Hydraulic Research
in the United States

1959

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Miscellaneous Publication 227

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(Including Contributions from Canadian Laboratories)

Edited by Helen K. Middleton

FOREWORD

The information contained in this publication was compiled from reports by the various hydraulic and hydrologic laboratories in the United States and Canada. The cooperation of these agencies is greatly appreciated. The National Bureau of Standards cannot assume responsibility for the completeness for this publication. We must depend upon reporting laboratories for the completeness of the coverage of their own programs, as well as upon new laboratories engaged in hydraulics to bring their activities to our attention.

Projects are numbered chronologically, and the number once assigned is repeated for identification purposes until a project is completed. Numbers commencing with 3006 refer to projects which are reported for the first time. All projects are in active state, unless otherwise noted under (f).

The National Bureau of Standards does not maintain a file of reports or detailed information regarding the research projects reported by other organizations. Such information may be obtained from the correspondent listed under (c) or immediately following the title of the organization reporting the work. It is of course understood that any laboratory submitting reports on its work will be willing to supply information to properly qualified inquirers.

A similar bulletin, "Hydraulic Research", compiled and published by the International Association for Hydraulic Research, contains information on hydraulic research being conducted in foreign countries. This bulletin is edited by Professor J. Th. Thijsse, Director of the Hydraulic Laboratory at the Technical University of Delft, Netherlands, and Secretary of the International Association for Hydraulic Research. Copies may be obtained from the Secretary at $6.00 each (postage included).

                                        A. V. Astin, Director

CONTENTS

Key to Projects

(a) Number and title of project   (e) Description
(b) Project conducted for   (f) Present status
(c) Correspondent   (g) Results
(d) Nature of project   (h) Publications

LIST OF CONTRIBUTING LABORATORIES

UNIVERSITY OF ARKANSAS   1
Agricultural Engineering Dept.
Fayetteville, Ark.
Prof. Kyle Engler, Head

UNIVERSITY OF ARKANSAS   1
Civil Engineering Dept.
Fayetteville, Ark.
Prof. L. R. Heiple, Head

BALDWIN-LIMA-HAMILTON CORPORATION, THE   1
Hydraulic Turbine Laboratory
Philadelphia 42, Pa.
Mr. A. W. Madora, Supervisor, Hydraulic Turbine
Research Dept.

BEACH EROSION BOARD (see U. S. Government)

BONNEVILLE HYDRAULIC LABORATORY (see U. S. Govern-
ment)

BROOKLYN, POLYTECHNIC INSTITUTE OF   2
333 Jay Street, Brooklyn 1, N. Y.
Prof. Matthew W. Stewart, Civil Engineering

CALIFORNIA INSTITUTE OF TECHNOLOGY   2
Engineering Division, Pasadena 4, California
Prof. Milton S. Plesset, Applied Mechanics

CALIFORNIA INSTITUTE OF TECHNOLOGY   3
Hydrodynamics Laboratory
Pasadena 4, Calif.

CALIFORNIA INSTITUTE OF TECHNOLOGY   4
Sedimentation Laboratory, Pasadena 4, Calif.
Dr. Vito A. Vanoni, Professor of Hydraulics

CALIFORNIA, UNIVERSITY OF   4
College of Agriculture, Davis, Calif.
Mr. Robert M. Hagan, Chairman Dept. of Irrigation

CALIFORNIA, UNIVERSITY OF   83
College of Agriculture, Los Angeles 24, Calif.
Prof. A. F. Pillsbury, Chairman
Dept. of Irrigation and Soil Science

CALIFORNIA, UNIVERSITY OF   5
College of Engineering, Berkeley 4, Calif.
Prof. J. W. Johnson, Prof., Hydraulic Engrg.

CALIFORNIA, UNIVERSITY OF   11
Dept. of Naval Architecture, Berkeley 4, Calif.
Prof. H. A. Schade, Chairman

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Dept. of Civil Engineering, Pittsburgh 13, Pa.
Dr. T. E. Stelson, Acting Head

CASE INSTITUTE OF TECHNOLOGY   12
Dept. of Civil Engrg. and Engineering Mechanics
Cleveland 6, Ohio
Dr. H. R. Nara, Head of Department

COLORADO STATE UNIVERSITY   12
Hydraulics Laboratory
Civil Engineering Section, Fort Collins, Colo.
Dr. A. R. Chamberlain, Chief

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Civil Engineering Dept., Box U-37, Storrs, Conn.
Prof. Victor Scottron, Prof., Civil Engineering

CORNELL UNIVERSITY   19
School of Civil Engineering
Applied Hydraulic Laboratory, Ithaca, N. Y.
Prof. Marvin Bogema, in Charge

DAVID TAYLOR MODEL BASIN (see U. S. Government)

FLORIDA, UNIVERSITY OF   20
The Engineering and Industrial Experiment Sta.
Coastal Engineering Laboratory, Gainesville, Fla.
Dr. Per Bruun

GEORGIA INSTITUTE OF TECHNOLOGY   21
Hydraulics Laboratory, School of Civil Engrg.
Atlanta, Georgia
Prof. C. E. Kindsvater

HARVARD UNIVERSITY   22
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Cambridge 38, Mass.
Prof. Harold A. Thomas, Jr.

HOUSTON UNIVERSITY   23
Dept. of Chemical Engineering, Houston 4, Texas
Dr. H. W. Prengle Jr., Chairman

IDAHO, UNIVERSITY OF   23
Engineering Experiment Station, Moscow, Idaho
Dean Allen S. Janssen, Director

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Mr. William C. Ackerman, Chief

ILLINOIS STATE WATERWAYS DIVISION   27
Dept. of Public Works and Buildings
201 West Monroe St., Springfield, Ill.
Mr. Thomas B. Casey, Chief Waterway Engineer

ILLINOIS, UNIVERSITY OF   28
Dept. of Agriculture Engineering, Urbana, Ill.
Dr. Frank B. Lanham, Head

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Dept. of Civil Engineering, Urbana, Ill.
Dr. N. M. Newmark, Head

ILLINOIS, UNIVERSITY OF   31
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214 Talbot Laboratory, Urbana, Ill.
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IOWA INSTITUTE OF HYDRAULIC RESEARCH   31
State University of Iowa, Iowa City, Iowa
Dr. Hunter Rouse, Director

IOWA STATE COLLEGE   35
Dept. of Agricultural Engineering, Ames, Iowa
Prof. Hobart Beresford, Head

IOWA STATE COLLEGE   36
Dept. of Agronomy, Ames, Iowa
Prof. William H. Pierre, Head of Dept.

UNIVERSITY OF ARKANSAS, Agricultural Experiment Station.

(2255) GROUND WATER, RESOURCES AND RECHARGE, IN THE RICE GROWING AREA OF ARKANSAS.

(b) Arkansas Agricultural Experiment Station cooperative with U. S. Geological Survey and U. S. Corps of Engineers.
(c) Prof. Kyle Engler, Head of Agricultural Engineering, Dept., University of Arkansas, Fayetteville, Arkansas.
(d) Basic and applied research.
(e) A 16-inch vertical recharge well is surrounded by test wells for the purpose of observing hydraulic information and for sampling chemical quality and bacterial analyses. A series of tests of short duration have been run using treated surface water as recharge media. This water has been copper sulphated to kill plankton, treated with alum to clock out collodial materials, chlorinated to kill bacteria, and areated to remove free air. This treated water has given satisfactory results in the tests. The next step will be removal of treatments to see what the minimum treatment will have to be. A straight 26-inch, sand packed recharge well has been completed and will be tested.
(g) The project is not developed to a point for satisfactory reporting.
(h) "Artificial Recharge Experiments in the Grand Prairie Region of Arkansas", R. T. Sniegocki, WATER for Texas, Proceedings of the Third Annual Conference on Water for Texas, Sept. 16-18, 1957, pp. 75-76. "Ground Water Recharge in Arkansas", Kyle Engler, 55th Annual Proceedings Association of Southern Agricultural Workers, pp. 52, 1958. "Plugging by Air Entrainment in Artificial Recharge Tests", R. T. Sniegocki, paper presented at National Water Well Association Meeting, Wash., D. C., Nov. 6, 1958 (U. S. Geological Survey, Little Rock Arkansas).

UNIVERSITY OF ARKANSAS, Civil Engineering Dept.

(2741) ROCKEFELLER FILTRATION PROJECT.

(b) Laboratory project.
(c) Prof. L. R. Heiple, Head, Civil Engineering Dept., University of Arkansas, Fayetteville, Arkansas.
(d) Experimental and field investigation; applied research has been used for three master's theses to date.
(e) This project involves a study of the removal of turbidity and bacteria from surface water supplies using coarse grained media (1/4" to 1"). The variables investigated included: (1) Depth of bed; (2) size of media; (3) shape and nature of

media; (4) effect of head of water on filter bed; and (5) rate of filtration. Laboratory model investigations are complete with long range field study under way for the past year.
(f) Completed.
(g) Field studies have disclosed that turbidity from normal surface waters may be substantially reduced by filtration, without prior treatment, through a coarse grained material such as pea gravel. With a 16-inch bed of 1/4"-1/2" gravel as a filter media and operation at a rate of 1/10 gallon per sq ft per minute the average efficiency of turbidity removal is well in excess of 50 percent and has achieved 90 percent efficiency on occasions. Such a filter has a capacity for effective long range operation without development of appreciable head loss or the need for cleaning and with minimum attention. Such filtration will also remove at least 50% of total bacteria present in normal waters. Filtration efficiency is most effective in low turbidity waters where particle size is predominately colloidal.
(h) Several articles are now ready for release, but the date of publication has not been determined. Such material may be available upon request at a later date.

THE BALDWIN-LIMA-HAMILTON CORPORATION, Hydraulic Turbine Laboratory.

Inquiries concerning Projects Nos. 271, 2050, 2500, 3006, and 3007, should be addressed to Mr. W. R. MacNamee, Chief Engineer, Hydraulic Turbines and Marine Products Division and Mr. A. W. Madora, Supervisor, Hydraulic Research Laboratory, Baldwin-Lima-Hamilton Corp., Philadelphia 42, Pa.

(271) ADJUSTABLE AND FIXED BLADE PROPELLER-TYPE HYDRAULIC TURBINE MODELS.

(b) Laboratory project.
(d) Experimental; applied research for design.
(e) To improve performance of present designs, and to extend the range of application of this type turbine. Propeller runners of various designs in combination with modified turbine settings are methodically tested in the 11-inch cavitation flume. Efficiency output, cavitation, runaway speed, hydraulic thrust, and hydraulic blade torque are measured.
(g) Results provide data for improvement of existing design and information for designs which extend the range of application.

(2050) PUMP TURBINE LABORATORY.

(b) Laboratory project.
(d) Experimental; applied research.
(e) Pump-turbines of various specific speeds

have been designed and tested in settings hydraulically similar to proposed field installations. The performance characteristics of efficiency, discharge, runaway speeds, horsepower, cavitation, thrust data for thrust bearing, and wicket gate torques.

(g) Results provide data for the design of future proposed installations and modifications to existing designs.

(2500) AXIAL FLOW PUMP LABORATORY.

(b) Laboratory project.
(d) Experimental; applied research.
(e) Axial flow pumps of various specific speeds have been designed and tested. Investigations pertaining to the number of impeller blades, proper diffuser vane angle, and intake conditions, have been completed. Performance characteristics of efficiency, discharge, horsepower, runaway speeds and blade torques have been obtained.
(g) Results provide data for the design of future proposed installations, and modifications to existing designs.

(3006) NIAGARA RIVER PROJECT, LEWISTON POWER PLANT.

(b) Power Authority of the State of New York.
(d) Official contract acceptance tests.
(e) A complete homologous model has been tested encompassing the operating conditions expected in the field in its entirety.
(f) Completed.
(g) Results obtained generously exceed all guaranteed conditions as requested by the customer in the specifications.

(3007) AIR TEST FLUME.

(b) Laboratory project.
(d) Basic research.
(e) The purpose of constructing an air test flume is for the expediency in obtaining basic information pertaining to flow patterns of model pumps, turbines, and pump turbines at both inflow and outflow and for other component parts. The information obtained will be utilized in determining blade shapes and contours, suitable angles at entry and exit of model runners and pumps.

POLYTECHNIC INSTITUTE OF BROOKLYN.

(3008) ORIFICE AND TUBE TESTING APPARATUS.

(b) Laboratory project.
(c) Prof. Matthew W. Stewart, Brooklyn Polytechnic Institute, 333 Jay Street, Brooklyn 1, New York.
(d) Student experimentation.
(e) An apparatus with transparent sides for the study of flow through various shaped tubes and orifices. Both submerged and free jet flow may be studied.

CALIFORNIA INSTITUTE OF TECHNOLOGY, Engineering Division.

(1548) SPECIAL PROBLEMS IN HYDRODYNAMICS.

(b) Office of Naval Research, Dept. of the Navy.
(c) Prof. Milton S. Plesset, California Inst. of Technology, Engineering Div., Pasadena, California.
(d) Theoretical and experimental; basic research.
(e) Studies of cavitating and noncavitating flow; dynamic behavior of cavitation bubbles; theoretical and experimental studies of cavitation damage.
(h) "Physical Effects in Cavitation and Boiling" by M. S. Plesset, Symposium, Naval Hydrodynamics, National Academy of Sciences, National Research Council, Publication 515 (1957), pp. 297-318.
"Ion Exchange Kinetics - A Nonlinear Diffusion Problem. I", by F. Helfferich and M. S. Plesset, Journal of Chemical Physics, 28, No. 3, March 1958, pp. 418-424.
"Ion Exchange Kinetics - A Nonlinear Diffusion Problem. II. Particle Diffusion Controlled Exchange of Univalent and Bivalent Ions", by M. S. Plesset, F. Helfferich and J. N. Franklin, California Inst. of Technology, Engineering Div. Report No. 85-9, June 1958.
"Cathodic Protection in Cavitation Damage Tests of Mild Steel in a Salt Solution", by M. S. Plesset, B. C. Bass, and R. Hickling, Calif. Inst. of Technology, Engineering Div. Report No. 85-10, Nov. 1958.
"Unsteady Supercavitating Flows", by T. Y. Wu, Calif. Inst. of Technology, Engineering Div. Report No. 85-11, (in press).
"The Growth of Vapor Bubbles in Rapidly Heated Liquids", by S. A. Zwick and M. S. Plesset, Calif. Inst. of Technology, Engineering Div. Report No. 85-12, in preparation.

(1816) FORCE CHARACTERISTICS OF SUBMERGED HYDROFOILS UNDER CAVITATING CONDITIONS.

(b) Bureau of Ships, Dept. of the Navy.
(c) Prof. Milton S. Plesset, California Inst. of Technology, Engineering Div., Pasadena, California.
(d) Theoretical and experimental; basic research.
(e) Studies of hydrofoils.
(h) "A Note on the Cavity Flow past a Hydrofoil in a Liquid with Gravity", by Blaine R. Parkin, Calif. Inst. of Technology, Engineering Div. Report No. 47-9, Dec. 1957.
"Numerical Evaluation of the Force Coefficients for Supercavitating Hydrofoils", by Zora M. Lindberg, Calif. Inst. of Technology, Engineering Div. Report No. 47-11, in preparation.
"Experimental Investigations of Three-Dimensional Effects on Supercavitating Hydrofoils", by R. W. Kermeen, Calif. Inst. of Technology, Engineering Div. Report No. 47-12, in preparation.

CALIFORNIA INSTITUTE OF TECHNOLOGY, Hydrodynamics Laboratory.

(2502) MECHANICS OF CAVITATION DAMAGE.

(b) National Science Foundation.
(c) Dr. A. T. Ellis, Asso. Prof. of Applied Mechanics, Calif. Inst. of Technology, Pasadena, California.
(d) Project includes field investigations (see ref. 1 under (e)), and is both experimental and theoretical. It is primarily basic research, but it is anticipated that it will also have applications. The work will be the basis of two doctoral theses.
(e) The purpose of the project is to determine the detailed mechanism of mechanical damage by cavitation and to attempt to correlate this with field results. Preliminary work has been completed by Prof. Knapp, showing details of high-speed photography while the damage was actually taking place. The following experiments are contemplated: (1) Generate spherical shock waves of known strength in water by the electric discharge method and record these photographically by a high-speed Schlieren system; (2) determine reflection and refraction of these waves at the solid-liquid interface by means of photoelastic techniques; (3) record transient pressures by means of piezoelectric pickups and oscilloscopes presently available with a frequency response to 25 megacycles; and (4) generate shock waves in water by collapse of simple vapor or gas bubbles and record these as in Item 1, which will provide calibration. High speed photographic equipment will be used for combined photoelastic and Schlieren pictures at framing rates up to one million per second.
(g) The physical manner in which aluminum is damaged by cavitation has been observed. Shock waves in water due to cavitation bubble collapse have also been observed, and quantitative measurements will soon be made. Theoretical analysis describing the collapse of a cavitation bubble in contact with a solid boundary is nearly complete. Strain waves in metals have been photographed by means of photoelastic bonded apoxy resins. This technique will be applied later to studying the behavior of metals during cavitation damage. This is a new technique of general interest which has never been accomplished before.

(2746) HYDRODYNAMICS OF UNDERWATER BODIES.

(b) Bureau of Ordnance, Dept. of the Navy.
(c) Dr. Vito A. Vanoni, Hydrodynamics Laboratory, Calif. Inst. of Tech., Pasadena, California.
(d) Experimental and theoretical investigations.
(e) Investigations of the mechanics of hydrodynamic phenomena involved in the motion of underwater bodies, including (1) studies of forces on such bodies in cavitating and noncavitating conditions; (2) investigations of the detailed mechanics of the fluid motions giving rise to the above forces.
(h) "An Experimental Determination of Dynamic Coefficients for the Basic Finner Missile by Means of the Angular Dynamic Balance", by Taras Kiceniuk, Hydrodynamics Laboratory, Calif. Inst. of Tech. Report No. E73.3, June 1957.
"An Experimental Determination of Dynamic Coefficients for the Basic Finner Missile by Means of the Translational Dynamic Balance", by Taras Kiceniuk, Hydrodynamics Laboratory, Calif. Inst. of Tech. Report No. E73.9, May 1958.

(3009) CAVITATION SIMILITUDE.

(b) Office of Naval Research, Dept. of the Navy.
(c) Prof. A. J Acosta, Calif. Inst. of Tech., Pasadena, Calif.
(d) Experimental program of basic unclassified work.
(e) To determine the effect of the various thermal properties on cavitation in a venturi tube. It is known that cavitation similitude parameters based upon the vapor pressure of the liquid at the bulk temperature are misleading since the pressure in the cavity may be less or may exceed this value depending on air content, speed, size, thermal conductivity, etc. To investigate this question, a simple test loop with a venturi-section made with glass windows has been constructed and run with water. In the future, other fluids will be used. Measurements of cavity pressure, air content, temperature, are being made.
(g) Results in water ranging in temperature from 70° to 200° show that the cavity pressure can depart appreciably from the value at the bulk temperature. The results are still incomplete and inconclusive.

(3010) FULLY CAVITATED HYDROFOIL NEAR A FREE SURFACE.

(b) Bureau of Ordnance, Department of the Navy.
(c) Prof. V. A. Vanoni, A. J Acosta, Hydrodynamics Laboratory, Calif. Inst. of Tech, Pasadena, California.
(d) Unclassified basic research.
(e) Experimental investigation of the lift and moment of a fully cavitating two-dimensional flat plate hydrofoil near a free surface. Pressure distributions and cavity proportions for various angles of attack, cavitation numbers and depth in chords are being found. Basic research, part of which is being done as the thesis for an advanced degree.

(3011) CAVITATION IN AXIAL INDUCERS.

(b) Office of Naval Research, Dept. of the Navy.
(c) Prof. A. J. Acosta, Calif. Inst. of Tech., Pasadena, California.

(d) Experimental; unclassified.
(e) A test circuit and associated equipment suitable for investigating the flow through two-inch diameter axial inducers was made. A large number of experiments were conducted on inducers ranging in blade angle at the tip from 6° to 12°. The solidity and tip clearance was also varied over an appreciable range. The objectives of these tests were to observe the cavitating flow patterns in the impellers studied so as to gain insight as to the detailed flow processes occurring in these devices, to obtain design information, and to see whether any simple physical model of the cavitation breakdown process could be found.
(f) Suspended for the present.
(h) "Experimental Study of Cavitating Axial Inducers", by A. J. Acosta. Second Conference of Naval Hydrodynamics, in preparation.

CALIFORNIA INSTITUTE OF TECHNOLOGY, Sedimentation Laboratory.

(2747) STUDY OF THE DESIGN OF LOW DROPS AND THEIR EFFECT ON THE CAPACITY OF FLOOD CHANNELS.

(b) U. S. Dept. of Agriculture, Soil Conservation Service, Berkeley, Calif.
(c) Prof. Vito A. Vanoni, Sedimentation Laboratory, Calif. Inst. of Tech., Pasadena, Calif.
(d) Experimental investigation carried on by graduate students.
(e) The work is carried out in a specially designed tilted flume to obtain information for use in connection with the design of flood control channels.
(g) Tests have been completed for two drop heights.

(2748) STUDY OF RELATIONS BETWEEN THE TRANSPORT OF SEDIMENT AND THE HYDRAULIC CHARACTERISTICS OF STREAMS.

(b) U. S. Dept. of Agriculture, Agricultural Research Service.
(c) Prof. Vito A. Vanoni, Prof. Norman H. Brooks, Calif. Inst. of Tech., Pasadena, Calif.
(d) Experimental and analytical basic research.
(e) This work, the experimental part of which will be carried on in laboratory flumes, is an extension of the program of sedimentation research which has been carried on by the Sedimentation Laboratory for some time. The program is devoted primarily to a study of the roughness and sediment transport in alluvial streams with anti-dunes and standing surface waves, which are usually associated with Froude numbers in the vicinity of one or slightly greater.

UNIVERSITY OF CALIFORNIA, Division of Agricultural Sciences, Dept. of Irrigation and Soil Science.

(26) DRAINAGE INVESTIGATION IN COACHELLA VALLEY, CALIFORNIA.

(b) Cooperative between the Coachella Valley County Water District, Coachella, Calif.; U. S. Salinity Laboratory, Riverside, Calif.; U. S. Bureau of Reclamation, Boulder City, Nev.; and this laboratory.
(c) Prof. A. F. Pillsbury, Chairman, Dept. of Irrigation and Soil Science, Univ. of Calif. Los Angeles 24, Calif.
(d) Field investigations; applied research and design.
(e) To develop and improve techniques for observing shallow ground water levels and movement, for reclamation of saline and sodic soils, and for drainage design. New experiments being planned to develop more rational criteria for drainage design.
(g) Techniques and criteria developed have resulted in land being adequately drained before problems of salinization developed.

(27) HYDROLOGY OF WATER SUPPLIES IN CALIFORNIA.

(b) Laboratory project coordinated with similar work of Dept. of Irrigation, University of Calif., Davis, and with work of California Forest and Range Exp. Sta., U. S. F. S.
(c) Prof. A. F. Pillsbury, Chairman, Dept. of Irrigation and Soil Science, Univ. of Calif., Los Angeles 24, Calif.
(d) Experimental; applied research.
(e) Factors in watershed management that influence the disposition of precipitation and yield of useable water. Soil and water factors in change of vegetation from brush to grasses and forbs, control of consumption use by phreatophytes, experiments in watershed paving.
(g) Evidence found of modest increases in useable water supply with vegetation manipulation on semi-arid watersheds.

(1058) SOIL PHYSICAL CONDITIONS IN RELATION TO IRRIGATION.

(b) Coordinated laboratory studies with field observations of water transfer in soils.
(c) Prof. A. F. Pillsbury, Chairman, Dept. of Irrigation and Soil Science, Univ. of Calif., Los Angeles 24, Calif.
(d) Continuing laboratory and field studies; basic and applied research.
(e) Study of the soil properties and management practices which affect the flow of water into and through soils, the storage of water in soils and evaporation from soil, and soil compaction.
(f) Inactive in 1958. Work will be resumed in 1959.
(h) "Use of Infiltration Equation Parameters to Evaluate Infiltration Differences in the Field", D. Swartzendruber and M. R. Huberty, Trans. Amer. Geophysical Union 39: 84-93, 1958.

(1303) HYDRAULIC CHARACTERISTICS OF IRRIGATION DISTRIBUTION SYSTEMS.

(b) Laboratory project, cooperative with College of Engineering, Univ. of Calif., Los Angeles 24, Calif.

(c) Prof. A. F. Pillsbury, Chairman, Dept. of Irrigation and Soil Science, Univ. of Calif., Los Angeles 24, Calif.

(d) Basic and applied research.

(e) Continued analysis of the operational characteristics of pipe water distribution systems. Principally concerned with automation in the operation of low pressure systems.

(2504) DYNAMICS OF WATER FLOW IN SATURATED SOILS, AND ITS APPLICATION TO THE DESIGN OF DRAINAGE SYSTEMS.

(b) Laboratory project - coordinated with similar work of Dept. of Irrigation, Davis, Calif.

(c) Prof. A. F. Pillsbury, Chairman, Dept. of Irrigation and Soil Science, Univ. of Calif., Los Angeles 24, Calif.

(d) Experimental; applied research.

(e) Mechanics of flow of water through soil and into drainage facilities.

(g) Mid-point recession rates of water table between drain tile lines has been found to be a good index of subsurface drainage adequacy.

(h) "Shallow Ground Water and Tile Drainage in the Oxnard Plain", by J. D. Isherwood and A. F. Pillsbury, accepted for publication in Trans. Amer. Geophysical Union. "Wetting Expansion of Drain Tile and Effects Upon Water Entry", by A. F. Pillsbury, R. E. Pelishek, and Nathan Buras. Submitted to ASAE for publication.

UNIVERSITY OF CALIFORNIA. College of Engineering, Fluid Mechanics Laboratory.

Inquiries concerning the following projects should be addressed to Prof. J. W. Johnson, Dept. of Engineering, Hydraulic Laboratory, Hesse Hall, University of California, Berkeley 4, California.

(40) FLOW CHARACTERISTICS OF GAS-SOLIDS MIXTURES.

(b) Laboratory project.

(d) Experimental; basic and applied research, design.

(e) The flow characteristics of a gas-solids mixture (Alumina catalyst and air) have been investigated in a 17 mm I.D. glass conduit for various gas flow and solids flow rates. Pressure drops across test sections have been accurately measured for a series of air flow rates in which the solids to air ratio is varied from zero to 11.0 pounds of solids per pound of air. The solids are introduced into the flow system through a mixing nozzle fed by a slide valve controlled weighing tank, and

have a size distribution varying from particles less than 10 microns to particles greater than 220 microns. Investigation on the metering of solids-gas mixtures by nozzle and Venturi-tubes has been carried out. Studies on the heat transfer to flowing gas-solids mixtures have been carried out and are being continued. Metering and heat transfer studies are being continued using fixed size glass spheres.

(g) Equipment for the study of the heat transfer characteristics of flowing mixtures has been modified to study the behavior of very dense mixtures.

(h) "Heat Transfer to Flowing Gas-Solids Mixtures in a Circular Tube", by Leonard Farbar and Morgan J. Morley, Industrial Engineering Chemistry, Vol. 49, p. 1143, July 1957. "Heat Transfer to Flowing Gas-Solids Mixtures Using Solid Spherical Particles of Fixed Size", by C. A. Depew, M. S. Thesis, 1957, University of California Library, Berkeley, Calif.

(280) SEDIMENT TRANSPORT.

(b) Laboratory project and U. S. Corps of Engineers.

(d) Experimental and theoretical.

(e) Various fundamental problems in relation to sediment transport have been studied, and efforts have been made to apply the results of research to solve practical problems.

(f) Suspended.

(g) The changes in the bed-load relationships are studied as they result from high sediment concentrations near the bed. No results are available as yet.

(h) "Effects of Heavy Sediment Concentration Near the Bed on the Velocity and Sediment Distribution", H. A. Einstein and Ning Chien, University of California Institute of Engineering Research Report, Series 33, Issue No. 2.

(529) LITTORAL SEDIMENT FLOW UPON A BEACH.

(b) Beach Erosion Board, Dept. of the Army, Washington, D. C.

(d) Field, laboratory; experimental and theoretical research.

(e) The object of this investigation is to study the regimen of 18 beaches in the vicinity of San Francisco. The beaches studied are Point Reyes Beach, Drakes Cove on the south side of the Point Reyes peninsula, Stinson Beach near Bolinas Bay midway between Drakes Cove and the Golden Gate, and several beaches along the coast south of the Golden Gate extending from the Cliff House at the north end of Ocean Beach to Rockway Beach 11 miles to the south. The beaches have been occupied at intervals from 2 weeks to 3 months for the past two years. The beaches build forward during spring and fall and erode back during winter and spring. The grain size is 40 to 75 percent coarser and the

sorting about 10 percent poorer in spring than in fall. The beaches north of the Golden Gate may advance and retreat as much as 100 feet in the course of a year whereas those south of the Gate rarely migrate more than 50 feet in the course of a year. The berms are one to two feet higher in winter and spring than in summer and fall. The average grain size on Point Reyes Beach is about 600 microns, at Drakes Cove and Stinson Beach, 200 microns, 275 microns at the Cliff House and 425 microns at Rockway Beach. The sorting on all the beaches ranges mainly between 1.25 and 1.30 except at Drakes Cove where the average is 1.18. Berm height averages about 16 feet at Point Reyes Beach, 8 to 9 feet at Drakes Cove and Stinson Beach and 11 feet at the Cliff House and 13 feet at Rockway Beach. Sand on all the beaches evidently migrates both up and down during the course of a year, but data are lacking as to which is the prevalent direction of drift except at Point Reyes Beach where most of the drift comes from the mainland to the east of Tomales Bay.

(h) "Beaches near San Francisco, California 1956-1957", by Parker D. Track, Univ. of California Publ. Inst. Engineering Research, Series 14, Issue 21, 101 pages, November 1958.

(1554) SEA WATER RESEARCH.

(b) State of California.
(c) Prof. E. D. Howe, 177 Richmond Field Sta., University of California, Richmond, Calif.
(d) Experimental, theoretical, field investigation, and pilot plant; basic research, applied research, design and operation.
(e) The purpose of this investigation is to discover whether there is available any method for the large-scale, low-cost demineralization of sea water.
Operation of the solar stills was continued, with an additional wick-type still in operation. Also, a small project was carried out on the use of paraffin wax as a heat absorber and storage material. The data on the large Low-Temperature-Difference plant is being extended to the study of carry-over of gas and brine. The U.C.L.A. program of work on the use of reversed osmosis was continued and a larger unit has been constructed. Work was initiated at Berkeley on a means for constructing high strength osmotic membranes. The Berkeley development consists of the use of bundles of parallel fibers with flow parallel to the fibers. By using synthetic materials which swell in water, it has been possible to get down to pore sizes of the order of a few Angstroms. Present efforts are directed toward reducing these pore sizes.
(g) Detailed results may be obtained from the progress reports published by the Inst. of Engineering Research.
(h) "Research on the Demineralizing of Water", Proceedings of the 1958 Annual Dairy

Industry Conference, U. C., Davis, January 27, 1958.
"Status of Sea Water Conversion Research", Trans. of the Amer. Geophysical Union, Vol. 39, No. 3, June 1958, pp. 540-41.
"Upgrading of Brackish Waters", Proceedings on Conference on Quality of Water Irrigation, Jan. 1958, Water Resources Center Contribution No. 14.
"Water for Industrial Use: Prospects of its Being Obtained by De-Salinization of Sea Water", prepared for the 2nd Annual Water Resources Conference, Montana State University, Missoula, Mont., June 28, 29, 1957. Paper prepared for publication but exact title and publication date unknown.
"Progress in Conversion of Saline Water", Journal American Water Works Association, Vol. 50, No. 3, March 1958.
"Fresh Water from Saline Sources", Chapter in book "An Introduction to Solar Energy", edited by A. M. Zarem, Pub. McGraw-Hill Book Co. Also published in Natural Resources Volume 1957, UCLA.

(1823) THE MECHANICS OF BOTTOM SEDIMENT MOVEMENT WITH OSCILLATORY WAVES.

(b) Beach Erosion Board.
(d) Experimental; basic research.
(e) To obtain experimental information on the criterion for initial and general movement of bottom sediment by wave action. Prototype conditions of the relative motion of water and bed were simulated by use of an oscillating plate in still water.
(g) A theoretical solution has been found for the turbulent boundary layer flow along an oscillating surface and was empirically checked for the smooth bottom. A solution has been found for the rough wall, but must be checked for various different types of roughness.
(h) "Stability of Oscillatory Laminar Flow Along a Wall", by Huon Li, USA Corps of Engineers B.E.B. Techn. Memo. No. 47, July 1954.
"Mechanics of Bottom Sediment Movement due to Wave Action", by Madhav Manohar, USA Corps of Engineers B.E.B. Tech. Memo No. 75, June 1955.
"Turbulent Flow Near an Oscillating Wall", by G. Kalkanis, USA Corps of Engineers B.E.B. Tech. Memo. No. 97, July 1957.

(1825) WIND WAVES IN SHALLOW WATER.

(b) Beach Erosion Board, Dept. of the Army.
(d) Experimental.
(e) To obtain experimental information on the factors of wind velocity, wind duration, water depth, bottom slope, and bottom roughness as related to wave generation and wind tide produced in shallow water of limited extent. A glass-wall channel 70 ft long, 15 inches deep, and 12 inches wide has been constructed for this study.
(f) Completed.
(h) "Effects of Reefs and Bottom Slope on Wind Setup in Shallow Water", by E. G. Tickner,

IER, University of California, Series 71, Issue 10, February 1958. "Transient Wind Tides in Shallow Water", by E. G. Tickner, IER, Univ. of Calif., Series 71, Issue 11, September 1958.

(1829) STUDY OF INCLINED GAS-LIQUID FLOW IN TUBES

(b) Laboratory research project.
(d) Experimental and theoretical; basic.
(e) Collection and correlation of data on several diameters of tubing at inclinations from horizontal to vertical.
(f) Completed.
(g) One-inch diameter smooth and rough tubes tested. Paper in preparation.
(h) "Two-Phase Flow in Rough Tubes", by D. Chisholm and A. D. K. Laird, Trans. ASME, Vol. 80, 276, 1958.

(2058) STUDY OF EXCHANGE CHARACTERISTICS IN A TURBULENCE COLUMN.

(b) Laboratory project, thesis study.
(d) Experimental.
(e) Exchange of various properties are studied and compared for various properties in a column with reproducible turbulence pattern.
(f) Suspended.
(g) The column is constructed. Sediment distributions are observed for various degrees of turbulence. One of the major results is the fact that a high velocity jet is much less efficient in creating large scale turbulence than wall friction in open channel flows.

(2059) STUDY OF BED-LOAD MOTION IN A FLOW SUBJECTED TO COMPOSITE FRICTION.

(b) Laboratory project.
(d) Experimental; thesis study.
(e) A granular bed is developed between a system of obstructions such as piles. It is attempted to determine the part of the flow resistance which determines the rate of sediment motion.
(f) Experimental work completed.
(g) In a thesis study limitations are investigated to the independence of frictional drag forces.

(2062) STRESS-STRAIN RELATIONSHIPS FOR SHEAR IN A SAND-WATER MIXTURE.

(b) Laboratory project.
(d) Experimental; basic research.
(e) The relationship is determined in an especially constructed rotating shear device for various normal pressures. The results will be used to predict the behavior of a granular stream bed subjected to high shear by a flow.
(g) Results have been obtained. Work is now concentrating on the analysis of the results.

(2063) METHODS OF DETECTING AND TRACING THE MOVEMENT OF GROUND WATER.

(b) U. S. Bureau of Reclamation.
(d) Experimental; applied research.
(e) This study has as its objectives study of velocity variations observed in tracing the flow of liquids through porous media, development of methods and tracers for field determination of water movement underground, and application of these methods to location and measurement of seepage from canals.
(g) A study was made of five sands to relate the medium dispersion constants to pore size distributions, which were determined from moisture tension curves. No well defined relation could be established.
(h) "Studies of Flow Dispersion in Porous Media", by Leung-ku Lau, W. J. Kaufman, G. T. Orlob, and D. K. Todd, IER, Series No. 93, Issue No. 4, Univ. of Calif., 67 pp., July 1958.

(2261) WAVE REFRACTION RESEARCH.

(b) Beach Erosion Board, Dept. of the Army, Washington, D. C.
(d) Laboratory.
(e) In shallow water the velocity of a water gravity wave depends upon the depth of water as well as upon the length of the wave. When it travels in shoaling water it bends. This refraction changes the wave height and direction. Powerful graphical and analytical tools are available for use by the engineers; however, there is an almost complete lack of evidence as to their accuracy. The purpose of this contract has been to perform laboratory experiments to check the validity of the techniques used in practice. The first series of tests was performed in a ripple tank; these showed that the techniques were fairly reliable from a practical standpoint. A series of tests has been made in a model basin 150 ft by 64 ft by $2\frac{1}{2}$ ft deep. The results of these tests have been published. Tests have been conducted on the formation of multi-crest waves as periodic waves pass into shoal water, and the results have been found to compare favorably with theory.
(h) "Model Study of Wave Refraction", by R. L. Wiegel and A. L Arnold, Tech. Memo. No. 103, Beach Erosion Board, Corps of Engineers, U. S. Army, 31 pp., Dec. 1957.

(2262) ANCHORING FORCES RESEARCH.

(b) Shell Development Company.
(d) Laboratory.
(e) Model studies are being made of the forces in mooring lines of specially designed anchored vessels at sea. Tests are being made with uniform wave conditions.

(2265) FORCES ON ACCELERATED CYLINDERS.

(b) Engineering Foundation and laboratory project.
(d) Experimental; basic research.
(e) Measurement of drag coefficients and flow

configurations about cylinders during ac-
celerated motion in fluids as related to
wave forces as cylinders.

(h) "Forces on Cylinders in Constant Linear
Acceleration and Uniform Motion in Water",
A. D. K. Laird, C. A. Johnson, R. W.
Walker. Journal Waterways and Harbors
Division, Am. Soc. Civil Engineers (in
press).

(2505) EFFECT OF SEDIMENT DISTRIBUTION IN STREAM
CHANNELS.

(b) University project.
(d) Experimental; basic research.
(e) Alluvial flows in channels with artifi-
cially secured banks are studied system-
atically for their tendency to meander as
expressed by the development of alternate
bars. It is the aim of this study to de-
velop criteria for stability.
(f) Suspended.
(g) The important parameters seem to be the
Froude's number, the depth-width ratio and
the size and uniformity of the bed sedi-
ment.

(2506) SEDIMENT MOTION IN SILT CARRYING STREAMS.

(b) National Science Foundation.
(d) Experimental; basic research.
(e) An alluvial stream with a bed material in
the sand sizes or coarser follows relation-
ships generally called bed-load formulas.
This study tries to find what the corre-
sponding laws are if the bed sediment con-
sists mainly of particles in the silt
sizes as fines.
(g) The transport of silts coarser than 5 mi-
crons seem to follow laws very similar to
those for fine sand.

(2507) SAND DEPOSITS IN CANALS.

(b) U. S. Bureau of Reclamation.
(d) Experimental; basic research.
(e) The relationships are sought governing the
deposit of various sediment sizes and
types of lined canals under various flow
conditions. Of particular interest is any
resulting change of the effective channel
roughness and of its flow capacity.
(g) The case of fine sediment on a rough bottom
has been solved. The case of coarse sedi-
ment on a smooth bottom is being investi-
gated.

(2508) SHIP WAVES IN WATERWAYS.

(b) Laboratory project.
(d) Experimental.
(e) To obtain experimental information on the
characteristics of waves generated by
ships in shallow water. Such information
is of value in the problem of wave wash
and bank erosion in waterways. Ship models
are towed at various speeds in water of
various depths and the wave characteristic
measured at various distances from the
sailing line.

(f) Completed.
(h) "Ship Waves in Navigation Channels", by
J. W. Johnson, Proceedings of the Sixth
Conference on Coastal Engineering, pp.
666-690, 1958.

(2509) NON-STEADY FLOW ANALOGY.

(b) Department of Water Resources, State of
California.
(d) Experimental; applied research.
(e) By means of an electric analog model of
the San Francisco Bay and the Sacramento-
San Joaquin Delta Region, the feasibility
of barriers and channel works is being in-
vestigated, with the purpose of providing
a greater flow of fresh water southward in
the Central Valley.
(f) Completed.
(g) The tidal amplitude changes which should be
expected due to the imposition of each of
several proposed salinity barriers have
been predicted, and are in accordance with
analytic results where these are available.
Prototype tidal amplitudes, phases, and
currents were duplicated in the analog
model within three to five percent at all
major points. A new type of square-law
resistor has been developed which takes
into account changes in the water depth.
(h) "The Theoretical Basis for Non-Linear
Electric Analogs for Open Channel Flow",
James A. Harder, Inst. of Engineering Re-
search, Univ. of Calif., Berkeley 4, Calif.
"An Electric Analog Model Study of Tides
in the Delta Region of California", James
A. Harder, Inst. of Engineering Research,
Univ. of Calif., Berkeley 4, Calif.

(2750) DROP STRUCTURE WITH SELF-DRAINING STILLING
BASIN.

(b) U. S. Department of Agriculture.
(d) Experimental; development.
(e) Stilling basins with permanent pools are
dangerous to playing children and make
mosquito breeding places, both undersirable
in inhabited areas. A stilling device is
developed which is self draining and which
is efficient at widely varying tailwater
conditions.
(f) Completed.
(g) Solutions for a range of cases have been
found and some have been constructed.
(h) "Tailwater Characteristics of Drop Struc-
tures", by G. Kalkanis, IER Series ES6044,
Issue No. 1, April 1958.

(2751) DEVELOPMENT OF A TRASH RACK AND INTAKE
STRUCTURE TO BARREL TYPE SPILLWAYS.

(b) U. S. Department of Agriculture.
(d) Experimental; development.
(e) Barrel type spillways can highly increase
the effectiveness of small flood control
retaining basins, if they can be prevented
from plugging by floating trash. An effec-
tive intake and trash rack is developed
from the viewpoint of clogging.
(f) Completed.

(g) A syphon-type intake with low intake velocity appears to provide for the most desirable hydraulic and trash conditions.

(h) Project report in preparation.

(2752) REVOLVING FISH SCREEN.

(b) California Dept. of Fish and Game.

(d) Experimental.

(e) Development and testing of a revolving fish screen which continuously rotates in front of a hydraulic cleaning device.

(f) Completed.

(g) Head-loss coefficient found to be about 6.0.

(h) Final report forwarded to Dept. of Fish and Game, Sacramento 19, Calif.

(2753) HYDRAULIC BREAKWATER.

(b) Office of Naval Research, Dept. of the Navy.

(d) Experimental; applied research.

(e) Determination by model tests of the mechanisms by which hydraulic breakwaters dampen water gravity waves.

(g) Three-dimensional tests in a model basin show that the effect of wave refraction due to the currents generated by the hydraulic breakwater is of primary importance. For certain conditions the area in the lee of the breakwater can be made to be almost free of waves, while for other conditions the waves behind the breakwater will be higher than if there were no hydraulic breakwater in operation.

(2754) UNDERWATER MISSILES.

(b) U. S. Naval Ordnance Test Station, China Lake, California.

(d) Experimental; applied research.

(e) The determination of the trajectories of missiles fired vertically under the influence of water gravity waves and currents.

(f) Completed.

(g) Analysis of data has been completed.

(2755) DEVELOPMENT OF METHODS TO TRACE SEDIMENTS USING RADIOACTIVE MATERIALS.

(b) U. S. Corps of Engineers.

(c) Prof. H. A. Einstein, Univ. of Calif., College of Engineering, Berkeley 4, Calif.

(d) Experimental; theoretical and field.

(e) Radioactive materials are sought which can be permanently attached to sediment grains from the sand to the clay sizes. The instrumentation is to be developed by which these tagged sediments can be observed in prototype water courses, particularly in the San Francisco Bay.

(g) Scandium-46 and gold-198 have been found to be the best suited materials. The instrumentation for field detection of radio activity has been developed, and some field tests are completed.

(h) "First Annual Progress Report on the Silt Transport Studies Utilizing Radioisotopes", by R. B. Krone, 117 pp., December 1957.

Obtain from author at U.C.E.F.S., 1301 South 46 Street, Richmond, California.

(3012) RADIAL FORCES IN A RADIAL FLOW CENTRIFUGAL PUMP.

(b) Laboratory project.

(d) Theoretical and experimental; basic and applied research.

(g) Radial forces on the impeller of a radial flow centrifugal pump were measured and were correlated with forces evaluated from the measured pressure distribution in the volute of the pump. A mixing analysis was made of the flow conditions in the volute. The volute pressure distributions and resulting radial forces were predicted. The analysis was extended to show the influence of the mixing in the volute on the pump performance.

(h) "Centrifugal Pump Radial Load", by R. E. Rolling, M.S. Thesis, January 1958. "Pressure Distribution in the Volute of a Radial Flow Centrifugal Pump", by J. J. Carlson, M.S. Thesis, June 1958.

(3013) ARTIFICIAL INCREASE OF FRICTION IN ALLUVIAL CHANNELS.

(b) U. S. Department of Agriculture.

(d) Experimental.

(e) Decrease of flow velocities and consequently prevention of erosion in alluvial channel with limited capacity can be effected by increasing artificially the friction.

(g) Low sills placed on the banks at properly determined intervals, result to a uniform dissipation of the excess energy along the channel.

(3014) ENERGY DISSIPATION IN LINED CHANNELS.

(b) California State Dept. of Public Works, Division of Highways, San Francisco Office.

(d) Experimental.

(e) Drops on the bed of lined channels to reduce longitudinal slopes proved uneffective. The purpose of the study was to develop a type of structure which would dissipate the excess energy more effectively.

(f) Completed.

(g) An arrangement consisting of three pairs of sills placed on the banks of the channel at equal spacings of about 30 feet downstream from each drop proved satisfactory.

(h) Project Report "Los Gatos Channel Energy Dissipators" in preparation.

(3015) EDDY DIFFUSION IN OPEN CHANNEL FLOW.

(b) Water Resources Center and Sanitary Engineering Research Laboratory, Univ. of Calif., Berkeley, Calif.

(c) Prof. G. T. Orlob, 412F Hesse Hall, Univ. of Calif., Berkeley, Calif.

(d) Experimental verification of theories of eddy diffusion in statistically homogeneous flow. Basic research for doctoral thesis.

(e) Objectives of investigation included de-
velopment of technique of determining
scale of eddies and turbulence intensity
and the experimental verification of the
Kolmogoroff-von Weizsächer similarity
principle and the Richardson "Four-thirds
Law." The theory of eddy diffusion by
continuous movements as originally derived
by Taylor provided the basis for the ex-
perimental determination of scale and tur-
bulence intensity. A broad open channel
with a rough bottom served to produce a
turbulence which was statistically homo-
geneous in two dimensions. Dispersion
patterns of floating polyethylene discs
were analyzed in relation to scale, tur-
bulence intensity, energy dissipation,
Reynolds number, and Schmidt number. The
coefficient of eddy diffusion was related
to each of these factors.

(g) A simple method of determining eddy scale
and turbulence intensity from particle
dispersion patterns was developed. The
Kolmogoroff-von Weizsächer similarity
principle was verified experimentally.

(h) "Eddy Diffusion in Open Channel Flow",
Ph.D. Thesis, Stanford University, Jan.
1959.
"Eddy Diffusion in Open Channel Flow",
contribution No. 19 Water Resources
Center, Univ. of Calif., Berkeley, Calif.,
January 1959.

(3016) ARTIFICIAL ROUGHNESS IN OPEN CHANNELS.

(b) Laboratory project.
(d) Experimental thesis for Master of Science.
(e) The purpose of the study was to determine
the effect of the spacing of a center row
of piles on the carrying capacity of a
channel and to compare the friction
losses of a solid wall to those obtained
from the above series of tests.
(f) Completed.
(g) The drag force obtained by computation
from theory was compared to the actual
measured force per linear foot and a pres-
entation of the separation and vortex for-
mation theory was made. The mutual inter-
ference due to the spacing of the piles
has been found and given in relation with
the dimensionless parameter, spacing over
diameter, of the central row of piles.
(h) "Artificial Roughness in Open Channels",
by Aristides C. Liukopoulos, Master of
Science Thesis in Engineering.

(3017) HELIUM AS A GROUND WATER TRACER.

(b) Laboratory project.
(d) Experimental and field; applied research.
(e) The purpose of this work is to determine
the feasibility of helium as a ground
water tracer. Included in the study have
been methods of adding helium to water,
methods of recovery and analysis, and rate
of loss of helium from ground water.
(g) Helium was traced through 188 feet of con-
fined aquifer. The breakthrough curve of
helium was found to lag behind the break-

through of chloride tracer. A pressure-
volume apparatus has been constructed and
tested for separating and analyzing dis-
solved helium gas concentrations of 0.004
to 1.5 ppm in water.

(3018) GROUND WATER INFLOW.

(b) Laboratory project.
(d) Experimental; applied research.
(e) Investigation of seepage from leveed
rivers during high stages into adjacent
agricultural lands. An electric analogy
model is being constructed to study flows
under various boundary conditions, through
layered soils, and through anisotropic
media.

(3019) ANALOG MODELS FOR HYDRAULIC SYSTEMS.

(b) Committee on Research in Water Resources,
University of California.
(d) Experimental and theoretical; design and
development.
(e) Electric analog elements to represent all
major hydraulic features of a flood con-
trol project are being designed and con-
structed, with the purpose of devising a
tool enabling hydraulic engineers to op-
timize the design and operation of flood
control systems.

(3020) BOUNDARY LAYER FRICTION IN THE DOLPHIN.

(b) Laboratory project.
(d) Experimental; basic research.
(e) Purpose is to elicit whether there is an
anomaly in skin friction of dolphins.

(3021) A HYDRAULIC STUDY OF SUSPENSION AND TRANS-
PORT OF ORGANIC SEDIMENTS IN HIGH-RATE
PONDS.

(b) Laboratory project.
(c) Field Station, University of California,
Richmond, California.
(d) Field investigation; design and operations.
(e) The velocity of flow is to be varied from
0 to 2 feet per second in a high rate
sewage stabilization pond. Observations
will be made of the formation, sedimenta-
tion, suspension, transport, and ultimate
oxidation of organic sediments as a func-
tion of flow velocity.
(g) New project--upper limiting velocities for
total sediment transport appear to be
about 1 foot per second. Studies of lower
velocities are in progress.
(h) "Studies of Photosynthetic Oxygenation
Pilot Plant Experiments", William J.
Oswald, Edwin M. Lee and H. B. Gotaas,
Univ. of Calif., I.E.R. Series 44 No. 9,
pg. 115, January 1958.

(3022) FLOATING BREAKWATER.

(b) U. S. Navy Civil Engineering Laboratory.
(d) Analytical and experimental; applied re-
search.
(e) Analytical and experimental studies of

new concepts of floating breakwaters.

