berlin, Marquadt, Dresden, Munich, Walchensee, Karlsruhe and Darmstadt.
Sweden: Stockholm.
Czechoslovakia: Brünn and Prague.
Austria: Vienna and Gratz.
Switzerland: Zurich and Bern.
France: Grenoble, Saulcy near Metz, Nancy, Toulouse and Paris.
Holland: Delft.
England: London, Manchester and Teddington.
Italy: Milan and Padua (not visited but member of the staff met at the World Power Conference meeting.)

WORK IN PROGRESS.

Movement of Sediment. Devices were being developed for sampling sand and silt in tidal streams and rivers. The transportation of gravel, sand, silt and clay by flowing water was being studied theoretically, as well as experimentally in both fixed and tilting flumes. In this connection, devices for feeding and trapping the material were being used and the water slopes were being measured by point or hook gages.

Gravel and sand are used for constructing mobile beds in river and tidal models, although a preference is shown for powdered coal. By means of these models the design of hydraulic engineering structures as affecting the bed of the river was being studied both with distorted and undistorted scales, including erosion below dams, scouring around bridge piers, scouring from controlled gates and sluiceways. The continuous bed changes made by a river over long periods of time were also being studied with models and the results compared with surveys of the actual river. The effect on the mobile bed of the model of various combinations of salt water tidal flow and the fresh river water were being studied, including deposition of the sediment carried by the river, maintenance of harbors, and the crossing of rivers and canals at the same level. Attrition of river gravel was being studied by means of revolving drums. Fixed bed models of cement mortar sometimes coated with sand or gravel were used to study the storage effect of overflowing banks, and the regulation of river flow by cylinder gates at a dam and the sequence of operations at a canal lock were being studied.

Fluid Flow. The subject of hydraulic similitude was being studied by a number of persons and the results of experiments upon models of different scales compared. Fluid flow through and around obstructions was being studied theoretically and also experimentally by injecting dye and photographing the currents. Turbulence in open channels and pipes was being studied.

Hydraulic friction. Hydraulic frictional resistance was being studied very generally, including losses at bends in pipes and open channels of various materials both for smooth surfaces and for surfaces artificially roughened with paint and sand, losses in canals lined with various types of asphalt paving and losses occasioned by various types of "quick" pipe couplings. Comparisons were being made experimentally of open channel formulas. The hydraulic frictional force on asphalt-cement pipes was being measured directly by experimental means. The distribution of pressure in the overfalling sheet of water on a spillway dam and the flow through siphon spillways were being studied. The forces acting upon a quay wall and those acting upon boats in canal locks have been studied experimentally. Other problems noted include the effect of temperature upon the flow of water, dissipation of energy at stepped side channel spillways, transitory flow, velocity distribution in canals, measurement of flow of water by color change and studies of rotating liquids.

Model studies were being made of estuaries in which a constant mean sea level was maintained with all of the variations in the tides automatically controlled. A small percentage of alum is added to simulate the coagulating action of salt water on the fine silt. The periodic variations in flow of the rivers, as well as their content of silt, are also automatically controlled.

A current meter was being developed to indicate direction of flow, and experiments also were being made upon the effect of angularity upon the registration of these instruments.

Cavitation. General interest was found to exist in the phenomenon of cavitation. Different types of devices - "rotoscope" and "roboscope"- were being developed to study cavitation within model pumps and turbines, and cavitation on fixed surfaces was beingstudied for ship propellers and fixed vanes. By means of a large open model, the absolute and relative motion of fluids around rotating vanes was being studied.

Flow measurement. A new and more accurate method for the determination of flow in a flume by means of a travelling screen was being worked out. An improved apparatus for measuring pressures has been developed for use with the Gibson method of flow measurement. A comprehensive study of velocity formulas for open channels and pipes was also being made.

Ship models. In the model ship experimental laboratories, the design of the ship is checked by measurement of frictional resistance of models, both towed and self-propelled, also the force of propulsion and measurement of centers of gravity and buoyancy, dry and immersed, rolling and pitching. The steamer Monte Rosa was equipped with most all of the most recent marine testing instruments and set out from Hamburg in June for an eight-day test cruise.

The design of a canal barge with an internal propeller rotating in a pipe in the middle of the boat has been developed in the laboratory and a successful barge built.

New laboratories. New hydraulic laboratories are being provided in Holland at Delft and in Germany at Brunswick, Munich and Darmstadt.

Further details of the work summarized above can be found in the following references, although some work is still awaiting publication. This list represents mainly references obtained by Dr. Wright this summer and is of necessity incomplete. The Bureau of Standards would be glad to receive references to other hydraulic research work which may have been published but which has not been mentioned here.