(g) Several new concepts have been investigated. One of these systems consisted of a series of long plastic tubes (slightly buoyant) connected side by side and filled with water. The effectiveness of the system was remarkable for wave lengths of the order of one-half the tube length, or less.

(3023) PRESSURE GENERATED WATER WAVES.

(b) National Science Foundation.
(d) Experimental; basic research.
(e) This is a study of the coupled waves generated by a pressure area moving over the water surface, both two dimensional and three dimensional; in addition, analytical studies are being made of long waves.
(g) The cnoidal wave theory has been reduced to the form that rapid calculations can be made with it, using curves and tables. Laboratory tests in three dimensions have been made to determine the limit of the effect of surface tension. Tests are now being conducted well within the gravity wave regime.

UNIVERSITY OF CALIFORNIA, Department of Naval Architecture.

(3024) STABILITY OF VESSELS IN A SEAWAY.

(b) Society of Naval Architects and Marine Engineers.
(c) Mr. John R. Paulling, Jr., Room 224, Bldg. T-3, Univ. of Calif., Berkeley, Calif.
(d) Experimental and theoretical; applied research.
(e) A study of the effect of the seaway on the transverse stability and capsizing of ships.
(g) Studies of stability of a ship in a longitudinal seaway have been completed.
(h) "Stability and Rolling of Ships in a Following Sea", by J. R. Paulling, Jr., Univ. of Calif., IER Report, Series 121, Issue 1, August 1958.

(3025) STABILITY OF TUNA CLIPPERS.

(b) University of California.
(c) Mr. J. R. Paulling, Jr., Room 224, Bldg. T-3, Univ. of Calif., Berkeley, Calif.
(d) Theoretical and experimental; applied research.
(e) A study of the transverse stability of a class of fishing vessels while operating in a seaway.
(g) The transverse stability of tuna clippers while operating in a seaway may be appreciably less than that computed by the designer using conventional methods.
(h) "Certain Factors Influencing the Transverse Stability of Tuna Clippers", to be presented at the Second World Fishing Boat Congress sponsored by FAO of UN, Rome, Italy, in April 1959.

(3026) SHIP RESISTANCE IN UNIFORM WAVES AS A FUNCTION OF WAVE STEEPNESS.

(b) David Taylor Model Basin, Dept. of the Navy.
(c) Mr. O. J. Sibul, Dept. of Naval Architecture, Univ. of Calif., Berkeley 4, Calif.
(d) Experimental (laboratory).
(e) A series of experiments were performed to study the effect of wave steepness on the resistance of the ship. The 5-foot model, Series 60 of 0.60 block coefficient, was towed in waves five feet long at nine different wave heights so that the wave steepness H/λ varied between 0.0684 (1:14.6) and 0.0146 (1:68.5). The resistance of the ship in still water was measured in a separate experiment so that the added resistance due to the oncoming waves could be computed.
(f) Completed.
(g) The results indicate that the added resistance coefficient depends upon the Froude number and the steepness of the waves. The lower the Froude number, the higher the added resistance coefficient. For a given Froude number, the added resistance coefficient increases as the 1.9 power of the wave height.
(h) "Ship Resistance in Uniform Waves as a Function of Wave Steepness", by O. J. Sibul and G. Reichert, Univ. of Calif., IER Report, Series 61, Issue 14, June 1957.

(3027) MOTION OF SHIPS OF SHALLOW DRAFT IN LONG-CRESTED PROGRESSIVE WAVE SYSTEMS.

(b) David Taylor Model Basin, Dept. of the Navy.
(c) Mr. O. J. Sibul, Dept. of Naval Architecture, Univ. of Calif., Berkeley 4, Calif.
(d) Theoretical; basic and applied research.
(e) An investigation was made of the oscillations of a long ship of shallow draft placed broadside to a long-crested progressive wave system. Later the methods developed were applied also in case the ship is subject to a uniform translational motion in a direction perpendicular to the wave crest. The method used is based on an integral equation approach.
(f) Completed.
(h) "Motion of Ships of Shallow Draft", by R. C. MacCamy, Univ. of Calif., IER, Series 61, Issue 10, December 1956. "Motion of Ships of Shallow Draft with Forward Velocity", by R. C. MacCamy, Univ. of Calif., IER, Series 61, Issue 15, May 1958.

(3028) A GAGE FOR THE MEASUREMENT OF PRESSURE DISTRIBUTION ON 5-FOOT SHIP MODELS IN WAVES.

(b) David Taylor Model Basin, Dept. of the Navy.
(c) Mr. O. J. Sibul, Dept. of Naval Architecture, Univ. of Calif., Berkeley 4, Calif.
(d) Applied research; design.
(e) The gage is flush-mounted so that the flow around the model is not disturbed. The active diameter of the gage is 1/4 inch; the frequency response from 0 to 2,500 cps, and sensitivity from 0.1 inch up to

12 inches of water. The gage is of capaci-
tance-type and is to be used in conjunc-
tion with an ionization transducer patented
and manufactured by Decker Aviation Co.
- (f) Suspended.
- (h) Report is in preparation.

(3029) REPRODUCTION OF RECORDED OCEAN WAVES IN A
SHIP MODEL TOWING TANK.

- (b) National Science Foundation (a grant for
the purchase of equipment) and University
of California research funds.
- (c) Mr. O. J. Sibul, Dept. of Naval Architec-
ture, Univ. of Calif., Berkeley 4, Calif.
- (d) Basic research; applied research, design.
- (e) The work undertaken under this program was
the design and construction of a power and
control system for the existing wave gen-
erator, such that a recorded ocean wave in
a desired scale could be reproduced in the
towing tank. The system utilizes a mag-
netic tape input to servomechanism which
makes the wave-generator follow a pre-
scribed time-distance curve.
- (h) "Reproduction of Recorded Ocean Waves in
a Ship Model Towing Tank", by M. H. Dost,
Univ. of Calif., IER, Series 61, Issue 16,
May 1958.

CASE INSTITUTE OF TECHNOLOGY, Dept. of Civil Engi-
neering and Engineering Mechanics.

Inquiries concerning the following projects should
be addressed to Prof. Boris S. Browzin, Case In-
stitute of Technology, Cleveland 6, Ohio.

(3030) TRANSIENT FLOW THROUGH POROUS INCOMPRESS-
IBLE MEDIA WITH VARIOUS BOUNDARY CONDITIONS.

- (b) National Research Council of Canada.
- (d) Experimental and theoretical; basic re-
search.
- (e) The unsteady laminar flow was reproduced
by a highly viscous liquid flowing between
closely spaced translucid plates on a
number of models with geometric boundaries
representing various types of earth dams
on impervious foundations and earth mas-
sives crossed by open channels, when hy-
draulic boundary conditions are of tran-
sient character with respect to the time.
- (g) An approximate function, relating by di-
mensionless parameters the shape and the
position of free surface of flow through
an earth dam following rapid reservoir
drawdown, the degree of drainage and the
time to the geometry of an homogeneous
dam, was obtained theoretically and con-
firmed by experiments.
- (h) "Transient Flow Through Earth Dams", pre-
liminary report. Proceedings of the 10th
Canadian Soil Mechanics Conference, Sec-
tion 14, p. 59, Ottawa.

(3031) THE VARIATION OF HYDROLOGIC FACTORS AND
THEIR INFLUENCE ON RIVER REGIMES IN THE
GREAT LAKES-ST. LAWRENCE DRAINAGE AREA.

- (b) Laboratory project.
- (d) Basic research.
- (e) Research is based on long range flow and
meteorologic record. Flow and precipita-
tion data on U. S. and Canada stations
were statistically investigated in order
to obtain river regime characteristics.
Other climatic, geologic and botanic data,
will be included, depending on availability.
- (g) Classified discharges and precipitation
for long range gauging and meteorologic
stations are calculated. Characteristic
parameters for river classification of
the area are obtained.

(3032) REGULATION OF SEVERAL RIVERS FOR COMBINED
MAXIMUM FIRM POWER ON SEVERAL STATIONS.

- (b) Laboratory project.
- (d) Theoretical; applied research.
- (e) A study is made to facilitate economic
design of hydro-power developments and
storage dams in cases outlined above.
- (g) A graphical method is obtained to deter-
mine the theoretical regulation of flow
simultaneously on several rivers by reser-
voirs of given volumes in order to obtain
maximum combined firm power on several
stations working in a single system.

COLORADO STATE UNIVERSITY, Civil Engineering Sec.

(55) SNOW COURSE MEASUREMENTS AND FORECAST
ANALYSIS.

- (b) Soil Conservation Service, Colorado Agri-
cultural Experiment Station.
- (c) Mr. Homer J. Stockwell, Soil Conservation
Service, Colorado State Univ., Fort Collins
Colo.
- (d) Field investigations; applied research.
- (e) Systematic measurements of depth and water
content of snow at high elevations in
Colorado mountain areas for the purpose of
forecasting the runoff of the principal
rivers of the state in the interest of
irrigation, power, domestic supplies, and
other uses. The use of electrical resist-
ance soil moisture units is being tested
to determine a factor of soil moisture
deficiency for water supply forecast pur-
poses.
- (g) Snow measurement data are correlated with
runoff. Once the relationship is estab-
lished, the snow measurement data are used
to predict the runoff for the coming sea-
son.
- (h) Colorado Agricultural Experiment Station
General Series Papers--Monthly Snow Sur-
vey Reports for the Rio Grande, Colo. and
Platte-Arkansas Drainage Basin.

(821) GROUND-WATER FLUCTUATIONS AND THEIR RELA-
TION TO PUMPING.

- (b) Colorado Agricultural Experiment Station.
- (c) Mr. M. Bittinger, Civil Engineering Sec.,
Colo. State Univ., Fort Collins, Colo.

(d) Field investigation.

(e) The work consists of semi-annual measurements of the depth to the water table in about 260 observation wells in the Arkansas and South Platte Valleys in Colorado. Observation wells are strategically located in pumping areas. Data on power consumption are also gathered for comparison with water-table elevations. The work is coordinated with the Ground Water Branch, U.S.G.S.

(g) Favorable weather in 1957 and 1958 has resulted in significant recoveries of the water table in nearly all areas of the South Platte and Arkansas Basins. However, areas with limited recharge possibilities continued to decline.

(h) "Water Table Fluctuations in Eastern Colorado", by W. E. Code, Colo. State Univ. Agr. Expt. Sta. Bulletin 500-s, 34 pp., August 1958.
"Leaky Reservoir Aids Water Table", Colo. Farm and Home Research, Vol. 9, No. 1, pp. 3-4, summer 1958.

(1074) HYDRAULICS OF STILLING BASINS.

(b) U. S. Bureau of Public Roads.

(c) Mr. G. L. Smith, Civil Engineering Sec., Colorado State University, Fort Collins, Colorado.

(d) Experimental; applied and fundamental.

(e) This study consists of several phases. The first phase, which has been completed, was development of generalized design criteria for stilling basins for cantilevered pipe flow. The stilling basin is a pre-shaped scour hole in an alluvial bed armorplated with well graded riprap. The second phase of the study, which is in progress, is to investigate the efficiency of the armorplated, pre-shaped stilling basin in scour control for different boundary geometry.

(g) Scour in alluvial beds increases with an increase in channel width. The contributing factor to the increased rate of scour is growth and vortex action of secondary currents transverse to the direction of jet flow. Armorplating of channel banks is essential to stability of alluvial channels. Decreasing the slope of the channel banks increases the effectiveness in scour control of the armorplated, pre-shaped stilling basins and banks.

(h) "Analytical Study of the Mechanics of Scour for Three-Dimensional Jet", by Y. Iwagaki, G. L. Smith and M. L. Albertson, Colorado State University, Civil Engineering Dept., (in preparation).
"The Manifold Stilling Basin", by G. R. Fiala and M. L. Albertson, Colo. State University, Civil Engineering Dept., Report No. CER58MLA35.

(1837) SEALING OF IRRIGATION CANALS BY BENTONITE SEDIMENTING.

(b) U.S.D.A. Agricultural Research Service, several irrigation companies.

(c) Mr. R. D. Dirmeyer, Jr., Asst. Geological Engineer, Colo. State Univ., Fort Collins, Colorado.

(d) Applied research and development; both field and laboratory investigations.

(e) Research and development investigations are being carried on at five field sites in operating canals: (1) Twin Lakes (Colo.) site in fractured rock; (2) Coors Farm (Colo.) site in sand and gravel; (3) Coachella Canal (Calif.) site in dune sand; (4) Lateral 1 (Wyo.) site in dune sand; (5) Lateral 19.3 (Nebr.) site in loessial soil. Purpose of research and development activities is to develop practical and effective canal sealing methods for irrigation canals in a representative range of pervious materials and operational conditions.

(g) As a result of development work to date, two normally satisfactory methods for sealing irrigation canals have been developed. Additional development work is needed, but in general the two methods are: (1) For fractured rock--multiple dam method involving use of bentonite and saw-dust, and (2) for sandy and loessial soils--Wyoming method involving use of bentonite-water mixture with harrowing of canal bottom and sides during the bentonite ponding and sealing procedure.

(h) "Interim Report on the Bentonite Sediment Sealing Activities in the Trans-Mountain Diversion System of the Twin Lakes Reservoir and Canal Co.", by R. D. Dirmeyer, Jr., Colo. State Univ., Civil Engineering Sec., Report No. CER58RDD15, April 1958.
"Interim Report on Bentonite Sediment Sealing Activities in Lateral E-65-19.3 of the Central Nebraska Public Power and Irrigation District", by R. D. Dirmeyer, Jr., Colo. State Univ., Civil Engineering Section, Report No. CER58RTS25, Aug. 1958.
"Report on Laboratory Testing of the Sediment-Sealing Method", by E. C. Newman, Colo. State Univ., Civil Engineering Sec., Report No. CER57ECN19, August 1957.
"Report on Laboratory Testing of the Sediment-Sealing Method", by R. T. Shen, Colo. State Univ., Civil Engineering Sec., Report No. CER57RTS20, August 1957.

(2066) STUDY OF OPEN CHANNEL CONSTRICTIONS IN A SLOPING FLUME.

(b) U. S. Bureau of Public Roads.

(c) Dr. H. K. Liu, Civil Engineering Section, Colo. State Univ., Fort Collins, Colo.

(d) Experimental; applied.

(e) The study is divided into two stages. The first stage, which has been finished, was to study the backwater caused by the construction of a channel constriction in a tilting flume having a rigid bottom. The second stage of the study, which is in progress, is to study the effect of an alluvial bed on the backwater and also the maximum scour around the model highway abutments making up the constriction. The experiment work is conducted in a 150 foot

long, 8 foot wide flume. Both the sedi-
ment and the water are recirculated in this
system. A uniform flow is established
before the abutments are placed in the
system. The change of water surface con-
figuration and the change of bed configu-
ration are measured throughout the testing
period. The degree of contraction caused
by the abutments varies from 0.5 to 0.1

(g) The hydraulics of open channel flow through
constrictions has been classified as a
result of this research. The energy loss
has been subdivided into three parts:
normal, mixing, and excess. The distribu-
tion of these three losses is known.
Empirical curves were derived for esti-
mating the maximum backwater found in the
laboratory. A practical method for esti-
mating the maximum backwater for prototype
conditions is presented. The maximum
scour depends primarily upon the degree of
contraction, the Froude number and the
normal depth of the unobstructed flow and
the geometry of the abutments.

(2277) STUDY OF EVAPORATION FROM SOIL SURFACES IN
TERMS OF SOIL AND MICROMETEOROLOGICAL
FACTORS.

(b) Contributing project to Western Regional
Research Project W-32, "Basic Hydrological
Factors Relating to Water Conservation."

(c) Dr. A. T. Corey, Civil Engineering Section,
Colorado State Univ., Fort Collins, Colo.

(d) Experimental and theoretical; basic
research, part of which has been used for
master's and doctoral theses.

(e) The project is a comprehensive study of
moisture transfer from soil by evaporation
from the soil surface. The immediate
objectives of the investigation are to
evaluate the variables known to affect
evaporation from soil in order to determine
those that are most important in the field,
and secondly to search for relationships
among the pertinent variables which will
permit quantitative estimates of evapo-
ration from a given soil under prevailing
ambient conditions.

(g) There is a critical water-table depth for
soils. When the water-table is below this
depth, the rate of upward movement of the
water is greatly reduced and is only
slightly affected by ambient variables.
The critical depth can be related to mois-
ture characteristics of the soil.
When the surface of the soil becomes dry
(for any reason), the rate of evaporation
is only slightly affected by ambient
variables and may even be inversely related
to the corresponding evaporation rates
from a free water surface.
The rate of water loss from a soil profile
can be reduced by any surface treatment
that reduces the capillarity of the surface
pores. One effective treatment is a gravel
mulch, another is an application of some
types of surfactents.
At present no economical treatment for
large scale use has been found.

(h) "Factors Affecting Evaporation from Soils
in Contact with a Water Table", by R. A.
Schleusener, Ph.D. Dissertation, Colorado
State University, 1958.
"The Role of Hysteresis in Reducing
Evaporation from Soils in Contact with a
Water Table", prepared for American Geo-
physical Union by R. A. Schleusener and
A. T. Corey, 1958.

(2278) METHODS OF GENERATING A COMPLEX SEA.

(b) David Taylor Model Basin.

(c) Mr. Robert E. Glover, Civil Engineering
Sec., Colorado State University, Fort
Collins, Colorado.

(d) Theoretical; applied research.

(e) The research is directed toward the develop-
ment of ways and means to produce in a
wave basin seas which will permit the
testing of model ships under conditions
representing those encountered by ships on
the ocean under storm conditions.

(g) A new type of wave generator was developed
which promises to have the ability to pro-
duce a replica of an actual storm sea in
a circular or rectangular wave basin. The
replica sea would cover essentially the
entire area of the wave basin.

(h) Final report in preparation.

(2279) LABORATORY AND FIELD STUDY OF THE VORTEX
TUBE SAND TRAP.

Cooperative project; Colorado Agricultural
Experiment Station and Agricultural
Research Service. See U. S. Department of
Agriculture, Agricultural Research Service,
page 95.

(2510) RESEARCH DIRECTED TOWARD THE STUDY OF LOW
LEVEL TURBULENCE.

(b) Air Force Cambridge Research Center.

(c) Prof. J. E. Cermak, Civil Engineering Sec.,
Colorado State University, Fort Collins,
Colorado.

(d) Experimental; basic research to be used
towards a doctoral thesis.

(e) Measurements of mean velocity, mean temper-
atures, turbulence intensities and turbu-
lent shear stress profiles were made for
turbulent air flow over a plane, rough
boundary which was heated. A new wind
tunnel with low ambient turbulence level
and a test section 6 x 6 x 72 ft was de-
signed and partially completed.

(g) For the rough, heated surface the velocity
defect law for the outer regime of the
boundary layer follows the same law for a
smooth boundary provided the displacement
thickness includes the variation of density
with temperature. The temperature distri-
bution can be expressed by a wall law and
a temperature-defect law analogous to the
velocity-distribution laws.

(h) "Turbulent Boundary Layer Over Heated and
Unheated, Plane, Rough Surfaces", by G.
Chanda, Ph.D. Dissertation, Scientific
Report No. 1, AFCRC TN-58-428 (Astia-AD

152599), May 1958, Report No. CER58BC21, 131 pp.
"Wind Tunnel for the Study of Turbulence in the Atmospheric Surface Layer", by J. E. Cermak, (in preparation).

(2512) MODEL STUDIES FOR BOCONO DAM.

(b) R. J. Tipton Associated, Engineers, Inc., Denver, Colorado.
(c) Dr. A. R. Chamberlain, Chief, Civil Engineering Sec., Colorado State Univ., Fort Collins, Colorado.
(d) Experimental model study; applied research.
(e) The purpose of the model studies was to obtain information concerning the action of water flowing over and through the proposed dam and appurtenant works. Preliminary studies of the stilling basin were made in a 2-ft wide glass-walled flume and over-all performance of the spillway examined on a general model; both models were constructed to a scale of 1:49.2. For the river-outlet studies a separate model was built to a scale of 1:20 with a transparent plastic end section for the elbow.
(f) Completed.
(g) A suitable stilling basin was developed for spillway flows up to 10,000m³/s. The piers on the spillway crest were modified to minimize fin formation on the spillway face, and a rating curve was obtained for free and gate controlled flows. The flow characteristics and pressure distribution in the vicinity of the downstream end of the river outlets were examined and found satisfactory. An evaluation was made of the effect of stilling basin operation on pressures within draft tubes which discharge directly into the stilling basin.
(h) "Model Studies for Bocono Dam, Venezuela, South America", by Kersi S. Davar and M. Sh. Amin, Colorado State Univ. Research Foundation, Report No. CER58ARC24, May 1958.

(2513) WATER AND SEDIMENT MEASURING EQUIPMENT FOR EPHEMERAL STREAMS.

(b) Rocky Mountain Forest and Range Exp. Sta., Agricultural Research Service, Colorado Agricultural Experiment Station.
(c) Dr. A. R. Chamberlain, Chief, Civil Engineering Sec., Colorado State Univ., Fort Collins, Colorado.
(d) Experimental; applied research.
(e) The continuing phases are to further develop measuring flumes of trapezoidal shapes for the purpose of measurement on steep slopes and for a large range of flows. Test results from models are being compared with prototype behavior.
(g) Very good correlation of model prototype results have been obtained. Examination of prototype data reveals that the approach velocities change from super-critical to subcritical for increasing discharges. The relationship of depth in the contracted section to discharge does not change for

the different approach conditions.
(h) "Trapezoidal Flumes for Open Channel Flow Measurement", by A. R. Robinson and A. R. Chamberlain, Colorado State Univ., Report No. CER58ARR39, November 1958.

(2514) STUDY OF RESISTANCE TO FLOW AND SEDIMENT TRANSPORT IN ALLUVIAL CHANNELS.

(b) U. S. Geological Survey.
(c) Mr. D. B. Simons, Hydraulic Engineer, U. S. Geological Survey.
(d) Experimental, theoretical and field investigation; basic and applied research. Some phases of the study are being used to develop masters and doctoral theses; however, the investigation is basically a U.S. G.S. research project.
(e) This investigation consists of a laboratory study which will be followed by a field study of (a) resistance to flow in alluvial channels, (b) sediment transport theory, including the effect of very fine sediment on resistance to flow and sediment transport, and (c) the theory of rapid flow phenomenon in alluvial channels.
(g) Relationships describing alluvial channel flow phenomenon and the regimes of flow and forms of bed roughness have been developed based on flume data. The effect of small concentrations of very fine sediment on resistance to flow and silt-sand sediment transport has been and is being investigated. An equation for bed load transport, applicable when ripples or dunes exist, of the form $q_b = (1 - \lambda)V_s h/2$ has been developed and verified in which: q_b is the bed load, λ is the porosity of bed material, V_s is the average velocity of the ripples and/or dunes, and h is the average amplitude of ripples and/or dunes.
(h) "A Study of Roughness in Alluvial Channels", by D. B. Simons, E. V. Richardson and M. L. Albertson will be published as U.S.G.S. Circular.
"A Study of Roughness in Alluvial Channels", by D. B. Simons and E. V. Richardson, presented to A.S.C.E. for publication, November 1958.

(2516) ANALYTICAL STUDY OF ALLUVIAL CHANNEL ROUGHNESS.

(b) National Science Foundation.
(c) Dr. H. K. Liu, Civil Engineering Section, Colorado State University, Fort Collins, Colorado.
(d) Analytical; applied research.
(e) The purpose of this research is to establish a suitable discharge formula for flow in alluvial channels. Considerable field and laboratory data have been analyzed. Literature on turbulent shear flow near rigid boundaries has been critically reviewed.
(f) Completed.
(g) A new formula for mean velocity of alluvial streams has been formulated. It can be written as $V = CaD^x S^y$ where V is the mean velocity, D the depth of flow, S the energy gradient, Ca, x and y are

functions of the bed configuration and the mean size of the bed material. The formula can be reduced to Blasius' formula for turbulent flow near rough plane bed. In most cases the formula yields satisfactory result.

(h) "Analytical Study of the Roughness of Alluvial Channels", by Shoi-Yean Hwang, M.S. Thesis, Colorado State Univ., August 1958. "A Discharge Formula for Steady, Uniform, Turbulent Flow Carrying Granular Bed-Material Load in Open Channels", by H. K. Liu and S. Y. Hwang presented at Portland Convention of A.S.C.E. and submitted to A.S.C.E. for publication.

(2649) DEVELOPMENT OF DRAINAGE DESIGN CRITERIA FOR IRRIGATED LANDS.

Cooperative project; Colorado Agricultural Experiment Station and Agricultural Research Service. See U. S. Department of Agriculture, Agricultural Research Service, Page 95.

(2760) METEOROLOGICAL OBSERVATIONS.

(b) Colorado Agricultural Experiment Station and U. S. Weather Bureau.
(c) Mr. Maxwell Parshall, Civil Engineering Section, Colorado State Univ., Fort Collins, Colorado.
(d) Field investigation.
(e) The work is being done to obtain a precise long time record of climatological elements. The elements observed are: maximum, minimum and current air temperature, wet and dry bulb temperatures for dew point temperature and relative humidity, soil temperatures at 3, 6, 12, 24, 36 and 72 inches, wind direction and velocity at 65 ft and 15 in. above surface, barometric pressure, evaporation from a free water surface, water temperature at surface (maximum, minimum and current), precipitation, cloud cover, dew and frost.
(g) New extreme values of temperature have been recorded recently. The long time mean temperature is increasing. Precipitation varies widely with no long time trend apparent.
(h) Summary of 70 year's record of Meteorological Data in process of publication.

(2761) A STUDY OF THE ECONOMIC EFFECT OF CONTROLLING WATER USE IN AN AREA WHERE SURFACE AND GROUND WATER RIGHTS APPLY TO A SINGLE SUPPLY.

(b) Colorado Agri. Expt. Sta. and U.S.D.A. Region Project W-42, (revised).
(c) Mr. M. W. Bittinger, Civil Engineering Sec., Colorado State Univ., Fort Collins, Colorado.
(d) Field investigation; applied research.
(e) The engineering phase of this study has as its purpose the determination of the interrelationships of ground water and surface water in an area where both are used for irrigation. An area in the South Platte

Valley has been chosen for this study. The economic phase will be concerned with the implications of various types of legislative controls which may be applied to the situation.
(g) Investigation of surface rights and pumping plants indicates that the potential capacity of all irrigation pumps in the study area is considerably greater than allowable surface water diversions from the river. These pumps all draw upon underground water that would otherwise contribute to river flow, and under previous court decisions are therefore subject to injunction if surface rights are injured. Nearly all wells were drilled at least 50 years after the most junior surface right.
(h) "Engineering Aspects of Ground Water Conditions in Bijou Valley, Colo., Together with Comments on Applicable Types of Legislation", by W. E. Code, W-42 Progress Report, 22 pp., 1958. "Understanding Colorado's Ground Water Problems, The Physical Picture", by M. W. Bittinger, "The Legal Picture", by E. J. Farmer, "The Economic Picture", by I. F. Davis. (To be published by the Colorado Agri. Expt. Sta., 1959.)

(2762) CURRENT METER INVESTIGATION.

(b) U. S. Geological Survey.
(c) Dr. A. R. Chamberlain, Chief, Civil Engineering Sec., Colorado State University, Fort Collins, Colorado.
(d) Experimental; applied.
(e) To determine the effect on the performance of various types of current meters of: (1) Several intensities and scales of turbulence; (2) proximity of the current meter to a water-air interface; (3) proximity of the bed to the meter; and (4) the orientation of the meter with respect to the flow. The meters being tested are the standard Price and Pygmy and several models of a new vane meter which have various numbers and shapes of vanes. The vane meters were designed by Mr. Frazier, U.S. G.S., Columbus, Ohio.
(f) Suspended.
(h) "Behavior of Experimental Current Meters in Still Water and Turbulent Flows", Administrative Report by A. R. Chamberlain and C. B. Ham, February 1958.

(2763) EQUILIBRIUM CONDITIONS IN OPEN CHANNELS.

(b) National Science Foundation and laboratory project.
(c) Dr. M. L. Albertson, Director, Colorado State University Research Foundation, Colo. State Univ., Fort Collins, Colo.
(d) Experimental and theoretical; basic research.
(f) Completed.
(h) "Meandering Characteristics of Alluvial Rivers", by H. Nagabhushanaiah, Masters thesis, Colo. State Univ., May 1958. "Secondary Circulation in Open Channels", by Y. W. Wang, Colo. State Univ., May 1958.

16

(2764) DESIGN AND CONSTRUCTION OF A TILTING FLUME.

  (b) National Science Foundation.
  (c) Dr. A. R. Chamberlain Chief, Civil Engi-
       neering Section, Colorado State University,
       Fort Collins, Colorado.
  (d) Design and construction.
  (e) A 2-ft wide, 2½-ft deep, by 60-ft long
       steel-frame flume has been designed and con-
       structed. The flume is supported so that
       any slope from horizontal to a maximum of
       about 10 percent can be easily obtained.
       Flow is recirculated through a 4,000 gpm
       centrifugal pump. The walls of the flume
       are clear plastic the full length of the
       flume and the floor is 1/4-inch stainless
       steel plate.
  (g) Design completed and construction is nearly
       completed.

(2765) FLOWMETER CALIBRATION.

  (b) The Martin Company.
  (c) Dr. A. R. Chamberlain, Chief, Civil Engi-
       neering Section, Colorado State University,
       Fort Collins, Colorado.
  (d) Experimental; applied research.
  (e) Calibration of turbine type flowmeters
       which range in size from 3/16 in. to 12 in.
       for the Titan ICBM program.

(2767) EDUCATIONAL FILMS ON OPEN CHANNEL FLOW.

  (b) U. S. Bureau of Public Roads.
  (c) Mr. J. R. Barton, Civil Engineering Section,
       Colorado State University, Fort Collins,
       Colorado.
  (d) Laboratory and field.
  (e) Project involves the making of a color film
       on open channel flow in connection with
       highway drainage problems for educational
       purposes.

(2768) CUMBAYA BYPASS STRUCTURE.

  (b) R. J. Tipton Associated Engineers, Inc.,
       Denver, Colorado.
  (c) Mr. S. Karaki, Civil Engineering Section,
       Colo. State Univ., Fort Collins, Colo.
  (d) Experimental; applied research.
  (e) The bypass is a unique underground struc-
       ture which conveys water around a power-
       house into a tunnel 74 meters below for use
       at such times as the powerhouse units may
       not operate. The model study is to check
       adequacy of original design of manifold
       stilling basin, a basin which dissipates
       kinetic energy of flow by diffusion of sub-
       merged jets.
  (g) The stilling basin as designed would per-
       form satisfactorily, however modifications
       are necessary in the conduit approaching
       the stilling basin.
  (h) "Report on a Hydraulic Model Study of the
       Bypass of the Cumbaya Project, Quito,
       Ecuador", by S. Karaki and S. Ayoub, Report
       No. CER58SSK30.

(2769) EVALUATION OF FLOWMETERS FOR THE MARTIN
        COMPANY, DENVER DIVISION.

  (b) The Martin Company, Denver, Colorado.
  (c) Dr. A. R. Chamberlain, Chief, Civil Engi-
       neering Sec., Colo. State Univ., Fort
       Collins, Colo.
  (d) Experimental; applied.
  (e) The purpose of the project is to carry out
       tests on the dynamic, kinematic, and gener-
       al performance characteristics of various
       types of flowmeters to be inserted in pipe-
       lines. The flowmeters to be considered are
       the Gulton, Gentile Tube, and Maxson Ultra-
       sonic, impact strain gauge, turbine rota-
       meters. The fluids under consideration are
       water, liquid oxygen, liquid nitrogen,
       JP-4 fuel, RP-1 fuel, and MIL-0-5606 hy-
       draulic fluid.
  (h) ."Evaluation of the Effect of Approach
       Tubing Size Upon the Calibration of 3/4-
       Inch Turbine Flowmeters", by M. W.
       Bittinger, CER57MWB32, November 1957.
       "Evaluation of the Effect of Viscosity on
       the Calibration of Several Flowmeters", by
       Fred Videon, CER58ARC5, February 1958.

(2770) DETERMINATION OF SHEAR STRESS BY MEASURE-
        MENT OF THE ELECTROKINETIC POTENTIAL.

  (b) Research Corporation of New York.
  (c) Prof. J. E. Cermak, Civil Engineering Sec.,
       Colorado State University, Fort Collins,
       Colorado.
  (d) Experimental and theoretical; basic re-
       search for doctoral thesis.
  (e) Electrokinetic potentials between two elec-
       trodes placed in the wall of a precision
       glass pipe are amplified after passing
       through an electrometer tube circuit and
       displayed on an oscilloscope. The dis-
       played signal frequencies are being studied
       for the cases in which the water flowing
       through the tube is in a laminar state,
       transition state, and turbulent state.

(2771) DISTRIBUTION OF A WETTING AND NON-WETTING
        FLUID PHASE IN A POROUS SOLID.

  (b) National Science Foundation.
  (c) Dr. A. T. Corey, Civil Engineering Section,
       Colo. State Univ., Fort Collins, Colo.
  (d) Experimental and theoretical; basic re-
       search.
  (e) The primary objective of this project is to
       determine the effect of rate of displace-
       ment on the distribution of wetting and
       non-wetting fluid phases in porous solids.
       Particular emphasis is placed on the situ-
       ation occurring when a non-wetting phase
       displaces a wetting phase at various rates.
       The ultimate aim is to obtain basic infor-
       mation which will enable better techniques
       to be devised whereby field situations in-
       volving flow in porous media can be studied
       by laboratory models.
  (f) Project is in a preliminary stage involving
       design of equipment and incidental experi-
       ments to characterize the porous solids
       employed.

(2901) LABORATORY STUDY OF GRAVEL FILTER DESIGN
        FOR IRRIGATION WELLS.

Cooperative project; Colorado Agricultural
Experiment Station and Agricultural Re-
search Service. See U. S. Department of
Agriculture, Agricultural Research Service,
page 96.

(2902) DEVELOPMENT AND IMPROVEMENT OF WATER
MEASURING DEVICES.

Cooperative project; Colorado Agricultural
Experiment Station and Agricultural Re-
search Service. See U. S. Department of
Agriculture, Agricultural Research Service,
page 96.

(3033) DETERMINATION OF PROPER IRRIGATION WELL
CONSTRUCTION MATERIALS AND MAINTENANCE
PRACTICES FOR OBTAINING MAXIMUM ECONOMICAL
LIFE AND PERFORMANCE.

(b) Colorado Agricultural Experiment Station.
(c) Mr. M. W. Bittinger, Civil Engineering
Sec., Colo. State Univ., Fort Collins, Colo.
(d) Experimental and field investigations;
applied research.
(e) The study is to determine the extent and
causes of partial and complete failures of
irrigation wells in Colorado and to develop
recommendations for construction methods,
materials, maintenance and repairs of irri-
gation wells.
(g) Review of literature available indicates a
wide variance in recommendations for ma-
terials in irrigation-well construction,
and in maintenance methods.

(3034) EFFECT OF FLUVIAL HYDRAULICS ON TRANSPORT
OF RADIOACTIVE MATERIALS.

(b) U. S. Geological Survey.
(c) Dr. A. R. Chamberlain, Chief, Civil Engi-
neering Sec., Colorado State University,
Fort Collins, Colorado.
(d) Office research; applied and basic.
(e) The purpose of the study is to bring to-
gether knowledge from the fields of dif-
fusion of heat, mass and momentum, ad-
sorption and absorption of radioactive
materials to sediments in streams, and
alluvial channel hydraulics. The results
of these studies will be used in developing
a program of experimental and theoretical
research on the relationships of fluvial
hydraulics to the movement of radioactive
materials in alluvial channels.

(3035) CONSEQUENCIES OF RESTRAINT ON MOTIONS OF A
MODEL SHIP.

(b) David Taylor Model Basin, Dept. of the
Navy.
(c) Mr. E. F. Schulz, Civil Engineering Sec.,
Colo. State Univ., Fort Collins, Colo.
(d) Experimental; applied research.
(e) The purpose of this project is to obtain
experimental data on the influence of
restraint on the model motions resulting
from wave trains acting on a model ship.
Initially the model motions will be re-
strained and the forces and moments on the

model caused by the waves will be measured.
A new type wave probe will be used to
measure the wave field in the vicinity of
the model.
(g) Activity to date has been confined to de-
velopment of instrumentation. These in-
clude the improvement of a capacitance
probe which does not touch or disturb the
water surface. Six transistorized probe
units will be used to measure the waves in
the vicinity of the model. Comparison of
the records with a record of the undis-
turbed wave will yield information on the
influence of the ship on the waves. A six
component balance has been constructed to
measure the forces and moments on the re-
strained model.

(3036) THE LONGITUDINAL DISTRIBUTION OF FORCES
AND MOMENTS ON A RESTRAINED MODEL IN WAVES.

(b) S-3 Panel of Hull Structure Committee,
Society of Naval Architects and Marine
Engineers.
(c) Mr. E. F. Schulz, Civil Engineering Sec.,
Colo. State Univ., Fort Collins, Colo.
(d) Experimental; applied research.
(e) The primary objective of this project is
to impose pitching and heaving displace-
ments (separately) varying sinusoidally in
time upon a model ship and to measure the
forces and moments as a function of time.
The models are segmented and attached to
an oscillating strongback by means of a
stiff spring. The force on each end of
the segment is sensed by means of an SR4
strain gage. The simultaneous records of
the forces on the seven segments may be
used to construct a longitudinal shear
curve. The longitudinal bending moment is
found by graphical integration.
(g) The pitching and heaving experiments on a
five-foot model of a T2-SE-A1 tanker have
been completed. The model was oscillated
at seven frequencies at rest and at three
speeds of advance. The results are being
analyzed and will be compared with the
analytical findings of Haskind, Havelock
and Grimm.

(3037) STUDY OF ATMOSPHERIC SURFACE LAYER
PHENOMENA IN A WIND TUNNEL.

(b) National Science Foundation.
(c) Mr. J. E. Cermak, Civil Engineering Sec.,
Colo. State Univ., Fort Collins, Colo.
(d) Experimental and theoretical; basic re-
search.
(e) Measurements of mean velocities and mean
temperatures together with turbulence in-
tensities and correlations have been made
over a smooth, plane, heated or unheated
surface. The objective of the program is
to relate the turbulent boundary layer
structure to the thermal stratification
obtained by heating.
(g) Heating of the turbulent boundary layer at
low Reynolds number has been found to pro-
duce the following effects: (1) Increase
the coefficient of drag; (2) increase the

18

eddy viscosity; and (3) increase the corre-
lation between vertical and horizontal
velocity fluctuations.

(3038) SCOUR BELOW CULVERT OUTLETS.

(b) Association of American Railroads.
(c) Mr. G. L. Smith, Civil Engineering Section,
Colo. State Univ., Fort Collins, Colo.
(d) Experimental and theoretical; fundamental.
(e) Systematic measurements were made of the
velocity profile of a submerged jet im-
pinging upon a normal boundary to determine
its influence on jet diffusion. The ve-
locity profile was measured for the various
zones of diffusion and along the boundary.
The pressure profile was measured radially
along the boundary from the point of stag-
nation to a point where the mean radial
velocity is approximately zero.
(g) The behavior of the water jet was the same
as that found by others for an air jet
impinging upon a normal boundary. The
error curve serves as a satisfactory repre-
sentation of diffusion profiles for water
jets.

(3039) MAKIO DAM SPILLWAY.

(b) Erik Floor and Associates, Inc., Chicago,
Illinois.
(c) Mr. S. Karaki, Civil Engineering Sec., Colo.
State Univ., Fort Collins, Colorado.
(d) Experimental; assist design.
(e) The purpose of the model study of the Makio
Dam spillway, to be constructed in Japan,
is to check the hydraulic performances of
an original and alternate spillway design
and to introduce changes as required. The
spillway is for a reservoir impounded by a
rockfall dam 80 meters high; located on
the left bank of the river.
(g) Modifications to the spillway approach and
chute have been made. The choice of
stilling basin has been made with modifi-
cations thereto.

(3040) STUDY OF SPUR DIKES FOR HIGHWAY BRIDGE
OPENINGS.

(b) State Highway Departments of Mississippi
and Alabama.
(c) Mr. S. Karaki, Civil Engineering Section,
Colo. State Univ., Fort Collins, Colo.
(d) Experimental; applied research.
(e) Spur dikes in connection with highway
bridge openings are used to eliminate
scour adjacent to abutments and piers. The
flow which would normally cause an eddy
near the abutment is made to approach the
bridge opening as normal as possible. The
purpose of this phase of the study is to
determine the best shape and location as
well as length of spur dike for a given
set of conditions which might be prevalent
at a bridge opening.
(g) An apparent shape and location has been de-
termined for one set of conditions in the
testing flume.

(3041) MAGNITUDE AND FREQUENCY OF FLOODS IN ARID
AND SEMI-ARID AREAS.

(b) U. S. Bureau of Public Roads, Department of
Commerce.
(c) Mr. R. A. Schleusener, Civil Engineering
Sec., Colo. State Univ., Fort Collins, Colo.
(d) Experimental; applied research.
(e) The purpose of the study is to develop pro-
cedures for estimating the frequency and
magnitude of peak rates of runoff from
watersheds in arid and semi-arid areas.
(g) Basic data have been collected and analysis
is being continued to delimit the basic
factors that control flood events in arid
and semi-arid areas.

CORNELL UNIVERSITY, School of Civil Engineering.

Inquiries concerning Projects Nos. 2285, 2777,
3042 to 3045, incl., should be addressed to Prof.
Marvin Bogema, School of Civil Engineering, Applied
Hydraulic Laboratory, Lincoln Hall, Cornell Univ.,
Ithaca, New York.

(2285) QUADRANT EDGE ORIFICE STUDIES.

(b) ASME Research Committee on Fluid Meters;
laboratory project.
(d) Experimental.
(e) Study of the quadrant edge orifice for
discharge measurements at low Reynolds
numbers. Reproducibility. Effect of size.
Effect of diameter ratio. Influence of
pipe roughness. Tap location. Both oil
and water used.
(h) "Studies on the Quadrant Edge Orifice",
Peter L. Monkmeyer, M.S. Thesis, Cornell
University, September 1956.

(2773) ROLL WAVES AND SLUG FLOWS.

(b) Basic Research.
(c) Dr. Paul G. Mayer, School of Civil Engi-
neering, Cornell Univ., Ithaca, N. Y.
(d) Theoretical and experimental.
(e) The cause and subsequent development of
intermittent flows in open channels are
studied and analyzed. Two distinctly
different wave train phenomena are noted.
These are designated as Roll Waves and
Slug Flow. Roll Waves result from the
interaction of surface tension and gravity
forces and are characterized by transverse
ridges of high velocity and intermittent
quiescent zones. Slug Flows result from
instabilities which cause the transition
from supercritical laminar flow to turbu-
lent flow and are characterized by a
succession of highly agitated surges.
(g) A theory has been established. The experi-
mental data is analyzed and the pertinent
characteristics of Roll Waves and Slug
Flow are presented in terms of significant
dimensionless parameters.
(h) "A Study of Roll Waves and Slug Flows in
Inclined Open Channels", Paul G. Mayer,

(2777) FLOW NOZZLES AND ORIFICE PLATE CALIBRATION.

    (b) Public Service Electric and Gas Co.
    (d) Experimental.
    (e) Calibration of four 2.8-inch, four 4.5-inch flow nozzles, and one 7.5 orifice plate. All meters installed in 12-inch pipe and calibrated with two sets of upstream and downstream pipe.
    (f) Completed.

(3042) VARIABLE AREA FLOW METER.

    (b) ASME Research Committee on Fluid Meters; laboratory project.
    (d) Experimental.
    (e) Calibration of variable area flow meter with floats of different weights.
    (f) Completed.

(3043) ORIFICE PLATE CALIBRATION.

    (b) General Electric Company.
    (d) Experimental.
    (e) Calibration of six orifice plates in 24-inch pipe. β = .2, .3, .4, .5, .6, and .7.

(3044) FLOW NOZZLE CALIBRATION.

    (b) Ingersoll Rand.
    (d) Experimental.
    (e) Calibration of 1.250 and 1.500-inch long radius ASME flow nozzles.
    (f) Completed.

(3045) SUBMERGED FLOW UNDER A SLUICE GATE.

    (b) Laboratory.
    (d) Experimental.
    (e) A study of the effect of rounding the sluice gate lip on the discharge coefficient when operating under low head differentials. Eight conditions of entrance rounding were considered.
    (f) Completed.
    (h) "Submerged Flow Under a Sluice Gate: The Effects of Entrance Rounding", William Don Lash, M.S. Thesis, Cornell Univ., June 1958.

UNIVERSITY OF FLORIDA, The Engineering and Industrial Experiment Station, Coastal Engineering Laboratory.

Inquiries concerning the following projects should be addressed to Dr. Per Bruun, Coastal Engineering Laboratory, University of Florida, Gainesville, Fla.

(2296) INVESTIGATION OF EXISTING DATA ON TIDAL ENTRANCES.

    (b) Beach Erosion Board, Washington, D. C.
    (d) Field investigation; basic research.
    (e) To analyze existing data on tidal inlets, including estuaries in order to relate tidal characteristics, tidal prism, inlet area, littoral drift, and pertinent

factors to the controlling depth and shoaling tendencies of tidal inlets.

(2297) FIELD STUDY OF BEACHES.

    (b) Laboratory project.
    (d) Field investigation; applied research.
    (e) Beach profiles and configurations of shore line on protected and unprotected coasts in Florida are being investigated. The purpose is to obtain data from the Florida shore line. From these data basic information will be derived and they will be used as a basis for practical coastal protection design.

(2298) MODEL STUDY OF DESTRUCTION OF WAVE ENERGY BY VERTICAL WALLS.

    (b) National Science Foundation.
    (d) Experimental and theoretical; basic research.
    (e) The destruction of wave energy by vertical walls is being studied in the Laboratory's new wave tank.

(2781) COASTAL ENGINEERING STUDY AT DEERFIELD BEACH.

    (b) City of Deerfield Beach.
    (c) City Manager, Deerfield Beach, Florida.
    (d) Field investigations; applied research.
    (e) The purpose of the investigations was to secure information about the actual situation of the erosion of Deerfield Beach and to secure some technical data based upon which recommendations could be made for immediate relief of the acute erosion problem. The plan of research involved investigations of changes in the shore line and beach profiles.
    (f) Completed.

(2782) COASTAL ENGINEERING STUDY AT BAKER'S HAULOVER.

    (b) Dade County Park Department.
    (c) Dade County Park Department, Miami, Fla.
    (d) Field investigation; applied research.
    (e) The purpose of the investigations was to secure information about the actual situation of the erosion of Baker's Haulover and to secure some technical data based upon which recommendations could be made for immediate relief of the acute erosion problem. The plan of research involved investigations of changes in the shore line and beach profiles.
    (f) Completed.

(2783) COASTAL ENGINEERING STUDY AT FT. PIERCE BEACH.

    (b) Ft. Pierce Beach Erosion District.
    (c) Ft. Pierce Beach Erosion District, Ft. Pierce, Florida.
    (d) Field investigation; applied research.
    (e) The purpose of the investigations was to secure information about the actual situation of the erosion of Ft. Pierce Beach

and to secure some technical data based upon which recommendations could be made for immediate relief of the acute erosion problem. The plan of research involved investigations of changes in the shore line and beach profiles.

(f) Completed.

(h) Results are published in Technical Progress Report No. 7, Vol. XII, EIES, Univ. of Fla.

(3046) COASTAL ENGINEERING STUDY AT CASEY KEY.

(b) Board of County Commissioners, Sarasota County, Florida.

(c) Board of County Commissioners, Sarasota County, Florida.

(d) Field investigation; applied research.

(e) The purpose of the investigations is to secure information about the actual situation of the erosion of Casey Key and to secure some technical data based upon which recommendations can be made for immediate relief of the acute erosion problem. The plan of research involved investigations of changes in the shore line and beach profiles.

(f) Field study and analysis have been completed.

(3047) COASTAL ENGINEERING STUDY AT LIDO KEY.

(b) City of Sarasota.

(c) City Manager, City of Sarasota, Florida.

(d) Field investigation; applied research.

(e) The purpose of the investigations is to secure information about the actual situation of the erosion of Lido Key and to secure some technical data based upon which recommendations can be made for immediate relief of the acute erosion problem. The plan of research involved investigations of changes in the shore line and beach profiles.

(f) Field study and analysis have been completed.

(3048) COASTAL ENGINEERING STUDY AT RAGGED KEYS.

(b) J. W. Moore, Attorney-at-Law.

(c) J. W. Moore, Attorney-at-Law, Miami, Fla.

(d) Field investigation; applied research.

(e) To secure information as basis for recommendations on establishment of fills at Ragged Keys and to furnish information on the influence of channels in the development.

(f) Field study has been completed.

(3049) MODEL STUDY OF THE APPLICABILITY OF FIBER-GLASS MATERIAL IN COASTAL STRUCTURES.

(b) Owens-Corning Fiberglas Corp., Newark, Ohio.

(c) Owens-Corning Fiberglas Corp., Newark, Ohio.

(d) Experimental basic research.

(e) Study of applicability of Fiberglas material in coastal structures.

(f) First tests scheduled for December 1958.

(3050) COASTAL ENGINEERING STUDY OF BAKER'S HAULOVER INLET.

(b) Dade County, Florida.

(c) County Engineer, Dade County, Florida.

(d) Field investigation and model study; applied research.

(e) Investigate possibilities of improving navigation conditions at Baker's Haulover Inlet caused by high current velocities and to evaluate the situation in regard to the inlet's contribution to the erosion of the sea shore on both sides of the inlet.

(f) Field study has been completed. Model under construction.

(3051) BASIC STUDY OF THE RELATION BETWEEN WIND AND WATER BEHAVIOR IN COASTAL WATERS.

(b) National Science Foundation.

(d) Field and laboratory study; basic research.

(e) A combined field and laboratory research program analyzing the effect of sloping offshore profiles as compared with bodies of water with constant depth; study of the combined setup by waves and wind for different standard profiles. Experiments will be carried out in the new wave tank of the Coastal Engineering Laboratory.

(f) Actual tests will be started early in 1959.

GEORGIA INSTITUTE OF TECHNOLOGY, Hydraulics Lab.

Inquiries concerning Projects Nos. 291, 1584, 1852, 1855, and 2529, should be addressed to Prof. C. E. Kindsvater, School of Civil Engineering, Georgia Institute of Technology, Atlanta, Ga.

(291) FLOW OF WATER OVER HIGHWAY EMBANKMENTS.

(b) Laboratory project.

(d) Experimental; partly sponsored by U.S.G.S.

(e) Experimental data are being obtained on the discharge characteristics of an embankment-shaped weir. Emphasis has been placed on free discharge over smooth-surfaced embankments. Data have been obtained on the influence of embankment height and tailwater submergence. Detailed velocity surveys have been made to define the boundary layer between the upstream edge of the upstream shoulder and the crown. Tests are being made on a 1:9-scale model in a 3-ft wide flume.

(f) Experimental work on effect of roughness underway.

(g) It has been established that the discharge characteristics of an embankment can be related to the theoretical equation of discharge for a broad-crested weir by means of the discharge-displacement boundary-layer thickness. Data and procedures for computing the thickness of the boundary layer at the control section have been determined as a means of generalizing the discharge equation for various shapes, sizes and roughness of embankments.

(h) "Discharge Characteristics of an Embankment-Shaped Weir", Master's Theses by Gunnar Sigurdsson, 1956; Sherwood P. Prawel, 1959; available on loan from Price Gilbert Library, Georgia Institute of Technology. Third

Master's Thesis, by J. Davidian, in preparation. Summary report also in preparation.

(1331) THE DIFFUSION OF FOREIGN PARTICLES IN A FLUID.

(b) Laboratory project; sponsored by the National Science Foundation.
(c) Dr. M. R. Carstens, School of Civil Engineering, Georgia Institute of Technology, Atlanta, Georgia.
(d) Experimental; basic research for doctoral dissertation.
(e) The diffusion of macroscopic foreign particles is being studied in a diffusion column in order to determine the difference in diffusion of the foreign particles and the fluid. The diffusion mechanism is created by a pattern of pulsing jets. The amplitude and frequency of the pulse of the jets is controlled. The foreign particles are ion-exchange resin beads to which are attached radioactive cesium molecules. Particle concentration within the column is determined by gamma-ray radiation count.
(f) The diffusion measurements with the foreign particles is nearly complete.

(1584) FLOW OF WATER OVER WEIRS AND SPILLWAYS.

(b) Water Resources Division, Surface Water Branch, U. S. Geological Survey.
(d) Library search; re-analysis and correlation of published data, plus original research as required. Original experimental work for one thesis (F. H. Ruggles).
(e) A comprehensive study of the discharge characteristics of practical forms of weirs and spillways. Initial phase includes the preparation of bibliography and the collection and analysis of experimental data from all known sources. Objectives include the publication, in generalized form, of available experimental data.

(1852) DISCHARGE CHARACTERISTICS OF RECTANGULAR PLATE WEIRS IN RECTANGULAR CHANNELS.

(b) Laboratory project; partly sponsored by the U. S. Geological Survey.
(d) Experimental and analytical; research for two master's theses and one graduate research problem.
(e) An investigation of the comprehensive discharge characteristics of the basic sharp-edged, rectangular-notch weir. An attempt to evaluate by experimental means the influence of the several variables excluded by restrictions on the standard weir formulas. Tests cover a full range of notch widths, weir heights, and heads. Investigation limited to free flows of water at normal temperatures.
(h) "Discharge Characteristics of Rectangular, Thin-Plate Weirs", by Carl E. Kindsvater and Rolland W. Carter, American Society of Civil Engineers Journal of the Hydraulics Division, Paper No. 1453, December 1957.

(1855) TRANQUIL FLOW THROUGH SEVERAL OPENINGS IN

AN OPEN-CHANNEL WIDTH CONSTRICTION.

(b) Water Resources Division, Surface Water Branch, U. S. Geological Survey.
(d) Experimental; basic research.
(e) Objective is to establish principles of flow division at a multi-opening width constriction. A 14-foot wide by 80-foot long flume is being used in the experimental investigation. Channel shape, degree and pattern of boundary roughness and constriction geometries will be varied. Boundary conditions considered will be governed by highway bridge practice.
(h) Final report in preparation.

(2529) UNIFORM FLOW IN OPEN CHANNELS.

(b) Water Resources Division, Surface Water Branch, U. S. Geological Survey.
(d) Re-analysis and correlation of existing data; original experimental research and analysis.
(e) A fundamental investigation of the mechanics of uniform flow in open channels, with emphasis on the influence of channel shape. Experimental work is being conducted in a variable-slope 90-ft long flume, 18 in. deep and 3.5 ft wide.

(3052) DEZ RIVER DAM SPILLWAYS.

(b) Resources and Development Corp., 50 Broadway, New York, New York.
(c) Dr. M. R. Carstens, School of Civil Engineering, Georgia Institute of Technology, Atlanta 13, Ga.
(d) Experimental; design.
(e) An arch dam, 600 feet high is being designed for a narrow gorge of the Dez River in Iran. Two circular conduit spillways are placed on one side of the canyon. The horizontal portions of the two spillways are placed one above the other and discharge a free jet from the canyon wall. The inlet is a typical ogee section with Tainter gates followed by a horizontal passage which discharges into a vertical shaft. All hydraulic features of the spillways are being investigated with the model.

HARVARD UNIVERSITY.

(3053) MODEL STUDIES OF HYDRODYNAMIC SMALL SCALE DELTAS.

(b) Laboratory project, cooperative with U. S. Geological Survey.
(c) Prof. H. A. Thomas, Jr., Civil and Sanitary Engineering Dept., Harvard University, Cambridge, Mass.
(d) Experimental, supplemented by field studies; for a doctor's thesis.
(e) The salient objective of the investigation is to elucidate the hydrodynamic environment controlling the formation of inclined bedding in sedimentary strata. Studies

are being made to determine the inter-
relationship between current velocity,
depth of water, thickness of cross-strati-
fied units, particle texture, and the
mechanism of turbulence at the site of
deposition. Information is also being
sought on the mechanics of the formation
of "scour and fill" structures in sedi-
mentary rocks.

(3054) HYDROLOGIC ASPECTS OF OVERALL DESIGN OF
MULTI-PURPOSE, MULTI-UNIT, WATER RESOURCE
SYSTEMS.

(b) Research project in Graduate School of
Public Administration, Harvard University.
(c) Prof. Harold A. Thomas, Jr., Division of
Engineering and Applied Physics, Room 223,
Pierce Hall, Harvard University, Cambridge,
Mass.
(d) Experimental and theoretical; applied re-
search.
(e) Examination of various approaches to
analysis of physical input-output relation-
ships in complex multi-unit, multi-purpose
river basin systems. Includes feasibility
of determining optimum system design through
use, singly or in combination, of (1) simple
mathematical models applied to the deter-
ministic case, (2) queuing theory for the
stochastic aspects, and (3) simulation of
system operations on high-speed electronic
computers. Also, includes analysis of use
of synthetic hydrology in simulation oper-
ation in obtaining meaningful data on
system yields and shortages for a combi-
nation of different outputs. The role of
the operating policy on system design, in-
cluding the effect of forecasting, is also
being studied.
(g) Only preliminary results obtained thus far
on simulation procedures and simple mathe-
matical model for deterministic case.

UNIVERSITY OF HOUSTON, Dept. of Chemical Engineering.

(2303) ENTRAINMENT IN TWO-PHASE GAS-LIQUID FLOW.

(b) Laboratory project.
(c) Prof. A. E. Dukler, Chemical Engineering
Dept., University of Houston, Houston,
Texas.
(d) Experimental, theoretical, basic research,
master's thesis.
(e) A study of the factors which control the
entrainment of liquid into a concurrent
gas phase for annular flow. Purpose of
the study is to gain an understanding of
the entrainment mechanism and to relate
the entrainment and the drop size distri-
bution to system geometry, fluid proper-
ties and flow rates.
(g) A probe technique has been developed and
data obtained over a wide range of fluid
rates in one- and three-inch tubes for the
system air-water. A preliminary correlation
has been prepared.
(h) "Entrainment and Pressure Drop for

Horizontal Two-Phase Flow of Air and Water",
by Moye Wicks, III, M.S. Thesis, 1958. Ob-
tainable on interlibrary loan.

(3055) HYDRODYNAMICS OF FILM FLOW AND HEAT TRANS-
FER IN FILM CONDENSATION.

(b) Laboratory project.
(c) Prof. A. E. Dukler, Chemical Engineering
Dept., University of Houston, Houston,
Texas.
(d) Theoretical; basic research.
(e) The velocity distribution equations of
Deissler are redeveloped for thin films
and applied to the prediction of film
thickness and film coefficients for con-
densation in turbulent and laminar flow.
(g) Differential equations have been developed.
Solutions using an electronic computer are
now in progress for a wide range of con-
ditions.

UNIVERSITY OF IDAHO, Engineering Experiment Sta.

Inquiries concerning Projects Nos. 1859, 2080,
3056, and 3057, should be addressed to Associate
Director, Prof. C. C. Warnick, College of Engi-
neering, and Projects Nos. 1861, 1862, 2304, and
2786, should be addressed to Prof. G. L. Corey,
Dept. of Agricultural Engineering, University of
Idaho, Moscow, Idaho.

(1859) A STUDY OF EFFECTIVENESS OF CANAL LININGS
AND SOIL SEDIMENTS IN CONTROLLING SEEPAGE
LOSSES.

(b) Laboratory project; cooperative with U. S.
Bureau of Reclamation.
(d) Field investigation; basic and operational
research.
(e) Different types of canal linings are being
studied and various ways of evaluating
performance are being considered especially
ideas for measuring canal seepage from both
lined and unlined canals.
(g) Six years of field work have been completed
on seepage loss characteristics and per-
formance of experimental canal linings.
New devices for seepage measurements are
being developed.
(h) Annual progress report is available for
limited distribution.

(1861) THE IMPROVEMENT AND DEVELOPMENT OF STREAM-
FLOW MEASURING DEVICES.

(b) Laboratory project; cooperative with
Agricultural Research Service, being carried
on under the Agricultural Experiment Sta.
(d) Experimental; applied research.
(e) A gage to measure flow over a weir which
has approach velocity is being developed.
(g) Several gages have been laboratory tested.
Relationships between gage height and dis-
charge is being evaluated.

(1862) DETERMINATION OF ANNUAL RUNOFF FROM WATER-
SHED CHARACTERISTICS.

(b) Laboratory project, being carried on under Agricultural Experiment Station.
(d) Experimental; applied research.
(e) A study of the hydrological factors affecting the Moscow Mountain Watershed as it applies to the total water use in the area.
(f) Completed.
(h) "A Water Balance Study of Two Small Watersheds", G. L. Bloomsburg, University of Idaho, M.S. Thesis, 1958.

(2080) A STUDY OF RIME ICE AND SNOW CAPPING ON HIGH ALTITUDE PRECIPITATION GAGES.

(b) Laboratory project; in cooperation with U. S. Weather Bureau, Bureau of Reclamation, Corps of Engineers, Soil Conservation Service and City of Moscow.
(d) Field investigation; basic and applied operational research.
(e) Several experimental gages have been installed to obtain basic data on snow capping. An electrical means of heating the orifice of the gage is being studied.
(g) Field gages have been in operation for three years and new special heated-orifice gages have been placed in operation. Several pieces of weather measuring equipment have been incorporated into the project the past year.
(h) Annual progress report is available on limited loan basis.

(2304) MECHANICS OF WATER CONTROL ON STEEP IRRIGATED LAND.

(b) Laboratory project; under investigation in Agricultural Experiment Station.
(d) Field investigation; applied research for master's thesis.
(e) To test the characteristics and effectiveness of water control structures and devices used on farms. To evaluate the resistance to erosion of irrigated soils. To develop improved devices and techniques for control of erosion and to increase efficiency in application of water.
(g) Field tests were made on furrow erosion with varying slopes in discharges.
(h) A publication is being prepared in the form of an M.S. Thesis.

(2786) FARM IRRIGATION EFFICIENCIES.

(b) Laboratory project; cooperative with Bureau of Reclamation under the Agricultural Experiment Station.
(d) Field investigation; basic and applied research.
(e) To evaluate irrigation efficiencies on actual farms to aid in planning of a water use on irrigation projects. To consider efficiency from aspect of farm operations and not just consumptive use of crops.
(g) Project has been in progress about one year by C. Tyler in a new irrigation tract near Rupert, Idaho, called the Northside Pumping Division of the Minidoka Project.

(3056) TELEMETERING HYDROLOGIC DATA FROM MOUNTAIN LOCATIONS.

(b) Laboratory project; in cooperation with federal agencies and power companies.
(d) Laboratory and field investigation; basic and applied operational research.
(e) A complete system for reporting six or more hydrologic data is being studied and basic parameters of snow are being considered for conversion into time delay circuits for transmission by radio.
(g) Preliminary circuit designs have been worked out and mock up models of the system's developed prototype installation has been started.
(h) "Preliminary Design of Hydrologic Data Telemetering Equipment", L. A. Beattie, G. G. Hespelt, and L. M. Maxwell. A progress report not for public disclosure.

(3057) CONSERVATION OF WATER FOR RANGE STOCK.

(b) Laboratory project.
(d) Field investigation; applied operational research.
(e) Experimental stock watering ponds in desert areas will be lined and evaporation control measures applied to see if extension of water supplies can be developed economically.
(g) Project was activated in October and sites have been selected for testing work.

ILLINOIS STATE WATER SURVEY DIVISION.

Inquiries concerning Projects Nos. 556 to 560, incl., 2315, 2535, and 3059, should be addressed to Mr. R. H. Harmeson, Peoria Lab., Box 717, Peoria, Ill.

(552) SEDIMENTATION OF ILLINOIS RESERVOIRS.

(b) Laboratory project, cooperative with Agricultural Research Service, Soil Conservation Service, and University of Illinois Agricultural Experiment Station.
(c) Mr. R. L. Corinth, Illinois State Water Survey, Box 232, Urbana, Illinois.
(d) Field investigation; applied research.
(e) For design of water-supply reservoirs, measurements of sediment accumulation on lakes in Illinois. Sediment samples are analyzed and complete surveys of watershed soil type, slopes, land use, and conservation practices are made.
(g) Results of Lake Decatur, Ill., show correlation between rate of sedimentation and land use on watershed.
(h) Reports of Investigation Nos. 4, 7, 8, 9, 10, 12, 15, 16, and 18; sedimentation surveys of Spring Lake, Ridge Lake, Lake Chautauqua, Carbondale Reservoir, Lake Bracken, West Frankfort Reservoir, Lake Calhoun, Lake Springfield, and Lake Carthage, respectively.
"Water and Land Resources of Crab Orchard Lake Basin", Bulletin 42.
"Correlation of Reservoir Sedimentation and Watershed Factors, Springfield Plain,

Ill.", Report Investigation 37.

(553) RADAR-RAINFALL PROJECT.

(b) Laboratory project, cooperative with U. S. Army Signal Research and Development Lab.
(c) Mr. G. E. Stout, Illinois State Water Survey, Box 232, Urbana, Illinois.
(d) Field investigation; basic research.
(e) Radar is being used to determine precipitation quantitatively. Emphasis is being concentrated on the measurement of raindrop size distribution at Miami, Fla.; Corvallis, Ore.; Champaign, Ill.; Bogor, Indonesia; and Majuro, Marshall Islands, to determine climatic variation of drop size.
(g) Data being collected.
(h) Reports of Investigation Nos. 13, 19, 21, 27, 29, and Circular 49 of Water Survey; final report dated March 31, 1958.

(555) EVAPORATION IN ILLINOIS.

(b) Laboratory project.
(c) Mr. W. J. Roberts, Ill. State Water Survey, Box 232, Urbana, Illinois.
(d) Field investigation; applied research.
(e) Measurements are made of evaporation at four stations in northern, central, and southern Illinois. Vapor pressure gradients are obtained at Urbana. Evaporimeters constructed and installed adjacent to pans for year-round records.
(h) Measurements published in Climatological Data, Illinois Section.

(556) PERMEABILITY OF GRADED SAND MIXTURES.

(b) Laboratory project.
(d) Experimental; basic research.
(e) Permeabilities of known mixtures of graded sand are measured to determine functional changes.
(f) Suspended; to be resumed in 1959 or 1960.
(g) Sand mixtures containing 60 to 70 percent of fine material in 40 to 30 percent of coarser from 2 adjoining sieves of the $\sqrt{2}$ series have less permeability than the material of the fine screen alone. Evidence accumulates that the permeability is not much influenced by the amount of voids but greatly by the size of the smallest opening between sand grains.

(557) TURBULENT FLOW THROUGH GRANULAR MEDIA.

(b) Laboratory project.
(d) Experimental; basic research.
(e) Critical flow is determined to define conditions under which turbulent flow occurs outside well screens.
(f) Suspended; to be resumed in 1959 or 1960.
(g) In flow through granular media, the Reynolds number cannot be calculated from ordinary formulas. By assuming a critical Reynolds number as existing at the determined critical flow conditions, the corresponding pore size can be calculated. This has been done in preliminary tests,

but further work is needed to obtain a correlation with screen analysis.

(558) STUDY OF CAUSES AND PREVENTION OF SAND BOILS.

(b) Laboratory project.
(d) Field investigation; basic research.
(e) Sand boils occurring during floods in levied districts are mapped, classified, and sampled. Also sampled are river and nearby well waters.
(f) Suspended. Dependent upon flood conditions in river.
(g) From chemical analyses and temperature measurements, it was found that the water flowing in typical sand boils (those free from pipe connections towards the river) is different from the river water and similar to well water in neighboring wells. Such sand boils can be stopped from flowing by damming them up to a level that is below that of the river stage. They are not caused by leaks through the levee.

(559) ARTIFICIAL RECHARGE OF GROUND WATER.

(b) Laboratory project.
(d) Experimental laboratory and field investigation; basic research.
(e) Experimental pilot plant consists of river intake, control tower with chlorination equipment, flow-measuring devices, and pumping equipment; two pits. One pit is gravity fed, has 40 x 62.5 ft bottom area, 1:2 side slopes, surface at bottom is 8 ft below river pool stage. Second pit is fed by 3 mgd pump, has 20 x 75 ft bottom area, 1:3 side slopes, bottom surface is 5 ft below river pool stage. A model of 1/8 pit (centerline to diagonal) is being used to study different types of pits and variations in ground water gradients.
(g) Pits in operation for eighth winter. Present season is third successive without intermediate cleaning of pea gravel filter media. Filter media calculated to have sufficient unsilted capacity remaining to complete season's operation. Operating data show slight decrease in average rate of inflow due to silting of filter media.
(h) Report covering all operations since inception is being prepared.

(560) GROUND WATER INVESTIGATION IN THE PEORIA, ILLINOIS, DISTRICT.

(b) Laboratory project.
(d) Field investigation; basic research.
(e) To determine the ground water resources of the district; inventory of wells made, including construction and logs of wells. Ground water levels are measured continuously, pumpage data collected, river stages and rainfall recorded, physical and chemical analyses for changes in composition of ground water are made, areas of infiltration are determined, and all data are correlated with consideration of local ground conditions.
(g) To date conservation measures have shown

more effect than artificial recharge.

(561) GROUND WATER INVESTIGATION IN EAST ST. LOUIS AREA.

    (b) Laboratory project.
    (c) Mr. W. J. Walton, Illinois State Water Survey, Box 232, Urbana, Illinois.
    (d) Field investigations; applied research.
    (e) To evaluate the ground water resources of American Bottoms (E. St. Louis region). Ground water levels are measured continuously. Pumpage, river stage, and rainfall data are collected; chemical quality of ground water is measured. Areas of infiltration are to be determined and all data correlated with consideration of local conditions. Statistical studies have been made of the service lives of municipal wells.

(843) GROUND WATER RESOURCES IN JO DAVIESS, STEPHENSON, AND CARROLL COUNTIES.

    (b) Laboratory project.
    (c) Mr. H. F. Smith, Illinois State Water Survey, Box 232, Urbana, Illinois.
    (d) Field investigation; applied research.
    (e) To determine ground water resources of area, water level contours of sandstone aquifers, transmissibility and storage coefficients of aquifers, and quantity of water available were obtained.
    (f) Suspended.
    (g) Data indicate piezometric surface conforms generally with topography, with a 500-foot drop in about 30 miles with no apparent withdrawal. Sandstone aquifers overlain by 100 to 300 feet and more of impervious limestone.

(1092) HYDROLOGIC CYCLE EVALUATION.

    (b) Laboratory project; cooperative with U. S. Geological Survey.
    (c) Mr. H. F. Smith, Illinois State Water Survey, Box 232, Urbana, Illinois.
    (d) Field investigation; applied research.
    (e) Data from rain gage networks (gathered under Project 553) together with information from 5 stream gaging stations and 5 ground water level recorders are being maintained. Data will be used in analyzing storm rainfall-runoff relationships on small watersheds and effect of runoff on water table. Analysis in progress.

(1335) GROUND WATER INVESTIGATION IN THE CHICAGO AREA.

    (b) Laboratory project.
    (c) Mr. H. F. Smith, Box 232, Urbana, Illinois.
    (d) Field study on variations of natural resources. Investigation of artesian well field with wells 1200 to 2200 feet deep, locally heavily pumped. Study of ground water level recession, interferences, transmissibilities, effect of additional demands.
    (g) Results determine recession and give good

data for future prediction. Collection of data continuing.
    (h) Progress report in preparation.

(1342) STUDY OF CORROSION AND DEPOSITION RATES WITH DIFFERENT FLOW RATES.

    (b) Laboratory project.
    (c) Dr. T. E. Larson, Illinois State Water Survey, Box 232, Urbana, Illinois.
    (d) Experimental.
    (e) One-half inch pipes of different materials are in service. Changes in flow due to corrosion and at constant head are being measured.
    (f) Abandoned; lack of personnel.

(1865) HYDRAULIC DESIGN OF DROP-INLET SPILLWAY STRUCTURES FOR SMALL RESERVOIRS.

    (b) Laboratory project, in cooperation with Agricultural Research Service, Soil Conservation Service, and University of Ill. Agricultural Experiment Station.
    (c) Mr. H. W. Humphreys, Illinois State Water Survey, Box 232, Urbana, Illinois.
    (d) Experimental; generalized applied research for development and design.
    (e) To determine the most desirable proportions and shapes of drop-inlet spillway structures that have unique flow characteristics and to develop anti-vortex devices. To provide the necessary information on flow relations and discharge coefficients so that these structures may be economically designed. Initial phases of study concerned with hydraulics of square risers with free discharge. Effect of lip or crest shape and anti-vortex devices being studied. Second phase to include the complete spillway. Experimental apparatus constructed and tests are being conducted on the complete spillway.
    (g) Hydraulics of various types of flow possible in square risers are well defined as well as some of the effects of non-square crest shape.

(2314) ELECTRICAL ANALOGUE OF CHICAGO GROUND WATER CONDITIONS.

    (b) Laboratory project.
    (d) Experimental; applied research.
    (e) Tap water about 2 inches deep is held on a paraffin base. The boundary of the depression cone is given by a metal band. Wells or well groups are marked geographically by metal rods. These are charged by electrical voltage in proportion to existing or planned pumpage. A separate probe measures the location of equal potential lines which correspond to equal heights of ground water levels. Variations in permeability are represented by variations in water depth and determined by comparison with the actual ground water levels as found in observation wells.

(2315) INTERFERENCE BETWEEN RECHARGE PITS.

(b) Laboratory project.
(d) Field investigation; basic research.
(e) A recharge pit has been built about 200 ft from the pit mentioned in project 559 and the mutual influence of the two pits is studied by a series of observation wells between the pits.
(g) Two pits in operation. To date no interference has been detected.

(2532) EVAPORATION RETARDATION.

(b) Laboratory project.
(c) Mr. W. J. Roberts, Box 232, Urbana, Ill.
(d) Field investigation; applied research, design.
(e) Experiments with monomolucular chemical films to retard evaporation from a 3-acre pond and a 230-acre lake in Illinois. Laboratory studies continuing on smaller containers.
(g) Analysis in progress.

(2533) MOISTURE INFLOW STUDY.

(b) Laboratory project.
(c) Mr. R. G. Semonin, Illinois State Water Survey, Box 232, Urbana, Illinois.
(d) Applied research.
(e) Computation of moisture inflow of Illinois and subsequent correlation with precipitation. Moisture and wind data obtained from RAOB data.
(f) Analysis nearing completion.

(2534) DENSE RAIN GAGE NETWORK PROJECTS.

(b) Field and laboratory project.
(c) Mr. F. A. Huff, Illinois State Water Survey, Box 232, Urbana, Illinois.
(d) Field investigation; applied research.
(e) Data from four rain gage networks, consisting of 50 gages in 400 square miles, 10 gages in 100 square miles, 51 gages in 544 square miles, and 11 gages in 8 square miles. Obtained to study: (1)Rainfall variability; (2) frequency of point and areal mean rainfall; (3) area-depth relations; (4) variation of point rainfall with distance; (5) areal representativeness of point rainfall; and (6) reliability of areal mean rainfall estimates.
(f) Static; awaiting new data.

(2535) FILTERING THROUGH COARSE MATERIALS.

(b) Laboratory project.
(d) Various sizes of rounded gravel and of broken limestone have been studied in tile rings in the bottom of both recharge pits under field conditions, to determine limit of coarseness of filter material. Further work is planned in the laboratory with control of the variables involved.
(g) Field studies indicate filtering occurs through materials up to 3/4-inch size.

(2787) PRECIPITATION FREQUENCY.

(b) Laboratory project.

(c) Mr. F. A. Huff, Illinois State Water Survey, Box 232, Urbana, Illinois.
(d) Applied research.
(e) Recurrence intervals of heavy precipitation in periods of 1 to 10 days duration are being determined on an annual and seasonal basis for Illinois, using data from 39 stations for a 40-year period. Average relations with definition of their reliability are being calculated for sections of similar storm climate. Several statistical approaches used for frequency analysis are being evaluated.
(f) Analysis completed and report written.
(h) "Frequency Relations for Storm Rainfall in Illinois", State Water Survey Bulletin 46.

(2788) METEOROLOGY OF FLOOD-PRODUCING STORMS.

(b) Laboratory project.
(c) Mr. F. A. Huff, Illinois State Water Survey, Box 232, Urbana, Illinois.
(d) Applied research.
(e) Investigation of meteorological conditions associated with flood-producing storms in Illinois to obtain basic data for reliable definition of time and space distribution of such storms and for calculation of probable maximum rainfall.
(f) Analysis progressing on storm area-depth relations, orientation of storms, seasonal and geographic distribution, synoptic weather types, topographic influences.

(3058) HYDROMETEOROLOGICAL ANALYSIS OF SEVERE RAINSTORMS.

(b) Field investigation; applied research.
(c) Mr. D. M. A. Jones, Illinois State Water Survey, Box 232, Urbana, Illinois.
(d) Applied research.
(e) Field surveys and detailed analyses of severe rainstorms in Illinois. Analyses based upon radar, synoptic weather, and field survey data and includes area-depth-duration relations, antecedent rainfall evaluation, isohyetal for peak periods of storm, etc.
(f) Continuing project.
(g) Analyses completed on 11 storms since 1951.
(h) Illinois Water Survey Reports of Investigation 14, 24, 27, and 35.

(3059) THERMAL LOADINGS AND CHARACTERISTICS OF SURFACE WATERS.

(b) Laboratory project.
(d) Experimental laboratory and field investigations; applied research.
(e) To determine the relationships between temperature, water usage, stream assets, and stream recovery capabilities.

ILLINOIS STATE WATERWAYS DIVISION, Springfield.

(1863) EROSION CONTROL, ILL. SHORE OF LAKE MICH.

(b) State of Illinois.

(c) Mr. Thomas B. Casey, Chief Waterway Engineer, Division of Waterways, Dept. of Public Works and Buildings, 201 West Monroe Street, Springfield, Illinois.

(d) Field investigation; applied research.

(e) To obtain and correlate basic data on the erosion processes along the Illinois Shore of Lake Michigan to the end that future efforts toward the prevention of erosion might be founded upon a more definite and factual basis with a consequent greater degree of assurance that the works will serve the intended purposes.

UNIVERSITY OF ILLINOIS, Soil and Water Conservation Engineering Laboratory, Department of Agricultural Engineering.

Inquiries concerning the following projects should be addressed to Prof. B. A. Jones, 100 Agricultural Engineering, University of Illinois, Urbana, Ill.

(2316) RUNOFF FROM SMALL AGRICULTURAL AREAS IN ILLINOIS.

(b) Laboratory project cooperative with ARS, U. S. Department of Agriculture.

(d) Experimental and field investigation; basic research.

(e) To determine frequencies of peak rates and total amounts of runoff from agricultural watersheds of 25 to 1,500 acres; to determine maximum rates of runoff from agricultural watersheds in different soil association areas in Illinois; to compare runoff from agricultural watersheds under accepted soil conservation practices with watersheds cultivated without soil conservation practices. Watersheds of 45.5, 63, 82, and 390 acres near Monticello, Ill. are covered with a rain gage network, and runoff is measured at weirs and spillway structures by water level recorders. Maximum stage recorders are installed at field structures on 8 watersheds in Champaign, Piatt, Vermilion, and Ford Counties on watersheds ranging in size from 45 to 1,400 acres. Model studies and field calibrations are made on the field structures.

(2317) A STUDY OF DRAINAGE OF SOME ILLINOIS SOILS.

(b) Laboratory project cooperative with ARS, U. S. Department of Agriculture.

(d) Field investigation; applied research.

(e) To determine on different soil types the effect of tile spacing and depth on (1) water table as measured by drawdown wells, (2) on crop yields; to verify present tile depth and spacing formulas for soil types investigated; and to compare physical laboratory measurements with field measurements.
The rate of water table drawdown is measured in wells perpendicular to tile lines. Field permeability and laboratory permeability measurements are made as well as physical analysis of the soil type.

Crop yields are determined laterally from the tile lines.

(2789) LABORATORY MODEL STUDIES OF CONSERVATION AND DRAINAGE STRUCTURES.

(b) Laboratory project.

(d) Experimental investigation in the laboratory applied and basic research.

(e) To investigate the performance of soil and water conservation structures by means of hydraulic model studies, to study water flow patterns into surface drains and to determine the cause of failures and remedial measures of certain conservation structures under flood conditions.

(g) Three subprojects were completed during 1958 and are reported in the publications listed in "h" below.

(h) "A Study of the Effect of Crack Width at Tile Joints on Soil Movement into Drain Tile Line", by B. A. Jones, Ph.D. Thesis, University of Illinois, June 1958. (Available on loan).
"A Study of the Critical Flow Criteria for the Determination of Discharge from Circular Conduits", by J. A. Replogle, M.S. Thesis, University of Illinois, August 1958. (Available on loan.)
"Hydraulics of Single Outlet Surface Inlets" by R. D. Black, Paper 58-506 presented at the Winter Meeting of the American Society of Agricultural Engineers, December 1958.
"The Effect of Crack Width at Tile Joints on Soil Movement into Drain Tiles Lines", B. A. Jones, Paper 58-508 presented at the Winter Meeting of the American Society of Agricultural Engineers, December 1958.

UNIVERSITY OF ILLINOIS, Civil Engineering Dept.

Inquiries concerning Projects Nos. 1589, 2085 to 2088, incl., 2318, 2790, 3060 to 3062, incl., should be addressed to Prof. J. C. Guillou, Civil Engineering Dept., University of Illinois, Urbana, Ill.

(564) HYDROLOGY OF URBAN AREAS.

(b) Laboratory project, cooperative with Illinois State Water Survey.

(c) Prof. V. T. Chow, Univ. of Ill., Urbana, Ill

(d) Experimental, theoretical, and field investigation; applied research and design.

(e) Rainfall-runoff study of an urban watershed, having an effective drainage area of 4.45 square miles and a population density of 14 persons per acre. Runoff is measured by a U.S.G.S. stream gage and precipitation by a network of fourteen rain gages strategically located in and out of the watershed. New types of evaporimeter are being developed and check results are being made.

(h) "Hydrologic Studies of Urban Watersheds, Rainfall and Runoff of Boneyard Creek, Champaign-Urbana, Illinois", by Ven Te Chow, Civil Engineering Studies, Hydraulic Engineering Series No. 2, University of Illinois.

(1589) OPEN CHANNEL METER.

    (b) Laboratory project in cooperation with
        Theoretical and Applied Mechanics Dept.
    (d) Experimental and analytical.
    (e) This study is concerned with a critical
        depth meter which may be economically
        built in a sewer after the sewer has been
        in service. Preliminary tests and analyses
        have been completed. Tests are underway
        using a 16-inch diameter pipe, with
        adjustable slope, and lucite test section.
        Laboratory results agree favorably with
        theoretical indications.

(1591) DETERMINATION OF WATERWAY AREAS.

    (b) Laboratory project, cooperative with
        Illinois Division of Highways and Bureau
        of Public Roads.
    (c) Prof. V. T. Chow, University of Illinois,
        Urbana Ill.
    (d) Analytical and field investigation;
        applied research and design.
    (e) To determine the discharge of water which
        will reach openings of highway drainage
        structures, such as bridges and culverts
        and to provide a simple but scientific
        procedure for use of engineers in estab-
        lishing the economical and adequate size
        of opening.
    (g) Six preliminary reports and two field
        reports have been prepared. The field
        reports are:
        "Preliminary Report of the Study of
        Culverts at Petersburg, Ill."
        "Preliminary Report of the Study of
        Channel Relocation and Culvert Problem at
        Florence, Illinois."
        The preliminary reports are:
        "A Compilation of Formulas for Waterway
        Area Determination."
        "A Historical Review of Engineering Studies
        of Waterway Area Determination."
        "Annotated Bibliography of Waterway Area
        Determination."
        "A Survey of the Current Practice of Water-
        way Area Determination Employed by Differ-
        ent State Highway Agencies in the United
        States."
        "The Development of a Tentative Procedure
        for the Determination of Waterway Areas."
        "Simplification of a Tentative Procedure
        for the Determination of Waterway Areas."
    (h) Publications not yet available to the
        public.

(2085) CALIBRATION AND USE OF CERTAIN INLET
        GRATES.

    (b) Illinois Division of Highways.
    (d) Laboratory investigation; applied research.
    (e) Full scale model tests of four standard
        Division of Highways inlets. Original and
        revised inlet grate designs have been
        tested.
    (h) Publication as a Bulletin of the Engineer-
        ing Experiment Station is in progress.

(2086) A STUDY OF FISHWAYS.

    (b) Departmental graduate study.
    (d) Laboratory investigation; basic research.
    (e) Scale model tests of a pool-type fishway
        to investigate efficient orifice design
        and ladder pool length.
    (f) Completed.
    (h) Laboratory report has been completed.

(2087) EFFECTIVENESS OF SUBWAY GRATINGS FOR
        HIGHWAY DRAINAGE.

    (b) Departmental special study.
    (d) Laboratory investigation; applied research.
    (e) Full scale model tests of two subway
        grating designs are being tested in
        standard Illinois Division of Highways,
        Type II inlet frame.
    (f) Suspended temporarily.

(2088) DISCHARGE CHARACTERISTICS OF RECTANGULAR
        TYPE INLET BOXES.

    (b) Departmental study.
    (d) Laboratory investigation; basic research.
    (e) Scale model investigation of rectangular
        inlet box with long lucite discharge pipe
        to verify or disprove the weir-orifice
        discharge theory.
    (f) Suspended temporarily.

(2318) FAUBER BRIDGE MODEL STUDY.

    (b) Departmental graduate study.
    (d) Laboratory investigation; applied research.
    (e) A design has been developed whereby a
        three tube culvert and an energy dissipator
        may replace an inadequate highway bridge.
        Model studies have been conducted to
        verify the proposed design.
    (h) Final report in preparation.

(2319) FREQUENCY STUDY OF HYDROLOGIC DATA.

    (b) Departmental study.
    (c) Prof. V. T. Chow, University of Illinois,
        Urbana, Ill.
    (d) Basic and applied research.
    (e) A survey of existing literature and
        applications of the probability law to the
        distribution of hydrologic data. The
        method of analysis ·thus developed is being
        applied to small watersheds in the State
        of Illinois in order to expose the runoff
        characteristics of the watersheds.
    (g) Results include development of theoretical
        procedure of analysis, derivation of
        characteristic values of the probability
        law, plotting of actual data, and deriva-
        tion of characteristic indexes of the
        runoff data.
    (h) "Discussion of Frequency of Discharges
        from Ungaged Catchments," by Ven Te Chow,
        Trans. Amer. Geophys. Union, Vol. 38,
        No. 6, pp. 963-966, Dec. 1957.
        "Discussion of a Nomogram for Lognormal
        Frequency Analysis," by Ven Te Chow, Trans.
        Amer. Geophys. Union, Vol. 38, No. 6, pp.
        962-963, Dec. 1957.
        "Frequency Analysis in Small Watershed
        Hydrology," by Ven Te Chow, Agri. Engrg.,

(2790) SIDE CHANNEL SPILLWAY STUDY.

  (b) Departmental graduate study.
  (d) Laboratory investigation; applied research.
  (e) Model investigation of flow conditions on the apron below the spillway crest and above the spillway channel. The purpose of the investigation is to determine the geometrics of the apron and the necessity of a critical depth control at the entrance to the spillway channel.

(3060) OPERATIONAL CHARACTERISTICS OF FILTER DRAINS.

  (b) American Association of Railroads.
  (d) Experimental; applied research.
  (e) Literature study and experimental investigation of characteristics of flow through granular filters and perforated drain pipe.

(3061) FLOW CHARACTERISTICS OF REND LAKE SPILLWAY.

  (b) Laboratory project and class problems.
  (d) Model investigation of uncontrolled apron type spillway.
  (e) 1:50 scale model of approach section, spillway and energy dissipator.

(3062) INVESTIGATION OF INFILTRATION THROUGH GRANULAR MEDIA.

  (b) Post doctoral research by Dr. Shigeru Tanaka.
  (d) Theoretical and experimental.
  (e) Investigation of advance of wetted front and attendant pressure temperature and moisture conditions. The test apparatus consists of an instrumental vertical cylinder filled with Ottawa Sand and subject to rates of infiltration.

(3063) THEORETICAL STUDY OF PROFILES OF GRADUALLY VARIED FLOW.

  (b) Departmental study.
  (c) Prof. V. T. Chow, University of Illinois, Urbana, Ill.
  (d) Theoretical; basic and applied research.
  (e) Mathematical analysis of the profiles of gradually varied flow in artificial open channels.
  (f) Completed.
  (g) A mathematical method of integration was developed. Bakhmeteff's varied-flow function table was extended to cover the range of application required by the new method.
  (h) "Integrating the Equation of Gradually Varied Flow," by Ven Te Chow, Proceedings, ASCE, Vol. 81, No. 838, pp. 1-32, Nov. 1955 and discussion in Vol. 83, No. HY1, pp. 9-22, Feb. 1957.

(3064) FLOW PATTERNS NEAR THE CRACK IN TILE DRAINS.

  (b) Graduate project, doctoral thesis for

Prof. E. J. Monke.
  (c) Prof. V. T. Chow, University of Illinois, Urbana, Ill.
  (d) Theoretical and experimental; basic research for doctoral thesis.
  (e) A study of the flow patterns around a circular drain. In the study use was made of an electrical analog model, a physical hydraulic model for one half the tile in a sand bed, and a mathematical analysis with numerical approximations.
  (f) Completed.
  (g) The results indicate: Darcy's law is applicable to the surface of seepage existing along the peripheral opening of a nearly empty five-inch circular drain; the effective gain in head in the empty drain was slightly greater than the diameter of the drain which was located in a saturated, homogenous medium 4 ft. deep, 100 ft. apart, and 8 ft. above an impervious layer when the outer boundary was circular, the effective potential gain was less than the diameter of the drain and varied with the nearness of that boundary; the efflux from the medium of a three-dimensional model varied, not only with drain-opening width, but also with the hydraulic conductivity of the flow medium; and the unsymmetrical drain opening effected by sealing part of the circumferential drain opening gave higher discharges near the drain than in the cases where the openings were symmetrical.

(3065) STUDY OF A TORNADO MODEL FOR DESIGN PURPOSES.

  (b) Graduate project, doctoral thesis for Mr. G. E. Martin.
  (c) Prof. V. T. Chow, University of Illinois, Urbana, Ill.
  (d) Analytical and field investigations; basic research for doctoral thesis.
  (e) An attempt is being made to correlate the laws of thermodynamics, atmospheric physics, dynamic meteorology, and fluid mechanics with the available data from actual tornados and to construct a model tornado from these data for design purposes that is compatible with the theory. The facilities of both the Civil Engineering Department and the Illinois State Water Survey, including a weather radar, are available for use in this study.

(3066) THE MECHANICS OF SQUARE ELBOW LOSSES.

  (b) Graduate project, doctoral thesis for Mr. R. D. Black.
  (c) Prof. V. T. Chow, University of Illinois, Urbana, Ill.
  (d) Experimental; basic research for doctoral thesis.
  (e) This is a study of the factors that contribute to the loss in energy experienced by the flow of water as it passes through an abrupt angle and size reduction such as that of a plugged "tee." The study will be conducted by means of hydraulic models.

UNIVERSITY OF ILLINOIS, Fluid Mechanics and Hydraulics Laboratory.

Inquiries concerning Projects Nos. 1343 and 2083 should be addressed to Prof. W. M. Lansford, 219 Talbot Laboratory, and Projects Nos. 2320, 2536, and 2537 should be addressed to Prof. J. M. Robertson, 125 Talbot Laboratory, University of Illinois, Urbana, Ill.

(1343) VELOCITY DISTRIBUTION STUDY IN A FLOOD-PLAIN CHANNEL.

   (b) Laboratory project.
   (d) Basic research.
   (f) Inactive - being reactivated.

(2083) VELOCITY DISTRIBUTION IN AN OPEN CHANNEL HAVING A TRIANGULAR CROSS SECTION.

   (b) Laboratory project.
   (d) Basic research.
   (e) Data were obtained from a channel artificially roughened.
   (g) Investigation reactivated, additional data being taken.

(2320) TURBULENT BOUNDARY LAYER IN A DIFFUSER.

   (b) Laboratory project.
   (d) Experimental and analytical; basic research.
   (e) Effect of adverse pressure gradient on the development of a turbulent boundary layer is being studied in a 10-degree conical diffuser. Air is the fluid medium being used.
   (g) Thesis completed; additional tests in progress.

(2536) STUDY OF HOMOLOGOUS TURBULENCE.

   (b) National Science Foundation.
   (d) Basic research.
   (e) The nature of turbulence, its production and dissipation, are to be studied in the simplest possible shear flow. This is to be produced in plane Couette flow in which the shear is constant and the turbulence homogeneous but not isotropic.
   (g) Tests and analysis under way; report being written.

(2537) WATER EXIT HYDROBALLISTICS.

   (b) Office of Naval Research, Dept. of the Navy.
   (d) Basic research; experimental.
   (e) Information on water exit behavior of ellipsoidal bodies of fineness ratios 4 to 12 is being obtained photographically.
   (g) Tests underway. Effects are found to be small, velocity first increases and then decreases as body exits. Significant amounts of water are carried out with the body.

IOWA INSTITUTE OF HYDRAULIC RESEARCH, State University of Iowa.

(66) HYDROLOGIC STUDIES, RALSTON CREEK WATERSHED.

   (b) Cooperative with Department of Agriculture, U. S. Geological Survey.
   (c) Prof. J. W. Howe, Department of Mechanics and Hydraulics, State University of Iowa, Iowa City, Iowa.
   (d) Field investigation; applied research, and masters theses.
   (e) Study being made of relation between rainfall and runoff over a small area. Discharge from a 3-square-mile area measured by U. S. Geological Survey; rainfall records at five automatic recording stations collected by Soil Conservation Service. Continuous records since 1924 of precipitation, runoff, groundwater levels, and vegetal cover.
   (g) Yearly records available for examination at Iowa Institute of Hydraulic Research.
   (h) Reports prepared annually since 1924 available in files at the Iowa Institute of Hydraulic Research. Summary of 33 year record in progress.

(67) COOPERATIVE SURFACE-WATER INVESTIGATIONS IN IOWA.

   (b) Cooperative with Geological Survey.
   (c) Mr. V. R. Bennion, Iowa Institute of Hydraulic Research, Iowa City, Iowa.
   (d) Field investigation; collection of basic stream-flow data.
   (e) Stream-flow and sediment measuring stations maintained throughout the State of Iowa cooperatively on a continuous basis. Records collected by standard methods of U. S. Geological Survey.
   (g) Records of stream flow and sediment discharge computed yearly.
   (h) Records contained in Water-Supply Papers available through offices of the Geological Survey.

(68) HYDROLOGIC STUDIES, RAPID CREEK WATERSHED.

   (b) Cooperative with Geological Survey.
   (c) Mr. V. R. Bennion, Iowa Institute of Hydraulic Research, Iowa City, Iowa.
   (d) Field investigation; applied research and masters theses.
   (e) Study being made of relation between rainfall and runoff over a small area. Discharge from a 25-square-mile area measured and flood runoff on main sub-basins determined by U. S. Geological Survey; rainfall records at four automatic recording stations collected by U. S. Weather Bureau. Continuous records since 1941 of precipitation, runoff and ground-water levels.
   (g) Rainfall records published in Weather Bureau Climatological Bulletins and surface runoff and ground-water levels published in Geological Survey Water-Supply Papers.

(73) MEASUREMENT OF TURBULENCE IN FLOWING WATER.

   (b) Cooperative with Office of Naval Research, Department of the Navy.
   (c) Dr. Philip G. Hubbard, Iowa Institute of

Hydraulic Research, Iowa City, Iowa.
(d) Experimental and theoretical.
(e) Instruments, primarily electrical in operation, are being developed to measure the charcteristics of turbulent flow under a wide range of laboratory and field conditions. Both sensing and computing elements are involved.
(g) Complete analysis of the sensing element operation and the circuit performance and descriptions of finished instruments are presented in the publications below.
(h) "Operating Manual for the IIHR Hot-Wire and Hot-Film Anemometers", P. G. Hubbard, S.U.I. Bulletin 37, 1957.

(79) CAVITATION.

(b) Cooperative with Office of Naval Research, Department of the Navy.
(c) Dr. Hunter Rouse, Iowa Institute of Hydraulic Research, Iowa City, Iowa.
(d) Experimental and theoretical; basic research and graduate thesis.
(e) Basic information is sought on cavitation for systematically varied boundary conditions. Tests are conducted in two variable-pressure water tunnels and a special cavitation tank. Studies of high-velocity submerged jets are being continued, with supplementary measurements of pressure fluctuations in air; instrumentation is being developed for measurement of the correlation between the velocity and pressure fluctuations to make possible prediction of the incipient cavitation index for given mean-flow conditions. Previous measurements of the pressure distribution around cavitating rounded, blunt, and hollow head forms are being extended in one tunnel to various angles of yaw. Previous measurements on a grid of normal cylinders are being extended through use of dynamometer in other water tunnel. Cavitating flow about a rotating cylinder in a normal stream is being investigated.
(h) "Pressure and Velocity Fluctuations in a Submerged Jet", S. R. Carr, M. S. Thesis, February 1958.
"The Drag of Cavitating Cylinders Arranged in a Straight Grid", J. J. Geist, M. S. Thesis, February 1959.

(81) MATHEMATICAL ANALYSIS OF PRESSURE DISTRIBUTION.

(b) Cooperative with Office of Naval Research and David Taylor Model Basin, Dept. of the Navy.
(c) Dr. Louis Landweber, Iowa Institute of Hydraulic Research, Iowa City, Iowa.
(d) Theoretical; basic research.
(e) (1) A theory of stream functions for general three-dimensional flow has been developed and published. (2) The development of a method for the determination of flow about bodies of revolution and symmetrical two-dimensional forms in arbitrary states of motion, based on solutions of integral equations of the first kind, has

been completed and a description of the method will be submitted for publication. (3) An analog computer for potential flow, consisting of an array of electrical resistances, has been constructed. A manual describing its application has been prepared.

(854) BOUNDARY-LAYER DEVELOPMENT ON SMOOTH AND ROUGH SURFACES.

(b) Cooperative with Office of Naval Research, Department of the Navy.
(c) Dr. Louis Landweber, Iowa Institute of Hydraulic Research, Iowa City, Iowa.
(d) Experimental and theoretical; basic research.
(e) Purpose of work is to determine the relations between boundary-layer characteristics for smooth and rough boundaries of arbitrary shape. A critical study of the boundary layer on a smooth flat plate in zero pressure gradient has been completed and a report written. The boundary layer on a smooth circular cylinder with axis parallel to the stream, in a zero pressure gradient, has also been investigated.
(h) "Effect of Transverse Curvature on Turbulent-Boundary-Layer Characteristics", Y. S. Yu, Journal of Ship Research, Dec. 1958.

(1102) HISTORY OF HYDRAULICS.

(b) Institute project.
(c) Dr. Hunter Rouse, Iowa Institute of Hydraulic Research, Iowa City, Iowa.
(e) To trace the historical development of the important theories of hydraulics, covering the fundamental ideas of the science, the critical periods of its development, and the personalities whose contributions were of major importance.

(1107) TRANSPORTATION OF SEDIMENT AS SUSPENDED AND TOTAL LOAD.

(b) Laboratory project; formerly cooperative with Office of Naval Research, Department of the Navy.
(c) Dr. Lucien Brush, Jr., Iowa Institute of Hydraulic Research; Iowa City, Iowa.
(d) Experimental; basic research.
(e) To determine the suspended and total load as a function of hydraulic and sediment parameters.
(f) Completed.
(g) An empirical relationship has been found for both suspended and total load as a function of the velocity and depth of flow, the shear velocity, the sediment size, and the fall velocity.
(h) "The Total Sediment Load of Streams", by E. M. Laursen, Amer. Soc. Civ. Engrs., Vol. 84, No. HY1, February 1958.

(1875) CHARACTERISTICS OF STABLE EDDIES.

(b) Laboratory project, partially supported by Office of Naval Research, Department of the Navy.

(c) Dr. Hunter Rouse, Iowa Institute of Hydraulic Research, Iowa City, Iowa.

(d) Experimental; basic research for master's thesis.

(e) Distributions of velocity, pressure and turbulence are being measured in an air tunnel throughout the vicinity of separation zones produced by abrupt changes in flow section to the end of establishing the primary eddy characteristics as functions of the boundary geometry.

(g) Mean eddy patterns behind normal plates have been investigated. Preliminary study has also been made of the flow pattern produced by a normal wind curtain. Mean eddy patterns at pipe inlets and behind bluff bodies. Additional measurements on the hydraulic jump have also been made.

(h) "Penetration of a Jet into a Counterflow", by T. R. Krishna Rao, M. S. Thesis, State University of Iowa, Feb. 1958. Available on loan.
"Discussion of Turbulence Characteristics of the Hydraulic Jump", by P. G. Hubbard, Journal of Hydraulics, ASCE, Nov. 1958.

(2091) RESEARCH ON SHIP THEORY.

(b) Cooperative with Office of Naval Research, Department of the Navy and Society of Naval Architects and Marine Engineers.

(c) Dr. Louis Landweber, Iowa Institute of Hydraulic Research, Iowa City, Iowa.

(d) Experimental and theoretical; basic research.

(e) To determine the laws governing the forces, moments, and motions of ships in smooth and disturbed seas, in order to furnish design data to the naval architect. A towing tank 10 feet wide, 10 feet deep, and 300 feet long has been constructed. Theoretical work on the added-mass coefficients and the forces and moments on bodies is under way. The rolling of ships is being investigated.