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(55) Paper Y - Experiment to Determine the Limit of Backwater Influence in the Illinois River February, 1931. (Out of Print)
(57) Paper D - Hydraulic Studies of Proposed Dam No. 37, Ohio River. May, 1931. (Out of Print)
(68) Paper R - Experiments to Determine the Erosive Effects of Floodwaters on Railroad Embankments. May, 1931. (Out of Print)
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(51) Paper U - Sediment Investigations on the Mississippi River and Its Tributaries 1930-31. December, 1931.
(62) Paper L - Model Study of Effects of Dikes on the River Bed at Walkers Bar, Ohio River. January, 1932.
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(69)(70)(71)
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Paper 11 - Model Studies of Dike Location. June, 1933.
(73) Paper 12 - Investigations of Certain Proposed Methods of Bank and Embankment Protection. July, 1933.
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Paper 14 - Model Studies of Spillways for St. Lucie Canal, Martin County, Florida. September, 1933.

First Series (Limited Mimeographed Edition)
(64) Paper HS - Head Losses in Various Types of Pipe Bends.

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(77) Paper __ Island No. 35, Mississippi River.
(81) Paper __ St. Clair River Compensatory Sills.

PAPERS TO BE MIMEOGRAPHED IN THE NEAR FUTURE.

(80)(83)(84)
(90) Paper __ Channel Modification - Mississippi River.

Note: 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.

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West Virginia University.

(49) Sedimentation of Small Particles Suspended in Water.
Progress report.

The first series has been completed and written up as an under-graduate thesis, the synopsis of which follows:

"The efficiency of a sedimentation basin is defined as the ratio of the flowing through period to the theoretic detention period. The method of making the tests and calculating the data is described in detail. Three efficiency determinations are made.

"Several attempts were made to trace currents of water through the basin by adding a salt with the influent and measuring the chloride content of the water in various parts of the basin. A method of measuring this concentration by means of conductivity was given up as unsuccessful after considerable had been done on it.

"An ingenious method of determining the particle size and grading of a soil is described and computations of an example included. This method known as the 'combined sieve and hydrometer method' was used in determining the characteristics of sediment used in this work, and has been found satisfactory by several soil laboratories.

"Sediment was mixed with water flowing into the model basin and samples of the effluent analyzed to determine the amount retained by the basin. This was expressed as a percentage of the concentration of sediment in the influent, and a formula expressing the relation of the per cent removed to the concentration of sediment is developed.

"Considering this basin as a model of a similar basin 10 times as large in each dimension, the velocity which should exist in the full size basin to give dynamic similarity, is calculated. Also the quantity of water which the large basin would be treating is shown."

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TRANSLATIONS.

In progress: U. S. Waterways Experiment Station.

"Modellgeschiebe und Schleppkraft", by Hans Kramer. Mitteilungen der Preussischen Versuchsanstalt für Wasserbau und Schiffbau, Heft 9, Berlin, 1932. To be published soon.

Completed: Horton Hydraulic and Hydrologic Laboratory.

BAZIN-DARCY. - Experimental Researches on the propagation of Waves (Fr.) (Recherches Expérimentales sur la Propagation des Ondes.) Complete translation, with tables; also full abstract digest. Translated and copy available at Horton Hydrologic Laboratory. Some means of publication is desired.

BELANGER, M.J. - B. - Essay on the Numerical Solution of some Problems relative to the Permanent Motion of Flowing Waters (Fr.) (Essai sur la solution numérique de quelques problèmes relatifs au mouvement permanent des eaux courantes; Paris: Chez Carilian-Goeury, Libraire des Corps Royaux des Ponts et Chaussées et des Mines, Quai des Augustins, no. 41, 1828.) Translated at Horton Hydroligic Laboratory; copies at Horton Hydrologic Laboratory and at Iowa Institute of Hydraulic Research, Iowa City, Iowa. In this important paper the laws governing the form of surface profiles in non-uniform flow were first established and the significance of the critical velocity pointed out. Some means of publication is desired.

LESBROS, M. - Experimental Hydraulics (Fr.) (Hydraulique Expérimentale; Paris; Victor Dalmont, Éditeur; Libraire des Corps Impériaux des Ponts et Chaussées et des Mines, Quai des Augustins, 49; 1850.) Translated under the supervision of Robert E. Horton by Roswell D. Trimble, Consulting Engineer, Tenth St. Bldg., Richmond, Va. There is a copy in the Horton Hydrologic Laboratory and also at the office of Roswell D. Trimble. This is a very careful and complete translation of all that part of Lesbros' monumental work relating to flow through orifices. Some means of publication is desired.

There are many translations of shorter monographs relating to flood waves, variable flow, hydraulics of ground-water and various hydrologic topics which have been made at the Horton Hydrologic Laboratory. Many of these contain matter of great importance. If funds to provide the cost of manifolding these were obtainable they could be made generally available to English readers.

Completed translations:

U. S. Engineer Office, Memphis, Tenn.
"The Rhone and Rivers of Shifting Bed", by M.P.DuBoys, Annales des Ponts et Chaussees, 1879-2c Semestre. Translation by H. G. Doke, August, 1932.

Technical Memorandum No. 726, National Advisory Committee for Aeronautics, Washington, D. C., "Attaining a Steady Air Stream in Wind Tunnels", by L. Prandtl. Handbuch der Experimentalphysik. The section on entrance conditions and honeycombing would apply to water as well as to air.

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