(h) "Irrotational Motion of the Liquid Surrounding a Vibrating Ellipsoid of Revolution", E. O. Macagno and L. Landweber, Journal of Ship Research, June 1958.
"A Three-Parameter Family of Two-Dimensional Forms Oscillating in a Free Surface", L. Landweber and Matilde Macagno, Journal of Ship Research; to be published.
"The Added Masses of Prolate Spheroids Accelerating Under a Free Surface", M. R. Bottaccini, Ph. D. Dissertation, to be available as an IIHR report.

(2320) A STUDY OF THE FLOW CHARACTERISTICS OF HIGHWAY CULVERTS.

(b) Iowa Highway Research Board and U. S. Bureau of Public Roads.

(c) Prof. D. E. Metzler, Iowa Institute of Hydraulic Research, Iowa City, Iowa.

(d) Experimental; applied research.

(e) The purpose is to determine the flow characteristics of box culverts.

(f) Completed.

(g) Variation in culvert performance described. Advantages of "broken back" culvert

indicated.

(h) Bulletin in press.

(2322) EFFECT OF RESERVOIR STORAGE UPON SUPER-FLOODS.

(b) Graduate project.

(c) Prof. C. J. Posey, Dept. of Mechanics and Hydraulics, State University of Iowa, Iowa City, Iowa.

(d) Theoretical, master's thesis.

(e) To find what effect reservoirs of various characteristics will have in decreasing the peak of increasingly greater super-floods.

(g) A quick approximate method has been devised which takes the principal variables into account.

(h) "Investigation of Storage Effects of Reservoirs Subjected to Superfloods", Yuan-po Kou, M. S. Thesis, State University of Iowa, Feb. 1958. Available on loan.

(2324) ANALYSIS OF FLOW PATTERNS FOR SHARP-CRESTED WEIRS.

(b) Laboratory project.

(c) Dr. Hunter Rouse, Iowa Institute of Hydraulic Research, Iowa City, Iowa.

(d) Analytical and experimental; basic research for doctor's and master's degrees.

(e) Determination of streamline configuration by means of relaxation process and electrical analog computer for various relative heights of weirs, supplemented by experimental study for relatively low weirs and sills.

(f) Experimental study of low weirs and sills completed.

(2328) INVESTIGATION OF SURFACE ROUGHNESS.

(b) Cooperative with U. S. Geological Survey, Department of the Interior.

(c) Dr. Hunter Rouse, Iowa Institute of Hydraulic Research, Iowa City, Iowa.

(d) Experimental research.

(e) Initial purpose is to determine effect of areal distribution of roughness elements on resistance in both subcritical and super-critical flow. Tests are being conducted on cubical elements cemented to floor of 30-foot tilting flume in varying concentration.

(h) "The Effect of Free Surface Instability on Channel Resistance", by Herman J. Koloseus, Doctoral Dissertation, Aug. 1958, State University of Iowa. Obtainable from University Microfilms, 313 N. 1st St., Ann Arbor, Mich.

(2540) SCOUR AT BRIDGE CROSSINGS.

(b) Cooperative with Iowa Highway Research Board and U. S. Bureau of Public Roads.

(c) Dr. Lucien Brush, Jr., Iowa Institute of Hydraulic Research, Iowa City, Iowa.

(d) Experimental; applied research.

(e) To investigate the pattern of general scour caused by contracting the flow section at

a bridge crossing.

(f) Completed.

(g) Depth and shape of the scour hole are a function of the geometry of the bridge site and the ratio of the flow in the normal stream and on the floodplain.

(h) "Scour at Bridge Crossings", by E. M. Laursen, Iowa Highway Research Board Bulletin, submitted for publication.

(2541) DEVELOPMENT OF INSTRUMENTS FOR USE IN ANALYZING APERIODIC SIGNALS.

(b) Cooperative with Office of Naval Research, Department of the Navy.

(c) Dr. Philip G. Hubbard, Iowa Institute of Hydraulic Research, Iowa City, Iowa.

(d) Experimental; applied research.

(e) The purpose is to improve the analysis of turbulent velocity and pressure fluctuations.

(2792) THE DECAY OF TURBULENCE IN A ZERO-MOMENTUM WAKE.

(b) Cooperative with the Office of Naval Research, Department of the Navy.

(c) Dr. Philip G. Hubbard, Iowa Institute of Hydraulic Research, Iowa City, Iowa.

(d) Primarily experimental.

(e) Powered models are driven through a towing basin, and the wake is explored with a hot-wire anemometer.

(g) In the initial stages. Only sample measurements are available.

(2794) STUDY OF BACKWATER CURVE DATA.

(b) Graduate project.

(c) Prof. C. J. Posey, Dept. of Mechanics and Hydraulics, State University of Iowa, Iowa City, Iowa.

(d) Analysis of experimental data; basic, master's thesis.

(e) Analysis of backwater curves incidentally obtained in 400-foot variable-slope flume of Rocky Mountain Hydraulic Laboratory.

(h) "Study of Backwater Curves in a Triangular Channel", by K. P. Singh, M. S. Thesis, State University of Iowa, Aug. 1958. Available on loan.

(2795) PREDICTION OF RUNOFF FREQUENCY FROM PRECIPITATION AND INFILTRATION FREQUENCIES.

(b) Laboratory project.

(c) Prof. J. W. Howe, Dept. of Mechanics and Hydraulics, State University of Iowa, Iowa City, Iowa.

(d) Statistical.

(e) Exploration of possibility of estimating frequencies of rare floods based on combination of observed frequencies of precipitation and infiltration.

(f) First phase complete.

(g) Good correlation for a small, a medium, and a large watershed found.

(h) M. S. Thesis, by M. A. Chowdhury, 1958.

(2796) EXTENSION OF WIND TUNNEL STUDIES ON PRESSURE

DISTRIBUTION ON FLAT ROOFED RECTANGULAR BUILDINGS.

(b) Laboratory project.

(c) Prof. J. W. Howe, Dept. of Mechanics and Hydraulics, State University of Iowa, Iowa City, Iowa.

(d) Experimental, basic research, master's thesis.

(e) Rectangular, flat-roofed building models having height:width ratios from 1/2 to 6 and length:width ratios from 1 to 4 exposed to uniform wind velocity in tunnel. Pressure variations at 3 orientations observed.

(f) Completed.

(g) Negative pressures over roof increase until building height is six times its down wind width.

(h) M. S. Thesis by Wm. S. Hartley, 1958.

(2797) OPTIMUM SHAPE OF 90° BEND IN RECTANGULAR CHANNEL.

(b) Laboratory project.

(c) Prof. J. W. Howe, Dept. of Mechanics and Hydraulics, State University of Iowa, Iowa City, Iowa.

(d) Experimental for M. S. thesis.

(e) Bend width varied through 50-percent increase to determine optimum proportions.

(3067) A STUDY OF THE FACTORS WHICH AFFECT INFILTRATION RATES ON THE RALSTON CREEK AND RAPID CREEK WATERSHEDS.

(b) Laboratory project.

(c) Prof. J. W. Howe, Dept. of Mechanics and Hydraulics, State University of Iowa, Iowa City, Iowa.

(d) Analytical, statistical correlation.

(e) To determine the effects of antecedent precipitation, rainfall duration and intensity, temperature, and season on infiltration rates on Ralston and Rapid Creeks.

(f) Completed.

(g) Graphical correlations with above variables.

(h) M. A. Thesis by Merwin D. Dougal and M. S. Thesis by Jyuh Sheng Chang, 1958.

(3068) DETERMINATION OF DYNAMIC FORCES ON FLASHBOARDS.

(b) Laboratory project.

(c) Prof. J. W. Howe, Dept. of Mechanics and Hydraulics, State University of Iowa, Iowa City, Iowa.

(d) Experimental for M. S. Thesis.

(e) Measurement of dynamometer of moment exerted by water flowing over flashboard.

(3069) INSTALLATION OF GRADED RIP-RAP FOR PROTECTION OF PIERS AND ABUTMENTS AGAINST SCOUR.

(b) Graduate project.

(c) Prof. C. J. Posey, Engineering Building, Iowa City, Iowa.

(d) Experimental; applied, for master's thesis.

(e) Methods of placement and areal extent necessary for effective protection will be studied.

(3070) ASPIRATIVE EFFICIENCY OF VARIOUS CHIMNEY
        SHAPES.

    (b) Graduate project.
    (c) Prof. C. J. Posey, Engineering Building,
         Iowa City, Iowa.
    (d) Experimental; applied, for master's thesis.
    (e) Investigation of possibility of using winds
         to move air through pipe systems for evapo-
         rative stabilization of pavement subsoils
         makes it necessary to test efficiency of
         "chimney" shapes.

(3071) MEASURING EQUIPMENT FOR SURFACE ROUGHNESS.

    (b) Graduate College, Civil Engineering Dept.
    (c) Prof. C. J. Posey, Engineering Building,
         Iowa City, Iowa.
    (d) Developmental; applied.
    (e) Design and construction of equipment to
         evaluate roughness parameters for range of
         surface roughness of interest to hydraulic
         engineers.

(3072) SCOUR AT RELIEF BRIDGES.

    (b) Laboratory project.
    (c) Dr. Lucien Brush, Jr., Iowa Institute of
         Hydraulic Research, Iowa City, Iowa.
    (d) Experimental; master's thesis.
    (e) To determine the amount and rate of scour
         at relief bridges.

(3073) SEDIMENT TRANSPORT IN MEANDERING CHANNELS.

    (b) Laboratory project.
    (c) Dr. Lucien Brush, Jr., Iowa Institute of
         Hydraulic Research, Iowa City, Iowa.
    (d) Experimental; basic research and graduate
         thesis.
    (e) To determine the amount of transport occur-
         ring in meandering channels of different
         curvature.

(3074) WAKE OF ZERO MOMENTUM FLUX.

    (b) Cooperative with Office of Naval Research,
         Department of the Navy.
    (c) Mr. Arthur Toch, Iowa Institute of Hydrau-
         lic Research, Iowa City, Iowa.
    (d) Experimental.
    (e) Distribution of velocity, mean and turbu-
         lent, and of pressure is to be measured in
         the field of flow created by flow past a
         bluff, axisymmetric body with a centrally
         located jet for the particular condition
         of zero momentum flux.

(3075) ANNULAR JETS IN GROUND PROXIMITY.

    (b) Cooperative with Office of Naval Research,
         Department of the Navy.
    (c) Dr. Lawrence R. Mack, Iowa Institute of
         Hydraulic Research, Iowa City, Iowa.
    (d) Experimental and theoretical; basic
         research and graduate theses.
    (e) The distributions of mean velocity and
         mean pressure in the flow and on the
         boundaries near an annular jet are being
         studied for four cases: (1) A stationary

annular jet impinging against a rigid
ground plate; (2) an annular jet imping-
ing against a rigid ground plate in the
presence of an ambient transverse flow
(wind tunnel study); (3) a stationary
annular jet directed against a nearby
water surface; and (4) an annular jet
traveling over water.

(3076) EFFECT OF EAVES ON PRESSURE DISTRIBUTION
        AROUND RECTANGULAR BUILDING MODELS.

    (b) Laboratory project.
    (c) Prof. J. W. Howe, Dept. of Mechanics and
         Hydraulics, State University of Iowa, Iowa
         City, Iowa.
    (d) Experimental; basic research.
    (e) Varying widths of eaves on roofs having
         several different pitches tested in wind
         tunnel.

IOWA STATE COLLEGE, Department of Agricultural
Engineering.

Inquiries concerning the following projects should
be addressed to Mr. H. P. Johnson, Dept. of Agri-
cultural Engineering, Iowa State College, Ames, Ia.

(2330) DEPTH, SPACING AND HYDRAULICS OF TILE
        DRAINS.

    (b) Laboratory project.
    (d) Theoretical and field investigation; basic
         and applied research; master's and doctor's
         thesis.
    (e) Analytical and physical approach is being
         studied to determine depth and spacing of
         tile drain by analyzing geometry of systems
         and soil characteristics. Work is coopera-
         tive with that of Dr. Don Kirkum, Soil
         Physics Department of Agronomy, and which
         is primarily analytical nature. Studies
         of effect of tile misalignment and observa-
         tions of nature of flow in experimental
         field tile lines are being made.

(2331) ESTIMATIONS OF SURFACE RUNOFF FROM
        AGRICULTURAL WATERSHEDS.

    (b) Laboratory project.
    (d) Theoretical; applied research; doctoral
         thesis.
    (e) The surface runoff volume for individual
         storms is being estimated by superimposing
         infiltration curves on the rainfall histo-
         gram. Data from point rainfall records
         are being analyzed. Hydrographs from
         watersheds of up to 25 square miles are
         being analyzed.

(2333) IMPROVEMENT OF SURFACE DRAINS WITH TILE
        BLIND INLETS.

    (b) Laboratory project.
    (d) Field Investigation; design.
    (e) Field study is being made to determine the
         effect of different tile backfill materials
         on the flow of water into the tile drains.

(2334) RUNOFF FROM SMALL WATERSHEDS.

   (b) Laboratory project, cooperative with ARS, USDA.
   (d) Field Investigations; applied research, design.
   (e) Measurements are being made of watershed rainfall and surface runoff on ten agricultural watersheds. Sediment measurements are being made in six small reservoirs in the gaged watersheds.

(3077) INFILTRATION CAPACITIES OF FAYETTE SILT LOAM FROM HYDROLOGIC DATA.

   (b) Laboratory study.
   (d) Analytical statistical study, master's thesis.
   (e) Correlation of antecedent moisture and cover with infiltration rates based on data taken from La Crosse, Wisconsin, runoff plots.

(3078) LOW FLOW CHARACTERISTICS OF STREAM IN NORTH CENTRAL AND WESTERN IOWA.

   (b) Laboratory project.
   (d) Analytical study, master's thesis.
   (e) An analysis of the frequencies of given discharges from selected streams in the above area. An attempt is being made to relate parameters such as rainfall to the flows at times of the year when pumping from streams for irrigation may have detrimental effects.

IOWA STATE COLLEGE, Department of Agronomy.

(3079) MOVEMENT OF WATER IN SOIL.

   (b) Laboratory project.
   (c) Prof. Don Kirkham, Soil Physics, Dept. of Agronomy, Iowa State College, Ames, Iowa.
   (d) Theoretical and applied research.
   (e) Work is being done on the movement of ground water in soil, particularly in the saturated phase. Work has also been initiated on the use of the mass spectrometer for studying the movement of water through soil and plants using deuterium as a tracer.
   (h) "Potential and Capacity of Concentric Coaxial Capped Cylinders", Journal of Applied Physics, Vol. 28, pp. 724-731, 1957. "Graphs and Formulas for Cross Product Bessel Functions", Journal of Mathematics and Physics, January 1958. "Seepage of Steady Rainfall Through Soil into Drains", Trans. Amer. Geoph. Union. Vol. 39, pp. 892-908, October 1958.

UNIVERSITY OF KANSAS, Department of Engineering Mechanics.

Inquiries concerning the following projects should be addressed to Dr. David W. Appel, Dept. of

Engineering Mechanics, University of Kansas, Lawrence, Kansas.

(3080) TRANSMISSION AND DISSIPATION OF SURGES IN ELASTIC TUBES.

   (b) Sohio Pipe Line Company and Department of Engineering Mechanics.
   (d) Basic research; theoretical and experimental investigation. Also M. S. thesis.
   (e) This is a basic study of the speed of propagation and rate of dissipation of surges in liquid-filled elastic tubes. Comparisons are being made between theoretical evaluations of these characteristics and observed values on long oil pipe lines. Additional data are to be obtained from laboratory experiments on tubes having very elastic walls.
   (g) The celerity of both positive and negative pressure surges was found to be independent of surge amplitude in an oil pipe line. The losses in transmission of surges were found to be greater than predicted theoretically for viscous dissipation alone, though of the same order of magnitude. The results indicate that a surge technique may be used for locating leaks in oil pipe lines.

(3081) DIFFUSION OF A JET FORMED AT AN ABRUPT ENLARGEMENT IN TWO-DIMENSIONAL FLOW.

   (b) Kimberly-Clark Corporation, Neemah, Wis.
   (d) Experimental; basic research.
   (e) The characteristics of the mean flow through abrupt two-dimensional expansions are to be determined in a recirculating water tunnel. The stability of the eddy formed in the corner of the expansion is also to be investigated.

(3082) MEASUREMENT OF LOW VELOCITIES IN WATER.

   (b) Laboratory project.
   (d) Development.
   (e) An instrument is being developed for measuring low velocities in small hydraulic models which will utilize the known relationship between frequency of shedding of vortices in the wake of a circular cylinder and the velocity of flow.

THE JAMES LEFFEL AND COMPANY.

(3083) HYDRAULIC TURBINE TESTING.

   (b) Laboratory project.
   (c) Mr. J. Robert Groff, The James Leffel and Company, 426 East St., Springfield, Ohio.
   (d) Experimental and applied research.
   (e) Model turbines using Francis, propeller and impulse design, testing for power and efficiency at various speeds; and under wide range of conditions and requirements pertaining to performance and installation setting. Study of draft tubes design and improvements possible by this means.
   (f) Active.

LEHIGH UNIVERSITY, Department of Civil Engineering.

Inquiries concerning the following projects should be addressed to Prof. W. J. Eney, Head, Dept. of Civil Engineering, Director, Fritz Engineering Laboratory, or Prof. J. B. Herbich, Chairman, Hydraulics Division, Fritz Engineering Laboratory, Lehigh University, Bethlehem, Pennsylvania.

(1602) PRESSURE DISTRIBUTION IN CONDUIT BENDS.

  (b) Laboratory project.
  (d) Experimental; undergraduate special prob-
      lem.
  (e) Study of a rectangular bend with a central
      dividing wall, by means of electrical-
      analogy has been completed.
  (f) Inactive.

(1603) BUTTERFLY VALVE STUDY.

  (b) CDC Controls Services, Inc., Hatboro, Pa.
  (d) Experimental; applied research.
  (f) Completed.

(2339) BUCKET-TYPE ENERGY DISSIPATOR CHARACTER-
       ISTICS.

  (b) Gannett, Fleming, Corddry and Carpenter,
      Inc., 600 North Second Street, Harrisburg,
      Pennsylvania.
  (d) Experimental; for general design.
  (e) Suspended.

(2543) STUDY OF CONDUIT EXIT PORTALS.

  (b) Laboratory project.
  (d) Experimental; M. S. Thesis.
  (e) General pressure-distribution study
      completed.
  (g) Tests of square and circular conduit with
      free-jet, horizontal apron, and three dif-
      ferent wall flares, have been completed.

(3084) STUDY ON IMPROVING DESIGN OF A HOPPER
       DREDGE PUMP.

  (b) District Engineer, U. S. Army Engineer
      District, Philadelphia, Corps of Engrs.
  (d) Experimental and applied research.
  (e) The project has been divided into four
      phases: (a) Model tests of the existing
      dredge pump; (b) recommendation for design
      changes of the dredge pump; (c) model
      investigation of the modified design of
      the dredge pump; and (d) analysis of the
      investigation and final recommendations.
  (f) Phase A active.

(3085) STUDY OF SCALE EFFECT BETWEEN MODEL AND
       PROTOTYPE SPILLWAYS.

  (b) Laboratory project.
  (d) Graduate students project.
  (e) 1:100 scale two-dimensional model built of
      Chief Joseph Dam. Prototype crest pres-
      sures will be compared with the data
      obtained on the model.

(3086) INVESTIGATION OF DESIGN CRITERIA OF SPUR

DIKES.

  (b) Laboratory project.
  (d) Theoretical and experimental.
  (e) The project has been divided into three
      phases: (1) literature survey; (2) theo-
      retical analysis; and (3) experimental
      study to determine the proper proportions
      and alignment of the dikes.
  (f) Phase 1 active.

MARYLAND UNIVERSITY, Institute for Fluid Dynamics and Applied Mathematics.

Inquiries concerning the following projects should be addressed to Dr. M. H. Martin, Director, Inst. for Fluid Dynamics and Applied Mathematics, Univ. of Maryland, College Park, Maryland.

(3087) EFFECT OF SURFACE ROUGHNESS ON TURBULENT
       SHEAR FLOWS.

  (b) Office of Naval Research, Dept. of the Navy.
  (d) Experimental. Francis R. Hama, Principal
      Investigator.
  (e) Investigate systematically the effect of
      spacing of two-dimensional roughness
      elements on the drag increase in a two-
      dimensional wind tunnel.
  (g) Velocity distribution and drag formula for
      smooth plate have been determined with
      excellent correlations.
  (h) "Experiment on Turbulent Shear Flows in
      Smooth Two-Dimensional Tunnels", M.
      Stevenson, Progress Report No. 1, Institute
      for Fluid Dynamics and Applied Mathematics,
      Tech. Note BN-147, July 1958.

(3088) TRANSITION FLOW PATTERNS.

  (b) Air Force Office of Scientific Research.
  (d) Basic experimental and theoretical re-
      search. John R. Weske, Principal Investi-
      gator.
  (e) Results of initial experimental work have
      furnished a basis for the theoretical
      treatment of three-dimensional transition
      patterns and related behavior of vortices.
  (f) Completed.
  (h) "Calculation of the Cross-Stream Wave
      Length of the Three-Dimensional Transition
      Pattern in the Boundary Layer Along a Flat
      Plate" and "On the Origin and Mechanism of
      Vortex Motion at the Inlet of Intakes
      Placed Near a Flat Surface." In prepara-
      tion.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY, Department of Civil and Sanitary Engineering, Hydrodynamics Laboratory.

Inquiries concerning projects Nos. 577, 2546, 2547, 2548, 2801, 2803, and 3089, and requests for re-prints and Technical Reports should be addressed to Dr. Arthur T. Ippen, Prof. of Hydraulics, Hydrodynamics Laboratory, Massachusetts Institute

(307) STABILITY OF FLOW STRATIFIED DUE TO
DENSITY DIFFERENCES.

(b) Laboratory project.
(c) Prof. D. R. F. Harleman, Hydrodynamics Lab.
Mass. Inst. of Tech., Cambridge 39, Mass.
(d) Theoretical and experimental; graduate
research.
(e) 1. Theoretical and experimental investiga-
tions have been made on steady-state uniform
density current flows including determina-
tion of velocity distributions, resistance
laws and interfacial stability. 2. Investi-
gation of control structures for stratified
flow. 3. Investigation of vertical intake
structures for stratified flow.
(g) Phases (1) and (2) have been completed.
In phase 3 vertical intakes for a two layer
stratified system having a density differ-
ence of the order of one percent are being
investigated experimentally. Interface
drawdown curves and critical discharge
rates have been obtained for various intake
geometries.
(h) "Submerged Sluice Control of Stratified
Flow," by D. R. F. Harleman, R. S. Gooch,
and A. T. Ippen, Proc. A.S.C.E., Journal
of Hydraulics Division, No. 2, April 1958,
paper No. 1584.

(577) CHARACTERISTICS OF SOLITARY WAVES.

(b) Office of Naval Research, Department of the
Navy.
(d) Experimental; basic research.
(e) Experimental investigation of solitary wave
characteristics in a horizontal channel.
Measurements of attenuation for various
bottom roughnesses. Investigation of
amplitude change, profile deformation and
breaking characteristics of the solitary
wave on a sloping beach. Measurement of
unsteady velocities in the boundary layer
region. Experimental investigation of
wave characteristics in the transition
between oscillatory and solitary waves.
Investigation of the unsteady boundary
shear due to the passage of a solitary
wave.
(f) Completed.
(g) Instantaneous force measurements by means
of a shear plate on the channel bottom
have been made. A comparison with average
resistance coefficients obtained from
attenuations records was made and satis-
factory correlation was found. Due to the
unsteady nature of the flow under the
solitary wave, the instantaneous shear
stresses cannot adequately be described by
steady state relations except at the point
of zero acceleration under the crest.
(h) "The Damping of the Solitary Wave from
Boundary Shear Measurements," by A. T.
Ippen, and M. M. Mitchell, M.I.T. Hydro-
dynamics Laboratory Technical Report No. 23,
June 1957.

(1355) CAVITATION INCEPTION FOR STEADY MOTION.

of Technology, Cambridge 39, Massachusetts.

(b) Office of Naval Research, Department of the
Navy.
(c) Professor J. W. Daily, Hydrodynamics Lab.,
Mass. Inst. of Tech., Cambridge 39, Mass.
(d) Experimental; basic research.
(e) Study of cavitation inception for steady
motion for systematic variation in boundary
layer development and in the turbulence
level in the zone of minimum pressure.
(f) Completed.
(g) The working section of a closed jet water
tunnel is arranged so that the boundary
layer growth is controlled by a systematic
change of its shape. Provision is also
made for control of turbulence level, pres-
sure intensity and air content.
Experiments involving the effect of velocity
variation on incipient cavitation and on
the influence of dissolved air content have
been completed. Information on the turbu-
lence of the flow in the cavitation region
has been obtained by high-speed photographs
of the cavitation bubbles.
Explorations in the boundary layer were
made to determine the local mean pressure
intensities and their relation to the local
velocity and turbulence. This investiga-
tion included one case of uniform boundary
roughness.
(h) "The Influence of Roughness on the Incep-
tion of Cavitation," by D. Benson, S.M.
Thesis, September, 1958.

(1609) EXPERIMENTAL STUDY OF THE SORTING OF BEACH
SEDIMENTS BY WAVE ACTION.

(b) Beach Erosion Board, U. S. Army Corps of
Engineers.
(c) Prof. P. S. Eagleson, Hydrodynamics Lab.
Mass. Inst. of Tech., Cambridge 39, Mass.
(d) Experimental; basic research.
(e) Quantitative study of the sorting action
and selective transport of beach material
by shallow water waves moving on a granular
beach.
(g) Equipment consists of a wave channel 30 in.
wide, 36 in. deep and 100 ft. in length
together with a piston-type wave generating
mechanism. The wave generator is controlled
by a hydraulic servomechanism which permits
continuous variation of both wave amplitude
and frequency during operation.
A systematic series of observations of
velocities of spherical bottom sediment
particles for a horizontal bottom and two
beach slopes has been completed for various
surface roughnesses including a smooth
beach. The data are shown to verify a
derived equation of net sediment motion.
Studies of smooth bottom resistance involv-
ing direct measurement of boundary shear
stress and boundary layer velocity dis-
tribution have been completed. Measure-
ments of the equilibrium characteristics
of sand beaches are currently being made.
(h) "Motion of Discrete Bottom Sediment Parti-
cles due to Shoaling Waves," by P. S.
Eagleson, L. A. Peralta, and R. G. Dean,
Beach Erosion Board, Tech, Memorandum No.
104, February 1958.

(1881) WAVE FORCES ON OFFSHORE STRUCTURES.

   (b) Humble Oil and Refining Company, Houston,
       Texas.
   (c) Prof. D. R. F. Harleman, Hydrodynamics Lab.,
       Mass. Inst. of Tech., Cambridge 39, Mass.
   (d) Experimental; basic research.
   (e) Objective is the determination of the
       design forces to be expected on offshore
       structures subjected to shallow water wave
       action.
   (f) Completed.
   (g) Tests have been completed on a series of
       vertical cylinders in waves of various
       characteristics. Lift and drag measurements
       have also been made on horizontal and verti-
       cal cylinders with variable submergence and
       on basic shapes such as spheres and cylin-
       ders.
       Various configurations of buoyancy members
       for a movable platform have been tested to
       obtain dynamic forces when the platform is
       rigidly fixed. Tests have been extended
       to include a study of mooring cable forces
       on a floating platform subjected to wave
       forces.
       An experimental and analytical study of
       the dynamics of a submerged hollow sphere
       moored by a cable have also been made.
       Measurements of horizontal and vertical
       components of the cable tension have been
       obtained as a function of wave frequency
       and length. Particular attention was de-
       voted to conditions near resonance where
       the natural frequency of the moored object
       equals the forcing frequency of the wave.
   (h) "Experimental and Analytical Studies of
       Wave Forces on Offshore Drilling Structures.
       Part II: Buoyancy Components for Floating
       Platforms," by D. R. F. Harleman, W. C.
       Shapiro, and T. A. Marlow, II, M.I.T. Hy-
       drodynamics Laboratory Technical Report No.
       24, June 1957.
       "Investigation on the Dynamics of Moored
       Structures in Waves," by D. R. F. Harleman,
       and W. C. Shapiro, Hydrodynamics Laboratory
       Technical Report No. 28, July 1958.

(2103) ENERGY DISSIPATION IN STILLING BASINS AND
        DOWNSTREAM EROSION.

   (b) Laboratory project.
   (c) Prof. D. R. F. Harleman, Hydrodynamics Lab.,
       Mass. Inst. of Tech., Cambridge 39, Mass.
   (d) Experimental; graduate and undergraduate
       theses.
   (e) General study of energy dissipation in
       stilling basins and erosion conditions
       downstream.
   (g) Hydrodynamic forces on a single baffle
       pier have measured as a function of the
       initial Froude number and the distance
       between the toe of the hydraulic jump and
       the pier. Additional studies have also
       been made on the effect of arrangement and
       position of baffle piers in stilling per-
       formance.
   (h) "Application of Baffle Pier Hydrodynamics
       in Stilling Basin Design," by D. W.
       McDougall, S. B. Thesis, June 1958.

(2341) FLUID MECHANICS OF TURBOMACHINERY COMPONENTS.

   (b) Office of Ordnance Research, Department of
       the Army.
   (c) Prof. J. W. Daily and Prof. R. E. Nece,
       Hydrodynamics Lab., Mass. Inst. of Tech.,
       Cambridge 39, Mass.
   (d) Experimental; basic research.
   (e) Investigation of problems connected with
       the several secondary effects in a turbo-
       machine such as seal ring friction and
       leakage, rotor-to-wall clearance effects,
       and vane tip clearance.
   (f) Completed.
   (g) The investigation was concerned with the
       effect of roughness, chamber dimensions and
       disk shape on disk friction. Torque tests
       were conducted over a wide range of disk
       Reynolds numbers for smooth and rough disks
       of 19 3/4 inches diameter rotating within
       a symmetrical casing at various disk-to-
       wall clearances at a constant small tip
       clearance. Both plane and tapered disks
       were tested. Pressure and velocity dis-
       tribution measurements within the chamber
       were made for correlation with theoretical
       and experimental determinations of friction-
       al torque.
   (h) "Effects of Roughness and Chamber Dimensions
       on the Induced Flow and Surface Resistance
       of Enclosed Rotating Disks," by R. E. Nece,
       Sc.D. thesis, 1958.
       "Roughness and Chamber Dimension Effects on
       Induced Flow and Frictional Resistance of
       Enclosed Rotating Disks," by J. W. Daily
       and R. E. Nece, Technical Report No. 27,
       M.I.T., Hydrodynamics Laboratory, 1958.

(2546) CHARACTERISTICS OF FLOW WITH DILUTE FIBER
        SUSPENSIONS.

   (b) Technical Association of Pulp and Paper
       Industries.
   (d) Experimental and analytical; basic research.
   (e) Basic investigation of the hydrodynamic
       features of paper fiber suspensions.
   (g) Following a survey of existing knowledge
       of the fluid mechanics of the flow of
       fiber suspensions as related to the flow
       in paper making machines, an experimental
       program was initiated for investigating
       the hydrodynamic characteristics of fiber
       suspensions in fully developed shear flows
       and in non-shear fields for both the
       laminar and turbulent ranges. Measure-
       ments of energy loss were made for wood
       pulp fibers and synthetic fibers flowing
       through circular tubes of different
       diameters. This data was correlated with
       velocity distributions and turbulence
       records obtained with one wood pulp fiber.
   (h) "Techniques for Velocity and Turbulence
       Measurements in Fiber Suspensions," W. W.
       Troutman, S. M. Thesis, Sept. 1958.
       "The Characteristics of Flow with Dilute
       Fiber Suspensions; A Progress Report on
       Work under TAPPI Project 93", by J. W.
       Daily and G. Bugliarello, M.I.T. Hydro-
       dynamics Laboratory Technical Note No. 2,
       December 1957.

(2547) CHARACTERISTICS OF THE CIRCULAR HYDRAULIC JUMP.

    (b) Laboratory project.

    (d) Theoretical and experimental; graduate theses.

    (e) A study of the characteristics of the circular hydraulic jump which is formed by axially symmetrical supercritical flow from a source or to a sink.

    (g) A lucite water table has been constructed to obtain supercritical flows issuing radially outward from a source or directed inward toward a sink. By proper control of tailwater hydraulic jumps circular in plan view are created. Measurements of depths and velocities are being made for comparison with the momentum equations for the two types of jumps described above and with analytical expressions for water surface profiles in the supercritical radial flow regime.

    (h) "Transition Phenomena in Radial Free Surface Flow," by W. B. Davis, S. M. Thesis, September 1958.

(2548) MECHANICS OF WASTE WATER DIFFUSION.

    (b) U. S. Public Health Service.

    (d) Theoretical and experimental; basic research.

    (e) An investigation of various turbulent diffusion processes for application to waste disposal in tidal estuaries.

    (g) Experimental facilities have been constructed to study the diffusion of salt concentration in a one-dimensional field of uniform turbulence. Turbulence is created mechanically in a body of water contained in a 32 foot long channel by means of a stack of expanded aluminum sheets oscillating vertically with amplitudes up to one inch and frequencies up to six cycles per second. Concentrations versus time are measured and recorded electrically at various stations by means of probes sensitive to the changes in resistivity of the saline solution. Experiments have been made to determine: rate of energy dissipation, longitudinal and vertical turbulent diffusion coefficients, as a function of amplitude and frequency of oscillation. Experiments are being made to determine the longitudinal distribution of salinity in a uniform basin with fresh water inflow at one end and a constant ocean salinity maintained at the other end. Salinity distributions are determined for various fresh water inflow rates and turbulence levels in the flume and compared with solutions of the diffusion equation.

    (h) "Mass Transfer Rates in a Turbulent Fluid Body," by J. M. Jordaan, Sc. D. Thesis, June 1958.

(2801) INTERACTION OF WAVES WITH FLOATING BODIES.

    (b) Office of Naval Research, Dept. of the Navy.

    (d) Theoretical and experimental; basic research.

    (e) Analytical and experimental study of the interaction of floating bodies and waves. Results to be applied to development of movable breakwaters for shallow and deep water waves.

    (g) Initial studies were concerned with experimental verification of wave-maker theory and a precise determination of the reflection characteristics of the 100 ft. wave tank used in this program. The following problems are currently under experimental investigation: (a) Breakwater efficiency of a semi-immersed circular cylinder in a train of regular waves; (b) wave generation characteristic of a circular cylinder oscillating vertically about a semi-immersed position. Corresponding analytical solutions of these problems are being obtained by means of a high speed digital computer.

    (h) "Forced Small-Amplitude Water Waves: A Comparison of Theory and Experiment," by F. Ursell, R. G. Dean and Y. S. Yu, M.I.T. Hydrodynamics Laboratory Technical Report No. 30, July 1958.

(2802) EXPERIMENTAL STUDY OF WAKE MECHANICS.

    (b) Office of Naval Research, David Taylor Model Basin, Dept. of the Navy.

    (d) Experimental; basic research.

    (e) A study of the effect of trailing edge geometry on the characteristics of the wake of a thin flat plate with particular emphasis on transverse plate vibrations.

    (g) The water tunnel is complete and contains a 7 1/2 in. by 9 in. closed jet test section. Instrumentation for force and turbulence measurement is under development.

    (h) "Design of a Closed Jet, Open Circuit Water Tunnel for the Study of Wake Mechanics," by G. H. Toebes, F. E. Perkins, and P. S. Eagleson, M.I.T. Hydrodynamics Laboratory Tech. Note No. 3, April 1958.

(2803) PROXIMITY EFFECTS ON DRAG COEFFICIENTS.

    (b) Laboratory project.

    (c) Prof. R. E. Nece, Hydrodynamics Lab., Mass. Inst. of Tech., Cambridge 39, Mass.

    (d) Experimental, undergraduate theses.

    (e) Study of resistance of submerged objects due to variations of geometry of group spacing.

    (f) Completed.

    (g) Drag coefficients for the center one of three equally spaced circular cylinders aligned normal to the free stream velocity were determined at a Reynolds number of 2 by 10^4 for a range of lateral spacings. Tests were performed in a free surface water channel. Experimental procedures check the drag coefficient of a single cylinder in an infinite fluid.

    (h) "Variation of Drag Coefficient for a Circular Cylinder due to Geometrical Arrangements," by G. Mueller and R. Tweedie, B. S. Thesis, June 1958.

(3089) EXPERIMENTAL STUDY OF EROSION IN CURVED
CHANNELS.

    (b) Agricultural Research Service, U. S. Dept.
of Agriculture.
    (d) Experimental; basic research.
    (e) Investigation of boundary shear stress
distribution in curved, open channels to
determine degree and extent of protection
required in natural streams.
    (g) Study is concerned with the effects of
flow rate, channel slope, shape, roughness,
and curvature upon the boundary shear
stress distribution in curved, open chan-
nels. A trapezoidal channel of variable
slope is being constructed as the test
facility; initial testing will be with a
single 60° curve.

(3090) MODEL OF PUMPING PLANT FOR CHARLES RIVER
BASIN (BOSTON) DRAINAGE CONTROL.

    (b) Commonwealth of Massachusetts, Metropolitan
District Commission.
    (c) Prof. D. R. F Harleman, Hydrodynamics Lab.,
Mass. Inst. of Tech., Cambridge 39, Mass.
    (d) Experimental.
    (e) Model study to determine forebay and pump
suction intake geometry for high capacity,
low head axial flow pumps.
    (g) Model reproduces portion of Charles River
Dam and Ship lock through which flow is
admitted asymmetrically to pumping station
forebay. Methods of uniformly distributing
flow to six pump units are under investiga-
tion. Problems of air-entrainment at the
suction intakes will also be studied.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY, Department
of Mechanical Engineering.

(1901) THREE-DIMENSIONAL TURBULENT BOUNDARY LAYER
IN A FREE VORTEX DIFFUSER.

    (b) Office of Naval Research, Dept. of the Navy.
    (c) Prof. Y. Senoo, Mechanical Engineering
Dept., Mass. Inst. of Technology, Cambridge
39, Mass.
    (d) Theoretical and experimental; applied re-
search.
    (e) Theoretical and experimental study of the
flow in a free vortex diffuser.
    (h) Gas Turbine Laboratory Report No. 42.

(2344) ATOMIZATION STUDY.

    (b) Laboratory project.
    (c) Prof. K. R. Wadleigh, Mechanical Engineer-
ing Dept., Mass. Inst. of Technology,
Cambridge 39, Massachusetts.
    (d) Experimental and theoretical; applied
research for S.M. and Sc.D. Theses.
    (e) Study of the atomization of liquid streams
injected into high-velocity gas streams.
Simplified theoretical models of the vari-
ous phenomena are used to guide experimental
programs. Considerable instrument develop-
ment has been accomplished in course of

work.
    (g) A theoretical study of the dynamics of
break-up of a large liquid droplet in a gas
stream predicts that such break-up will
occur at a critical value of the Weber
number. Experimental verification has been
achieved.
A photometric device for measurement of
mean droplet size in high velocity gas
streams has been developed. A high-speed,
rotating mirror camera is also being
developed to study detailed size spectra.

(2550) BOUNDARY LAYER FLOW NEAR THE CORNER OF TWO
INTERSECTING PLANES.

    (b) Office of Ordnance Research.
    (c) Prof. A. H. Shapiro, M.I.T., Room 3-264,
Cambridge 39, Massachusetts.
    (d) Experimental and theoretical; basic re-
search for doctoral thesis.
    (e) The laminar boundary near the corner of a
rectangular duct is being investigated
from the point of view of velocity profiles,
skin friction, transition, and effects of
pressure gradients.
    (g) Experimental work completed. Analytical
work nearing conclusion.

(2552) TWO-PHASE FLOW STUDIES IN PIPES.

    (b) Babcock and Wilcox Research Center,
Alliance, Ohio.
    (c) Prof. S. W. Gouse, Jr., Mechanical Engineer-
ing Dept., Mass. Inst. of Technology, Room
3-164, Cambridge 39, Massachusetts.
    (d) Experimental and theoretical; basic re-
search for Master's and docotr's thesis.
    (e) Determination and prediction of pressure
drop in two phase flow in a vertical tube.
Investigation of flow regimes.

(2560) INVESTIGATIONS OF HEAT TRANSFER TO FLUIDS
FLOWING IN RECTANGULAR DUCTS.

    (b) Laboratory project.
    (c) Prof. L. C. Hoagland, Mech. Engineering
Dept., Mass. Inst. of Technology, 77 Mass.
Ave., Cambridge, Mass.
    (d) Analytical and experimental studies of
laminar flow heat transfer. Experimental
studies of turbulent flow in rectangular
ducts.
    (e) Overall objectives: To provide a means
of predicting the heat transfer character-
istics of flows in rectangular tubes with
specific interest in application to com-
pact heat exchanger surfaces. Analytical
studies of laminar flow problems, both
fully developed and entrance region flows.
Experimental velocity investigations for
turbulent flow with heat transfer-momentum
analogy solution for heat transfer char-
acteristics.
    (g) Laminar Flow: Fully developed laminar
flow with heat flux numbers to be 2.9 and
independent of aspect ratio.
    (h) "The Secondary Flow in Rectangular Ducts",
by Raphael Moissis, S. M. Thesis, M.I.T.,
June 1956.

41

"Fully Developed Laminar Flow Forced Convection Heat Transfer in Rectangular Ducts with Uniform Heat Flux", Henry Cheng, S. M. Thesis, M.I.T., September 1957.

(2805) LAMINAR BOUNDARY LAYER IN OSCILLATORY FLOW.

  (b) General Electric, Westinghouse, Allison Division of General Motors.
  (c) Prof. P. G. Hill, Mechanical Engineering Dept. Mass. Inst. of Technology, Cambridge 39, Massachusetts.
  (d) Experimental and theoretical; basic research, Sc. D. thesis.
  (e) Apparatus to produce a flow consisting of a steady flow plus a sinusoidal oscillation, with and without adverse pressure gradient.
  (g) Good agreement between theory and experiment for intermediate frequencies.
  (h) Gas Turbine Laboratory Report No. 45, available after April 1959.

(2806) GEAR PUMP STUDY.

  (b) Chandler Evans Company.
  (c) Prof. K. R. Wadleigh, Mass. Inst. of Tech., Cambridge 39, Massachusetts.
  (d) Experimental and theoretical; applied research and design.
  (e) Study of the performance characteristics and losses in aircraft gear pumps to permit optimization of designs for specific performance requirements.
  (g) Predictions of mechanical friction and fluid friction losses and of fluid leakage losses agree well with experimental data. Techniques of using these models and experimental data to optimize design variables have been developed.

(2807) THE HYDRAULIC ANALOGY APPLIED TO COMPRESSIBLE FLOW IN THE PARTIAL ADMISSION TURBINE.

  (b) Office of Naval Research and United States Naval Underwater Ordnance Station.
  (c) Prof. Robert W. Mann, Room 3-482, Mass. Inst. of Technology, Cambridge 39, Mass.
  (d) Theoretical and experimental; applied research for master's and doctoral theses.
  (e) In a partial admission turbine the nozzle flow through the rotor blading constitutes an unsteady flow field. The purpose of this investigation is to study this flow with the ultimate goal of recommending design improvements. The flow field is varying both in time and in space and is therefore very complex. In order to explore theoretical approaches to the flow field the feasibility of experimental models based on interferometry and the hydraulic analogy to compressible fluid flow is here explored. The hydraulic analogy proved a superior approach and an unsteady flow water table simulating the turbine flow has been constructed and successfully tested. The water flow experimental data has been very successfully correlated with the theoretical analysis of shock and rarefraction wave propagation in the rotor channels. The theoretical

study of the complex two-dimensional field at the nozzle exit has been limited but has shown good qualitative correlation with experimental data. In order to explore wide ranges of design point, blading geometry, nozzle design and shroud configuration the use of photo-stereo techniques with machine reduction of water height data is being experimentally explored.
  (g) The water table has been shown to be an accurate reproduction of the compressible flow gas case.
  (h) "Nonsteady, Two-Dimensional Flow in a Partial Admission Turbine - The Hydraulic Analogy", by Helge Kolbjorn Heen, Sc. D. Thesis, Dept. of Mech. Engineering, Mass. Inst. of Technology, Cambridge, Mass., September 5, 1958.
    "Fuels and Prime Movers for Rotating Auxiliary Power Units", by Robert W. Mann, Report No. 121, Dynamic Analysis and Control Laboratory, Mass. Inst. of Technology, Cambridge, Mass.

(3091) FLUIDIZED FLOW OF GAS-SOLID SUSPENSIONS IN ACCELERATING AND DECELERATING PASSAGES.

  (b) Laboratory research.
  (c) Prof. A. H. Shapiro, Mass. Inst. of Tech., Room 3-264, Cambridge, Mass.
  (d) Experimental and theoretical; basic research for doctoral thesis.
  (e) Experiments and theory for the flow of fluidized suspensions in nozzles and diffusors.

(3092) JET-PIPE VALVE STUDY.

  (b) Wright Air Development Command, U. S. Air Force.
  (c) Prof. S. Y. Lee, Dept. of Mechanical Engrg. Mass. Inst. of Technology, Cambridge 39, Massachusetts.
  (d) Research.
  (e) Study the pressure flow characteristics of conventional and unconventional jet-pipe valves for both compressible and incompressible fluids. Study the effect of geometry to the steady-state characteristics. Determine optimum design for a given application.
  (g) Jet-pipe of conventional design was constructed. The steady-state characteristics were measured as the relative sizes of the jet and receiving holes were varied. Modified jet-pipe was designed with the aim of improving the performance.
  (h) "Steady-State Characteristics of a Short-Stroke Jet-Pipe Valve", W. R. Brown, S. B. Thesis, Dept. of Mech. Engineering, Mass. Inst. of Technology, May 1958.

(3093) FLOW BEHAVIOR IN AN ANNULUS FORMED BY TWO CONCENTRIC CYLINDERS WITH THE INNER CYLINDER IN ROTATION.

  (b) Lincoln Laboratory, Mass. Inst. of Tech., Cambridge 39, Massachusetts.
  (c) Prof. Joseph Kaye, Mechanical Engineering Department, Room 1-210, M.I.T., Cambridge

39, Massachusetts.

(d) Experimental and theoretical; basic research for M. S. and Sc. D. degrees.

(e) The objective of this research study is to determine the type of flow behavior which exists in an annulus between two concentric cylinders when the outer cylinder is stationary and the inner cylinder is set in rotation. Both adiabatic and diabatic flow in the axial direction will be superimposed on the rotation. The entrance region of such differential flow will also be examined experimentally and theoretically.

(g) Adiabatic and diabatic flow measurements have been made for the fully-developed flow region.

(h) "Heat Transfer and Fluid Flow Between Concentric Rotating Cylinders", E. C. Elgar, September 1956.
"An Experimental - Theoretical Study of Heat Transfer in an Annulus with an Inner Rotating Cylinder", K. Becker, Sept. 1957.
"Modes of Adiabatic and Diabatic Fluid Flow in an Annulus with an Inner Rotating Cylinder", J. Kaye and E. C. Elgar, Lincoln Laboratory, Mass. Inst. of Technology, February 15, 1957.

(3094) CYCLONE SEPARATOR RESEARCH.

(b) Laboratory project.

(c) Mr. Joseph L. Smith, Jr., Room 3-266, Mass. Inst. of Technology, Cambridge, Mass.

(d) Experimental and theoretical; applied research for master's and doctoral degrees.

(e) The research is directed toward an understanding of the vortex flow in cyclone separators and of the relation between the flow and the overall pressure and separation parameters of the cyclone.

(g) Understanding has been gained from experimental observations and particularly from an application of the previously developed theory of rotating flows.

(3095) WINDAGE AND PUMPING LOSSES IN GAS PARTIAL-ADMISSION TURBINES.

(b) Office of Scientific Research, U. S. Air Force.

(c) Prof. Robert W. Mann, Room 3-482, Mass. Inst. of Technology, Cambridge 39, Mass.

(d) Experimental; applied research for master's thesis.

(e) Experimental evaluation of windage losses in a partial admission turbine. The windage losses in a partial admission turbine can be a controlling factor in their design, especially since shroud and blading geometry most suitable for increasing the efficiency of active flow from one or several nozzles is such as to cause high windage losses in those portions of the rotor not in the active flow. In this investigation experimental torque measurements will be made over a wide range of Reynolds numbers for progressive variations in blading aspect ratio and solidity and shroud axial and radial clearance. Analytic models which conform to the

experimental results will be generated in order to generalize the experimental data.

(g) Experimental work under way.

(h) "Fuels and Prime Movers for Rotating Auxiliary Power Units", by Robert W. Mann, Dynamic Analysis and Control Laboratory, Report No. 121, Mass. Inst. of Tech., Cambridge, Massachusetts.

(3096) REFLECTION OF A MAGNETOHYDRODYNAMIC SHOCK BY A MAGNETIC "WALL".

(b) Cambridge Air Force Research Center.

(c) Prof. Osman K. Mawardi, Dept. of Mechanical Engineering, Mass. Inst. of Technology, Cambridge 39, Mass.

(d) Thesis work.

(e) This is an experimental investigation of the behavior of a strong shock wave as it penetrates a region within which an intense magnetic field has been established. It is proposed to study the interactions processes (reflection and transmission of the wave) at the boundary. The apparatus is now being constructed.

(3097) STUDIES OF MAGNETOHYDRODYNAMIC SHOCKS.

(b) Cambridge Air Force Research Center.

(c) Prof. Osman K. Mawardi, Dept. of Mechanical Engineering, Mass. Inst. of Technology, Cambridge 39, Mass.

(d) Thesis work.

(e) A preliminary theoretical study, on the basis of continuum theory, has been completed in order to establish the dynamics and structure of a hydromagnetic shock wave. The analysis indicates the dependence of the state of the gas upstream and downstream of the shock as a function of the magnetic field, the pressure and temperature of the ionized gas. A prediction has also been made for the expected behavior of the electric and magnetic fields in the vicinity of the shock. The apparatus required for the experimental verification of this analysis is now being constructed.

(3098) FILM CONDENSATION OF VAPOR IN HORIZONTAL TUBES.

(b) American Society of Mechanical Engineers, Whirlpool Corporation.

(c) Prof. A. L. Hesselschwerdt, Jr., and Prof. John C. Chato, Dept. of Mech. Engineering, Mass. Inst. of Technology, Cambridge 39, Mass.

(d) Theoretical and experimental research for doctoral thesis.

(e) The purpose of the work is to analyze the fluid mechanics, heat and mass transfer phenomena occurring during condensation in a horizontal tube; and to develop a complete description of the process that will correlate reasonably well with the data obtained by experiments. The experimental work is designed primarily for the study of the fluid mechanics of the system.

(g) No complete results are available yet on

the present phase of the work
- (h) "Film Condensation of Vapor in a Horizontal Tube", J. B. Chaddock, Refrigerating Engineering, 65, No. 4, 37, 1957.

(3099) AXIAL INDUCERS FOR TURBO-PUMPS.

- (b) General Electric, Westinghouse, and Allison Division of General Motors.
- (c) Prof. E. S. Taylor, Dept. of Mech. Engineering, Mass. Inst. of Technology, Cambridge 39, Mass.
- (d) Theoretical and experimental; applied research.
- (e) Tests to determine the suitability of a procedure for designing an anti-cavitation inducer.
- (g) Design theory developed. Tests being made.
- (h) Gas Turbine Laboratory Report No. 44. Available after February 1959.

(3100) THREE-DIMENSIONAL FLOW IN COMPRESSOR CASCADES. PART I: EFFECT OF SKEWED FLOW AT BLADE EXTREMITIES.

- (b) General Electric, Westinghouse, Allison Division of General Motors.
- (c) Prof. E. S. Taylor, Dept. of Mech. Engineering, Mass. Inst. of Tech., Cambridge 39, Mass.
- (d) Theoretical and experimental; applied research for Sc.D. thesis.
- (e) Study of the effect of the flow approaching a blade row which occurs near the walls.
- (h) Gas Turbine Laboratory Report No. 46. Available after September 1959.

(3101) THREE-DIMENSIONAL FLOW IN COMPRESSOR CASCADES. PART II: EFFECT OF INCREASED DIFFUSION AT BLADE EXTREMITIES.

- (b) General Electric, Westinghouse, Allison Division of General Motors.
- (c) Prof. E. S. Taylor, Dept. of Mechanical Engineering, Mass. Inst. of Technology, Cambridge 39, Mass.
- (d) Theoretical and experimental; applied research for Sc.D. thesis.
- (e) Flow in a compressor cascade with retarded axial velocity. Measurements of velocity, pressure distribution and boundary layer.
- (g) Predictions of flow angles and stall appear to be possible.
- (h) Gas Turbine Laboratory Report No. 48. Available after October 1959.

UNIVERSITY OF MASSACHUSETTS ENGINEERING RESEARCH INSTITUTE.

(2561) HYDROLOGIC STUDIES IN WESTERN MASSACHUSETTS.

- (b) Cooperative with the U. S. Soil Conservation Service, U. S. Weather Bureau, and U. S. Geological Survey. Student assistance financed by Faculty Research Grant.
- (c) Prof. George R. Higgins, Engineering Research Institute, University of Mass., Amherst, Mass.

- (d) Experimental; field and laboratory; for design of watershed yield, flood peak reduction, and general information.
- (e) Rainfall and runoff studies will be made on small drainage areas in western Massachusetts which when combined with other hydrologic factors such as temperature, evaporation, vegetal cover, ground water, etc., will provide a better basis for design of small reservoirs with regard to yield and flood peak reduction.

MICHIGAN STATE UNIVERSITY, Department of Civil Engineering.

(2122) DEVELOPMENT OF THE BOUNDARY LAYER IN THE ENTRANCE TO A PIPE.

- (b) Laboratory project.
- (c) Prof. H. R. Henry, Dept. of Civil Engineering, Michigan State University, East Lansing, Michigan.
- (d) Experimental and theoretical; basic research.
- (e) Velocity and pressure measurements obtained to determine flow conditions at the entrance of a pipe.
- (f) Completed.
- (g) Present theories corroborated. Assymetry of velocity profiles appears to be a permanent characteristic.
- (h) Publication forthcoming.

(2125) SEDIMENT TRANSPORT IN RUNOFF WATER FROM SMALL AGRICULTURAL WATERSHEDS.

- (b) Michigan Agricultural Experiment Station.
- (c) Prof. R. Z. Wheaton, Agricultural Engineering Dept., Michigan State University, East Lansing, Michigan.
- (d) Field investigation; for design.
- (e) Samples of runoff water are collected at periodic intervals and more frequent intervals during flood flow to determine the concentration of sediment being transported. Runoff gaging stations serviced by USGS. Dense network of 22 recording raingages for 25 square mile area in two watersheds.
- (g) Sediment content of runoff is low.
- (h) "Hydrologic Studies of Small Watersheds in Agricultural Areas of Southern Michigan", Report No. 1, Deer-Sloan Basin, A. D. Ash, et al. Water Resources Commission, State of Michigan, 77 pp, 1958.

(2126) SURFACE AND SUBSURFACE DRAINAGE.

- (b) Michigan Agricultural Experiment Station.
- (c) Prof. E. H. Kidder, Agricultural Engineering Dept., Michigan State University, East Lansing, Michigan.
- (d) Experimental; field investigation, applied research.
- (e) To study the effect of bedding, bedding and moling, bedding and tile, and tile drainage on crop yields in a submarginal farming area. Crop yields in a grain-grain

hay-hay rotation are measured in increments away from the drainage feature.

(g) Two rod tile lateral spacing has given the highest crop yields. A 60-foot tile spacing ranks second.

(2127) AN INVESTIGATION OF THE STABILITY AND DURA-BILITY OF SUBSURFACE DRAINS PLACED IN MUCK.

(b) Michigan Agricultural Experiment Station.
(c) Prof. E. H. Kidder, Agricultural Engineering Dept., Michigan State University, East Lansing, Michigan.
(d) Experimental, field investigation; applied research.
(e) Four lateral underdrains were placed in muck (Ph6.5). Concrete and clay tile in one- and two-foot lengths. Perforated steel pipe in eight-foot lengths and perforated fibre pipe in six-foot lengths were installed in 1952.
Elevations of the ground surface and the underdrains are taken annually. Quality of material is checked at four-year intervals.
(g) The soil surface subsided 0.8 to 0.9 feet the first year, with little subsidence since. The underdrains settled about 0.3 feet the first year. Negligible since. Concrete drain tile from three manufacturers deteriorated by acid action. Considerable rusting was noted on galvanized steel. Hay blinding material was in excellent condition.
(h) "Stability and Durability of Underdrains in an Organic Soil", R. Z. Wheaton, et al. Quarterly Bulletin, Michigan Agricultural Experiment Station, Michigan State Univ., Article No. 40-63, pp 555-560, February 1958.

(3102) WATER REQUIREMENTS OF PLANTS.

(b) Michigan Agricultural Experiment Station.
(c) Prof. R. Z. Wheaton, Agricultural Engineering Dept., Michigan State University, East Lansing, Michigan.
(d) Experimental, field investigation; applied research.
(e) Four areas are protected against natural rainfall during the cropping season. Precision irrigation is practiced to maintain four levels of available water in the soil. Meteorological, evapotranspiration and evaporation data is also collected.
(g) The highest level of available water (range between 70 and 100% in the surface foot) gives the highest yield of potatoes. Consumptive use peak rate of 0.18 inches per day.

(3103) A STUDY OF SECONDARY FLOW IN THE BEND OF A CLOSED CONDUIT.

(b) Michigan Agricultural Experiment Station.
(c) Mr. Chung-sheng Cornelius Shih, Agricultural Engineering Dept., Michigan State University, East Lansing, Michigan.
(d) Theoretical; basic Ph.D. thesis.
(e) Mathematical analysis of flow in the bend

of a closed conduit.

(3104) SPRINKLER IRRIGATION FOR FROST PROTECTION OF PLANTS.

(b) Michigan Agricultural Experiment Station.
(c) Prof. E. H. Kidder, Agricultural Engineering Dept., Michigan State University, East Lansing, Michigan.
(d) Experimental, laboratory and field investigation; applied research.
(e) To determine the application rates and repeat frequency of water application to give effective protection to plants against frost damage.
(g) Application rates of 0.1 inch per hour, repeat frequency of 12 to 20 seconds has protected truck crops against minimum temperature of 19° F.
(h) "Frost Protection with Sprinkler Irrigation", E. H. Kidder and J. R. Davis, Extension Bulletin No. 327, Michigan State University, Cooperative Extension Service, 12 pp, 1956.

(3105) SHEAR AND PRESSURE DISTRIBUTION ON DUNE-SHAPED BOUNDARIES.

(b) Laboratory project.
(c) Dr. E. M. Laursen, Dept. of Civil Engineering, Michigan State University, East Lansing, Michigan.
(d) Experimental; basic research.
(e) Since the bed of alluvial channels commonly consists of ripples or dunes, the distribution of shear and pressure over these roughness elements is of interest in regard to both sediment transportation and resistance to flow. A 44-foot Lucite conduit with schematic triangular dunes and air as the fluid will be used in the experimental investigation.

UNIVERSITY OF MICHIGAN, Dept. of Civil Engineering.

(2129) DEVELOPMENT OF OPEN CHANNEL FLOW CONTROL.

(b) Rackham Research Grant.
(c) Prof. V. L. Streeter, 322 W. Engineering Bldg., University of Michigan, Ann Arbor, Mich.
(d) Experimental and analytical.
(e) Determination of effectiveness of the principle of single-orifice flow control with a non-linear spring resistance as applied to open channels.
(f) Completed.
(g) The general principle of a spring force varying exponentially with displacement and an orifice area varying exponentially with spring displacement yielding substantially constant flow control over the design head range has been confirmed.
(h) "A Flow Controller for Open or Closed Conduits", V. L. Streeter, Trans. ASCE, pp. 883-907, 1958.

(2809) ELIMINATION OF WAVE MOTION IN MENTOR HARBOR, OHIO.

45

(b) The Mentor Harbor Yachting Club.
(c) Prof. E. F. Brater, 320 W. Engineering Bldg., Ann Arbor, Michigan.
(d) Model study.
(e) A 1:50 model of the harbor area was constructed. Prototype wave conditions were reproduced in the model and methods of eliminating the objectionable conditions were tested.
(f) Completed.
(g) Three plans were found which reduced wave heights in the harbor by amounts varying from 78 to 65 percent.
(h) Report supplied to sponsor.

UNIVERSITY OF MICHIGAN, Ship Model Tank.

(3106) BARGE RESISTANCE.

(b) Laboratory project.
(c) Prof. L. A. Baier, Naval Architecture and Marine Engineering, 450 West Engineering Building, University of Michigan, Ann Arbor, Michigan.
(d) Research.
(e) Effect of proportions and rakes in restricted waters.

(3107) EXT. OF TMB SERIES 60, BULBOUS BOW INVESTIGATIONS.

(b) Project conducted for Student Research Project sponsored in part by the Society of Naval Architects and Marine Engineers.
(c) Mr. R. B. Couch, Chairman, Naval Architecture and Marine Engineering, 450 West Engineering Building, University of Mich., Ann Arbor, Michigan.
(d) An experimental project of applied research for graduate student courses.
(e) Parent models of TMB Series 60, block coefficients of 0.65, 0.70 and 0.75 are being fitted with bulbous bows of 3%, 6%, and 9% area. Resistance tests are being run and flow studies made. Reports will be prepared on completion of the work.

MISSOURI SCHOOL OF MINES AND METALLURGY, Department of Civil Engineering.

(317) VELOCITY STUDIES IN A VERTICAL PIPE FLOWING FULL.

(b) Laboratory Project.
(c) Prof. Clifford D. Muir, Civil Engineering Department, Missouri School of Mines and Metallurgy, Rolla, Missouri.
(d) Experimental; basic research for master's thesis.
(e) Tests were conducted on vertical flow in 1/2 inch hard-drawn copper pipe to investigate flow with pipe flowing full and under positive pressure.
(f) Suspended.
(g) The experimental results obtained were in agreement with theoretical computations.

Continuing studies confirm the previous results.
(h) "Velocity Studies in a Pipe Flowing Full", R. F. Tindall. Master's Thesis, Missouri School of Mines, 1950. (Available on loan.

(319) WEIR STUDIES.

(b) Laboratory Project.
(c) Prof. E. W. Carlton, Civil Engineering Department, Missouri School of Mines and Metallurgy, Rolla, Mo.
(d) Experimental; basic research for master's thesis.
(e) Tests on rectangular weirs were made to determine effect of velocity of approach on the relation between crest depth and critical depth of an imaginary open channel having same dimensions as the weir opening
(g) Study produced a simple, accurate and quick solution for plotting of M function. Relationship between the M function and the critical depth is logarithmic. This greatly simplifies determination of critical flow where the critical depth is known or vice versa. A relationship exists between M function of channels of same shape but different dimensions. The velocity of approach does not affect the relationship between physical depth and crest depth.
(h) "Calibration of weirs by means of critical flow and specific energy," R. A. Rapp, Master's Thesis, Missouri School of Mines, 1950. (Available on loan.)

(2578) CORRELATION OF WEIR CREST DEPTH AND WEIR FLOW CHARACTERISTICS.

(b) Laboratory Project.
(c) Prof. Clifford D. Muir, Civil Engineering Department, Missouri School of Mines and Metallurgy, Rolla, Mo.
(d) Experimental.
(e) Tests on several cipoletti weirs were made in order to determine the effect of weir thickness, H/P ratio, and Froude's Number on the ratio of crest depths to the critical depth of an imaginary open channel having the same dimensions as the weir flow section.
(g) This study indicated a definite relationship between the crest depth to critical depth ratio and the Froude Number of the imaginary channel. However, the ratio tended to become constant at either high or low Froude Numbers. The H/P ratio had no noticeable affect on this relationship. A continuation of this study indicates probable superiority of crest depth flow relationships, when weirs having a narrow width with respect to head are being used.
(h) "Correlation of Weir Crest Depth Froude Number, H/P Ratio, and Weir Thickness." Paul Harrawood, Master's Thesis, Missouri School of Mines, 1956. (Available on loan.)

MONTANA STATE COLLEGE, Agricultural Experiment Station.

Inquiries concerning the following projects should be addressed to Mr. O. W. Monson, Head, Agricultural Engineering Dept., Montana State College, Bozeman, Montana.

(3108) FORECASTING OF WATER SUPPLY BASED ON WATER EQUIVALENT OF SNOW AND OTHER HYDROLOGIC FACTORS.

(b) Conducted for Montana Agricultural Experiment Station in cooperation with Soil Conservation Service, USDA.
(d) Experimental; applied research.
(e) The present objective is to (1) forecast maximum or peak discharge for flood control and (2) to forecast recession from peak to base, or mean, flow as an aid to water commissioners and water users whose water rights are based on priorities.
(g) Progress up to present time indicates that maximum or peak discharge can be forecast approximately. Forecasting of recession has not yet proved reliable.
(h) Annual reports to Western Regional Research Conference and to Federal Examiner, O.E.S.

(3109) IRRIGATION EFFICIENCY STUDIES.

(b) Montana Agricultural Experiment Station in cooperation with U. S. Bureau of Reclamation.
(d) Experimental; applied research.
(e) Development of a formula to guide irrigator in the application of the amount of water which can be stored within root zone for use by crop. Intended for irrigation by surface flooding methods of irrigation.
(g) Formula gives size of stream Q (cfs) in terms of length and width of strip, rate of water intake, slope or gradient of field, and a roughness factor depending on density of vegetation.
Formula:

$$Q = \left[\frac{LI}{3600KD}\right]^{-5/2} \left\{\frac{n}{1.486}\right\}^{3/2} \frac{w}{S^{3/4}}$$

(h) Annual reports to Western Regional Research Service and to Federal Examiner, O.E.S.

(3110) REDUCTION OF SEEPAGE IN CANALS BY APPLICATION OF BENTONITE.

(b) Laboratory project in cooperation with Cameron Ditch Co.
(d) Experimental; applied research.
(e) Bentonite applied in a slurry by sedimentation method proved inefficient when canal was constructed through coarse gravel with insufficient fine material to trap the bentonite.
(g) Four miles of ditch in coarse gravel was treated with 12 inch compacted earth lining reduced seepage by about 75%. Bentonite treatment may be necessary.

NEWPORT NEWS SHIPBUILDING AND DRY DOCK COMPANY.

Inquiries concerning the following projects should be addressed to Mr. C. H. Hancock, Hydraulic Laboratory, Newport News Shipbuilding and Dry Dock Company, Newport News, Virginia.

(123) HYDRAULIC TURBINE TESTS.

(b) Laboratory project.
(d) Experimental; for design data.
(e) Scale model turbines, using either Francis or propeller type runners, are tested for power and efficiency at various speeds.

(124) METER CALIBRATION TESTS.

(b) Laboratory project.
(d) Experimental.
(e) To establish calibration curve for determining correction for various rates of flow. Meters are tested at various rates of flow by weighing tank method. Time is recorded electronically by decade counters.

(896) VANE MOMENT TESTS ON ADJUSTABLE BLADE RUNNERS.

(b) Laboratory project.
(d) Experimental; for design data.
(e) Tests are to determine vane moment diagrams. The turbine load is applied by an electrical dynamometer and the gate openings are controlled by a governor. The blades adjust automatically and the blade moment is measured by a spring dynamometer.

(901) SHIP MODEL RESISTANCE TESTS.

(b) Laboratory project.
(d) Experimental; for design data.
(e) Scale ship models are towed to determine the effective horsepower, bare hull, required by the ship. Because of their small size, several models may be towed in a short period of time thus allowing much preliminary work to be done on the choice of lines. The final lines are checked by the David Taylor Model Basin. To eliminate a large portion of this preliminary testing, a schedule of systematic models was arranged in which the beam-draft ratio, the displacement-length ratio, and the prismatic coefficient are varied over a wide range. Towing this set of models is continuing and when completed will provide design data for a standard offset series covering a wide range.

(1132) HYDRAULIC PUMP TESTS.

(b) Laboratory project.
(d) Experimental; for design data.
(e) Scale model pumps, centrifugal and propeller types, are tested at constant speeds for head developed, power consumption, and efficiency at various rates of discharge. Cavitation tests are sometimes conducted by lowering the suction head to a point where the developed head and efficiency

break down.

(1133) CAVITATION TESTS OF HYDRAULIC TURBINE
MODELS.

  (b) Laboratory project.
  (d) Experimental; for design data.
  (e) Scale model turbines are tested on cavita-
     tion stand to determine sigma at which
     cavitation starts. By the use of a Plexi-
     glas throat ring and a Strobolux light
     synchronized with the shaft rotation,
     visual observations are made to determine
     the location on the blade where cavitation
     starts. Tests also run to determine runa-
     way speeds at low sigma values.

(2582) AIR TESTS ON HYDRAULIC TURBINE MODEL.

  (b) Laboratory project.
  (d) Experimental; for design data.
  (e) Plexiglas hydraulic turbine model is tested
     with air. Smoke and tufts are used in the
     flow visualization studies. Velocity and
     pressure distribution studies are made
     using a sensitive differential manometer.
     The gate moments obtained from the pres-
     sure distribution will be checked with a
     strain gage dynamometer.

(3111) PUMP-TURBINE TESTS.

  (b) Laboratory project.
  (d) Experimental; for design data.
  (e) Pump-turbine models are to be tested on
     this new facility. A previously tested
     pump model has been tested to verify cali-
     brations. A previously tested turbine
     model is now being readied for this stand
     to further correlate calibrations. This
     stand will be adaptable for either pump or
     turbine model tests as well as pump-turbine
     model tests. Cavitation as well as per-
     formance tests can be made on this facility.

NEW YORK UNIVERSITY, Department of Chemical Engi-
neering.

Inquiries concerning Projects Nos. 2135, 2583, 2584,
2812, 3113, and 3118 should be addressed to Prof.
J. Happel, Dept. of Chemical Engineering, New York
University, University Heights, New York 53, N. Y.

(2135) EFFECT OF A CYLINDRICAL BOUNDARY ON RIGID
SPHERES SUSPENDED IN A MOVING VISCOUS
FLUID.

  (b) Grant from Texas Company; Laboratory pro-
     ject.
  (d) Experimental; basic research for doctoral
     thesis.
  (e) A study of the effect of a cylindrical
     boundary on rigid spheres suspended in a
     moving fluid as a function of the Reynolds
     number, sphere to cylinder diameter ratio
     and sphere eccentricity by measurement of
     drag on spheres and pressure drop caused
     by their presence.

  (f) Completed.
  (g) At low Reynolds numbers the experimental
     results indicate very good agreement with
     existing theoretical treatments; however,
     at high Reynolds numbers marked deviations
     occur. Equations are presented which pre-
     dict the drag on the sphere and the pres-
     sure drop due to the presence of a sphere.
     It has been established that the boundary
     effect is constant at increasing fluid
     velocity and that the deviation from theory
     at high Reynolds number is due solely to
     inertial effects. An equation is presented
     which predicts the drag on one sphere in
     the presence of a second sphere as a func-
     tion of the center-to-center distance be-
     tween the two spheres.

(2583) EFFECT OF PARTICLE CONCENTRATION ON PRES-
SURE DROP AND SEDIMENTATION VELOCITY IN
DILUTE BEDS OF PARTICLES.

  (b) Grants from Texas Company and American
     Chemical Society; laboratory project.
  (d) Theoretical; basic research for doctoral
     thesis.
  (e) The slow translational motion of dilute
     beds of particles settling through a vis-
     cous fluid subjected to the influence of
     cylindrical boundaries is being studied.
     This will ultimately enable a theoretical
     prediction of the effect of particle con-
     centration on pressure drop and sedimenta-
     tion velocity in beds of particles.
  (g) The fluid velocity for a large number of
     field points within a cylindrical container
     has been computed for a spherical particle
     settling at six evenly spaced locations
     along the cylinder radius. The velocity
     field for all locations has also been
     obtained from the computed points by
     interpolation.

(2584) THE MOTION OF TWO SPHERES FOLLOWING EACH
OTHER IN A VISCOUS FLUID.

  (b) Grant from the American Petroleum Research
     Fund of the American Chemical Society;
     laboratory project.
  (d) Experimental; basic research for master's
     thesis.
  (e) Determination of the terminal settling
     velocity of two equal size spheres moving
     parallel to their line of centers as a
     function of the ratio of sphere diameter to
     center-to-center distance, and Reynolds
     number. An attempt to verify existing
     theoretical solutions of this problem for
     the case of "creeping motion" as well as
     to determine the magnitude of inertial
     effects which are present at higher
     Reynolds numbers.
  (f) Completed.
  (g) At Reynolds numbers less than 0.2 the
     experimental results agreed closely with
     existing theory and showed that the termi-
     nal velocity of a sphere falling in the
     presence of another equal sphere in a
     viscous fluid is greater than the velocity
     of one sphere falling alone. This

phenomenon is due to interaction forces between the two spheres which become greater as the distance between spheres becomes less; the interaction forces reach a maximum when the spheres are touching. At Reynolds numbers greater than 0.25 where inertial effects cannot be neglected, the two spheres were found to attract each other; the contribution of the inertial effects to the drag on each sphere was found to be approximately equal to $(1 + 0.11\ Re)$ in the Reynolds number range from .3 to .7.

(h) "The Motion of Two Spheres Following Each Other in a Viscous Fluid", Robert Pfeffer, Master's Thesis, 1958 (available on loan).

(2812) THE MOTION OF A RIGID SPHERE IN A FRICTIONLESS CYLINDER.

(b) Grant from the American Petroleum Research Fund of the American Chemical Society; laboratory project.
(d) Theoretical; basic research for the master's degree.
(e) Investigation was undertaken to develop a sphere and cylinder model which will serve as a basis for further theoretical studies of assemblages of particles. Stokes equations of viscous flow were assumed to apply to the motion of a rigid sphere along the axis of an infinitely long cylinder. Solution of the problem was carried out under the postulate that the fluid shear on the cylinder wall is everywhere zero.
(f) Completed.
(g) An exact solution has been obtained in the form of an infinite set of linear simultaneous equations for the coefficients in the Stokes stream function. Experimental work involved the measurement of the drag on a sphere suspended in a fluid having a parabolic velocity distribution at infinity. Results show that the measured drag is in good agreement with the theoretical predictions.
(h) "The Motion of a Rigid Sphere in a Frictionless Cylinder", Paul A. Ast, Master's Thesis, 1958 (available on loan),

(3112) DISSIPATION OF ENERGY DUE TO SOLID PARTICLES SUSPENDED IN A VISCOUS LIQUID.

(b) National Science Foundation Grant.
(c) Professor Howard Brenner, Department of Chemical Engineering, New York University, New York 53, N. Y.
(d) Theoretical; basic research.
(e) Establishment of the conditions of applicability of Einstein's viscosity equation; applicability of relation between pressure drop and weight of a fluidized bed.
(f) Completed.
(h) "Dissipation of Energy Due to Solid Particles Suspended in a Viscous Liquid", H. Brenner, Physics of Fluids 1, 338-46 (1958).

(3113) THE MOTION OF TWO SPHERES PERPENDICULAR TO THEIR LINE OF CENTERS IN A VISCOUS FLUID.

(b) Laboratory project.
(d) Experimental; basic research for the master's degree.
(e) This work will continue previous studies on the motion of two spheres in a viscous fluid. Experiments will be conducted in a five foot tall, sixteen inch diameter glass column. These large dimensions will minimize any errors due to the wall and end effects. Two one-quarter inch spheres will be dropped side by side and the forces of repulsion between them will be measured; the study will be carried out using spheres of various densities and fluids of various viscosities.

(3114) SLOW VISCOUS FLOW PAST A SPHERE IN A CYLINDRICAL TUBE.

(b) Laboratory project.
(c) Professor Howard Brenner, Department of Chemical Engineering, New York University, New York 53, N. Y.
(d) Theoretical; basic research.
(e) A theoretical treatment is developed for the slow flow of a viscous fluid through a cylindrical container within which a small particle is confined; the sphere is situated in an arbitrary position within the cylinder and moves at constant velocity parallel to the walls.
(f) Completed.
(g) Approximate expressions have been derived which give the frictional drag, rotational couple, and permanent pressure drop caused by the presence of the obstacle in the original Poiseuillian field of flow as a function of the ratio of sphere to cylinder radius and fractional distance of the particle from the longitudinal axis of the cylinder. The results are directly applicable to devices such as the falling ball viscometer when the sphere is eccentrically located.
(h) Brenner, H. and Happel, J., Journal of Fluid Mechanics 4, Part 2, 195 (1958).

(3115) SOLUTION OF OSEEN'S EQUATIONS FOR FLOW PAST AN OFF-CENTERED SPHERE IN A CYLINDER.

(b) Laboratory project.
(c) Professor Howard Brenner, Department of Chemical Engineering, New York University, New York 53, N. Y.
(d) Theoretical; basic research for doctoral degree.
(e) It is the purpose of this project to determine the sidewise force exerted on an off-centered sphere in a cylinder. This will be obtained by satisfying the boundary condtions in the solution to Oseen's equations for fluid flow.

(3116) FLOW FROM A POINT SOURCE INTO A PIPE.

(b) Laboratory project.
(c) Professor Howard Brenner, Department of Chemical Engineering, New York University, New York 53, N. Y.
(d) Theoretical; basic research for the

master's degree.

(e) The development of laminar flow in a pipe
from a symmetrically placed point source,
at low Reynolds numbers, has been investi-
gated as a basis for further theoretical
studies of assemblages of such point
sources. Stokes equation of viscous flow
were assumed to apply to the case of axi-
symmetrical motion in an infinitely long
cylinder. The solution of the problem was
obtained under the assumption that there
is no motion of the fluid with respect to
the wall and that at large distances from
the source (i.e. at infinity) the field
must be parabolic.

(g) An exact solution has been derived by the
method of reflection resulting in an infi-
nite series expressing Stokes stream func-
tion as a function of position. A plot of
constant stream lines versus position
along the cylinder was obtained.

(3117) NON-NEWTONIAN FLUIDS THROUGH A FLUIDIZED
BED.

(b) Laboratory project.
(c) Prof. Howard Brenner, Dept. of Chemical
Engineering, New York University.
(d) Experimental; basic research for master's
thesis.
(e) To determine the pressure drop in a fluid-
ized bed by using a fluid that gives Bing-
ham flow. A thick suspension of Illinois
yellow clay in water is being used as a
fluid. The data will be used in the
designing of fluidized beds.

(3118) VISCOUS FLOW IN MULTIPARTICLE SYSTEM: SLOW
MOTION OF FLUIDS RELATIVE TO BEDS OF
SPHERICAL PARTICLES.

(b) Laboratory project.
(d) Theoretical; basic research.
(e) A mathematical treatment is developed on
the basis that two concentric spheres can
serve as the model for a random assemblage
of spheres moving relative to a fluid. By
using appropriate boundary conditions
which apply to the model a closed solution
was obtained which satisfies the Stokes-
Navier equations omitting inertia terms.
(f) Completed.
(g) The analytical solution enables the rate
of sedimentation or alternatively pressure
drop to be predicted as a function of
fractional void volume.
(h) Happel, J., AIChE Journal, 4, 197 (1958).

NEW YORK UNIVERSITY, Fluid Mechanics Laboratory.

(1912) DISCHARGE CHARACTERISTICS OF A SIDE WEIR.

(b) Laboratory project.
(c) Prof. A. H. Griswold, New York University,
New York 53, N. Y.
(d) This is an applied research project in
which a theoretical analysis is being
checked experimentally.

(g) A test program has been completed that
included tests of two widths of channel two
lengths of crest and two crest heights.
The analysis of this data is underway.

(3119) VELOCITY AND BOUNDARY LAYER DISTRIBUTION
OF FLOW IN A SMOOTH CIRCULAR PIPE.

(b) Laboratory project.
(c) Prof. Glen N. Cox, Chairman, Engineering
Mechanics Dept., New York 53, New York.
(d) Experimental; basic research for master's
thesis.
(e) The purpose of this investigation was to
study the velocity distribution and the
mixing length for flow of water in a 2.5
diameter brass pipe having a well rounded
entrance. Velocity traverses were made at
numerous sections using a small pitot tube.
(f) Suspended.
(g) The experimental data showed that the mix-
ing length extended for a distance of
approximately 46 pipe diameters from the
entrance.
(h) "Velocity and Boundary Layer Distribution
of Flow in a Smooth Circular Pipe," John F.
Farrell, Jr., New York Univ., New York 53,
New York, June 1958 (unpublished thesis).

NEW YORK UNIVERSITY, Department of Meteorology and
Oceanography.

(2356) SHIP MOTIONS PROJECT.

(b) David Taylor Model Basin, Department of the
Navy.
(c) Prof. Willard J. Pierson, Jr., Research
Associate Professor of Meteorology, New
York University, University Heights, New
York 53, New York.
(d) Theoretical and experimental; basic and
applied research.
(e) Studies of the theory of a stationary
Gaussian process as applied to the motions
of ships in waves; experimental and theo-
retical determination of co-spectra and
quadrature spectra.
(g) Theoretical studies of cross spectra, and
theoretical papers on wave theory and ship
motion theory.
(h) "Certain Probabilities Associated with Bow
Submergence and Ship Slamming in Irregular
Seas," Leo J. Tick, Journal of Ship Re-
search, 1958.

(2357) WAVE PROJECT.

(b) Bureau of Ships, Department of the Navy.
(c) Prof. Willard J. Pierson, Jr., Research
Associate Professor of Meteorology, New
York University, University Heights, New
York 53, N. Y.
(d) Theoretical and experimental, and basic
and applied.
(e) Attempt to formulate the zero crossing
problem of a stationary Gaussian process
and solve it for spectra like those of
ocean waves.

(g) Excellent results have been obtained.
(h) "Theoretical and Observed Results for the Zero and Ordinate Crossing Problems of Stationary Gaussian Noise with Application to Pressure Records of Ocean Wave", by S. Ehrenfeld, N. R. Goodman, S. Kaplan, E. Mehr, W. J. Pierson, R. Stevens, and L. F. Tick, Tech. Report, College of Engineering, New York University, 1958.

(3120) OFFICE OF NAVAL RESEARCH OCEAN ATMOSPHERE INTERACTION AND WAVE PROJECT.

(b) Geophysics Branch, Office of Naval Research, Department of the Navy.
(c) Prof. Gerhard Neumann, Professor of Oceanography, and Prof. Willard J. Pierson, Jr., Research Associate Professor of Meteorology, New York University, University Heights, New York 53, N. Y.
(d) Experimental and theoretical; basic and applied research.
(e) Study of the generation and propagation of waves in deep water; of wave observation and forecasting techniques, of waves as a three variable stationary Gaussian process, and of non-linear random models of waves. Study of the circulation of the oceans as described last year is continuing. A study of the capillary wave spectrum is still under way.
(g) A study of swell records obtained by J. E. Dinger at N.R.L. at Barbados is under way. Important non-linear results are being applied to the study of the Project SWOP data.
(h) "The Directional Spectrum of a Wind Generated Sea as Determined from Data Obtained by the Stereo Wave Observation Project", by Joseph Chase, L. J. Cote, W. Marks, E. Mehr, W. J. Pierson, Jr., F. C. Ronne, G. Stephenson, R. C. Vetter, and R. G. Walden. Revised report to appear in Journal of Marine Research.
"A Non-linear Random Model of Gravity Waves", by Leo J. Tick, 1958. Technical Report for the Office of Naval Research.

NORTH CAROLINA STATE COLLEGE OF AGRICULTURE AND ENGINEERING OF THE UNIVERSITY OF NORTH CAROLINA, Department of Engineering Research.

(1636) RAINFALL, INTENSITY, DURATION, FREQUENCY, CURVES FOR NORTH CAROLINA.

(b) Laboratory project.
(c) Prof. Chas. Smallwood, Dept. of Engineering Research, North Carolina State College, Raleigh, N. C.
(d) Experimental work consists of collecting information on rainfall.
(e) The collection and analysis of data pertaining to intensity, duration and frequency of rainfall in North Carolina.
(h) Information will be published later.

NORTH DAKOTA AGRICULTURAL COLLEGE, Agricultural Engineering Department.

(3121) PREFABRICATED DITCH LININGS.

(b) Laboratory project.
(c) Mr. Harold Holmen, Assistant Agricultural Engineer, Agricultural Engineering Dept., North Dakota Agricultural College, Fargo, North Dakota.
(d) Experimental; applied research.
(e) Four mil polyethylene lining was used in irrigation ditches to determine its durability and usefulness in preventing seepage.
(g) Results of one year's work indicate that surface linings must be well anchored and may last more than one season. One half of the linings were removed at the end of the season and showed some damage.

NORTHWESTERN UNIVERSITY, The Technological Institute.

(2361) FATE OF FISSION PRODUCTS IN SURFACE WATERS.

(b) U. S. Atomic Energy Commission.
(c) Prof. Carlos G. Bell, Jr., Northwestern University, Evanston, Illinois.
(d) Theoretical and experimental; doctoral research of Mr. Ivor Thomas.
(e) Study of the fate of fission products when injected into the Chicago Sanitary Ship Canal near Lemont, Ill. Two injections have been made and the data have been analyzed to obtain longitudinal dispersion coefficients.
(h) Final report to A.E.C. being prepared at present.

(2586) DISPERSION OF FLUID IN POROUS MEDIA.

(b) Laboratory project.
(c) Professor Robert B. Banks, Northwestern University, Evanston, Illinois.
(d) Theoretical, experimental.
(e) Packed column apparatus permits sampling of fluid flow to determine effects of dispersion, diffusion and convection on the change in solute concentration. One-dimensional studies have been completed; experiments in progress on radial flow apparatus.
(g) A theoretical analysis of the problem indicates that the phenomena is described by an equation similar to the heat conduction equation. A correlation between the longitudinal dispersion coefficient and Reynolds number has been obtained.
(h) "Dispersion in Porous Media", Akio Ogata, Ph.D. Thesis, Northwestern University, August 1958.

(2814) TORQUE CHARACTERISTICS OF A BUTTERFLY GATE.

(b) Laboratory project.
(c) Prof. W. S. Hamilton, Northwestern Univ., Evanston, Ill.

(d) Theoretical and experimental; master's thesis.

(e) Pressure patterns were obtained for a butterfly sluice gate by model tests, flow nets and conformal mapping.

(f) Completed.

(g) Theoretical and experimental pressures in agreement; a suitable mapping function was found.

(h) "Pressures on a Curved Sluice Gate - An Application of Conformal Mapping", Fuat Odar, M.S. Thesis, Northwestern University, August 1958.

(2816) UNSTEADY FLOW ABOUT CYLINDERS AND SPHERES.

(b) Laboratory project.

(c) Prof. Robert B. Banks, Northwestern Univ., Evanston, Illinois.

(d) Theoretical, experimental; master's degree research.

(e) An experimental apparatus is under construction which will allow determination of unsteady forces on submerged bodies. Velocities, accelerations and forces will be measured for flows around cylinders and spheres.

(f) Commencing.

(2818) DIFFUSION IN TIDAL ESTUARIES.

(b) Laboratory project.

(c) Prof. Carlos G. Bell and Prof. Robert B. Banks, Northwestern University, Evanston, Illinois.

(d) Theoretical and experimental; doctoral thesis.

(e) Experimental work is being conducted in long, variable slope channel, modified to simulate a tidal estuary. Test results will be interpreted in the light of turbulent diffusion coefficients obtained by measurement of the longitudinal distribution of fluid tracers.

(h) "Diffusion in a Vertically Homogeneous Tidal Estuary", P. J. Huiswaard, Ph.D. Thesis, Northwestern University, Aug. 1958.

(2819) NON-NEWTONIAN FLUID FLOW.

(b) Laboratory project.

(c) Prof. Robert B. Banks, Northwestern Univ., Evanston, Ill.

(d) Theoretical; for master's thesis.

(e) Analysis of existing data of flow of non-Newtonian fluids in pipes.

(f) Completed.

(g) A correlation has been obtained between the pipe friction factor and a modified Reynolds number.

(h) "Correlations of Newtonian and Non-Newtonian Fluid Flow Behavior", by J. W. Curtis, M. S. Thesis, Northwestern Univ., August 1958.

(2820) OBSERVATIONS IN TWO-DIMENSIONAL FLUIDIZED BEDS.

(b) Laboratory project.

(c) Prof. W. T. Brazelton, Northwestern Univ.,

Evanston, Illinois.

(d) Experimental.

(e) Photographic study of an approximate two-dimensional bed to observe bubble growth factors and the onset of slugging.

(2821) PHYSICAL CHARACTERISTICS OF FLUIDIZED BEDS.

(b) Laboratory project.

(c) Prof. W. T. Brazelton, Northwestern Univ., Evanston, Ill.

(d) Experimental; doctoral thesis.

(e) Use of radiation absorption to determine density variations and describe particle motion and agglomerative tendencies. Physical characteristics as a function of bed position to correlate and explain heat and mass transfer.

(g) Bed densities from gamma ray absorptions available.

(2822) HEAT AND MASS TRANSFER IN FLUIDIZED BEDS.

(b) Laboratory project.

(c) Prof. W. T. Brazelton, Northwestern Univ., Evanston, Ill.

(d) Experimental, basic research.

(e) A study considering usual variables of particle size, gas rate, settled bed height but giving particular attention to parameter of bed position. Similar conditions are maintained for heat and mass transfer for comparative purposes.

(g) Effect of longitudinal position has been demonstrated for case of heat transfer. To test same for mass transfer.

(2824) RANQUE-HILSCH VORTEX TUBE.

(b) Laboratory project.

(c) Prof. G. M. Brown, Northwestern University, Evanston, Ill.

(d) Experimental, basic research; for doctoral thesis.

(e) Investigate flow pattern, pressure, temperature, velocity vector throughout vortex flow region. Explain resulting temperatures.

(h) "The Ranque-Hilsch Vortex Tube", William Alfred Scheller and George Martin Brown, Ind. Eng. Chem. 49, 1013-16 (1957).

(3122) TRANSPORT PROCESSES IN THE FLOW OF GASES AROUND SINGLE SPHERES.

(b) Laboratory project.

(c) Prof. George Thodos, Northwestern Univ., Evanston, Ill.

(d) Experimental applied research; doctoral research for Mr. Yin-Chao Yen.

(e) Studies are to be initiated for obtaining experimental data associated with the simultaneous transfer of momentum, heat and mass from single spheres surrounded by a gas flowing past it. In this connection it is proposed to utilize a suspended sphere made of a diatomaceous earth and capable of absorbing significant quantities of liquids. In addition this material should be capable of permitting the fluid to flow to the surface by means of capillary

action. With this condition, a constant
rate of drying should prevail. Consequent
measurements of temperature and buoyant
effects, in conjunction with the rate of
mass transfer should permit the evaluation
of the transport processes which occur
simultaneously.

(f) Commencing.

(3123) FLOW PARAMETERS IN HYDROSTATIC LUBRICATION
FOR SEVERAL BEARING SHAPES.

(b) Laboratory project.
(c) Prof. S. Raynor and Prof. A. Charnes,
Technological Institute, Northwestern
University, Evanston, Ill.
(d) Theoretical; basic.
(e) In the case of hydrostatic lubrication the
designer of thrust bearings has to make
decisions regarding the shape of pads,
location of oil holes, and configuration
of oil grooves. In this paper several pad
shapes and associated oil inlets were in-
vestigated using conformal mapping tech-
niques to obtain the total load carrying
capacity, flow rate of oil, oil film thick-
ness, pressure and velocity distribution.
(f) Completed.
(g) The pressure and velocity distribution as
well as the total load carrying capacity
were computed for: (1) Circular plates
with central hole; (2) square plates with
central hole; (3) elliptical plates with
oil groove; and (4) infinite strip with
central hole.

UNIVERSITY OF NOTRE DAME, Dept. of Civil Engrg.

(2827) OBLIQUE RATINGS OF A CURRENT METER.

(f) Completed.
(h) "The Use of a Current Meter in Turbulent
and Divergent Channels", by S. Kolupaila,
Comptes Rendus et Rapports, AIGG, Assemblee
Generale de Toronto, 1957. Gentbrugge
1958, Vol. 1, pp. 437-444. Some reprints
available.

(3124) HISTORY OF HYDROMETRY IN THE UNITED STATES.

(b) Laboratory project.
(c) Dr. S. Kolupaila, Dept. of Civil Engineer-
ing, University of Notre Dame, Notre Dame,
Indiana.
(d) Applied research.
(e) Development of water measurement technique
by U. S. Army Corps of Engineers, U. S.
Geological Survey, U. S. Lake Survey,
universities and power companies. Com-
parison with the European development.
(f) Completed.
(h) Publication pending.

(3125) UNSTEADY LAMINAR BOUNDARY LAYERS ON
ARBITRARY CYLINDERS WITH VARIABLE PHYSICAL
PROPERTIES AND SUCTION OR INJECTION.

(b) Laboratory project.

(c) Dr. K. T. Yang, Dept. of Mechanical Engi-
neering, University of Notre Dame, Notre
Dame, Indiana.
(d) Theoretical investigation.
(e) Project deals with solutions to unsteady
laminar boundary-layer equations with
special attention to the effects of variable
physical properties and surface suction or
injection on laminar boundary-layer char-
acteristics. Exact solutions are first
obtained for a specific unsteady free-
stream velocity distribution. The results
may then be generalized to any free-stream
velocity distribution by means of an inte-
gral procedure.
(h) "On Certain Similar Solutions to Unsteady
Laminar Boundary-Layer Equations in Low-
Speed Flow", by K. T. Yang, Journal of the
Aeronautical Sciences, Vol. 25, No. 7,
July 1958.

THE OHIO STATE UNIVERSITY, Mechanical Engineering
Department.

(3126) FRICTIONAL RESISTANCE TO THE FLOW OF AIR
THROUGH DUCTS LINED WITH INSULATING
MATERIAL.

(b) The Owens-Corning Fiberglas Corp., Newark,
Ohio.
(c) Mr. Aubrey I. Brown, Mech. Engineering Dept.,
Ohio State University, Columbus, Ohio.
(e) Use of high air velocities in insulated
ducts of modern air-conditioning systems
calls for data on the friction factor and
the relative and absolute roughness of
various duct liners at air velocities up to
6000 feet per minute. Results of the tests
show characteristic variations in those
factors at various air velocities to be
slightly different than for air flow
through unlined metal ducts. The results
of these tests have contributed to the
development of a duct liner which offers a
frictional resistance to air flow that com-
pares very favorably with that of ordinary
galvanized-iron ducts of similar inside
cross-sectional dimensions.

(3127) CAPACITY TESTS OF SAFETY AND RELIEF VALVES.

(b) ASME Boiler and Pressure Vessel Committee,
National Board of Boiler and Pressure
Vessel Inspectors.
(c) Mr. Paul Bucher, Mech. Engineering Dept.,
The Ohio State University, Columbus, Ohio.
(e) A research and test program which has
developed standardized methods of testing
and rating pressure relief valves which has
been adopted by The ASME Power Boiler Con-
struction Code, The ASME Low Pressure
Heating Boiler Construction Code and The
Code for Unfired Pressure Vessels. The
Code requires that the above tests be con-
ducted in an approved laboratory by ap-
proved personnel. The Mechanical Engineer-
ing Department of the Ohio State University
has participated in this program for twenty

years.

(3128) VELOCITY DISTRIBUTION IN THE INLET REGION
OF TWO CO-AXIAL CYLINDERS WITH THE INNER
ONE ROTATING.

(c) Mr. L. S. Han, Mech. Engineering Dept.,
The Ohio State University, Columbus, Ohio.
(d) M.Sc. Thesis, L. Powers.
(e) An analytical investigation using the
method of von Karman's integral equation.

(3129) TEMPERATURE DISTRIBUTION IN A HOMOGENEOUS
MATRIX CONTAINING HEAT SOURCES AND SINKS.

(c) Mr. S. M. Marco, Mech. Engineering, Dept.,
The Ohio State University, Columbus, Ohio.
(d) M.Sc. Thesis, Charles K. Smith.
(e) This investigation accomplished the devel-
opment of equations for the description of
temperature fields in a matrix containing
heat sources and sinks such as a homogeneous
fuel-moderator nuclear reactor cooled by
tubes through which a coolant flows. The
resulting equations are so arranged that
they may be used for design purposes.

(3130) NATURAL CONVECTION BOILING HEAT TRANSFER OF
WATER IN VERTICAL RECTANGULAR DUCTS.

(c) Mr. S. M. Marco, The Mech. Engineering Dept.
The Ohio State University, Columbus, Ohio.
(d) Ph.D. Dissertation, Hi Chang Chai.
(e) An experimental investigation of the effect
of temperature difference, ratio of the
length of the sides of the rectangular
openings, additive agents, water level,
feedwater temperature and scale on the heat
transfer rate was conducted. It was found
that two distinct ranges of the variable Δt
exist. Two equations for the heat transfer
coefficient as a function of the tempera-
ture difference Δt were developed. One
equation is valid for one range of the
function $\Delta t/De$ where De is the equiva-
lent diameter.

(3131) FREE CONVECTION HEAT TRANSFER COEFFICIENTS
FOR HEATED HORIZONTAL FLAT PLATES ADJACENT
TO A HEATED VERTICAL FLAT PLATE.

(c) Mr. S. M. Marco, The Mech. Engineering
Dept., The Ohio State University, Columbus,
Ohio.
(d) M.Sc. Thesis, V. Torbert.
(e) The heat transfer coefficient on a hori-
zontal flat plate is affected by the
heated column of air flowing over the
vertical heated plate which is adjacent to
it. The results are applicable to the
computation of heat transfer from small
prismatic bodies such as transformers used
in electronic circuits.

(3132) TEMPERATURE AND VELOCITY PROFILES FOR HEAT
TRANSFER TO AIR IN TURBULENT FLOW IN A
CIRCULAR DUCT WITH CONSTANT WALL TEMPERA-
TURE.

(c) Mr. S. M. Marco, Mechanical Engineering

Dept., The Ohio State University, Columbus,
Ohio.
(d) M.Sc. Thesis, Paul Schumann.
(e) Equations based upon Deissler's variation
of the Reynold's Analogy for the Heat- and
Momentum-Transfer are developed and they
are being compared with extensive experi-
mental data obtained with high temperature
(up to 800° F) air, flowing through a 1-3/4
in. diameter tube at N_{re} up to 10^5. It is
anticipated that the results will be useful
for predicting temperature profiles in cir-
cular ducts with heat-transfer between the
duct wall and the flowing fluid.

(3133) CALIBRATION OF PRIMARY FLOW METERING.

(c) Mr. Charles F. Sepsy, Mechanical Engineering
Dept., The Ohio State University, Columbus,
Ohio.
(d) Calibrations conducted for various indus-
tries.
(e) Facilities are available in the Dept. of
Mechanical Engineering for conducting cali-
brations on orifices, flow nozzles, and
other types of primary elements used for
flow metering purposes. Water is used as
the calibrating medium. Calibrations are
made on a weight-time basis. The maximum
capacity of the equipment is approximately
ten cubic feet of water per second. In
determining the coefficient of discharge an
accuracy of 0.25 percent of the average
determined by calibration is held. Upon
completion of the calibration a complete
engineering report is prepared and submitted
to the sponsor.

(3134) STUDY ON 10-INCH MULTI-PLATE STRAIGHTENING
VANE.

(b) Bailey Meter Company.
(c) Mr. Charles F. Sepsy, Mechanical Engineering
Dept., The Ohio State University, Columbus,
Ohio.
(e) Flow measurement as used in acceptance tests
and performance monitoring must be accom-
plished with an accuracy considerably better
than present commercial limits, in fact,
within a fraction of 1%. This means the
flow itself must be uniformly turbulent at
the measuring point. If whirls, swirls or
other disturbances are present because of
the geometry of the preceding piping, they
must be eliminated completely before reach-
ing the orifice, flow nozzle, or other type
of primary element installed for metering
purposes. A study was made on a new type
of flow straightener, the Multi-Plate Vane,
which provides a uniformly turbulent flow
at the primary element. The flow straight-
ener was developed by the Bailey Meter Co.

(3135) THE EFFECT OF OBLIQUETY ON THE COEFFICIENT
OF DISCHARGE OF A THIN PLATE ORIFICE.

(c) Mr. R. H. Zimmerman, Mechanical Engineering
Dept., The Ohio State University, Columbus,
Ohio.
(d) M.Sc. Thesis, S. W. Angrist.

(e) To determine what effects (if any) thin plate orifices set at angles not perpendicular to the direction of flow will have on the coefficient of discharge. The test work included 3 angles from the vertical 20°, 40°, and 65° and 3 different ratios of orifice size to pipe size. The Reynolds number range over which these data were collected were from 50,000 to 400,000 with water as the flowing medium. This work will be of interest in the metering and gas turbine fields.

(3136) COEFFICIENTS OF DISCHARGE FOR ANNULAR ORIFICE PLATES.

(c) Mr. R. H. Zimmerman, Mechanical Engineering Dept., The Ohio State University, Columbus, Ohio.
(d) M.Sc. Thesis, C. W. Wolgemuth.
(e) An experimental investigation of the coefficient of discharge of various types of annular orifices and of orifices mounted oblique to the flow. The influence on the coefficient of discharge of various geometrical properties of the orifice. The flow Reynolds number and tap location are being evaluated.

(3137) SUPERSONIC INTERNAL FLOWS WITH HEAT ADDITION.

(c) Mr. R. H. Zimmerman, Mechanical Engineering Dept., The Ohio State University, Columbus, Ohio.
(d) M.Sc. Thesis, Floyd Bridge.
(e) An analytical investigation to predict the flow characteristics, total pressure loss and required area change during supersonic flow with heat addition. Various special cases of constant area, constant density, constant velocity, etc. are to be studied.

OKLAHOMA STATE UNIVERSITY, Agricultural Engineering Department.

(2365) HYDROLOGIC STUDIES ON SMALL GRASS-COVERED WATERSHEDS.

(b) Agricultural Experiment Station cooperative with Agricultural Research Service.
(c) Prof. F. R. Crow, Oklahoma State Univ., Dept. of Agricultural Engineering, Stillwater, Oklahoma.
(d) Field investigation; applied research.
(e) Measurements are being made to provide hydrologic data on total watershed runoff and peak rates of runoff from three small grass-covered watersheds (17 to 206 acres) in north central Oklahoma. Highway culverts, modified by the addition of weir sills, are being used as runoff measuring devices.
(g) Intensive model tests of culverts equipped with weir sills completed. Eight year data on precipitation and runoff completed.
(h) "Runoff from Small Watersheds in the Reddish Prairie Grasslands of Oklahoma",

W. O. Ree and F. R. Crow, Oklahoma Agricultural Experiment Station Technical Bulletin (in press).

(2828) THE EFFECTIVENESS OF MONOMOLECULAR FILMS FOR REDUCING EVAPORATION FROM RESERVOIRS.

(b) Oklahoma Agricultural Experiment Station.
(c) Prof. F. R. Crow, Oklahoma State Univ., Dept. of Agricultural Engineering, Stillwater, Oklahoma.
(d) Experimental; applied research.
(e) Studies are being made on evaporation pans, existing farm reservoirs and plastic lined experimental evaporation reservoirs to develop methods of application and determination of effectiveness of hexadecanol and octadecanol films for reducing evaporation. Effect of wind on stability of monolayers is being studied in low-speed laboratory wind tunnel.
(g) Evaporation reductions of 40% have been obtained using a slurry method of applying film to experimental pond. Curves have been developed relating wind speed and required film application rate.
(h) "Chemicals for Controlling Evaporation from Open Water Surfaces", F. R. Crow and E. R. Daniel, Trans. ASAE, First Edition, 1958.

OREGON STATE COLLEGE, School of Forestry.

(3138) SAMPLE ROUGHNESS COEFFICIENTS FOR USE IN DETERMINING MAXIMUM FLOW IN WESTERN OREGON STREAMS.

(b) Project conducted for partial completion of requirements for Master of Science degree.
(c) Mr. C. W. Dane, O.S.C. School of Forestry, Corvallis, Oregon.
(d) Experimental.
(e) Sample roughness coefficients for use in Manning's formula were computed from field measurements on 28 stream bottoms in central western Oregon. Streams varied from 50-5,000 cfs maximum flows.
(f) Completed.
(g) Values of the roughness coefficient computed and photographs of stream bottoms at low water levels taken.
(h) "Sample Roughness Coefficients for Use in Determining Maximum Flow in Western Oregon Streams", thesis filed in Library, Oregon State College, Corvallis, Oregon.

OREGON STATE COLLEGE, Hydraulic Laboratory.

(2829) MODEL INVESTIGATION OF AN ARTIFICIAL OUTLET FOR DOWNSTREAM MIGRATING FISH AT PELTON DAM, OREGON.

(b) Portland General Electric Co., Portland, Ore.
(c) Dr. Roy H. Shoemaker, Jr., Dept. of Civil Engineering, Oregon State College, Corvallis, Oregon.
(d) Experimental; applied research, design.

(e) Scale model of artificial outlet tested in model reservoir to determine: (1) Typical patterns of flow in reservoir as affected by discharge from penstocks; (2) effect of artificial outlet upon magnitude and direction of forebay currents; (3) effective limits of zone influence of the artificial outlet in the forebay and; (4) optimum flows into the artificial outlet for satisfactory operation.

(f) Completed.

(g) Unstable flow patterns observed in reservoir but reasonably consistent trend discovered in surface laying. No measureable effect of artificial outlet flow upon forebay current patterns. Limits of zone of influence of artificial outlet was limited to area in which no appreciable circulation currents existed. Optimum flow into skimmer was maximum design flow of 200 cfs.

(h) Limited number of final reports submitted directly to sponsor. No additional copies available.

(3139) BULL RUN DAM NO. 2 SPILLWAY MODEL STUDIES.

(b) City of Portland, Oregon.

(c) Dr. C. E. Behlke, Dept. of Civil Engineering, Oregon State College, Corvallis, Ore.

(d) Experimental, development.

(e) Model studies to determine flow patterns at the suction flanges of several process pumps were performed. Models were principally constructed of 5-inch I.D. lucite tubing.

(f) Completed.

(g) Design improvements.

(3140) HYDRAULIC CHARACTERISTICS OF THE FALL CREEK FISHWAY.

(b) U. S. Bureau of Public Roads, Division 8, Portland, Oregon.

(c) Dr. Roy H. Shoemaker, Jr., Dept. of Civil Engineering, Oregon State College, Corvallis, Oregon.

(d) Experimental; design.

(e) Model studies of fishway carrying water from outlet of 5-foot square box culvert. Studies were made to determine wall heights of fishway when carrying flows equal to and exceeding culvert design capacities.

(f) Completed.

(g) Required wall heights found to be only slightly greater than those estimated in preliminary design. Pier in diverging outlet of fishway was found to provide satisfactory distribution of flow across crest of outlet baffle.

(h) Limited number of reports submitted directly to sponsor. No additional copies available.

(3141) HYDRAULIC MODEL TESTS, PRIMARY PUMP SUCTION WELLS HANFORD WORKS.

(b) General Electric Co.

(c) Dr. Roy H. Shoemaker, Dept. of Civil Engineering, Oregon State College, Corvallis, Oregon.

(d) Experimental; design, development.

(e) Tests to determine nature of flow into pump suction well and pump suction bells at various flows and operating combinations of six vertical circulating pumps.

(3142) HYDRAULIC MODEL TESTS OF PROCESS PUMP SUCTION LINES.

(b) General Electric Co.

(c) Dr. C. E. Behlke, Dept. of Civil Engineering, Oregon State College, Corvallis, Ore.

(d) Experimental; development.

(e) Tests to determine flow patterns at suction flanges of certain process pumps at the Hanford Atomic Energy Plant.

(g) Developmental results.

(h) Information may be obtained from the sponsor to whom a limited number of reports have been submitted.

THE PENNSYLVANIA STATE UNIVERSITY, Ordnance Research Laboratory, Garfield Thomas Water Tunnel.

(2594) SCALE EFFECTS ON THE INCIPIENT CAVITATION CONNECTED WITH LOCAL SURFACE IRREGULARITIES.

(b) Laboratory project sponsored by the Bureau of Ordnance.

(c) Mr. J. William Holl, Ordnance Research Laboratory, Pennsylvania State University, University Park, Pennsylvania.

(d) Theoretical and experimental.

(e) The inception of cavitation on isolated surface irregularities were investigated experimentally and theoretically. The prime variable was the relative height of roughness, h/δ, where h is the height of roughness and δ the boundary layer thickness in the vicinity of the roughness. Circular arc and triangular-shaped, two-dimensional roughnesses were studied. The roughness varied in height from .002 to .500 inches.

(f) Completed.

(g) Results of tests showed significant variations of the incipient cavitation number with both size and velocity. The experimental results also showed that when the boundary layer thickness is 70 times greater than the height of a triangular roughness, the incipient cavitation number can be as great as 0.3. Thus for comparable conditions the incipient cavitation number of any smooth streamlined body of practical interest would be increased very significantl when an irregularity is located in the region of minimum pressure.

(h) "The Effect of Surface Irregularities on Incipient Cavitation", J. W. Holl, ORL TM 5.3410-03, June 1958.

(2832) MEASUREMENT OF FORCES ON A MODEL IN A WATER TUNNEL.

(b) Laboratory project.

(c) Messrs. T. E. Pierce and G. B. Gurney,

Ordnance Research Laboratory, Pennsylvania
State University, University Park, Pa.

(d) Experimental; developmental.

(e) The problem concerns the measurement of
forces on models in a water tunnel over a
velocity range up to 80 fps, pressure
ranges of 3 to 60 psia.

(g) Methods for waterproofing strain gages
permitting application to flooded internal
balance systems satisfactorily developed.
A three-component internal balance (lift,
pitching moment, and roll) for use with
8-inch diameter models has been success-
fully used under cavitating and non-cavi-
tating conditions. The drag link now in-
corporated in the pylon mounting strut is
being incorporated in the internal system.
A smaller balance measuring lift, drag,
pitching moment, and rolling moment for use
with string-mounted models up to about 4
inches in diameter is under construction.

(2833) EXCITATION OF CAVITY RESONANCE BY WATER FLOW.

(b) Laboratory project.

(c) Mr. R. E. Bland, Dr. E. J. Skudrzyk, Ord-
nance Research Laboratory, Pennsylvania
State University, University Park, Pa.

(d) Primarily experimental, some theoretical;
basic research.

(e) Experiments involving the excitation of
cavity resonance by water flow past an
opening will be undertaken in both the
large and small water tunnels. Test inves-
tigations to begin early in 1959.

(2834) INCIPIENT CAVITATION UNDER UNSTEADY
CONDITIONS.

(b) Laboratory project.

(c) Mr. J. J. Eisenhuth, Ordnance Research
Laboratory, Pennsylvania State University,
University Park, Pa.

(d) Theoretical; experimental.

(e) This investigation is concerned with the
unsteady interaction between propeller
blades and the wakes of stationary control
surfaces. The particular goal is to learn
the effects on incipient cavitation of pro-
peller blades when passing through these
wakes.

(f) Completed.

(g) Theoretical predictions were made of the
influence on the non-steady pressure per-
turbations on a blade row as a result of
periodic wakes shed from an upstream blade
row. These predictions were compared with
some cavitation experiments on a propeller.
The results indicate that the experimental
values of pressure perturbations are some-
what lower than theoretically predicted
values. The general trend, e.g., the in-
fluence of wake width and wake spacing, is
in substantial agreement between theory
and experiments.

(h) "The Unsteady Wake Interaction in Turbo-
machinery and its Effect on Cavitation",
Hsuan Yeh, J. J. Eisenhuth, ASME Paper
No. 58-A-114, December 1958.

(3143) REDUCTION OF SKIN FRICTION DRAG.

(b) Laboratory project sponsored by the Bureau
of Ordnance.

(c) Mr. A. F. Lehman, Ordnance Research Labora-
tory, Pennsylvania State University,
University Park, Pennsylvania.

(d) Experimental.

(e) Investigations into the reduction of skin
friction drag on submerged bodies through
boundary layer control. Actual test inves-
tigations scheduled for summer 1959.

PURDUE UNIVERSITY, Agricultural Experiment Station.

(2595) A MODEL STUDY OF BREATHERS IN TILE LINES.

(b) Laboratory project.

(c) Prof. E. J. Monke, Agr. Engineering Dept.,
Purdue University, Lafayette, Indiana.

(d) Field investigation; applied research;
master's thesis.

(e) Investigations were made to determine
whether breathers are necessary in tile
lines.

(f) Completed.

(g) An advantage of not using breathers in tile
lines is that greater discharge can be
obtained for heads in the range between
open channel flow and pipe flow.

(h) "Effect of Breathers on Flow Characteristics
in Tile Drains Laid on Steep Slopes", by
H. R. Honeyfield, M.S. Thesis, (available
at Purdue Library).

(2596) THE DEVELOPMENT AND USE OF A RAINFALL
SIMULATOR FOR SOIL AND WATER MANAGEMENT
STUDIES.

(b) Agricultural Research Service, SWC, ESW,
USDA and Purdue University.

(c) Mr. L. Donald Meyer, ARS, Agr. Engr. Bldg.,
Purdue University, Lafayette, Indiana.

(d) Experimental; development; operation.

(e) Methods of simulating rainfall, using the
kinetic energy of the drops as the primary
comparison, have been investigated. A
portable rainfall simulator has been de-
signed, constructed, and is in use as a
tool to aid in the rapid evaluation of
factors that influence runoff, erosion, and
infiltration. Commercial spray nozzles are
used to apply intensities of $2\frac{1}{2}$ and 5 inches
per hour to standard runoff study plots.
Construction of the simulator in units
makes it possible to vary the number and
size of plots that are covered simultane-
ously. Present use of the simulator is
primarily for qualitative evaluations of
various topographic soil, water, crop, and
management factors under controlled field
conditions.

(h) "Rainfall Simulator for Runoff Plots", by
L. Donald Meyer and Donald L. McCune in
Agricultural Engineering, Vol. 39, pp. 644
to 648, October 1958.
"An Investigation of Methods for Simulating

Rainfall on Standard Runoff Plots and a
Study of the Drop Size, Velocity, and
Kinetic Energy of Selected Spray Nozzles",
by L. Donald Meyer in Special Report No.
81, Eastern Soil and Water Mgmt. Research
Branch, SWC-ARS, U. S. Dept. of Agri.,
Plant Industry Station, Beltsville, Md.

(2597) THE EFFECTS OF TILLAGE ON RUNOFF AND
EROSION.

(b) Laboratory project.
(c) Prof. Helmut Kohnke, Agronomy Dept.,Purdue,
University, Lafayette, Indiana.
(d) Field investigation; applied research.
(e) Runoff and soil erosion will be measured
from 15 watersheds in five different
tillage systems. These systems involve
two surface soil treatments and three sub-
soil treatments, including subsoil ferti-
lization and vertical mulching. A complete
hydrologic analyses of these small water-
sheds will be used to evaluate the effects
of tillage on soil moisture, evapo-trans-
piration, crop growth and yield, runoff,
and soil losses.

(2835) PRELIMINARY INVESTIGATION OF WATER TABLE
CONTROL IN SANDY SOIL.

(b) Laboratory project.
(c) Mr. Walter D. Lembke, Agricultural Engi-
neering Dept., Purdue University,
Lafayette, Indiana.
(d) Field investigation; applied research.
(e) At two sites where water table control is
being practiced, the distance from the
soil surface that the water table can be
held is being measured.

(2837) TREATMENT OF SURFACE WATERS FOR DOMESTIC
USE ON THE FARM.

(b) Laboratory project
(c) Prof. A. C. Dale, Agr. Engineering Dept.,
Purdue University, Lafayette, Indiana.
(d) Field investigation; applied research.
(e) The effectiveness of treating pond water
through slow sand and diatomaceous earth
filters is being determined.
(h) "Treatment of Pond Water for Farmstead
Use", by C. R. Amerman, M.S. Thesis.

PURDUE UNIVERSITY, School of Chemical and
Metallurgical Engineering.

(3144) JET SPRAY DRYER.

(b) Swift and Company and the Purdue Research
Foundation.
(c) Prof. Stanford W. Briggs, Dept. of Chemi
cal Engineering, Purdue University,
Lafayette, Indiana.
(d) Experimental; applied research for master's
thesis.
(e) The application of the jet spray dryer to
the drying of milk is being studied. The
effect of operating variables including

temperature, velocity, and concentration
of milk on the particle size and quality
of the dried product are currently under
investigation.

(3145) FLOW OF NON-NEWTONIAN FLUIDS.

(b) Shell Fellowship Committee of the Shell
Companies Foundation, Inc.
(c) Prof. C. O. Bennett, Dept. of Chemical
Engineering, Purdue University, Lafayette,
Indiana.
(d) Experimental and theoretical investigation;
basic research for Ph.D. thesis.
(e) A survey of the literature on the fluid
mechanics and the heat transfer phenomena
of non-Newtonian fluids is under way, and
plans for the experimental apparatus are
being completed.

PURDUE UNIVERSITY, School of Civil Engineering.

(2839) HYDRAULICS OF RIVER FLOW UNDER ARCH BRIDGES.

(b) State Highway Department of Indiana and
Bureau of Public Roads.
(c) Dr. J. W. Delleur, School of Civil Engineer-
ing, Purdue University, Lafayette, Ind.
(d) Experimental; for design, for master's
theses.
(e) The purpose of the research is to study
systematically the hydraulic efficiency of
waterways under arch bridges, to provide
a criterion for determining the proper clear
span of arch bridges so as to compensate
for the loss of efficiency at high flows,
and to provide a method for computing the
backwater upstream of arch bridges.
(g) Testing of small scale models in 6 in. wide
12 ft. long tilting flume in progress.
Design of 5 ft. wide 64 ft. long tilting
flume completed.
(h) Monthly progress reports.

(2840) MECHANISM OF TURBULENCE IN FREE SURFACE FLOW.

(b) Purdue Research Foundation.
(c) Dr. J. W. Delleur, School of Civil Engrg.,
Purdue University, Lafayette, Indiana.
(d) Theoretical and experimental; for Ph.D.
theses.
(e) Analytical and experimental investigation
of the mechanism of turbulence in free
surface flow. The analytical part of the
project will investigate important flow
characteristics such as the spectrum of
turbulence, correlation of velocities in
the turbulent field, degree of isotropy,
and the various velocity functions. The
experimental portion of the program will
make tests coincident with theoretical
studies.
(g) Precision test flume designed. The flume
has variable longitudinal slope and changea-
ble cross section. The cross section may
be triangular, rectangular or trapezoidal
with different widths and side slopes.
Other instruments specified.

(2841) STUDY OF RUNOFF FROM SMALL WATERSHEDS FOR
HIGHWAY DRAINAGE DESIGN IN INDIANA.

(b) State Highway Department of Indiana.
(c) Dr. J. W. Delleur, School of Civil Engi-
neering, Purdue Univ., Lafayette, Ind.
(d) Analysis and field investigation.
(e) The purpose of the research is to study the
hydrology of watersheds less than 100 sq.
miles throughout the State of Indiana, to
improve the existing methods for estimating
the runoff from small watersheds, and to
improve the present methods of design of
highway drainage structures servicing small
watersheds.
(f) Temporarily inactive.
(g) Runoff and rainfall data have been col-
lected.

(3146) HYDROMECHANICS OF FLUID COLLECTOR SYSTEM
IN POROUS MEDIA.

(b) Purdue Research Foundation.
(c) Dr. J. W. Delleur, School of Civil Engi-
neering, Purdue University, Lafayette, Ind.
(d) Theoretical, and experimental; for Ph.D.
thesis.
(e) Analytical and experimental investigation
of the hydrodynamics of flow patterns
around horizontal fluid collector systems
in porous media. Theoretical investiga-
tion will include two- and three-dimensional
analyses. Theoretical considerations will
be based on existing data and concepts
drawn from investigation with electrical
analog. The analog instrument is designed
to indicate equipotential curves for various
water table and permeability conditions.
(g) Extensive European literature is being
compiled.

(3147) GEOHYDRAULICS.

(b) Laboratory project.
(c) Messrs. J. W. Delleur and A. L. Simon,
School of Civil Engineering, Purdue Univ.,
Lafayette, Indiana.
(d) Theoretical; basic research.
(e) Geohydraulic theory is being developed as
a science based on Fluid Mechanics and
Hydrogeology. Quantitative analyses are
developed. A bibliography includes prin-
cipal works of European scientists and
others.

PURDUE UNIVERSITY, Jet Propulsion Center.

(2374) THE MECHANISM OF TWO PHASE FLOW OF ANNULAR
LIQUID FILMS IN A VERTICAL TUBE.

(b) Project Squid, Contract Nonr-1858(25).
(c) Dr. M. J. Zucrow, Jet Propulsion Center,
Purdue University, West Lafayette, Indiana.
(d) Experimental and theoretical; basic re-
search for doctoral thesis.
(e) This problem is concerned with the ana-
lytical and experimental study of the
mechanism of the downward flow of a liquid

film on the inside wall of a vertical cir-
cular tube with co-current gas flow in the
core of the tube. The gas static pressure
drop caused by the liquid film, and the
magnitude and frequency of the waves on the
surface of the liquid film have been de-
termined experimentally.
(h) "Project Squid Progress Report," April 1958,
and October 1958 and references therein.

REED RESEARCH FOUNDATION.

(3148) THE STREAMING OF BLOOD IN VEINS AND
ARTERIES OF LIVING ANIMALS.

(b) National Heart Institute, under Grants
H-2402 and H-2403(c).
(c) Mr. Johann Martinek, Reed Research Founda-
tion, 1048 Potomac Street, N.W., Washington
7, D. C.
(d) Theoretical; basic research.
(e) Steady and non-steady flow of viscous
liquid in rigid and elastic tubes.
(g) It was considered premature to analyze the
rheological aspects of the blood of the
veins and arteries in the beginning of this
study. Hence the blood is considered
throughout as a viscous fluid described by
the Navier-Stokes equations. The veins and
arteries are described as either rigid or
elastic tubes. In Part 1., the mathematical
nature of the tube walls in steady and un-
steady flows is critically examined. Only
solutions compatible with the initial con-
dition and giving resistance (drag) are
acceptable physically. Such acceptable
solutions are given for unsteady flow in
rigid and elastic tubes respectively.
(h) "The Streaming of Blood in Veins and
Arteries of Living Animals", by H. de
Beaumont, Johann Martinek, and Gordon C. K.
Yeh, Progress Report, Research Grants H-
2402 and H-2402(c) for the period Aug. 1,
1956 to Oct. 31, 1957, Nov. 1, 1957.

REED RESEARCH INCORPORATED.

(2850) RESEARCH TO WORK OUT A THRUST DEDUCTION
EVALUATION OF THE SUBMARINE ALBACORE (THE
CONSTRUCTION OF THE TOTAL HARMONIC VELOCITY
FIELD AROUND A GENERAL ELLIPSOIDAL SUB-
MARINE WITH ONE PROPELLER).

(b) David Taylor Model Basin (Bureau of Ships
Fundamental Hydromechanics Research Pro-
gram).
(c) Mr. J. Martinek, Reed Research Inc., 1048
Potomac Street, N.W., Washington 7, D. C.
(d) Theoretical; basic research.
(e) The construction of the exterior Neumann
function, sometimes called Green's function
of second kind, is reported.
(f) Completed.
(g) The construction of the Green's function
of the second kind was possible because the
Green's function of first kind was secured

in Final Report I. The result of Final Report I is here applied in the general form of the expansion for the case of the exterior Neumann problem related to the general ellipsoid. Thus the construction of the Neumann function amounts in fact in this case to the consideration of a unique sink at a running point exterior to an ellipsoid with the hydrodynamic boundary conditions. In view of this, additional necessary details are given not contained in Final Report I in reference to the Green's function of first kind pertaining to the Dirichlet problem. Then the Neumann function for the general ellipsoid is derived. Final Report II is terminated with considerations of general nature and interest which are concerned with the construction of the most general types of solutions in terms of the derived Green or Neumann function.

(h) "Final Report II on Research to Work out a Thrust Deduction Evaluation of the Submarine Albacore (The Construction of the Total Harmonic Velocity Field Around a General Ellipsoidal Submarine with One Propeller)", by Johann Martinek, Henry de Beaumont and Gordon C.K. Yeh, Cont. No. Nonr 2192(00) to David Taylor Model Basin, August 1, 1958.

(2851) THE CONSTRUCTION OF THE TOTAL HARMONIC VELOCITY FIELD AROUND A GENERAL ELLIPSOIDAL SUBMARINE WITH ONE PROPELLER.

(b) David Taylor Model Basin, Department of the Navy (Bureau of Ships Fundamental Hydromechanics Research Program).

(c) Mr. J. Martinek, Reed Research Inc., 1048 Potomac Street, N.W., Washington 7, D. C.

(d) Theoretical; basic research.

(e) The Green's function for a Dirichlet problem related to ellipsoids has been constructed. So far, only bodies of simple shape with certain idealized propellers have been solved by the authors and others in an ideal fluid field obeying the Laplace equation. These self-propelled bodies have been essentially confined to shapes of point or axial symmetry (spheres, spheroids). In this study solutions for the more general problem of self-propelled bodies with plane symmetry such as ellipsoids in ideal fluid fields which have been non-existent so far have been derived. Such plane symmetry is the least idealized case with regard to submerged vessels of real shapes. A summary of known classical results is given and clarified. A new method pertaining to homothetic ellipsoids was then developed and some of the classical results are rederived. This was done in order to find if possible a formulation which may lend itself to the construction of theorems of the same nature as the several sphere theorems developed by the authors in previous reports. A discussion follows dealing with the homothetic ellipsoid study, with the aim of elucidating clearly the difference between the Dirichlet

and the Neumann problem. The last phase of this study presents the Green's function of first kind for the ellipsoid in a form suitable for numerical computations.

(f) Completed.

(g) The exterior Green's function of first kind (Dirichlet problem) for the general ellipsoid has been derived for the first time.

(h) "Final Report I on The Construction of the Total Harmonic Velocity Field Around a General Ellipsoidal Submarine with One Propeller", by Johann Martinek, Henry de Beaumont and Gordon C. K. Yeh, Contract Nonr 1445(00), to David Taylor Model Basin, Bureau of Ships Fundamental Hydromechanics Research Program, December 31, 1957.

(2852) THEORETICAL STUDIES ON STEADY FLUID MOTION UNDER A FREE SURFACE.

(b) David Taylor Model Basin (Bureau of Ships Fundamental Hydromechanics Research Program).

(c) Mr. J. Martinek, Reed Research Inc., 1048 Potomac Street, N. W., Washington 7, D. C.

(d) Theoretical; basic research.

(e) Theoretical studies leading to applications on steady and certain unsteady fluid motions under a free surface.

(g) The first part of this study establishes a new theorem for expressing the disturbance function of an n-dimensional field satisfying the Helmholtz equation due to the presence of a hyperplane boundary in terms of the undisturbed function. In the special case of a field satisfying the Laplace equation in three dimensions, the boundary conditions include those in hydrodynamics, heat, magnetism, and electrostatics. In the second part of this report, the disturbance potential due to the presence of a slightly curved free surface (approximating a plane free surface) is expressed in terms of the potential due to any simply harmonic oscillatory motion of an inviscid incompressible and irrotational fluid flow in an unlimited domain. By superposition of such oscillatory potentials, time-dependent potentials for a more general fluid motion under a free surface are obtained. A special case of the theorem derived in Part I expresses the disturbance velocity potential in an unlimited domain due to the presence of a plane boundary complying to the radiation condition with the constant factor zero or positive.

(h) "Final Report on Theoretical Studies on Steady Fluid Motion under a Free Surface", by J. Martinek and G. C. K. Yeh, Contract Nonr 2473(00) (Bureau of Ships Fundamental Hydrodynamics Research Program, NS 715-102). "Disturbance of a Many-Dimensional Field Satisfying the Helmholtz Equation Due to the Presence of a Hyperplane Boundary", by G.C.K. Yeh and J. Martinek. Proceedings of the Royal Society, Series A, Mathematical and Physical Sciences, Vol. 246 No. 1246 (August 19, 1958) pp. 423-428.

(2853) ANALYTICAL STUDIES OF SHIP SLAMMING.

(b) David Taylor Model Basin, Department of the Navy (Bureau of Ships Fundamental Hydromechanics Research Program).

(c) Dr. Gordon C.K. Yeh, Reed Research Inc., 1048 Potomac Street, N.W., Washington 7, D. C.

(d) Theoretical; basic research.

(e) A survey of existing literature has been carried out pertaining to analytical work on slamming with or without consideration of ship elasticity, and on transverse impact on beams and plates. The differential equation has been established for the pure pitching motion of an elastically supported cantilever beam according to the principle of work and energy. The analysis of the motion and stresses of a free-free beam subjected to various impact loads has also been formulated in terms of the characteristic functions representing the normal modes of vibration of a uniform beam. Further analysis which is now in progress pertains to equations of motions for plates under impact and in particular solutions for both beams and plates which simulate certain aspects of ship slamming.

(3149) THEORETICAL STUDIES ON STEADY FLUID MOTION UNDER A FREE SURFACE - II.

(b) David Taylor Model Basin.

(c) Dr. Gordon C. K. Yeh, Reed Research Inc., 1048 Potomac Street, N.W., Washington 7, D. C.

(d) Theoretical; basic research.

(e) Theoretical studies leading to applications on steady and certain unsteady fluid motions under a free surface.

(g) In Final Report I on Steady Fluid Motion under a Free Surface, a theorem of considerable generality pertaining to the Helmholtz equation in the presence of a hyperplane boundary was derived. A special case of the theorem expresses the disturbance velocity potential in closed form in terms of any given potential in an unlimited domain due to the presence of a plane boundary with the radiation boundary condition with the constant k zero or positive. For problems where k is negative in the boundary condition, the general sphere theorem derived by Yeh, Martinek and Ludford in a previous report has been used for slightly curved free surface boundary conditions. The study which is in progress now is to complete the general theorem mentioned above by extending it to include the plane boundary with conditions covering the negative values of k.

(3150) INTERACTION FORCE BETWEEN A PROLATE SPHEROID AND AN AXIALLY SYMMETRIC VORTEX RING IN POTENTIAL FLOW.

(b) David Taylor Model Basin (Bureau of Ships Fundamental Hydromechanics Research Program).

(c) Mr. J. Martinek, Reed Research Inc., 1048 Potomac Street, N. W., Washington 7, D. C.

(d) Theoretical; basic research.

(e) Formulation of force experienced by a deeply submerged prolate spheroid in a potential flow due to an axially symmetric vortex ring located exterior to the spheroid. Computation of a numerical example by the use of data corresponding to one of Weitbrecht's test models. Several investigations in the literature deal with the forces on obstacles due to discrete sources, sinks, and higher order singularities, as well as spreads of such singularities in steady and also particular cases of unsteady flows. All those investigations, however, apply only for cases where the singularity representation of the body in the given fluid field is known. A generalization of Lagally's theorem to a spread of axially symmetric singularities in the presence of a spheroid is now under study.

ROCKY MOUNTAIN HYDRAULIC LABORATORY.

(2140) EVALUATION OF OPEN-CHANNEL FRICTION LOSSES.

(b) National Science Foundation, Water Resources Division of the U. S. Geological Survey, and the State University of Iowa cooperating.

(c) Prof. C. J. Posey, Director, Rocky Mountain Hydraulic Laboratory, Allenspark, Colorado (summer), State University of Iowa, Iowa City, Iowa, (winter).

(d) Experimental; basic.

(e) Variable slope flume long enough to permit accurate evaluation of open-channel friction losses is being tested at slopes into the steep range, determining normal depth and velocity distribution for batten and rolled natural-type roughnesses in triangular and trapezoidal cross-sections.

(f) Active experimentation during summers.

(h) "Resistance Experiments in a Triangular Channel" by R. W. Powell and C. J. Posey, presented at the Hydraulics Division meeting, Oct. 1958 ASCE Convention, and pending publication in Proceedings. Preprints available.

ST. ANTHONY FALLS HYDRAULIC LABORATORY, UNIVERSITY OF MINNESOTA.

Inquiries concerning Projects Nos. 100, 2143, 2144, 2148, 2603, 2604, 2606, 2607, 2610, 2855, 2857, 2858, 2859, and 3151 to 3165, inclusive should be addressed to Dr. Lorenz G. Straub, Director, St. Anthony Falls Hydraulic Laboratory, Mississippi River at Third Avenue S.E., Minneapolis 14, Minn.

Inquiries concerning Projects Nos. 111, 1168, 1398, 1929, 2386 and 2860, which are conducted in cooperation with the Agricultural Research Service, should be addressed to Mr. Fred W. Blaisdell, Project Supervisor, Watershed Technology Research Branch, Soil and Water Conservation Research Division, Agricultural Research Service, St. Anthony

Falls Hydraulic Laboratory, Minneapolis 14, Minn.

Inquiries concerning Projects Nos. 985, 2923, and 2924, which are conducted in cooperation with the Corps of Engineers, should be addressed to the District Engineer, U. S. Army Engineer District, St. Paul, Corps of Engineers, St. Paul, Minnesota.

(100) AIR ENTRAINMENT RESEARCH.

   (b) Office of Naval Research, Department of the Navy.

   (d) Theoretical and experimental.

   (e) Investigation of self-aeration of high velocity open-channel flow. Air concentrations distributions in the flow have been measured for equilibrium aeration conditions in smooth channel for discharges up to 10 cfs and slopes up to 45° and in artificially roughened channels for discharges up to 15 cfs and slopes up to 75°.

   (f) Discontinued.

   (g) Air concentration distribution in both rough and smooth channels indicates that the flow consists of two parts: (1) Open channel flow in lower region with air distributed by turbulent mixing, (2) an upper region consisting of water clumps and droplets carried through nominal surface by intense transverse velocity fluctuations. Mean air concentration is a function of slope and discharge. Both effective depth and mean velocity increase with air concentration.

(111) CLOSED CONDUIT SPILLWAY.

   (b) Agricultural Research Service, U. S. Dept. of Agriculture, in cooperation with the Minnesota Agricultural Experiment Station and the St. Anthony Falls Hydraulic Lab.

   (d) Experimental; generalized applied research for development and design.

   (e) Tests have been made on three different sizes of Lucite pipe set on slopes ranging from 2.5% to 30% to verify the similarity relationships. Information on discharges, pressures, and flow conditions has been obtained. Characteristics, performance, losses, and pressures in the hood drop inlet are currently being studied.

   (g) Theory has been developed, verified, and published. Generalized methods for analysis and reporting results have been developed. Pipe culverts laid on steep slopes will flow completely full even though the outlet discharges freely. A conduit on either steep or flat slopes will flow full if the hood inlet is used, the hood being formed by cutting the pipe so that the crown projects beyond the invert by 3/4 of a pipe diameter. Minimum circular and square drop inlet sizes and heights have been determined for a conduit slope of 20%. Entrance loss coefficients vary with drop inlet size and height.

   (h) "Hydraulics of Closed Conduit Spillways, Part I Theory and Its Application" by Fred W. Blaisdell, St. Anthony Falls Hydraulic Laboratory Technical Paper No. 12, Series B,

January 1952, revised February 1958. "Hydraulics of Closed Conduit Spillway, Parts II through VII, Results of Tests on Several Forms of the Spillway", by Fred W. Blaisdell, St. Anthony Falls Hydraulic Laboratory Technical Paper No. 18, Series B, March 1958. "Hydraulics of Closed Conduit Spillways, Part VIII, Miscellaneous Laboratory Tests, Part IX, Field Tests" by Fred W. Blaisdell, St. Anthony Falls Hydraulic Laboratory Tech. Paper No. 19, Series B, March 1958. "Hydraulics of Closed Conduit Spillways, Part X, The Hood Inlet" by Fred W. Blaisdell and Charles A. Donnelly, St. Anthony Falls Hydraulic Laboratory, Technical Paper No. 20, Series B, April 1958.

(985) FILLING AND EMPTYING SYSTEMS FOR HIGH-LIFT LOCKS.

   See U. S. Army Engineer District, St. Paul, Minnesota, page 114.

(1168) A STUDY OF CANTILEVERED OUTLETS.

   (b) Agricultural Research Service, U. S. Dept. of Agriculture, in cooperation with the Minnesota Agricultural Experiment Station and the St. Anthony Falls Hydraulic Lab.

   (d) Experimental; generalized applied research for design.

   (e) Pipe outlet conduits for small spillways are frequently cantilevered beyond the toe of the earth dam. Attempts will be made to determine quantitatively the size of the scour hole to be expected under various field conditions.

   (f) Suspended.

(1398) STRAIGHT DROP SPILLWAY.

   (b) Agricultural Research Service, U. S. Dept. of Agriculture, in cooperation with the Minnesota Agricultural Experiment Station and the St. Anthony Falls Hydraulic Lab.

   (d) Experimental; generalized applied research for design.

   (e) This spillway is used as a grade control structure in ditches and streams. The study will result in general design rules for the spillway and outlet. Outlet studies have been completed. Present studies are to determine spillway performance and capacity with various approach channel shapes.

   (f) Suspended.

   (g) No method has yet been found by which the discharge coefficient can be related to the variables.

(1929) DRAIN TILE JUNCTION LOSSES.

   (b) Minnesota Agricultural Experiment Station in cooperation with the Agricultural Research Service, U. S. Department of Agriculture and the St. Anthony Falls Hydraulic Laboratory.

   (c) Prof. Philip W. Manson, University of Minn., St. Paul Campus, St. Paul, Minnesota.

   (d) Experimental; generalized applied research

(e) The junction losses in drain tile flowing
full are determined for laterals of differ-
ent sizes entering mains of different sizes
at various angles. The laterals enter the
main at the center line. Additional tests
have been made with the crowns (or inverts)
of both main and lateral in the same plane.

(g) Tests have been completed on sharp edge
junctions entering the main at angles
varying in 15 degree increments from 15
degrees to 165 degrees. Both the lateral
and the main are completely full. The
tests cover all possible combinations of
discharge in the lateral and the main.
Laterals having areas 1/1, 1/2, 1/4, 1/7
and 1/16 that of the main have been tested.
The data are being analyzed and a compre-
hensive report is planned. A sound color
motion picture film is in process of pre-
paration.

(2143) EXPERIMENTAL STUDIES OF SURFACE WAVE
ABSORPTION.

(b) Office of Naval Research, Department of the
Navy.
(d) Experimental; basic research.
(e) Procurement of experimental data on per-
formance and power requirements of pneu-
matic and hydraulic breakwaters.
(g) Hydraulic breakwater tests have been com-
pleted. Pneumatic breakwater tests of two
geometrically similar models are under way.
Preliminary results indicate that the
pneumatic breakwater is somewhat more
efficient than its hydraulic counterpart
for attenuations up to 70 per cent.

(2144) EXPERIMENTAL AND ANALYTICAL STUDIES OF
HYDROFOILS.

(b) Office of Naval Research, Department of
the Navy.
(d) Experimental and analytical; basic research.
(e) Investigation of the basic mechanism of
the ventilation of surface-piercing bodies,
such as circular cylinders and streamlined
lifting struts. Scale effect is of particu-
lar interest.
(g) Fundamental studies of the ventilation of
streamlined, lifting struts indicated that
the submergence Froude number and submer-
gence ratio can be used for correlating
ventilation data at high yaw angles. At
low angles, ventilation inception was also
dependent on the character of the water
surface, and minimum velocities were de-
termined for which ventilation would not
occur even for very severe conditions.
Hysteresis effects were investigated and
correlated satisfactorily with the Froude
number and submergence ratio.
(h) "Ventilation of Bodies Piercing a Free
Surface" by J. M. Wetzel. Paper presented
at Second Symposium on Naval Hydrodynamics,
Washington, D. C. August 1958.

(2148) AIR-WATER MIXTURES IN CLOSED CONDUITS.

(b) David Taylor Model Basin, Department of the
Navy.
(d) Experimental research and analysis.
(e) Horizontal conduits involving flow of air
bubbles in water are considered. Both a
straight conduit and conduit with two godet
bends were studied experimentally. Bubble
distribution, friction factor and velocity
profile were examined.
(f) Completed.
(g) A method for predicting pressure drop in
horizontal pipes with bubble, separated
and slug flows has been developed which is
probably more useful than the existing
Lockart-Martinelli correlations for these
flow regimes. Information was also ob-
tained on bubble size distribution and
velocity profiles in bubble-type flows.
(h) "Two-Phase Flow Studies in Horizontal
Pipes" by Walter James and Edward Silber-
man, University of Minnesota, St. Anthony
Falls Hydraulic Laboratory Project Report
No. 60, September 1958.

(2386) GENERALIZED DESIGN OF TRANSITIONS FOR
SUPERCRITICAL VELOCITIES.

(b) Agricultural Research Service, U. S. Dept.
of Agriculture, in cooperation with the
Minnesota Agricultural Experiment Station
and the St. Anthony Falls Hydraulic Labora-
tory.
(d) Experimental; generalized applied research
for development and design.
(e) Studies will be made to develop a transi-
tion and to determine the rules for its
design. The transition will be used to
change the flow cross section from circular
to rectangular when the velocities are
supercritical.
(f) Suspended.

(2603) WATER TUNNEL AIR CONTENT STUDIES.

(b) David Taylor Model Basin, Department of the
Navy.
(d) Experimental and analytical.
(e) Evaluation of improved method for control-
ling content of free air contained in water
tunnel. System involves separation and
extraction of large circulating air bub-
bles, controlled maintenance of small air
bubbles (cavitation nuclei) and measurement
of the free air content. Influence of air
content control on cavitation inception
and acoustic noise is sought.
(h) "A Study of the Influence of Gas Nuclei on
Cavitation Scale Effects In Water Tunnel
Tests" (with an Appendix, A Sonic Method
of Measuring the Concentration of Undis-
solved Gas Nuclei in Water), by J. F.
Ripken and R. M. Olson, University of Minn.,
St. Anthony Falls Hydraulic Laboratory
Project Report No. 58, February 1958.

(2604) FULL-SCALE TEST OF CONCRETE PIPE.

(b) State Road Department of Florida and
Bureau of Public Roads.

(d) Experimental; applied.
(e) Procure experimental data on frcition coef-
ficient for 24-inch and 36-inch concrete
pipe with (1) joints similar to field con-
ditions and (2) smooth joints. Tests were
performed on both machine-made and Vibro-
cast pipe.
(f) Completed except for report.
(g) Results indicate that 36-inch machine-made
pipe with joints similar to field installa-
tions had Darcy f value of about 0.0155
($n = 0.011$); with smooth joints f was about
0.0150 ($n = 0.0108$). In tests of 36-inch
Vibro-case pipe f varied as a function of
Reynolds number for both "field" and smooth
joints; resulting curves were approximately
parallel to smooth-pipe curve. Field
joints produced f value about 3 percent
higher than smooth joints.

(2606) PRIEST RAPIDS MODEL STUDIES.

(b) Public Utility District of Grant County,
Ephrata, Washington.
(d) Experimental; design and operation.
(e) A 1:120 scale model of the Priest Rapids
Development Project on the Columbia River
is reproduced to study the hydraulic design
of the spillway, powerhouse and fish facili-
ties.

(2607) PRIEST RAPIDS (COFFERDAM MODEL).

(b) Harza Engineering Company, Chicago; Public
Utility District of Grant County, Ephrata,
Washington; Merritt-Chapman and Scott, con-
tractors.
(d) Experimental; design and operation.
(e) A distorted model, scale 1:60 vertical and
1:180 horizontal is used to determine the
placement of the various stages of coffer-
dam construction. Measurements of channel
velocities to assure passage of fish mi-
grants during all phases of construction.
(f) Completed.
(g) Good correlation between distorted model
and prototype has been confirmed.

(2610) LABORATORY WAVE PROFILE RECORDER.

(b) David Taylor Model Basin, Department of
the Navy.
(d) Experimental; applied.
(e) Study of sonic-ranging type profile re-
corder for specialized laboratory use.
(g) A developmental program is in progress to
produce a water surface-wave recording
instrument based on the sonic ranging prin-
ciple in air. Preliminary tests show the
equipment capable of recording the profile
of a simulated wave, constructed of solid
material, to within 6 percent under extreme
conditions. This error can be reduced to
less than 1 percent through a simple geo-
metric construction. Many common wave
conditions can be recorded directly within
2 or 3 percent over the entire wave. Peak
and troughs are within 1 percent under all
conditions. It is expected that tests on
a moving towing carriage will produce small

additional error due to the relative motion
of the carriage with respect to the water.

(2855) PRIEST RAPIDS EAST BANK FISH FACILITIES
MODEL.

(b) Public Utility District of Grant County,
Ephrata, Washington.
(d) Experimental; design and operation.
(e) A 1:24 scale model of Priest Rapids fish
ladder, junction pool, gravity intake
system, and attraction water supply channel
including experimental design of all dif-
fusion chambers, also a 1:48 model of the
gravity intake system. For design and
operational studies.
(f) Completed.
(g) Report in preparation.

(2857) EFFECT OF BLOCKS ON HYDRAULIC JUMP.

(b) Laboratory project.
(d) Experimental and analytical; master's
thesis.
(e) To measure force on sills and blocks in
hydraulic jump for generalized design
criteria for stilling basins.
(f) Completed.
(g) Blocks and sills of various shapes and
arrangements permit a reduction in the
downstream depth. Theory and analysis of
data provide criteria upon which to base
design.
(h) "The Hydraulic Jump in a Horizontal Flume
With Obstructions" by Torkild Carstens,
Master's Thesis, 1958, on file at the
University of Minnesota Library.

(2858) DESIGN OF WEIR FOR CONSTANT CHANNEL
VELOCITY.

(b) Laboratory project.
(d) Experimental and analytical; master's
thesis.
(e) Investigation of weir shape to provide
arbitrary approach velocities in weir
channel.
(f) Completed.
(g) Results indicate that a weir can be de-
signed for a specified constant approach
velocity throughout the range in head. The
research included designs of weir to pro-
vide specified approach velocities as a
function of head.
(h) "Weirs for Controlling Velocities in Chan-
nels With Sides Sloped Part of the Depth"
by Robert L. Gordier, Master's Thesis,
March, 1958, on file at the University of
Minnesota Library.

(2859) RESISTANCE TO FLOW THROUGH STRATIFIED
GRANULAR MEDIA.

(b) Laboratory project.
(d) Experimental; master's thesis.
(e) To measure additional loss occurring at the
interface of a stratified medium.
(f) Completed.
(g) An additional loss occurs at the interface
of two media differing in size above that

which occurs in the separate media. The additional loss is a function of the sizes of the media and upon the flow discharge.

(h) "Flow Through Permeable Media With An Interface" by Junn-Ling Chao, Master's Thesis, 1958, on file at the University of Minnesota Library.

(2860) CALIBRATION OF MEASURING WEIRS.

(b) Agricultural Research Service, U. S. Dept. of Agriculture, in cooperation with the Minnesota Agricultural Experiment Station and the St. Anthony Falls Hydraulic Lab.

(d) Experimental; determination of rating curves.

(e) A portion of the stream and the weir used to measure the flow in certain steep streams of Northern Vermont are being modeled to experimentally design and calibrate the installations.

(2923) FILLING AND EMPTYING SYSTEMS FOR WALTER F. GEORGE LOCK, CHATTAHOOCHEE RIVER.

See U. S. Army Engineer District, St. Paul, Minnesota, page 114.

(2924) MODEL STUDY OF FILLING AND EMPTYING SYSTEMS FOR BARKLEY LOCK, CUMBERLAND RIVER.

See U. S. Army Engineer District, St. Paul, Minnesota, page 115.

(3151) DERBENDI KHAN MODEL STUDIES.

(b) Harza Engineering Company, Chicago, Government of Iraq.

(d) Experimental; design and operation.

(e) A 1:100 scale model of the Derbendi Khan Project on the Diyala Sirwan River in Iraq to study and improve the operation of the flip bucket spillway and the irrigation release valves. A 1:25 scale model of 96-inch "Howell Bunger" fixed cone release valve to arrive at optimum design of the deflector hood.

(f) Completed.

(g) Ski jump deflector designed that will handle a 40 to 1 range of discharges.

(3152) KARADJ REREGULATING SPILLWAY MODEL STUDIES.

(b) Harza Engineering Company, Chicago; Government of Iran.

(d) Experimental; design and operation.

(e) A 1:60 scale model of Karadj Reregulating Dam and Spillway to study the operation of the spillway.

(3153) FLOW ABOUT BODIES AT SMALL CAVITATION NUMBERS.

(b) Office of Naval Research, Department of the Navy.

(d) Experimental and analytical; basic research.

(e) The project is currently being directed toward study of two-dimensional, supercavitating bodies. A two-dimensional free-jet tunnel is being used for experimental work.

(g) Theoretical results for lift and drag on flat-plate hydrofoils and for drag on such bodies as wedges and circular cylinders in a free-jet at cavitation numbers down to zero have been verified experimentally.

(h) "Experimental Studies of Supercavitating Flow About Simple Two-Dimensional Bodies in a Jet", by Edward Silberman, to appear in an early issue of the Journal of Fluid Mechanics.

(3154) SHIP TOWING.

(b) David Taylor Model Basin, Department of the Navy.

(d) Experimental; applied.

(e) Measure (1) pitching of ship model in regular head seas and (2) pitch damping coefficient for model towed in still water.

(f) Completed.

(g) With Froude number of 0.2 maximum pitch angle achieved with relative wave lengths (λ/L) of 1.3. With Froude number of 0.1 a peak pitch angle occurred for λ/L=1.1 after which the angle decreased and then increased to a higher peak at λ/L = 1.55; the second peak was probably due to wall interference. Declining angle tests indicated that pitch damping coefficient varied inversely with towing speed.

(3155) FLUID JETS.

(b) David Taylor Model Basin, Department of the Navy.

(d) Experimental and analytical; basic research.

(e) This project involves study of the dispersion of a jet discharged into a stream of moving fluid, the angle between the jet and fluid being a right angle or other angle and the jet and stream being of the same or different fluids. The associated loss of energy and diffusion of momentum are also of interest.

(3156) WANAPUM SPILLWAY STUDIES.

(b) Harza Engineering Company, Chicago; Public Utility District of Grant County, Ephrata, Washington.

(d) Experimental; design and operation.

(e) A 1:144 scale sectional model of spillway for Wanapum Power Project on Columbia River to arrive at optimum stilling apron design. Authorization for a 1:120 scale comprehensive model of project.

(3157) PASSAMAQUODDY INTERNATIONAL TIDAL POWER SURVEY.

(b) New England Division, Corps of Engineers.

(d) Experimental; applied.

(e) Investigate stability, shape and permeability of dams constructed in deep water with tidal currents.

(f) Complete except for report.

(g) Preliminary results indicate that rock fill dams with either relatively impermeable core or impermeable blanket can be constructed. Permeability of core type is

dependent on velocity of tidal current, depth of water, available materials and method used to deposit core materials. Both barge dump and truck dump methods are feasible for placement of main quarry-run material in blanket type dam. Except for final closure barge dumping of the main rock fill was necessary for core type dams. Water depths up to 275 feet were considered in the study.

(3158) FLOATING BREAKWATERS.

   (b) U. S. Naval Civil Engineering, Department of the Navy, Eleventh Naval District.
   (d) Experimental and analytical.
   (e) Primarily a study whose objective is to develop new ideas for floating type devices intended to attenuate ocean type incident waves.

(3159) HYDRAULIC STUDIES OF BAIE COMEAU PAPER MACHINE.

   (b) The Ontario Paper Company, Ltd., Thorold, Ontario, Canada.
   (d) Experimental; for design.
   (e) To study flow patterns resulting from combination cascaded miter bends and vaned dividers.

(3160) MISSION DAM SPILLWAY MODEL STUDIES.

   (b) British Columbia Engineering Company, Vancouver, B. C., Canada.
   (d) Experimental; design and operation.
   (e) A 1:80 scale comprehensive model of the flip bucket spillway for the Mission Dam on the Bridge River in British Columbia to study the operation of the spillway.

(3161) HYDRAULICS OF SEWER DROPSHAFTS.

   (b) City of St. Paul, Minnesota.
   (d) Experimental; applied.
   (e) Investigate relative merits of sewer drop structures for discharges up to 1000 cfs and drops up to about 100 feet.

(3162) PITOT TUBE TESTS.

   (b) U. S. Army Engineer District, Louisville.
   (d) Experimental; applied.
   (e) Calibration tests have been made on four large Pitot tubes in a towing channel at speeds ranging from 2 to 15 feet per second.
   (f) Completed.
   (g) Information was obtained on the coefficient, effect of supporting-strut geometry, and effect of nose shape. Data yielded high values of and excessive variation in the Pitot tube coefficients, apparently due to the short spacing between static holes and both the blunt support strut and conical nose. Fairing of leading edge of strut resulted in considerable improvement.

(3163) SEDIMENT ANALYSIS BY ULTRASONICS.

   (b) U. S. Department of the Interior,

Geological Survey; laboratory project.
   (d) Experimental and analytical; Ph.D. thesis.
   (e) The eventual purpose of this project is the development of a field instrument capable of measuring sediment concentration, mean size, and size distribution. The thesis investigation was confined to the laboratory phase of this work.
   (f) Completed.
   (g) A laboratory method for determining concentration, mean size, and size distribution of an unknown sediment sample was developed for use with particle diameters above about 50 microns. The method is based on the assumption that attenuation of a sound wave is a linear function of concentration and, for the particular experiments used in the thesis, that the particle diameters are distributed in accordance with the log-normal law. The method involves measuring the attenuation in a given sample at two or more frequencies in the range from 2.5 to 25 megacycles. From the measured attenuations, the desired properties of the sediment can be found through a process of curve fitting. The method is very rough at present and needs to be extended to smaller particles.
   (h) "The Use of Ultrasonics in the Measurement of Suspended Sediment Size Distribution and Concentration", by Gordon H. Flammer, Ph.D. Thesis, August 1958, on file at the Univ. of Minnesota Library.

(3164) SCOUR AROUND BRIDGE PIERS.

   (b) Laboratory project.
   (d) Experimental and analytical; Ph.D. thesis.
   (e) Prediction and measurement of ultimate depths of scour around known shape and size of pier.
   (f) Experiments just started.

(3165) CHARACTERISTICS OF TURBULENT FLOW THROUGH A RECTANGULAR-BAR BAFFLE.

   (b) Laboratory project.
   (d) Experimental and analytical; master's thesis.
   (e) To determine the head loss in a bar baffle as governed by the clear spacing, bar width, and bar depth.
   (f) Experimental study in progress.

INTER-AGENCY SEDIMENTATION PROJECT IN COOPERATION WITH ST. ANTHONY FALLS HYDRAULIC LABORATORY.

   (194) A STUDY OF METHODS USED IN THE MEASUREMENT AND ANALYSIS OF SEDIMENT LOADS IN STREAMS.

   (b) Subcommittee on Sedimentation, Inter-Agency Committee on Water Resources. Personnel of the Corps of Engineers and U. S. Geological Survey are actively engaged on the project.
   (d) Experimental; applied research and development.
   (e) Plans and specifications to facilitate the manufacture of suspended sediment and bed material samplers, particle-size analyzers and associated laboratory apparatus have been prepared. Approved designs available

include a hand-operated sediment sampler weighing 4 pounds, a medium-weight sediment sampler (62 pounds), heavy sediment samplers (100 and 300 pounds), a sediment sample splitter, a bottom withdrawal tube, a hand-operated bed material sampler, a heavy bed material sampler (100 pounds), and a particle-size analyzing apparatus using visual-accumulation sedimentation tubes for sand samples.

(g) Tests are in progress on an automatic single-stage suspended sediment sampler for flashy and intermittent streams. Prototype tests on an intermittent pumping and settling-type sampler were started at a field testing station. Tests are progressing on experimental apparatus developed for determining suspended sediment concentration and particle-size distribution by means of pressure differential and acoustical devices.

(h) "Some Fundamentals of Particle Size Analysis", Report No. 12, 55 pages, 1957.

UNIVERSITY OF SOUTH CAROLINA, Civil Engineering Department.

Inquiries concerning the following projects should be addressed to Dr. Harold Flinsch, Civil Engineering Dept., University of South Carolina, 745 Sumter St., Columbia, South Carolina.

(4) THE DEVELOPMENT OF SURFACE WAVES BY WIND.

(b) Laboratory project.
(d) General theoretical and experimental research.
(e) Research on the theories of surface wave origin and growth, on measurements in the laboratory and in nature, and on the comparative results of theory and measurement. Experimental equipment has been developed particularly for the recording of wave height and period, and is being developed for the recording of wave direction.
(g) A device for telemetering wave direction records has been completed.

(1631) THE EFFECT OF WAVES ON BEACHES.

(b) Laboratory project.
(d) General theoretical and experimental research.
(e) Research on beach slopes and contours, in the laboratory and in nature.
A new wave tank for 8 directions is under construction.
(g) General formulas have been developed, which are now being applied to the Carolina capes and shores.

(1907) SHIP STABILITY AND ROLLING PERIOD.

(b) Laboratory project.
(d) General theoretical and experimental research.
(e) Rolling period and metacentric height relationships are studied, in the

laboratory and in nature, for stationary and moving ships, in still water and under wave action.
(g) Model experiments have been assembled in a brief report. Additional data under wave action are being assembled.

STANFORD UNIVERSITY, Department of Civil Engineering.

Inquiries concerning Projects Nos. 1944, 1945, and 1946, should be addressed to Prof. Ray K. Linsley; Projects Nos. 2150, 2151, and 2614 to Prof. John K. Vennard; and 2863, 2864, and 3166 to Prof. Byrne Perry, Stanford University, Department of Civil Engineering, Stanford, California.

(1944) STUDY OF METHODS OF ESTIMATING RESERVOIR EVAPORATIONS.

(b) U. S. Weather Bureau.
(d) Field investigation; applied research; Engineer Thesis.
(e) A small-scale radiation integrator patterned after Cumming's model is being designed and tested.
(g) Previous field work at campus reservoir is complete. Analysis of data underway. Tentative analysis of reservoir study indicates no significant difference from conclusions of Lake Hefner study.

(1945) ESTIMATING RAINFALL INTENSITY FROM TOPOGRAPHIC PARAMETERS.

(b) U. S. Bureau of Public Roads.
(d) Statistical analysis; applied research.
(e) Hourly rainfall intensities in Northern California for a two-year period are correlated with various topographic and climatological parameters.
(f) Completed.
(g) A relation having a correlation coefficient of 0.88 and standard error of 0.77 inch per hour was derived. A rainfall intensity map for Northern California was completed.

(1946) SYNTHESIS OF HYDROGRAPHS FOR SMALL AREAS.

(b) National Science Foundation.
(d) Theoretical and field investigation; basic and applied research; Ph.D. Thesis.
(e) An attempt to develop a universal method for estimating the runoff hydrographs from small areas.
(g) A simplified theory for non-equilibrium conditions has been compared with experimental results taken under controlled laboratory conditions. A statistical analysis of data from several typical basins has been started. A more comprehensive analysis for non-equilibrium flow with lateral inflow is underway.

(2150) STUDY OF FLOW FROM A SLOTTED PIPE.

(b) Laboratory project.
(d) Experimental; Engineer Thesis.

(e) Extension of manifold port problem to continuous slot.
(g) Experimental work completed; thesis being written.

(2151) MODEL STUDY OF PETERS DAM CHUTE SPILLWAY.

(b) Laboratory project.
(d) Experimental; engineer thesis.
(e) Comparison of spillway performance and design predictions.
(g) Experimental work completed; thesis being written.

(2614) PIPE FRICTION IN UNSTEADY FLOW.

(b) Laboratory project.
(d) Experimental and analytical; Ph.D. degree.
(e) Comparison of friction processes for steady and unsteady states.
(g) Experimental work completed; thesis being written.

(2863) FLOW THROUGH POROUS MEDIA.

(b) National Science Foundation.
(d) Theoretical and experimental; basic research.
(e) An attempt is being made to develop more general analytical methods than are now available for non-steady seepage flow with a free surface, e.g., the seepage through an earth dam.
(g) Theoretical work now in progress.

(2864) GRAVITY EFFECT ON POTENTIAL FLOW WITH A FREE SURFACE.

(b) Laboratory project and Office of Naval Research.
(d) Theoretical; basic research.
(e) Extension of two-dimensional potential flow analysis to include the effect of gravity in the free surface boundary condition.
(f) Analysis complete.
(h) "Methods for Calculating the Effect of Gravity on Two-Dimensional Free Surface Flows", B. Perry, Ph.D. Dissertation 1957.

(3166) HYDRODYNAMICS OF FLOW INTO CURB INLETS.

(b) U. S. Bureau of Public Roads.
(d) Experimental and analytical; Ph.D. thesis.
(e) Attempt to develop analytical methods for predicting phenomena observed.
(f) Experimental program started.

STEVENS INSTITUTE OF TECHNOLOGY, Experimental Towing Tank.

(340) HYDROFOILS AND HYDROSKIS.

(b) Office of Naval Research, Department of the Navy.
(c) Mr. Daniel Savitsky, Experimental Towing Tank, Stevens Institute of Technology, 711 Hudson Street, Hoboken, N. J.

(d) Theoretical and experimental; basic research.
(e) A continuous series of theoretical and experimental studies of the basic hydrodynamic processes involved in the planing action of seaplane hulls and seaplane alighting gear such as hydroskis and hydrofoils. In particular, the pressure distribution, wake main spray formation, steady and unsteady state loads and dynamic stability are being studied.
(g) Basic studies have been completed on the pressures, wake, loads, and main spray associated with simple prismatic planing surfaces and hydroskis. Studies are currently underway on the steady and unsteady forces on surface piercing supercavitating hydrofoils, and on the longitudinal dynamic stability of hydrofoil systems suitable for water-based aircraft.
(h) Seventeen papers on the results of research conducted under the subject contract have been prepared and published. The titles of the two most recent publications are: "On the Main Spray Generated by Planing Surfaces", by Daniel Savitsky and John P. Breslin, Experimental Towing Tank, Stevens Institute of Tech. Report No. 678, Jan. 1958. "The Force Characteristics of Surface Piercing, Super Cavitated, Dihedral Hydrofoils", by Peter Ward Brown, Experimental Towing Tank, Stevens Institute of Technology Report No. 698, November 1958.

(2153) EVALUATION BY COMPUTATIONAL METHOD OF THE THRUST DEDUCTION AND WAKE FRACTION OF A SHIP PROPELLER.

(b) David Taylor Model Basin, Bureau of Ships, Department of the Navy.
(c) Dr. Stavros Tsakonas, Experimental Towing Tank, Stevens Institute of Technology, 711 Hudson Street, Hoboken, N. J.
(d) Theoretical; applied research.
(e) The purpose of this investigation is to develop a working computational method on a sound physical basis for the evaluation of the wake fraction and thrust deduction of a ship propeller. This work, which is carried out on a "Victory" ship is restricted to the potential flow case, where the wavemaking effects as well as the viscous effect are omitted. By representing the hull by a discrete sink-source distribution and using the inflow propeller velocities based on a doublet representation of the propeller with cylindrical vortex sheets, a general expression for the evaluation of the strength of the hull singularity is developed. Furthermore under the assumption of a sink disc distribution for the propeller, expressions for the thrust deduction and wake fraction are developed in closed form. Numerical work was carried out on a Victory ship.
(f) Suspended since the results of the strength of singularity obtained by the solution of a system of 51 (or 31 or 25) linear algebraic equations do not actually represent the afterbody of the hull.
(g) General expressions for the evaluation of

the strength of the singularity system representing the hull are developed taking into account the inflow propeller velocities (for circumferentially uniform and non-uniform thrust distribution), the presence of the free surface and forward velocity. These expressions give the essential material for the evaluation of thrust deduction and wake fraction which have been expressed in closed form results as functions of complete elliptic integrals.

(h) "Analytical Expressions for Thrust Deduction and Wake Fraction for Potential Flows", by Stavros Tsakonas, Experimental Towing Tank Report No. 717, Dec. 1957, Journal of Ship Research, Vol. 2, No. 1, June 1958.

(2154) INVESTIGATION OF SHIP MOTIONS.

(b) Office of Naval Research, Dept. of the Navy.
(c) Prof. B. V. Korvin-Kroukovsky, Experimental Towing Tank, Stevens Institute of Tech., 711 Hudson Street, Hoboken, N. J.
(d) Theoretical and experimental; basic research.
(e) The development of a method of calculation for predicting ship motions caused by head or following seas. Towing tank tests of ship forms differing widely from the forms currently used in practice, in search of considerable improvement in seakeeping qualities of ships.
(g) The linearized theory of ship motions in head or following seas was completed and computations were made for eight ship models for comparison with experimental results. These results were reported in a paper by B. V. Korvin-Kroukovsky and Winnifred R. Jacobs at the Nov. 1957 meeting of the Society of Naval Architects and Marine Engineers. The work is being organized for the continuation of this project with the objectives of investigating non-linear effects on ship motions and also to investigate the motions with six degrees of freedom in oblique seas.

(2155) SEAKEEPING QUALITIES OF SHIPS AT ALL HEADINGS TO WAVES.

(b) Bureau of Ships, Department of the Navy (DTMB Technical Supervision).
(c) Mr. Edward V. Lewis, Experimental Towing Tank, Stevens Institute of Technology, 711 Hudson Street, Hoboken, N. J.
(d) Theoretical and experimental; basic research.
(e) To investigate the coupled responses of ship models at all headings to waves in order to assist in the prediction of seakeeping qualities and to evaluate means of reducing or controlling ship motions so as to increase sea speeds. Two self-propelled and rudder-controlled ship models of the same proportions but different forebody form are being tested at various headings to regular long-crested waves. Coupled motion responses are being measured and parallel analytic studies are being made of equations of motion for ships with six

degrees of freedom.
(g) A new apparatus for measuring model motions at oblique headings to waves has been tested and has performed satisfactorily. The six motions of a model in regular waves are obtained over a range of speeds.
(h) "New Facilities at Stevens for Research on Seakeeping Qualities of Ships", E. Numata, P. G. Spens and A. L. Miley, International Shipbuilding Progress, September 1958.

(2156) MOTION AND STABILITY OF HYDROFOIL SYSTEMS.

(b) David Taylor Model Basin, Bureau of Ships, Department of the Navy.
(c) Dr. Paul Kaplan, Experimental Towing Tank, Stevens Institute of Technology, 711 Hudson Street, Hoboken, N. J.
(d) Theoretical; basic research.
(e) To determine the longitudinal stability characteristics of tandem hydrofoil configurations in waves, including the effects of unsteady forces and moments. The resulting motions of the system and the loadings on the foils can then be determined.
(g) A theoretical analysis of motion in smooth water has been completed. An analysis of the forces and moments in waves has been completed and tests have been made, the results of which compare well with the theory. The results have been incorporated into a study of motions in waves, which has been completed. A study has also been made of the drag of hydrofoils in unsteady motion, together with a study of the surface waves created by oscillating and translating surface pressure distributions. Further studies of motion in waves using unsteady flow theory have been carried out.
(h) "The Drag of Hydrofoils in Unsteady Motion", by Paul Kaplan, Experimental Towing Tank Report No. 617, June 1958, submitted to the Journal of Ship Research.

(2387) BENDING MOMENTS OF SHIPS IN WAVES.

(b) Society of Naval Architects and Marine Engineers.
(c) Mr. Edward V. Lewis, Experimental Towing Tank, Stevens Institute of Technology, 711 Hudson Street, Hoboken, N. J.
(d) Experimental and analytical; applied research.
(e) Calculation of bending moments in waves, taking into account dynamic effects of ship motions and forward speed, for comparison with experimentally determined bending moments. Prediction of bending moments in irregular waves and comparison with irregular tank wave results. Extension to measurements of model bending moments at a range of headings to long-crested regular waves.
(g) Fairly good agreement has been obtained between calculated and observed bending moments in head seas, giving theoretical confirmation of reduction of moments under dynamic conditions of forward speed and pitching and heaving motions. Tests at

oblique headings to waves have shown that
horizontal bending moment can become large
in relations to vertical bending moment
while torsional moments are relatively
small.

   (h) "The Analytical Calculation of Ship Bending
        Moments in Regular Waves", Winnifred R.
        Jacobs, Journal of Ship Research, June 1958.
        A report on bending moment tests at oblique
        headings to waves is in preparation.

(2389) PERFORMANCE AND DYNAMIC CHARACTERISTICS OF
        HYDROFOIL CRAFT.

   (b) Office of Naval Research, Dept. of the Navy.
   (c) Dr. Paul Kaplan, Experimental Towing Tank,
        Stevens Institute of Technology, 711 Hudson
        Street, Hoboken, N. J.
   (d) Theoretical; applied research.
   (e) To investigate the scaling of performance
        of hydrofoil craft of different sizes in
        different seas and to develop a general
        method for the evaluation of the stability
        of various hydrofoil configurations while
        in the preliminary design state.
   (g) Three different scaling methods have been
        applied to representative craft, and a
        measure of their performance in different
        seas has been obtained. Motion spectra in
        different irregular seas were determined
        for each scaling and probabilities of
        broaching determined. Derivation of the
        equations of longitudinal and lateral dy-
        namic stability has been accomplished for
        tandem systems employing either flat foils
        or dihedral surface-piercing foils.
   (h) "Methods for Estimating the Longitudinal
        and Lateral Dynamic Stability of Hydrofoil
        Craft", by P. Kaplan, P. N. Hu, and S.
        Tsakonas, Experimental Towing Tank Report
        No. 691, May 1958.

(2390) CONTROLLED FINS FOR REDUCING SHIP PITCHING.

   (b) Bureau of Ships, Dept. of the Navy (DTMB
        Technical Supervision).
   (c) Mr. Edward V. Lewis, Experimental Towing
        Tank, Stevens Institute of Technology, 711
        Hudson Street, Hoboken, N. J.
   (d) Experimental and analytical; applied re-
        search.
   (e) To determine the most desirable action of
        controllable fins at the bow or stern of
        a ship to reduce pitching in regular and
        irregular head seas.
   (g) Analytical studies indicate that a combina-
        tion of fixed fins at the bow and oscillat-
        ing fins at the stern seems most promising
        in reducing ship pitching motions; model
        experiments have verified these findings.
   (h) "Pitch Reduction by Oscillating Stern Fins",
        P. G. Spens, Ship Behavior at Sea, Second
        Summer Seminar, Experimental Towing Tank
        Report No. 708.
        Final report in preparation.

(2391) THEORETICAL STUDY OF THE HYDRODYNAMIC PRES-
        SURE FIELD NEAR A ROTATING PROPELLER BLADE
        AND FORCES APPLIED TO CERTAIN SIMPLE, NEAR-
        BY BOUNDARIES.

   (b) David Taylor Model Basin, Bureau of Ships,
        Department of the Navy.
   (c) Dr. John P. Breslin, Technical Director,
        Experimental Towing Tank, Stevens Institute
        of Technology, 711 Hudson St., Hoboken, N.J.
   (d) Theoretical; applied research.
   (e) Theoretical studies of the hydrodynamic
        field about propeller-like singularities
        have been undertaken because of the in-
        creasing concern of naval architects with
        propeller-excited ship vibration, parallel
        to the axis.
   (f) Project continuing.
   (g) Studies utilizing doublet distributions to
        represent the thrust and torque loading
        have been completed and through the efforts
        of Dr. S. Tsakonas of the ETT Staff the
        results are expressed in terms of tabulated
        elliptic integrals. The effect of blade
        thickness has been recently included and is
        found to be essential in explaining the
        character and magnitude of experimental
        results obtained with a ship model pro-
        peller.
        Calculations of the vibratory forces and
        moments on a doubly infinite flat-plate
        parallel to the axis of a propeller have
        been completed. These show that for a
        propeller having three blades or more, the
        force and moment on the plate are zero. A
        thin elastic plate will, nevertheless, vi-
        brate and a formula to calculate the
        amplitudes is given.
   (h) "A Theory for the Vibratory Effects Pro-
        duced by a Propeller on a Large Plate",
        ETT Preliminary Report 689.
        A final paper on the free-space pressure
        field is in preparation. See also Pro-
        ceedings of Third U. S. National Congress
        of Applied Mechanics, June 1958.

(2393) MOTIONS AND BENDING MOMENTS OF SHIPS IN
        WAVES.

   (b) Bureau of Ships, Department of the Navy
        (DTMB Technical Supervision).
   (c) Mr. Edward V. Lewis, Experimental Towing
        Tank, Stevens Institute of Technology, 711
        Hudson Street, Hoboken, N. J.
   (d) Experimental and analytical; applied re-
        search.
   (e) Measurements of motions and external bend-
        ing moments and shear of a jointed model
        of a high-speed naval vessel underway in
        irregular head waves in a towing tank.
        Results will be analyzed by cross-spectral
        techniques to determine frequency response
        functions.
   (g) Pilot studies indicate that when cross-
        spectral techniques are applied to the
        analysis of moderate irregular wave data,
        the resulting frequency response functions
        show good agreement with response functions
        obtained from regular wave tests.
   (h) "Ship Model Tests in Irregular Waves with
        a Broad Spectrum", J. F. Dalzell, Experi-
        mental Towing Tank Note No. 471, April 1958.
        "The Analysis of Model Test Results in
        Irregular Head Seas to Determine the Ampli-
        tude and Phase Relations to the Waves", by

J. F. Dalzell and Y. Yamanouchi, Second
Summer Seminar on Ship Behavior at Sea,
Experimental Towing Tank Report No. 708.

(2615) FORCES AND MOMENTS ON SUBMERGED BODIES
BELOW WAVES.

(b) David Taylor Model Basin, Bureau of Ships,
Department of the Navy.
(c) Dr. Paul Kaplan, Experimental Towing Tank,
Stevens Institute of Technology, 711 Hudson
Street, Hoboken, N. J.
(d) Experimental and theoretical; basic and
applied research.
(e) To measure the forces and moments acting on
submerged bodies moving obliquely to the
crests of regular waves, and to compare the
results with available theory.
(g) Slender-body theory has been applied to
determine the forces and moments acting on
a submerged body and also on a surface ship
moving normal to the crests of regular
waves. Additional work has been carried
out for a submerged body moving obliquely
with respect to the waves, and the results
check with those obtained by more refined
theories. The forces have also been found
on body-appendage combinations by applica-
tion of the same theory. Further theoreti-
cal studies of forces and moments on other
configurations are continuing. The model
and balance system to be used in the experi-
mental study have been prepared. Dynamic
calibrations are being carried out in prep-
aration for the tests in the new three-
dimensional wave facility.
(h) "Application of Slender Body Theory to
Forces Acting on Submerged Bodies and Sur-
face Ships in Regular Waves", by Paul
Kaplan, Journal of Ship Research, Vol. 1,
No. 3, November 1957.
"The Forces Acting on Slender Submerged
Bodies and Body-Appendage Combinations in
Oblique Waves", by Paul Kaplan and Pung
Nien Hu, to be published in Proceedings of
the Third U. S. National Congress of
Applied Mechanics, 1958.

(2616) THEORETICAL STUDY OF THE TRANSIENT FORCES
PRODUCED BY A SHIP PROPELLER.

(b) David Taylor Model Basin, Bureau of Ships,
Department of the Navy.
(c) Dr. John P. Breslin, Technical Director,
Experimental Towing Tank,, Stevens Inst.
of Tech., 711 Hudson St., Hoboken, N. J.
(d) Theoretical; applied research.
(e) Theoretical study of the forces produced
by a rotating propeller as represented by
rotating bound vortices in the neighborhood
of bodies representable by doublet distri-
butions and source-sink distributions;
analysis limited to first order effects.
(g) Formulas for the transverse vibratory force
generated by an m-bladed propeller (offset
from a body of revolution) have been found.
Numerical evaluations have been made;
report in preparation.

(2617) THEORETICAL STUDY OF THE VIBRATORY THRUST

PRODUCED BY A SHIP PROPELLER OPERATING IN
THE WAKE OF A HULL.

(b) David Taylor Model Basin, Bureau of Ships,
Department of the Navy.
(c) Dr. John P. Breslin, Technical Director,
Experimental Towing Tank, Stevens Inst. of
Technology, 711 Hudson St., Hoboken, N. J.
(d) Theoretical; applied research.
(e) Existing methods for computing the axial,
vibratory thrust produced by a ship pro-
peller operating in a circumferentially
variable wake, assume that the forces on
the blade elements are developed instan-
taneously, i.e., only quasi-steady forces
are considered. This study attempts to
determine the influence of unsteady effects
on the accuracy of the predictions of ex-
isting methods.
(f) Completed.
(g) "A Theory for the Quasi-Steady and Unsteady
Thrust and Torque of a Propeller in a Ship
Wake", by Paul D. Ritger and John P. Breslin,
Report No. 686, July 1958.

(2865) EFFECT OF SPEED AND FULLNESS ON HULL BEND-
ING MOMENTS IN WAVES.

(b) American Bureau of Shipping.
(c) Mr. Edward V. Lewis, Experimental Towing
Tank, Stevens Institute of Technology, 711
Hudson Street, Hoboken, N. J.
(d) Experimental; applied research.
(e) To determine to what extent, if any, dif-
ferent longitudinal strength standards
should be adopted for ships of different
fullness and service speeds. The hull mid-
ship bending moments of three models with
block coefficients ranging from 0.68 and
0.80 were measured in regular and irregular
head and following seas.
(g) Experimental results show that dynamic mid-
ship hull bending moments in regular model
length waves vary with fullness at low
speeds according to the trend predicted by
standard static calculations.
(h) Report in preparation.

(2866) AN ANALYTIC STUDY OF THE PRESSURE FIELD
NEAR COUNTER-ROTATING PROPELLERS.

(b) David Taylor Model Basin, Bureau of Ships,
Department of the Navy.
(c) Dr. John P. Breslin, Technical Director,
Experimental Towing Tank, Stevens Inst. of
Technology, 711 Hudson St., Hoboken, N. J.
(d) Theoretical; applied research.
(e) In regard to the problem of mitigating the
vibratory hydrodynamic forces applied by
a ship propeller, the free-space field of
a counter-rotating propeller has been
studied. The study is divided into two
parts: (1) The effects from each propeller
are summed as though they were independent;
and (2) an approximate treatment of the
effect of blade interaction is attempted.
(h) Report in preparation.

(3167) THRUST DEDUCTION IN VISCOUS FLOW FOR A
BODY OF REVOLUTION.

(b) David Taylor Model Basin, Bureau of Ships, Department of the Navy.

(c) Dr. Stavros Tsakonas, Experimental Towing Tank, Stevens Institute of Technology, 711 Hudson Street, Hoboken, N. J.

(d) Theoretical applied research.

(e) Approximate methods for the rapid evaluation of the viscous component of the thrust deduction for a body of revolution. The viscosity will be taken into account by modifying the shape of the body by the corresponding displacement thickness.

(3168) STUDY OF THREE-DIMENSIONAL SHIP DAMPING.

(b) Society of Naval Architects and Marine Engineers.

(c) Dr. Paul Kaplan, Experimental Towing Tank, Stevens Institute of Technology, 711 Hudson Street, Hoboken, N. J.

(d) Theoretical; basic research.

(e) To evaluate the damping force acting on a local strip of an oscillating ship, including all the three-dimensional flow contributions. The effect of forward speed on the total damping will also be determined.

(g) Study has shown that local force and moment on a submerged oscillating spheroid differ appreciably from that found using two-dimensional flow values, depending upon frequency and location of local observation point. Work is continuing to find information for the Michell (thin) ship, and curves of two-dimensional damping values were prepared. Since all of the above is for zero speed of advance, the investigation of speed effects is being pursued.

(h) "Progress Report on Research: Three-Dimensional Strip Damping of Ships", by Paul Kaplan, Experimental Towing Tank Note No. 498, October 1958.

(3169) WAKE FORMS BEHIND HIGH SPEED PLANING SURFACES.

(b) Bureau of Aeronautics, Department of the Navy.

(c) Mr. Robert L. Van Dyck, Experimental Towing Tank, Stevens Institute of Technology, 711 Hudson Street, Hoboken, N. J.

(d) Experimental; basic research.

(e) An experimental study is being conducted in order to determine the surface contours of the wake shapes developed by planing forms associated with high-speed water-based aircraft. This work was undertaken because of the lack of accurate information concerning the wakes of planing forms operated at high speeds, high angles of attack, and heavy loadings. The effect of vee-bottom angle, chine flare, and step shape will be evaluated in addition to the above-mentioned parameters.

(g) The first tests are currently underway. Small, longitudinally-curved models of two-inch beam are being towed at a thirty-foot radius on a large rotating-arm apparatus. Measurements of the wake cross-sections are made with vertical probes which are manually adjusted by an observer riding

with the model.

(3170) EXPERIMENTAL STUDY OF THE INCEPTION OF VENTILATION ON SURFACE PIERCING BODIES.

(b) National Advisory Committee for Aeronautics Washington, D. C.

(c) Dr. John P. Breslin, Technical Director, Experimental Towing Tank, Stevens Inst. of Tech., 711 Hudson St., Hoboken, N. J.

(d) Experimental research.

(e) Interest in the phenomena of ventilation of the flow on the "suction" side of surface-piercing bodies has stemmed from the fairly recent interest in the behavior of seaplane alighting gear and the strut and foils on hydrofoil boats. Tests on two different surface piercing struts have been conducted to determine the way in which ventilation starts and to obtain force measurements in both the ventilated and non-ventilated condition.

(f) Completed. Report submitted for approval.

(g) Identification of modes of inception for ventilation has been made and conditions for both inception and closure determined for two strut models. Analysis of side loads on ventilated model shows applicability of fully cavitating theory to the prediction of the behavior of this force and Froude number.

(h) "An Exploratory Study of Ventilated Flows About Yawed Surface-Piercing Struts", by J. P. Breslin and R. Skalak, Report No. 668, Oct. 1957. (NASA Memorandum of same title will appear early in 1959).

(3171) THEORETICAL STUDIES OF THRUST DEDUCTION OF A PROPELLER WORKING BEHIND A THIN SHIP.

(b) David Taylor Model Basin, Bureau of Ships, Department of the Navy.

(c) Dr. Stavros Tsakonas, Experimental Towing Tank, Stevens Institute of Technology, 711 Hudson Street, Hoboken, N. J.

(d) Theoretical; applied research.

(e) It is intended to study analytically the importance of the parameters involved in the thrust deduction problem. Functional relationships of thrust deduction with the axial clearance and vertical position of the propeller will be developed for various thin ship configurations and compared to each other.

(f) Project is in the process of development.

(g) Mathematical procedures have been developed for the thrust deduction force in the case of a thin ship having a longitudinal wedge shape with a flat plate bottom, as well as with a wedge cross-section when the propeller is situated at the maximum submergence of the stern.

(3172) LIFT ON A SLENDER BODY OF REVOLUTION.

(b) David Taylor Model Basin, Bureau of Ships, Department of the Navy.

(c) Dr. Paul Kaplan, Experimental Towing Tank, Stevens Institute of Technology, 711 Hudson Street, Hoboken, N. J.

(d) Theoretical; basic research.

(e) Analytical study of the lift force acting on a slender body of revolution at an angle of attack, assuming the flow about any cross section on the after portion of the body contains a vortex separation region. Methods of slender-body theory and integral equations used to determine the force and the variation of the force with the body form parameters.

(3173) HYDROELASTIC INSTABILITIES OF SUPERCAVI-TATING HYDROFOILS.

(b) David Taylor Model Basin, Bureau of Ships, Department of the Navy.

(c) Dr. Paul Kaplan, Experimental Towing Tank, Stevens Institute of Technology, 711 Hudson Street, Hoboken, N. J.

(d) Theoretical; basic research.

(e) Theoretical analysis of the conditions for the occurrence of hydroelastic instabili-ties (i.e. divergence and flutter) of supercavitating hydrofoils (two-dimensional case) as functions of angle of attack, cavitation number, elastic axis location, elastic spring constant, and other perti-nent physical characteristics.

(3174) SUPERCAVITATING HYDROFOILS WITH GENERALIZED OSCILLATORY MOTIONS.

(b) Office of Naval Research, Department of the Navy.

(c) Dr. Paul Kaplan, Experimental Towing Tank, Stevens Institute of Technology, 711 Hudson Street, Hoboken, N. J.

(d) Theoretical; basic research.

(e) Analytical studies of the forces acting on supercavitating hydrofoils with any type of oscillatory motion. Techniques of mapping are to be used, in the two-dimen-sional case, and consideration will be given to the infinite cavity case and also to the finite cavity case, taking account of cavity volume changes.

(3175) STUDY OF VIRTUAL MASS FOR VERTICAL SHIP VIBRATION.

(b) David Taylor Model Basin (Structural Mechanics), Bureau of Ships, Department of the Navy.

(c) Dr. Paul Kaplan, Experimental Towing Tank, Stevens Institute of Technology, 711 Hudson Street, Hoboken, N. J.

(d) Review of theory and experiment.

(e) Reviews of the basic literature, both theory and experiment, related to the virtual mass associated with vertical ship vibration. Object is to indicate valid formulas for determining virtual mass from available data, and if this is insufficient or inaccurate, to recommend appropriate test program for proper determination.

(g) Extensive literature survey carried out and results discussed in draft of report. Effects of gravity waves, viscosity, sur-face tension and compressibility were con-sidered. Results of study show theory

overestimates experimental virtual mass, thereby leading to probable source of errors in comparison of computed and ex-perimental natural frequencies for low modes.

(3176) THEORY OF LATERAL MOTIONS OF SHIPS IN WAVES.

(b) David Taylor Model Basin, Bureau of Ships, Department of the Navy.

(c) Dr. Paul Kaplan, Experimental Towing Tank, Stevens Institute of Technology, 711 Hudson Street, Hoboken, N. J.

(d) Theoretical; basic research.

(e) Analytical study of the lateral motions of surface ships with three degrees of free-dom in oblique waves. This will include the evaluation of the virtual mass, damp-ing, and dynamic coupling for a surface ship in oscillatory motion, as well as the hydrodynamic excitation forces and moments due to the oblique waves. The free surface influence on the hydrodynamic forces will be included in the above.

(3177) STUDY OF THE HYDRODYNAMIC STATIC AND DYNAMIC FORCE AND MOMENT RATE COEFFICIENTS FOR SURFACE SHIPS.

(b) David Taylor Model Basin, Bureau of Ships, Department of the Navy.

(c) Dr. Stavros Tsakonas, Experimental Towing Tank, Stevens Institute of Technology, 711 Hudson Street, Hoboken, N. J

(d) Experimental; basic research.

(e) To determine the hydrodynamic character-istics which are essential in the course stability of surface ships. This problem leads first to the investigation of whether or not the rotating arm facilities are re-liable sources for the determination of the dynamic as well as the static hydro-dynamic characteristics. Secondly, to study the hydrodynamic behavior of a flat plate having a profile area and geometry of that of the surface ship and compare results with that of the corresponding configuration of the surface vessels. Finally, to correlate experimental results with that of the existing theories on low aspect ratio thin airfoils.

(f) Project is almost at the stage of comple-tion, pending the question of the inter-ference effect of hull and skeg configura-tion. Shortly, a preliminary report will be sent to the David Taylor Model Basin.

(g) The comparison of the results obtained by interpolation of the rotating arm with that obtained by a straight course experi-ment shows excellent agreement in all five cases of surface ships as well as the corresponding flat plate configurations. It can be decisively concluded that the straight course motion can be considered as intermediate between a large turn to the right and large turn to the left. Therefore, the hydrodynamic static and dy-namic coefficients can be obtained by the rotating arm facilities as well. The hy-drodynamic behavior of the flat plate

73

compared with that of the surface ship con-
figuration shows interesting similarity.
In particular, the yawing moment results
show good agreement in the general trend
and in magnitude, whereas the lateral force
shows some general trend but an increase
in magnitude. This increase in magnitude
can be explained in the light of the
boundary layer separation at the leading
edge of a thin and slowly moving plate.
The comparison of the obtained results
with that of the low aspect ratio wing
theories reveals the existing analogy of a
surface ship to a low-aspect ratio wing,
with the load-waterline length as chord
and twice the draft as the span.

(h) Preliminary report will be submitted short-
ly to David Taylor Model Basin.

TEXAS A AND M COLLEGE, Department of Oceanography
and Meteorology.

(2868) INVESTIGATION OF STORM SURGES ALONG THE
SOUTH SHORE OF NEW ENGLAND.

(b) Beach Erosion Board, Corps of Engineers,
U. S. Army, Contract DA-49-055-civ-eng-56-4.
(c) Professor Robert O. Reid, Project Super-
visor.
(d) Numerical analysis; applied research.
(e) Numerical and graphical procedures are
utilized in the evaluation of storm surge
behavior in schematic (mathematical) models
of Narragansett Bay, Long Island Sound and
Buzzards Bay, particular attention being
devoted to Narragansett Bay. The numerical
work is being carried out using an IBM 650
computer. Numerical studies of astronomi-
cal tides in Narragansett Bay are also
being carried out.
(g) A numerical procedure for computation of
water level changes in coastal bays and
estuaries has been utilized for estimating
the potential storm surges in Narragansett
Bay, Long Island Sound, and Buzzards Bay
for a selected design hurricane. The nu-
merical calculations are based upon the
quasi-linear, one-dimensional equations of
motion and continuity. In the numerical
evaluation of storm surge generation over
the continental shelf, the equations are
modified so as to allow for long shore
dispersion of energy in an approximate
manner. The calculations for the modifica-
tion of the surge as it enters the bay
include the provision for energy loss by
bottom friction and energy gain by wind
stress over the bay. In the calculations
for Narragansett Bay, the latter is regard-
ed as a network of interconnecting channels,
each of which are considered to be of uni-
form width and depth. The method of calcu-
lation has been "calibrated" by using the
known data for the September 21, 1938,
hurricane as a control. The calibration
involves the selection of appropriate fric-
tion, reflection, and refraction conditions
for the system, which will allow the best

fit of the numerical results with the con-
trol data.

(h) Final report in preparation.

(2869) INVESTIGATION OF PROBLEMS ASSOCIATED WITH
PREDICTION OF STORM-INDUCED WATER LEVELS.

(b) U. S. Weather Bureau, Dept. of Commerce,
Contract CWB-9559.
(c) Prof. R. O. Reid, Project Supervisor.
(d) Theoretical with verification from existing
data; applied and basic research.
(e) The generation of two-dimensional surges in
deep water for a moving radially symmetric
storm, including the effects of the earth's
rotation, is being investigated analytically.
In addition the modification and generation
of surges on a continental shelf of variable
depth is being investigated numerically,
with the aim of comparing computed water
levels at shore with those observed for
past hurricanes along the U. S. coast (East
coast and Gulf coast areas).
(g) Analytical and numerical methods of evalua-
tion of storm surges for deep and coastal
waters have been investigated for several
simplified mathematical models. The
coastal models include the cases of con-
stant depth and linear variation of depth
with distance from shore. The effect of the
earth's rotation is included in these
studies.
(h) "Effect of Coriolis Force on Edge Waves:
I. Investigation of the Normal Modes" by
R. O. Reid, Journ. Mar. Res. (in press).
"Effect of Coriolis Force on Edge Waves:
II. Specific Examples of Free and Forced
Waves", by K. Kajiura, Journ. Mar. Res.
(in press).

(2870) MODEL STUDY OF SURGE ACTION IN A PORT.

(b) Office of Naval Research, U. S. Navy
Project NR 083-036, Contract N7 onr-48702.
(c) Dr. B. W. Wilson, Principal Investigator.
(d) Experimental; basic and applied research.
(e) To collate results and conclusions from a
model study of long period wave action in
Table Bay Harbor, Cape Town, South Africa.
(f) Complete.
(g) The nature of the surge phenomenon has
been uncovered. Its reproduction in an
engineering model and experiments to con-
trol it are described. It is shown that
effects on shipping can be brought under
control by suitably containing the existing
harbor within an outer basin of tight mole
construction.
(h) "Research and Model Studies on Range Action
in Table Bay Harbour, Cape Town", by B. W.
Wilson. Paper due for presentation to
S. A. Inst. C. E. (Johannesburg, S. A.),
June 1959 (publication pending).

(2871) DIFFRACTION OF PLANE GRAVITY WATER WAVES
IN THE PRESENCE OF A HORIZONTALLY SUB-
MERGED CIRCULAR CYLINDER.

(b) Department project.
(c) Prof. R. O. Reid, Chairman (Faculty Comm.)

(d) Experimental; basic research; Ph.D. Dissertation (R. Ellis).

(e) To determine the nature of the pressure changes brought about at the bed boundary by the presence of a horizontally submerged circular cylinder, fixed transversely in the path of a uniform train of waves in water of uniform depth.

(g) Experiments have been conducted in a wave tank for generating water waves in which wave pressures have been measured at a number of locations at the bottom of the tank relative to a horizontally submerged circular cylinder, fixed transversely at different elevations in water of various depths. The ratio of the root-mean-square pressure in the presence of the cylinder to that in the absence of the cylinder is found to vacillate with distance symmetrically on either side of the cylinder. An empirical formula which satisfactorily predicts the pressure change has been derived but the theoretical solution of the problem has not yet been attained.

(2872) LONG WAVES GENERATED BY ATMOSPHERIC DISTURBANCES IN AN OPEN OCEAN.

(b) U. S. Weather Bureau, Contract No. CWB-9071.

(c) Prof. R. O. Reid, Project Supervisor and Chairman (Faculty Comm.).

(d) Theoretical; basic research; Ph.D. Dissertation (K. Kajiura).

(e) To determine the nature of long waves generated in an open ocean by travelling atmospheric disturbances.

(f) Completed.

(g) The nature of the response of the water surface and layered interface of a two-layered ocean of infinite expanse to the wind and pressure effects of a radially symmetric storm such as a hurricane or typhoon has been determined. Important parameters are the ratio of the storm speed to the free wave speed and the scale of the storm. The coriolis force is shown to be important in shallow water. In deep water the influence of atmospheric pressure dominates that of wind stress; in shallow water the reverse is true.

(h) "Response of a Boundless Two-Layer Ocean to Atmospheric Disturbances" by K. Kajiura, Ph.D. Dissertation, A and M College of Texas, May 1958.

(2873) COMPUTATION OF DESIGN STORM-TIDE FOR THE NEW YORK BAY AREA.

(b) Beach Erosion Board, Corps of Engineers, U. S. Army and New York District, Corps of Engineers, Contract DA-49-055-civ-eng-58-9.

(c) Dr. B. W. Wilson, Project Supervisor.

(d) Numerical analysis; applied research.

(e) This project concerns the correlation of observed effects in New York Bay with the characteristics of known storms and its application to the prediction of storm-tides for a design hurricane.

(g) Least squares multiple regression correlation of known storm-tide elevation at the

mouth of New York Bay with antecedent storm characteristics (wind stress and pressure gradient) at a number of off-shore stations has been undertaken with data for four storms, tabulated at 20 minute intervals. The derived coefficients of correlation have been used in the prediction formula to predict the time-sequences of water level change at the bay-mouth for each of the four storms as a check on the validity of the formula. The formula has then been applied to the case of a design hurricane travelling on a given path at six possible speeds. High speed digital computer techniques have been used for this study.

(h) "The Prediction of Hurricane Storm-Tides in New York Bay", by B. W. Wilson, Preliminary Report No. 165-1, Texas A and M Research Foundation, January 1959.

(3178) WAVE VARIABILITY AND WAVE SPECTRA FOR WIND-GENERATED GRAVITY WAVES.

(b) Beach Erosion Board, Corps of Engrs., U. S. Army.

(c) Prof. R. O. Reid, Chairman (Faculty Comm.).

(d) Theoretical and experimental; basic and applied research; Ph.D. Dissertation (C. L. Bretschneider).

(e) To analyze ocean wave records both for the marginal and joint distributions of heights, lengths, and periods of the waves. Thence to investigate the wave energy spectrum and its relation to the wind speed and the wave age. To revise wave forecasting relationships in the light of the findings and compare derived spectra with other known forms.

(f) Completed.

(g) It was found that both wave height and wave length variability conformed to a Rayleigh distribution. A derived distribution function for period variability was verified by the data. A theoretical summation function for joint distributions was also verified by the data. From this a family of theoretical energy spectra was derived. Wave height, length, and frequency spectra were evolved in terms of generation parameters such as wind speed and fetch. Wave forecasting relationships were re-examined and revised.

(h) "Wave Variability and Wave Spectra for Wind Generated Gravity Waves" by C. L. Bretschneider, Ph.D. Dissertation, A and M College of Texas, August 1958, 219 pp.

(3179) MOORING OF SHIPS EXPOSED TO WAVES.

(b) Office of Naval Research, U. S. Navy, Contract No. NR 083-036.

(c) Dr. B. W. Wilson, Principal Investigator.

(d) Theoretical; basic and applied research.

(e) To investigate the motion of a drifting ship under the influence of waves in head and beam seas in water of various depths; hence to determine the kinetic energy that must be absorbed through the tendency of a ship to drift in contact with offshore structures in exposed locations; finally

to consider the nature of ship motion in waves when restrained by mooring ropes.

(f) Completed.

(g) Problem has been investigated on the basis that a ship can be simulated by a rectangular block of equivalent displacement. Treatment determines ship surge, heave and pitch in a head sea of uniform long-crested waves and sway, heave and roll in a beam sea. Most critical conditions of approach of a ship to a berth in an exposed location apply in broadside on-movement in a beam sea. The kinetic energy to be absorbed depends on whether structure is permeable to the waves or reflects them. The non-linear problem of the surging of a moored ship under mooring restraints is analyzed.

(h) "The Energy Problem in the Mooring of Ships Exposed to Waves", by B. W. Wilson. Paper presented at The Princeton University Conference, Oct. 20-21, 1958 (publication pending).

(3180) PROBLEMS CONCERNING THE LAYING OF A SUB-MARINE LIQUID-SULPHUR PIPELINE IN THE GULF OF MEXICO.

(b) Freeport Sulphur Company, New Orleans, La.

(c) Dr. B. W. Wilson, Principal Investigator.

(d) Theoretical; applied research.

(e) Sponsor required information on four questions: (1) History of bottom erosion in the area of proposed pipeline near Grand Isle, La.; (2) effects of hurricane waves on pipeline and desirable depth of burial of latter; safe elevations of shore establishments; (3) vertical and lateral stability of the pipeline in the sediments; and (4) longitudinal stability of the pipeline under thermally induced forces.

(f) Completed.

(h) "Coastal Engineering Problems in the Laying of a Submarine Liquid-Sulphur Pipeline in the Gulf of Mexico", by B. W. Wilson, Final Tech. Report No. 187-1, Texas A and M Research Foundation, December 1958, 153 pp.

(3181) GRAVITY-CAPILLARY WAVES IN WATER AT A VIBRATING BOUNDARY.

(b) United Gas Pipeline Co. Fellowship.

(c) Prof. R. O. Reid, Chairman (Faculty Comm.).

(d) Experimental; basic and applied research; M.S. Thesis (C.S. Wells).

(e) To examine the nature of gravity-capillary waves in water developing transversely to a vibrating boundary.

(f) Completed.

(g) The oscillation of cone and wedge-shaped cylindrical plungers in water at high frequency was found to induce standing edge waves transverse to the water-plunger boundary. It was found that this phenomenon had been discovered by Faraday and interpreted by Rayleigh as a non-linear mechanism capable of existence in several distinct modes. It was found that the resulting standing water-wave system was unstable and capable of developing sub-harmonic as well as super-harmonic modes

of oscillation in relation to the forcing frequency. The wave length-frequency relationship of the waves in the fundamental mode was found to agree satisfactorily with Kelvin's analysis for gravity-capillary waves of small amplitude.

(h) "Transverse Gravity-Capillary Waves near a Vibrating Boundary", by C. S. Wells, M. S. Thesis, A and M College of Texas, January 1959.

UNIVERSITY OF TEXAS, Department of Civil Engineering.

Inquiries concerning Projects Nos. 948, 2162, 2396, 2397, 2629, and 2874, should be addressed to Dr. Walter L. Moore, Dept. of Civil Engineering, Univ. of Texas, Austin 12, Texas.

(948) DIFFUSION OF A TWO-DIMENSIONAL SUBMERGED JET.

(b) Laboratory project.

(d) Basic experimental.

(e) An investigation is being made of the diffusion of momentum in a two-dimensional jet as influenced by the proximity to a plane boundary. Apparatus was constructed for measuring the velocity field in the diffusion region of an air jet 0.05 ft. thick and 3.0 ft. wide with a plane parallel boundary at various distances from the axis of the jet.

(f) Inactive.

(2161) CHARACTERISTICS OF A HYDRAULIC JUMP AT AN ABRUPT CHANGE IN BOTTOM ELEVATION.

(b) University of Texas Research Institute and Bureau of Engineering Research.

(c) Prof. C. W. Morgan, Department of Civil Engineering, University of Texas.

(d) Experimental.

(e) Experimental determinations are made of the flow characteristics at two-dimensional channel drops and rises. The velocity distribution and surface profile will be determined throughout the length of the jump for various relative changes in bottom elevation. The longitudinal location of the jump in relation to the change in bottom elevation will be varied over a broad range in distinction to previous related investigations in which relative location of the jump was held constant.

(g) Results for the abrupt drop are complete and have been published. For a given entering Froude number lying between 2 and 8 three types of jump may form, the type and its longitudinal location depending only on the relative downstream depth. The velocities near the bottom below the drop are always less than the mean velocity in the downstream channel for the jump type of maximum height. Experimental measurements have been made on the related investigation for an abrupt rise.

(h) "The Hydraulic Jump at an Abrupt Drop", by W. L. Moore and C. W. Morgan, Proceedings,

76

2162) HYDROLOGIC STUDIES, WALLER CREEK WATERSHED.

(b) Cooperative with U. S. Geological Survey.
(d) Field investigation; applied research.
(e) Measurements of rainfall and runoff for a 4 square mile and a 2 square mile portion of the Waller Creek watershed are being made to provide basic information for estimating runoff from small urban watersheds in the Southwest area. Two streamflow stations and a rain gage net are in operation. Studies of the correlation between runoff, rainfall, and the characteristics of the drainage basin are being made by various proposed methods to serve as a base for comparison with the data as it is collected from the stream.
(f) Active (M.S. Thesis on analysis).
(g) Careful estimates of the peak discharges at the gaging station were made by various proposed methods based on measurable characteristics of the basin. These results will be of interest to compare with observed peak discharges in later years when the record is long enough to be significant.
(h) "Peak Discharge Predictions for Waller Creek at 23rd Street at Austin, Texas", by William H.S. Diehl, M.S. Thesis, Jan., 1959.

(2396) RESISTANCE OF PIERS IN FREE SURFACE FLOW.

(b) Laboratory project.
(d) Theoretical and experimental (thesis).
(e) An investigation is being made of the drag resistance of piers as a function of shape, relative submergence, spacing, and Froude numbers. The pier resistance is being correlated with the head loss for flow in a channel.
(g) A phase of the investigation has been completed for Froude numbers less that 0.5 with cylindrical piers at various submergence and spacing. An investigation of the resistance of H section piers at various orientations and longitudinal spacings has been completed. Another phase has been completed which demonstrates that the velocity gradient along a cylindrical pier effects the drag coefficient. The local drag coefficient decreases along the pier in the direction toward the end of the pier where the velocity is high. The reduction in drag coefficient is related to a dimensionless measure of the velocity gradient along the cylinder.
(h) "An Experimental Investigation of the Drag Characteristics of Model H-Section Bridge Piers", Donald R. Van Sickle, M.S. Thesis, May 1958.

(2397) EFFECT OF UPSTREAM DEVELOPMENT ON THE RUNOFF FROM SMALL WATERSHEDS IN THE SOUTHWEST.

(b) Laboratory project.
(d) Field investigation (thesis).
(e) For a selected watershed rainfall and runoff relations before the period of upstream

development are being analyzed. The relations obtained for this period will be applied to the rainfall records after the upstream development and the predicted runoff compared with the actual runoff.
(g) Sources of data have been located, the available information tabulated, and a method of evaluating the runoff devised that appears to be reasonable. Multiple correlation diagrams have been developed which may be used with storm rainfall records to predict the annual runoff of the selected watershed for the period before upstream development.

(2629) A MECHANICAL TURBULENCE INDICATOR FOR LIQUIDS.

(b) Bureau of Engineering Research, University of Texas.
(d) Experimental instrument development.
(e) There is need for a relatively simple device to give a quantitative measure of the degree of turbulence in a flowing fluid. Electrical instruments commonly measure the root mean square of the turbulent fluctuations as an indication of the intensity. The instrument being developed measures the maximum turbulent fluctuation as an indication of the intensity. The instrument is similar to a 1/2-inch diameter Prandtl velocity tube except that it has two stagnation openings; the conventional one which gives the mean stagnation head and an additional one which leads through a sensitive check valve and accumulator to a manometer tube. The check valve and accumulator elements are located in the tube less than 3/8 of an inch from the stagnation opening to minimize inertia effects.
(g) The instrument has been built and a membrane for the check valves developed. Turbulence data measured in a hydraulic jump and in a circular jet appear reasonable in relation to published data for similar flows. Calibration of the instrument with controlled pressure fluctuations at various frequencies indicate satisfactory response provided the instrument itself is prevented from vibrating. Turbulence measurements in a hydraulic jump and a circular jet are to be repeated.

(2874) AN INVESTIGATION OF THE SCOUR RESISTANCE OF COHESIVE SEDIMENTS.

(b) Bureau of Engineering Research, University of Texas.
(d) Analytical and experimental (laboratory).
(e) An attempt is being made to evaluate the scour resistance of cohesive sediments by means of a standardized scour test. An approximate analysis indicated that a nominal value of the shear stress at sediment surface could be obtained for radially outward flow between a circular disc and the sediment sample. An apparatus was constructed with which the net force on the circular disc and the rate of flow could be adjusted to desired values and measured.

Tests showed that the measurement of the net force on the disc became inaccurate at low rates of scour, thus giving an unreliable determination of the shear at incipient scour. The apparatus was revised to measure the rate of scour beneath a vertical circular jet. A correlation of the variables based on a dimensional analysis shows promise of giving consistent results. A third test to measure the shear stress on the soil at incipient scour has been devised but not tested. It is planned that results from this test can be correlated with various soil parameters commonly used in soil mechanics. It is hoped that as a minimum an arbitrary scale can be set up for comparing the scour resistance of various cohesive sediments and that possibly this scale can be related to flow parameters for other situations and to other measurable soil properties.

(3182) LONG TIME FLUCTUATIONS IN STREAM RUNOFF.

(b) Laboratory project.
(c) Dr. Carl W. Morgan, Dept. of Civil Engineering, Univ. of Texas, Austin 12, Texas.
(d) Analytical and field study.
(e) Values of runoff from selected drainage areas in the lower Mississippi River basin and in basins of the rivers emptying directly into the Gulf of Mexico were studied. Variations in the runoff values for each stream were considered and these trends compared with solar variations. The relative sunspot numbers were used as the measure of solar variations and were correlated with the mean annual runoff. Further correlations are being made with different "lag" periods between solar activity and surface runoff.
(g) The gradual shifting of the centers of runoff excess and deficiency is consistent rather than random and appears to represent a gradual cyclic change in the runoff pattern. It appears that the locations of the centers of runoff deficiency is following roughly the same path that it did some 22 to 24 years previously. Correlation coefficients of +0.2 to +0.5 are obtained for selected rivers in Mississippi, Alabama, Georgia and Arkansas when sunspot numbers in the 11-year sunspot cycle are correlated with runoff. Texas streams do not give significant correlation with the 11-year sunspot cycle but give better correlation if runoff is compared with the double sunspot cycle in which sunspot numbers are assumed as negative in alternate cycles.
(h) "Surface Runoff in the Gulf Coast Area in Relation to Solar Activity", by Carl W. Morgan, Ph.D. Dissertation, June 1958.

UTAH STATE UNIVERSITY, Engineering Experiment Station.

(3183) DYNAMICS OF FLOW IN STEEP, ROUGH, OPEN CHANNELS.

(b) Laboratory research.
(c) Dean F. Peterson, Jr., Dean of Engineering, Utah State University, Logan, Utah.
(d) Experimental, theoretical, and field investigation; basic research. A doctoral thesis is now under way.
(e) A basic study of parameters involved in flow in steep, rough channels where the roughness is a relatively appreciable part of the depth, and where flow may be in channels sufficiently steep that critical or super critical flow becomes an important factor. The work is basic, however, it could have widespread application to steep mountain streams, especially in the western United States. A forty-eight foot long sloping flume, two feet wide, has been used to study flow conditions under a number of roughness arrangements and for slopes ranging from one percent to eight and a half percent for various discharges.
(g) Three regimes of flow seem to be involved. One, a regime of relatively tranquil flow; two, a regime in which the roughnesses begin to act as distributed free overfalls and may exercise control; and three, a regime in which the roughnesses are essentially skimmed over by super critical flow. Tentative parameters delineating these three regimes have been proposed as have a partial set of parameters for describing flow in the tumbling regime.

(3184) FLOW TO A PARTIALLY PENETRATING WELL IN AN UNCONFINED AQUIFER.

(b) Laboratory project.
(c) Dean F. Peterson, Jr., Dean of Engineering, Utah State University, Logan, Utah.
(d) Experimental; basic research. A doctoral thesis is under way.
(e) The effect of drawdown relative to depth of penetration, well diameter, and relative thickness of aquifer on flow into an idealized well system is being studied using a combination electrical and membrane analogue and an electrical resistance analogue computer.
(g) The various factors have been arranged in dimensionless form and curves showing the functional relation between these parameters developed.

(3185) HYDRAULICS OF SURFACE IRRIGATION.

(b) Laboratory research.
(c) Dr. Vaughn E. Hansen, Director, Engineering Experiment Station, Utah State Univ., Logan, Utah.
(d) Experimental, theoretical; basic research.
(e) A basic study of the phenomenon of water advance over the soil where the intake varies with time.
(g) A doctoral thesis has been completed and the report is being written. The study was based primarily upon the phenomenon observed by using considerations. A second study is currently under way where a mathematical approach is used and computing machines are used to evaluate the

complex differential equations.

(h) "Hydraulics of Irrigation Water Application as Affected by Soils and Other Factors", Proceedings, First Intersociety Conference on Irrigation and Drainage, April 1957. Publication pending. "The Importance of Hydraulics of Surface Irrigation", Paper 1788, Journal of the Irrigation and Drainage Division, Proceedings, American Society of Civil Engineers, September 1958.

3186) EVALUATION OF GROUND WATER IN A NON-HOMOGENEOUS, ANISOTROPIC MEDIA.

(b) Laboratory research.
(c) Dr. Vaughn E. Hansen, Director, Engineering Experiment Station, Utah State University, Logan, Utah.
(d) Experimental, theoretical; basic research. Two masters theses have been completed.
(e) A variable resistance network has been developed wherein problems of non-homogenous anisotropic flow can be evaluated. This network has been used to establish the procedure, validity, and accuracy of solutions which can be expected from this approach. Boundary conditions necessary before unique solution and the method of application of boundary conditions have been studied.
(h) "The Development of an Electrical Analog for Non-homogeneous Anisotropic Soils" by Kenneth Craig (Master Thesis).

(3187) INVESTIGATION OF THE HYDRAULIC AND MECHANICAL CHARACTERISTICS OF SPRINKLERS.

(b) Laboratory research.
(c) Dr. Vaughn E. Hansen, Director, Engineering Experiment Station, Utah State University, Logan, Utah.
(d) Experimental.
(e) The basic criterion in the study was to reduce the turbulence in mechanical sprinklers in order to improve the range.
(f) Completed.
(g) Several rather simple modifications in the commercial product could be modified to materially increase the range.

(3188) STEADY FLOW TOWARD AN UNCONFINED WELL.

(b) Laboratory research.
(c) Dr. Vaughn E. Hansen, Director, Engineering Experiment Station, Utah State University, Logan, Utah.
(d) Theoretical.
(e) Unconfined flow toward a well is extremely complex because of the existence of a free surface. The objective of this is to arrive at a more sound mathematical evaluation of the flow which will describe the streamline distribution.

THE STATE COLLEGE OF WASHINGTON, The R. L. Albrook Hydraulic Laboratory.

Inquiries concerning the following projects should

be addressed to Dr. E. Roy Tinney, Head, The R. L. Albrook Hydraulic Laboratory, Division of Industrial Research, State College of Washington, Pullman, Washington.

(1689) STUDY OF FLUID FLOW IN PIPE NETWORKS.

(b) Designers and managers of water and gas distribution systems.
(d) Analyses by analogue and digital computers.
(e) Studies of distribution systems by the McIlroy Pipeline Network Analyzer. Analyses have been made of the water supply systems for over 30 cities. Gas systems have also been analyzed as well as the cooling system of a large hydro plant. An analysis has been developed whereby some of the problems not readily solvable by the McIlroy Analyzer can be carried out on an IBM 650 digital computer.

(2165) THE INFLUENCE OF LOGGING OPERATIONS ON RUN-OFF FROM PRECIPITATION.

(b) Laboratory project.
(d) Analytical with field investigation.
(e) The run-off from watersheds on which extensive logging has been made is being conducted to determine the correlation between run-off and logging in regions where the rainfall is heavy and regrowth rapid.
(f) Inactive.

(2631) ROCKY REACH HYDROELECTRIC DEVELOPMENT.

(b) Chelan County Public Utility District No. 1.
(d) Experimental; design.
(e) A 1:75 model 109 ft by 40 ft has been constructed of 7500 ft of the Columbia River to study construction phases and the operation of the complete development of the Rocky Reach site. Studies have been completed on the cofferdam layouts and tests are now underway on the operation of the spillway and fishway entrances. In addition, a 1:44.9 scale model of two bays of the spillway has been constructed in a large glass sided flume to determine specifically the design of baffles on the apron and skip buckets on the ogee.
(h) Status reports to the client.

(2632) PRIEST RAPIDS PENSTOCK GATE STUDIES.

(b) Pacific Coast Engineering Company.
(d) Experimental; design.
(e) A 1:18 model of fixed wheel intake gates for the Priest Rapids Hydroelectric Project has been constructed to determine the hydraulic downpull for several lip designs. A generalized study has also been made to investigate various designs of intake gates with a view toward a more economical design of gates and gantry cranes.
(h) Report to client.

(2633) WATER WALL FOR ATOMIC REACTORS.

(b) General Electric Company, Hanford Atomic Products Operation.

(d) Experimental; design.
(e) A 1:3 model of a large manifold has been constructed to determine the hydraulic stability, flow patterns, and pressure losses.
(f) Completed.
(h) Final report to client.

(2876) BROWNLEE FISH BARRIER.

(b) Idaho Power Company.
(d) Analytical and experimental.
(e) An analytical development was pursued to determine the forces and three-dimensional shape of a 2800 feet long and 120 feet deep fish barrier that was built in the Brownlee hydroelectric development reservoir. The solution of the differential equations developed was carried out on an IBM 650 digital computer. In order to check the theory, a 1:150 scale model of the fish barrier was built. The model was also used to design the anchorage system.
(f) Completed.
(h) Final report being published by the Idaho Power Company.

(2877) FISHWAY MODELS.

(b) Chelan County PUD No. 1.
(d) Experimental; design.
(e) Two 1:12 scale models have been built of the fish transportation facilities for the Rocky Reach Hydroelectric Development. One model is of the upper end of the ladder and orifice section of the facility and the second model is of the trifurcation at the junction of the powerhouse and spillway.
(h) Report to client.

(2878) HYDRODYNAMICAL STUDIES.

(b) Laboratory project.
(d) Theoretical.
(e) A mathematical analysis of segmental flip buckets has been developed using free streamline theory. Analysis shows the relation between the dimensions of the bucket, the thickness of the nappe, the face angle of the dam, and the exit angle of the jet. Evaluation of the integrals arising from the conformal transformation is being made using an IBM 650 digital computer.

(2879) HYDRAULICS OF LEVEL IRRIGATION.

(b) Laboratory project cooperative with the Department of Agricultural Engineering.
(d) Theoretical and experimental.
(e) Analysis is being developed to define rate of advance and recession of the water front on a level irrigation border taking into account the infiltration. A tilting flume 75 feet long, 3 feet wide and 2 feet deep has been erected. A mechanical apparatus to simulate infiltration is being installed.

(3189) DOWNCOMER FOR ATOMIC REACTOR.

(b) General Electric Company, Hanford Atomic Products Operation.
(d) Experimental; design and operation.
(e) A 1:6 model of a downcomer for cooling water from atomic reactors has been built to study methods of increasing the capacity of existing units.
(h) Status report to client.

(3190) PUMP SUCTION WELLS.

(b) General Electric Company, Hanford Atomic Products Operation.
(d) Experimental; design.
(e) A 1:10 model of a multiple pump suction well is being built with model pumps installed to study flow patterns into and throughout the walls at various depths of pools.

(3191) TRES MARIAS SPILLWAY MODEL STUDIES.

(b) Centrais Electricas de Minas Gerais S.A., State of Minas Gerais, Brazil.
(d) Experimental; design.
(e) A 1:100 model was built of the Tres Marias Project to investigate the design of the spillway chute and to perfect a suitable energy dissipating bucket at the downstream end of the spillway chute.
(f) Completed.
(h) Washington State Institute of Technology. Technical Report No. 10, November 1958.

(3192) ADVANCE OF A SHALLOW LIQUID FRONT DOWN A DRY CHANNEL.

(b) National Science Foundation Grant.
(d) Theoretical and experimental; basic research.
(e) Mathematical analysis of equations is being conducted. Experiments will be conducted in a tilting flume to supplement and verify the theoretical approach.

UNIVERSITY OF WASHINGTON, Charles W. Harris Hydraulics Laboratory.

(2637) INFLUENCE OF PROXIMITY OF ORIFICES TO EACH OTHER ON THEIR DISCHARGES.

(b) Laboratory project.
(c) Dr. Joseph C. Kent, University of Wash., Seattle 5, Washington.
(d) Experimental; for master's thesis.
(e) Discharge of orifices placed close together compared to similar orifices placed remotely.
(f) Completed.
(h) Thesis by Tsu Kai Chu is on file at the University of Washington Library.

(2884) A MODEL STUDY OF THE SPILLWAY SYSTEM FOR THE SOUTH FORK TOLT RIVER DAM.

(b) City of Seattle, Board of Public Works.
(c) Dr. E. P. Richey and Prof. H. S. Strausser, Univ. of Washington, Seattle 5, Washington.
(d) Experimental; for design.
(e) A 1:48 scale model study of a spillway system composed of a morning-glory

spillway, a horseshoe conduit, steep chute and stilling basin. The conduit was to operate with a free surface throughout the design flow range.

(f) Completed.

(g) Design was completed on basis of tests.

(2887) COMPARISON OF RIGID PLATE WAVE GENERATOR WITH FLEXIBLE PLATE WAVE GENERATOR.

(b) Engineering Experiment Station, Univ. of Washington, Seattle 5, Washington.

(c) Dr. Joseph C. Kent, Univ. of Washington, Seattle 5, Washington.

(d) Experimental, theoretical; master's thesis.

(e) Performances of flexible plate wave generator analyzed and compared with rigid plate wave generator.

(f) Completed.

(h) Thesis by Takao Hirota is on file at the University of Washington Library.

(2888) ANALYSIS OF STATUS OF LONG-TERM PREDICTION OF STREAMFLOW.

(b) Laboratory project.

(c) Prof. T. H. Campbell, 201 More Hall, Univ. of Washington, Seattle 5, Washington.

(d) Experimental; basic research.

(e) Comparative study of approaches which have been proposed for a long-term forecasting of streamflow, with a view to determining usefulness of each. This study probably will continue over a long period of time.

(3193) A MODEL STUDY OF THE SECOND STAGE DIVERSION FOR THE HIGH GORGE DAM.

(b) City of Seattle, Department of Lighting.

(c) Dr. E. P. Richey, Profs. H. H. Chenoweth and W. M. Miller, Univ. of Wash., Seattle 5, Washington.

(d) Experimental; for design.

(e) A 1:50 scale model of the diversion works to be used during the second-stage construction of the Gorge High Dam was built to determine a diversion plan that would be safe with respect to water surface elevations, velocities and other open-channel phenomena.

(f) Completed.

(g) Design was completed on basis of tests.

(3194) MINOR LOSSES IN VISCOUS FLOW.

(b) Engineering Experiment Station, University of Washington, Seattle 5, Washington.

(c) Prof. H. K. Moritz, Univ. of Washington, Seattle 5, Washington.

(d) Experimental, theoretical; master's thesis.

(e) Theoretical expansion loss in viscous flow compared to experimental results.

(f) Completed.

(g) Excellent agreement obtained between the theoretical and experimental analyses.

(h) Thesis by S. H. Siddiqui is on file at the University of Washington Library.

WOODS HOLE OCEANOGRAPHIC INSTITUTION.

(2408) OCEAN WAVE MEASUREMENTS.

(b) Office of Naval Research and National Science Foundation.

(c) Mr. Harlow G. Farmer, Woods Hole Oceanographic Institution, Woods Hole, Mass.

(d) Experimental; basic research.

(e) Measurements have been made in the open ocean of wave elevation and slopes in the two directions, up-down wind and crosswind. A special buoy was used which supported, vertically, three resistance wire sensing elements. Data to be analyzed so as to indicate the average asymmetry of ocean waves under various wind conditions. (In particular, the departures of the elevation and slopes from the Gaussian distribution are to be studied.) Initial results have been reported. Measuring circuits are now being redesigned for improved and more reliable operation and data presentation being made more suitable for analysis by hi-speed computers. Future measurements are to be made from fixed installations such as towers in bays or other inshore areas.

(g) Initial results were subject to considerable experimental error. Slope distributions agree roughly with other reported works. Elevation distributions and elevation-slope correlations are qualitatively as expected.

(h) "Some Recent Observations of Sea Surface Elevation and Slope", by Harlow G. Farmer. Woods Hole Oceanographic Institution Technical Report Ref. No. 56-37, June 1956.

(3195) TWO-DIMENSIONAL SPECTRUM OF WIND GENERATED WAVES.

(b) Office of Naval Research, Department of the Navy.

(c) Mr. Harlow G. Farmer, Woods Hole Oceanographic Institution, Woods Hole, Mass.

(d) Experimental; basic research.

(e) One- and two-dimensional spectra are to be obtained for wind generated waves in the vicinity of Buzzards Bay, Mass., and from some other installations where larger ocean waves may be obtained. Comparison of the above spectra are to be made in order to determine usefulness of the small wind seas as models of the large seas characteristic of the open ocean. Present plan is to use arrays of sensing element detectors for determining the directional spectrum.

(3196) EVALUATION AND USE OF NIO SHIP BORNE WAVE RECORDER.

(b) Office of Naval Research, Department of the Navy.

(c) Mr. Harlow G. Farmer, Woods Hole Oceanographic Institution, Woods Hole, Massachusetts.

(d) Experimental; applied research.

(e) Experiments are to be conducted to determine the expected overall accuracy of the instrument. To be investigated are the effects of the presence of the ship, the effect of the ship motion on the indicated pressures and accelerations and the best

way to combine the data to arrive at the wave spectrum. The instrument has been used on the Atlantis and is now being installed on a larger and more serviceable ship for the above tests.

(g) From observations aboard the Atlantis, a comparison was made with hindcasts for a number of sea conditions. Observed wave records were consistently and appreciably lower than the hindcasted seas. The differences may result in part from both sources.

(h) Auswertung van Seegangsregistrierungen des Forschungsschiffes "Atlantis" mit dem "Ship borne wave recorder" sowie Vergleich mit entsprechenden Seegangsberechungen aus den Windverhältnissen (hindcasting). Van H. Walden und H. G. Farmer, Deutschen Hydrographischen Zeitschrift, Band 10, Heft 4, 1957.

(3197) HYDRAULIC MODELS.

(b) Office of Naval Research, Department of the Navy.
(c) Dr. Alan J. Faller, Woods Hole Oceanographic Institution Woods Hole, Mass.
(d) Experimental and theoretical; basic research.
(e) The study of thermally and mechanically driven circulations in rotating systems with special emphasis upon analogy with geophysical phenomena.
(g) Models representing certain features of the ocean circulation such as western boundary currents. Thermally driven models resembling the large-scale atmospheric circulation.
(h) "Some Examples of Stationary Planetary Flow Patterns in Bounded Basins"; Stommel, Arons, and Faller; Tellus, 10, 2, 179-187.

WORCESTER POLYTECHNIC INSTITUTE, Alden Hydraulic Laboratory.

Inquiries concerning the following projects should be addressed to Prof. L. J. Hooper, Director, Alden Hydraulic Laboratory, Worcester Polytechnic Institute, Worcester 9, Mass.

(1963) METER CALIBRATION.

(b) Foxboro Company.
(d) Experimental; for design.
(e) Laboratory calibration of various sizes from 1" to 36" diameter magnetic flow meters.

(2411) METER CALIBRATION.

(b) Foster Engineering Company.
(d) Experimental; for design.
(e) Laboratory calibration of various sizes from 2" to 24" diameter.

(2638) METER CALIBRATION.

(b) Penn Instrument Div. - Burgess-Manning Co.

(d) Experimental; for design.
(e) Calibration of both open flow nozzles and venturi meters from 6" to 30" diameter pipe.

(2645) ELMHURST DAM - WATER SUPPLY.

(b) Thomas H. Wiggin.
(d) Experimental; for design.
(e) A 1/50 model of the original spillway, section of dam, new spillway and river bed downstream was constructed. Flow studies were conducted on walls, deflectors and energy dissipators.
(f) Completed.

(2647) SHERMAN HYDROELECTRIC DEVELOPMENT.

(b) New England Power Service Co.
(e) A 1/40 model of the dam, spillway, spillway chute, powerhouse and river bed was constructed. Studies included means of increasing capacity of spillway and allied structures as well as results of same.
(f) Completed.

(2889) POTOMAC PROJECT.

(b) Stone and Webster Engineering Corporation.
(d) Experimental; for design.
(e) A distorted model with a vertical scale of 1/80 and horizontal scale of 1/20 was constructed of a section of the Potomac River. The velocity distribution and heat transfer characteristics of the river in the area near the intake and outlet of the power plant were studied.
(h) Report being written.

(2897) ELRAMA POWER PLANT.

(b) Stone and Webster Engineering Corp.
(d) Experimental; for design.
(e) A distorted model with vertical scale of 1/90 and horizontal scale of 1/30 was constructed of a section of the Monongahela River upstream and downstream of the power plant. Velocity distribution in the area of the intake and outlet as well as heat transfer characteristics of the river were determined.
(f) Report being written.

(2890) NEW JERSEY ZINC COMPANY.

(b) Albright and Friel, Inc.
(d) Experimental; for design.
(e) A 1/250 horizontal scale and 1/80 vertical scale model of a section of the Delaware River was constructed to study the flow pattern in the area of the New Jersey Zinc plant.
(g) Tests in progress.

(2891) PENNSYLVANIA RAILROAD.

(b) Pennsylvania Railroad.
(d) Experimental; for design.
(e) A 1/200 horizontal scale and a 1/60 vertical scale model of a section of the

Deleware River was constructed. The flow pattern in the river near the Pennsylvania Railroad pier is being studied.

(g) Tests in progress.

(3198) METER CALIBRATION.

(b) Simplex Valve and Meter Company.
(d) Experimental; for design.
(e) Calibration of venturi meters in 14" pipe.
(f) Completed.

(3199) 10-INCH SWING CHECK VALVE.

(b) Atwood and Morrill Company.
(d) Experimental; for design.
(e) Evaluation of pressure transients due to variation in operation of the valve. The test series included several modifications of both valve and piping. A 10" centrifugal pump in the test line was used for producing flow opposite to the gravity system of the laboratory.
(f) Completed.

(3200) 10-INCH SWING CHECK VALVE.

(b) Westinghouse Electric Company.
(d) Experimental; for design.
(e) Evaluation of pressure transients due to operation of the valve. Several types of valve internals were studied during the program. A 10" centrifugal pump was included in the piping to produce flows in a reverse direction to the gravity system of the laboratory.
(f) Completed.

(3201) 10-INCH CENTER GUIDED CHECK VALVE.

(b) Westinghouse Electric Company.
(d) Experimental; for design.
(e) A series of tests will be performed to measure pressure surges during operation of the valve. A centrifugal pump in the line will be used to reverse the flow during part of the tests.

(3202) NIAGARA POWER PROJECT (PASSNY).

(b) Uhl, Hall and Rich.
(d) Experimental; for design.
(e) A 1/50 scale model of a section of the Niagara River has been reproduced including the area for the water intakes for the development. The model intakes are duplicated along with gate structures and the two underground conduits leading to the outlet structure at the power canal. The power canal along with the Tuscarora pump-generating station and the Lewiston power station are represented. Studies of water level in canal and conduit for various operating conditions are being made.
(g) Tests in progress.

UNIVERSITY OF CALIFORNIA, College of Agriculture, Department of Irrigation.

(21) STUDY OF HYDRAULICS OF SPRINKLING SYSTEMS.

(b) California Agricultural Experiment Station.
(c) Prof. V. H. Scott and Prof. J. R. Davis, Department of Irrigation, University of California, Davis, California.
(d) Experimental; operation.
(e) To evaluate sprinkler irrigation vs surface irrigation with respect to water application, relative production, and effect of fertilizers, a field comparison of these two methods for production of mountain hay was made on two adjacent 27-acre established hay fields. Rate of advance and recession were measured in irrigated borders, and uniformity of water distribution determined for the sprinkler system. Field performance and annual costs of the two systems were then compared. Laboratory studies were also conducted on sprinkler nozzles to evaluate (1) present methods of measuring discharge from sprinkler nozzles, (2) the effect of nozzle geometry on the coefficient of discharge, and (3) the influence of impinging jets on the uniformity of distribution of water.
(g) Comparisons of sprinkler and surface irrigation methods on mountain hay showed that surface methods of irrigation are more economically feasible than sprinkler methods for the conditions studied. Water application efficiency for irrigated borders reached 77 percent. The method of measuring sprinkler discharge by fitting a tightly fitting hose over the nozzle proved inaccurate, by as much as 15 percent. Water must discharge freely into atmospheric pressure if reliable measurements are required.
The effect of the ratio of the length of the converging section of a nozzle to the length of the straight bore on the coefficient of discharge was apparent only at ratios less than 3:1 for four nozzle sizes tested. Generally, the smaller the ratio, the smaller the coefficient of discharge. A system of three impinging jets allowed the creation of many shapes of distribution patterns, by merely changing the geometry of the system. Performance of this system was superior to that of a single circular nozzle.
(h) "Spray Characteristics of Water From Three Impinging Jets", by J. M. Langa, and J. R. Davis. Paper presented at Annual Winter Meeting, Amer. Soc. Agr. Engin., Chicago, December 1958.
"Spray Characteristics of Water From Three Impinging Jets", by J. M. Langa. Unpublished Master of Science thesis, Department of Irrigation, 1958.

(23) HYDROLOGY OF IRRIGATION SUPPLIED IN CALIFORNIA.

(b) California Agricultural Experiment Station.
(c) Prof. R. H. Burgy, Department of Irrigation, University of California, Davis,

California.

(d) Experimental and field investigation; applied research and operation.

(e) Studies were continued on the hydrologic effects of various watershed practices. Additional data were collected from several large storms during the latter part of 1957-58 season. Structural modifications were made to several gaging stations to permit greater accuracy in measurements of total outflow from the test areas. Work is nearing completion on a new electrical control system which provides timing synchronization for rainfall and runoff measurement on a series of major watersheds. Further instrumental work has included the installation of soil moisture units and of access tubes for neutron meter measurements of soil moisture. Frequency studies of longer precipitation records have been started together with other intensive studies of changes in hydrologic characteristics on managed small watersheds.

(g) Analysis of data is continuing to determine the hydrologic responses attributable to vegetation management on pilot watersheds. Methods and procedures to isolate specific hydrograph changes are being selected and will be applied to determine the redistribution of runoff under altered conditions on the watershed. These data support conclusions as to the effectiveness of converted vegetation on managed watersheds in controlling soil movement and in increasing the quantities of water yield.

(h) "The Erosion Hazard in Obtaining Increased water Yields on Dry Lands", by R. H. Burgy, presented at Amer. Soc. Agr. Engineers, 51st Annual Meeting, Soil and Water Erosion Session, Santa Barbara, June 23-25, 1958.
"Interception Losses in Grassy Vegetation", by R.H. Burgy, C.R. Pomeroy, Amer. Geophys. Union Trans. 39(6):1095-1100, Dec. 1958.
"Water Yield as Influenced by Watershed Management", by R. H. Burgy, Jour. of the Irrigation and Drainage Division, Proc. Amer. Soc. Civ. Engin., Paper 1590, April 1958.

(24) MEASUREMENT OF IRRIGATION WATER AND IMPROVEMENT IN FARM IRRIGATION STRUCTURES.

(b) California Agricultural Experiment Station.

(c) Prof. V. H. Scott, Prof. W. A.· Hall, and Prof. J. R. Davis, Department of Irrigation, University of California, Davis, California.

(d) Experimental; design.

(e) The project on measurement of rate of flow in aluminum sprinkler pipelines was completed. Attempts were made to devise an inexpensive totalizing meter for use on pump discharge pipes by the use of a small by-pass meter.
Investigations of plastic ditch liners were also continued during 1958. A comprehen-. sive study on the hydraulics of furrow irrigation systems was conducted in the field and laboratory.

(g) Results of the studies on measurement of rate of flow in aluminum sprinkler pipelines

indicated that an eccentric orifice plate could be easily installed in a pipe or a pressed-on coupler fitting resulting in an accurate inexpensive method of measurement. Rational equations for flow of water in forrows and borders have been developed and evaluated during the year. Measurements of furrow infiltration showed that the rate of water movement into soil depends on the furrow size and shape, the condition of the soil surface in the furrow, and the time of season or number of prior irrigations. Furrow shape and hydraulic roughness depended upon either flow rate or velocity of flow. Data are also being collected and · analyzed from artificial roughness studies in irrigation borders. Performance parameters of irrigation systems have been defined to establish standard and more realistic methods of evaluating the performance of irrigation systems.
Evaluation of seepage control, weed control, installation procedure, and economic feasibility of polyethylene ditch liners indicated that in general, films 4 mils and thicker appear to be economically feasible as ditch liners on coarse textured soils and to have an effective life of 3 years or longer. Hydraulic studies of these ditch liners indicate that considerable reductions in ditch size may be possible with plastic liners due to the relatively low hydraulic roughness.

(h) "Performance Parameters of Irrigation Systems", by W. A. Hall, paper submitted for publication in Agricultural Engineering.
"Characteristics of Flow in Irrigation Furrows", by J. R. Davis, Ph.D. thesis, Michigan State University, 1958.
"Plastic Films for Lining Irrigation Ditches", by J. A. Corry, paper presented at 51st Annual Meeting, ASAE, Santa Barbara, June 1958.

(25) PHYSICAL AND CHEMICAL FACTORS AFFECTING SOIL INFILTRATION RATES.

(b) California Agricultural Experiment Station.

(c) Prof. L. D. Doneen, Prof. D. W. Henderson and J. W. Biggar, University of California, Davis, California.

(d) Experimental and field; basic and applied research.

(e) Investigations on soil and water management practices have been continued in the field and laboratory. A new lysimeter experiment has been initiated concerned with salt balance and leaching requirements of chloride and bicarbonate waters. Infiltration rates will be measured and composition of the leachate made at regular intervals. A new investigation has been started on water quality in relation to irrigation of peat and muck soil. Studies on the addition of amendments to water for its improvement are continuing. Salt removal from a diatomaceous soil by leaching into tile drains has been investigated in the field.
Field investigations concerned with causes of phytophthora root rot of tomatoes were

continued. Methods of improving slow rates of water penetration were investigated.

(g) Results of the investigation concerned with the effect of changing from one water quality to another show that these changes in water quality often impair infiltration. This study is designed to predict when this will occur and procedure necessary for improvement or prevention. Changes in salinity before and after leaching are being evaluated by the saturation extract technique. Studies concerned with the fixation of boron by soils and its relation to the boron concentration in irrigation water indicate that wetting and drying drastically change boron fixation by soils. Field investigations show that most Phytophthora root rot of tomatoes is caused by slow internal drainage of the soil, largely because of naturally occurring dense subsoils at depths of 2 to 4 feet. Chemical amendments and subsoiling show little promise of improving slow rates of water penetration into soils according to field studies. Evaluation of rotation experiments showed significantly low infiltration rates with continuous potatoes and double cropped (mostly green-manured) treatments than with single cropped. In a field test, yields of corn, castor beans and cotton were improved by double furrowing between rows or flood irrigation as compared to conventional single furrow irrigation. A permanent grass cover crop for four years has improved the infiltration rate of a sandy soil in a peach orchard as compared to clean tilled. Improved water management is often the best approach to problems of slow water penetration and internal drainage in soils planted to field crops.

(h) "Studies on Water Quality Criteria", by L. D. Doneen, Proc. Quality of Water for Irrigation, Water Resources Center Contribution No. 14, University of California, 1958.
"The Relation of Fertilizers to Soil and Ground Water Salinity," by J. W. Biggar, Proc. Quality of Water for Irrigation, Water Resources Center Contribution No. 14, University of California, 1958.
"Influence on Soil Permeability of Total Concentration and Sodium in Irrigation Waters", by D.W. Henderson, Proc. Quality of Water for Irrigation, Water Resources Center Contribution No. 14, University of California, 1958.
"Effect of Rotation with Green Manuring and Irrigation on Physical Characteristics of Hesperia Sandy Loam", by W.J. Flocker, J.A. Vomocil, M.T. Vitum and L.D. Doneen, Jour. Amer. Soc. Agron. 50:251-254, 1958.

(1819) DRAINAGE IN RELATION TO IRRIGATION.

(b) California Agricultural Experiment Station.
(c) Prof. J. N. Luthin, Department of Irrigation, University of California, Davis, California.
(d) Experimental and field investigation;

basic and applied research.

(e) A field study of drainage problems in the Tulelake lease lands, Tulelake, California, has been underway since 1953. In this area high water table levels and subsequent salinity build-up has become apparent over the years since irrigated agriculture was initiated. Experiments have been made to determine the most effective method of draining this area in order to relieve this situation. A cooperative study was started during the summer of 1958 in Solano County to determine the effect of introducing surface water to an area formerly nonirrigated or irrigated by pumped supplies. An investigation was conducted at the Imperial Valley Field Station to determine drainage characteristics of the soils and other factors relative to the high water table situation found in certain areas. In addition to this field study, a voltage network laboratory study has been started on analyzing ponded water flow rates into tile lines which are placed at various depths in profiles typical of those found in the soils of the Imperial Valley. A drainage study to determine the best way to reclaim tidal lands was continued during 1958.

(g) The drainage-salinity study during 1958 on the Tulelake lease lands indicated that tile drains would effectively control water table levels but would be hindered by inadequate outlet facilities. The soils in the lease lands are unique because of very high permeability in the first five feet. However, since they cover about 20,000 acres, drainage is an important feature of their management. Data are being gathered from areas in Solano County where drainage problems are developing. By this means corrective measures can be instigated before such problems reach serious proportions. Most of the soils at the Imperial Valley Field Station are permeable and permit efficient operation of tile. Salt build-up was indicated in some areas. Lined ditches have been recommended to reduce seepage contributions. The data obtained during the investigation at the Field Station will aid planners of future drainage systems. The analog studies will have more widespread use in the Valley in giving more reliable criteria for specifying the most efficient depth for drains in these soils.

(h) "Machinery For Soil Drainage", by P. A. Boving, California Agriculture 12(6), 1958.
"Drainage Problems in the San Joaquin Valley", by L. G. Wilson, J. N. Luthin and F. B. Clendenen, University of California, Davis, California, 1958.

(2055) THE PHYSICS OF SOIL MOISTURE MOVEMENT.

(b) California Agricultural Experiment Station.
(c) Prof. J. N. Luthin, Department of Irrigation, University of California, Davis, California.

(d) Laboratory and theoretical studies; basic research.

(e) Analog studies were made to determine the optimum depth for drains in stratified soils under ponded water conditions. The water table drawdown relationships of Kirkham-Gaskell were modified to account for the change of drainable porosity with tension giving a more realistic approach to studies of falling water tables. Water table shapes have been predicted with greater accuracy when using this modified relationship. The resistance network analog has been used to study the water table shape and rate of drop.
In studying soil drainage the relationship between water removable and water table depth must be known with a degree of accuracy which is not usually obtained by ordinary techniques. An improved technique for obtaining this information has been devised by utilizing the outflow data obtained from soil columns during drainage. This technique is quite useful when such liquids as glycerine are used in tank model investigations. The new technique is more time consuming than established ones.

(g) The evaluation of maximum flow rates into drains will be useful in determining the capacity of tile drains which are located at variable depths in a stratified soil. The adaptation of rapid analog techniques to evaluate water table drawdown will provide information leading to better design of drainage facilities.

(h) "The Falling Water Table in Tile Drainage, Part II. Proposed Criteria for Spacing of Tile Drains", by J. N. Luthin, submitted for publication in Agr. Engineering.
"The Falling Water Table in Tile Drainage, Part III. Factors Affecting the Rate of Fall", by J. N. Luthin, and R. B. Worstell, submitted for publication in Agr. Engineering.
"An Improved Resistance Network Analog for Drainage Studies", by R. V. Worstell, submitted for publication in Soil Science.
"Flow Into Drain Tubes in Soils Whose Conductivity Decreases with Depth -- an Analog Study", by G. S. Taylor and R. V. Worstell, manuscript prepared to be submitted to Proceedings of Soil Science Society of America.

(2056) THE HYDRAULIC CHARACTERISTICS OF WELL CASING PERFORATIONS.

(b) California Agricultural Experiment Station.
(c) Prof. V. H. Scott, Department of Irrigation, University of California, Davis, California.
(d) Experimental; applied research.
(e) Static and pumping condition differences of individual aquifers at various depths were studied in relation to drainage, water quality and water supply. Analyses of several well waters were made to determine possible causes of corrosion in steel and aluminum pipe lines and in well casings.
(f) Temporarily suspended.

(g) Tables for estimating electric power cost for pumping irrigation water were revised.

CARNEGIE INSTITUTE OF TECHNOLOGY, Department of Civil Engineering.

Inquiries concerning the following projects should be addressed to Dr. T. E. Stelson, Dept. of Civil Engineering, Carnegie Institute of Technology, Pittsburgh 13, Pennsylvania.

(1834) AIR-WATER FLOW.

(b) Laboratory project.
(d) Theoretical and experimental.
(e) An investigation to determine the amount of air that can be carried by flowing water. Experiments are conducted with air-water mixtures flowing in pipes at different slopes past various transition sections.

(2064) VIRTUAL MASS.

(b) Laboratory project.
(d) Experimental and analytical.
(e) Measurement of virtual mass of bodies in fluids with free and fixed boundaries.
(h) "The Virtual Mass of Cylindrical Bodies at a Free Surface", T. E. Stelson and J. P. Murtha, Proceedings of Fifth Midwestern Conference on Fluid Mechanics, p. 330-336, 1957.
"Dynamic Response of Floating Bridges to Transient Loads", J. P. Romualdi, E. D'Appolonia, T. E. Stelson, Proc. Third U. S. National Congress of Applied Mechanics, p. 227-232, 1958.

(2275) FLOW OF LIQUID-SOLID MIXTURES.

(b) Laboratory project - Freeman Fellowship.
(d) Basic experimental and analytical research.
(e) Determination of energy losses, solid and liquid velocities, concentration of solids, and characteristics of flow.

(2276) UNSTEADY FLOW THROUGH CONDUITS, WEIRS AND ORIFICES.

(b) Laboratory project.
(d) Experimental and analytical for undergraduate thesis.
(e) Analysis of steady-flow characteristics from measurements with unsteady flow.

(2759) FLOW INTO VERTICAL SHAFTS.

(b) Laboratory project.
(d) Experimental and analytical.
(e) Evaluation of the characteristics of flow entering a vertical shaft for various geometric and hydraulic conditions.

(3203) PRESSURE SURGES IN CLOSED CONDUITS.

(b) Laboratory project - National Science Foundation Fellowship.
(d) Experimental and analytical for Master's

Thesis.

(e) Determining the effect of pipe geometry on the transmission and reflection of pressure surges.

(3204) EFFECT OF AIR ENTRAPMENT ON FLOW THROUGH ROUGHENED PIPES.

(b) Laboratory project.
(d) Experimental and analytical.
(e) A model study to determine the effect of entrapped air on the flow characteristics of unlined tunnels.
(h) "A Basic Model Study Simulating Effects of Air Entrapment in Unlined Water Tunnels Through Rock", F. T. Mavis and F.Bustamante, Trans. Seventh General Meeting I.A.H.R. p. c6 1-5, 1957.

(3205) FLOW OF LIQUID-SOLID MIXTURES IN INCLINED PIPES.

(b) Laboratory project.
(d) Experimental and analytical.
(e) Determination of energy losses, slurry velocities, concentration of solids, and characteristics of flow in inclined pipes.

(3206) HYDRAULIC CHARACTERISTICS OF INCLINED ELLIPTICAL WEIRS.

(b) Laboratory project.
(d) Experimental and theoretical.
(e) An investigation to determine the head-discharge and head-pressure relationships for sharp-crested inclined elliptical weirs.

UNIVERSITY OF CONNECTICUT, Hydraulic Research Laboratory, Civil Engineering Department.

(1078) HYDROLOGIC FACTORS INFLUENCING RAINFALL-RUNOFF RELATIONSHIPS ON SMALL WATERSHEDS IN EASTERN CONNECTICUT.

(b) Laboratory project, State Highway Dept.
(c) Prof. K. C. Tippy, Box U-37, University of Connecticut, Storrs, Conn.
(d) Field investigation; applied research.
(e) Rainfall and runoff measurements are being taken on small watersheds varying in size from 4 to 400 acres.

(1080) STUDY OF HYDRAULIC DESIGN OF CURB INLETS.

(b) Laboratory project, State Highway Dept.
(c) Prof. V. E. Scottron, Box U-37, University of Connecticut, Storrs, Conn.
(d) Experimental; for design.
(e) Tests are continuing on the influence of plan form of parallel bar gratings on hydraulic capacity. Field tests are also being conducted.
(g) A report has been issued to the Connecticut Highway Dept. on the design of parallel bar gratings. A paper covering a portion of this report is published in Annual Report of the Connecticut Society of Civil Engineers, Hartford, Conn., March 1955.

(2073) A STUDY OF SIDE FLOW INTO GUTTERS AND CHANNELS.

(b) Laboratory project.
(c) Prof. V. Scottron, Box U-37, University of Connecticut, Storrs, Conn.
(d) Experimental and analytical.
(e) Work is continuing on the hydraulics of rectangular channels with sloping bottoms and uniformly entering side flow.

THE JOHNS HOPKINS UNIVERSITY, Applied Physics Laboratory.

Inquiries concerning Projects Nos. 1876, 2335, 3207 and 3208, should be addressed to the Director, Applied Physics Laboratory, The Johns Hopkins Univ., 8621 Georgia Avenue, Silver Spring, Md. Inquiries concerning Project 1877 should be addressed to the McDonnell Aircraft Corp., Box 516, St. Louis 3, Mo.

(1876) ANALYSIS OF DYNAMIC OPERATION OF HYDRAULIC (FORCE) AMPLIFIER TRANSFER VALVES.

(b) Bureau of Ordnance, Dept. of the Navy.
(d) Theoretical and experimental; applied research and development.
(e) Designed to develop a set of linearized differential equations to describe the operation of single and double nozzle type hydraulic force amplifier, transfer valves.
(f) Suspended.
(g) The linearization of differential equations complete. Have been completed and compare favorably with experimental results.
(h) Present phase completed; refer to APL/JHU TG-198 "Electro-Hydraulic Valve Study", by Ahrendt Instrument Co.

(1877) ANALYSIS OF STATIC AND DYNAMIC OPERATING CHARACTERISTICS OF HYDRAULIC SERVO-MECHANISMS.

(b) Bureau of Ordnance, Dept. of the Navy.
(d) Theoretical and experimental, applied research and design.
(e) Phase (1) covers derivation of equations required in item 1876 above. Phase (2) covers the application of simple linearized equations to study the effects of complex mechanical loads and oil compressibility. Phase (3) covers the use of more sophisticated describing function techniques to analyze the nonlinear characteristics of transfer valve while operating in a closed loop and driving complex mechanical loads and including the effects of oil compressibility. Phase (3) includes single stage and two-stage hydraulic transfer valves. The work under Phase (3) is being carried out by McDonnell Aircraft Corporation, St. Louis, Mo., under technical cognizance of APL/JHU.
(f) Phase (2) completed. Phase (3) single stage valve completed, two-stage valve suspended.
(g) Phase (2), linearized differential equations produce reasonable correlations

between experiment and theory for small changes in variables. Phase (3) describing function techniques have been successfully applied to transfer valve hysteresis, spool reaction forces, and square root character- istics, etc.

(h) Phase (2) no unclassified report. Phase (3) Contract NOrd 12826. Single Stage Valve; McDonnell Aircraft Corp. reports 4580 and 4581. Two Stage Valve; McDonnell Aircraft Corp. reports 5278 and 5279.

(2335) APPLICATION OF SWITCHING TECHNIQUES TO HYDRAULIC CONTROL SYSTEMS.

(b) Bureau of Ordnance, Dept. of the Navy.
(d) Theoretical and experimental; applied de- velopment and design.
(e) Study of the dynamic properties of an ac- celeration switching hydraulic servo while operating in a closed loop under the pres- ence of various external loads and environ- mental conditions on the transfer valve and output actuator.
(g) The use of a two stage transfer valve and actuator as a double integrating switch has been found to have superior static and dynamic performance characteristics under normal and adverse environmental conditions (ambient temperature to 700° F) over the proportional flow control valve.
(h) "Acceleration Switching Hydraulic Servo", APL/JHU CM-843, by John Chubbuck. "Design and Performance Criteria of the Acceleration Switching Hydraulic Servo" APL/JHU CF-2652, by W. Seamone. "Performance Characteristics of the Accelera- tion Switching Hydraulic Servo" APL/JHU CM-945, by W. Seamone.

(3207) ACCELERATION SWITCHING HYDRAULIC SERVO- MECHANISMS UNDER EXTREME ENVIRONMENTAL CONDITIONS.

(b) Bureau of Ordnance, Dept. of the Navy.
(d) Experimental, applied development and design.
(e) Extend to regions of extreme high tempera- ture, a servomechanism capable of high force or horsepower requirements. The power amplifier, prime mover and feedback transducer must operate under the environ- mental conditions, while electronic ampli- fiers and associated circuitry are placed in a protective area.
(g) Three sets of tests have been completed, two being at North American Aviation Co. in Downey, California, while one was held at Boeing Aircraft Co., in Witchita, Kansas. These tests had oil temperatures up to 500F° and ambient air temperatures up to 750F°. The acceleration switching valves used performed reliably and rela- tively bias free under the condition of oil varnishing and sludging in these high temperature ranges. These valves, as well as hydraulic cylinders and feedback trans- ducers were commercially procured and as a servo system showed dynamic stability and servo closed loop bandpass within 15% of

room temperature value. Extensive work is necessary to replace all elastomeric seals in this system. Further effort in this servo area awaits completion of a high temperature test facility at APL/JHU.
(h) "Hydraulic (Acceleration Switching) Servo Dynamic Performance Under Extreme High Temperature Environment" by W. Seamone and K. E. W. Duning. APL/JHU CF-2737 dated June 17, 1958.

(3208) HYDRAULIC SERVOMECHANISM CHARACTERISTICS UNDER EXTERNAL FORCE DISTURBANCES.

(b) Bureau of Ordnance, Dept. of the Navy.
(d) Theoretical and experimental, applied re- search.
(e) Hydraulic Servomechanisms are primarily used in high power devices subjected to external force disturbances of random nature. Typical servomechanisms using linear proportional hydraulic servovalves as well as acceleration switching valves were loaded by an external dynamic force (up to 50 cps) and the reaction of the servo noted.
(f) Completed.
(g) The servo torque stiffness is a decreasing function of frequency for a linear servo using a transfer valve with good low signal level performance. The limiting value of stiffness is that of a blocked actuator with only the oil and actuator compliance contributing to the servo stiffness at the high frequencies. Some of the linear valve servos had low stiffness in the low fre- quency region but approached the nominal limiting stiffness of the blocked actuator condition at high frequencies.
The acceleration switching servo shows very high stiffness in the low frequency region, appears slightly softer in the intermediate frequency range, and approaches the nominal limiting stiffness of the blocked actuator for the high frequency condition. Repeata- bility was good between two valves.
The effect of dither on servo stiffness may either increase or decrease the stiffness depending on valve tolerance and frequency in question.
(h) "An Experimental Study of Hydraulic Servo Torque Characteristics as a Function of Frequency" by W. Seamone and L. A. Wenrich, APL/JHU CF-2753 dated September 23, 1958.

U. S. DEPARTMENT OF AGRICULTURE, AGRICULTURE
RESEARCH SERVICE, Soil and Water Conservation
Research Division.

EASTERN SOIL AND WATER MANAGEMENT RESEARCH BRANCH.

Runoff and Erosion Control Section.

(1966) IMPROVED SYSTEMS FOR CONTROL OF RUNOFF AND
EROSION.

(b) Cooperative with the following state
Agricultural Experiment Stations and other
agencies for use throughout the 31 Eastern
States: Georgia, Illinois, Indiana, Iowa,
Maine, Maryland, Minnesota, Mississippi,
Missouri, New Hampshire, New York, Wiscon-
sin. Some studies under this project are
reported in more detail as cooperative
research under the respective states.

(c) Dr. L. B. Nelson, Eastern Soil and Water
Management Research Branch, Plant Industry
Station, Beltsville, Maryland.

(d) Experimental and field investigations,
both basic and applied for development and
design.

(e) The purpose of these studies is to obtain
fundamental information on the mechanics
of rainfall runoff and erosion, to deter-
mine the effects of the basic factors -
climatic, topographic, soil and cover on
runoff and soil loss, and to evaluate
various soil and water management practices
from the standpoint of runoff and erosion
control in the humid region. Erosion con-
trol practices including terracing and
strip cropping are developed and improved
to function effectively in the present day
multiple-row-power system of farming. The
relationships and evaluations secured from
the studies are combined into equations or
graphs for estimating runoff and individual
field soil loss for use in the design of
conservation farm plans and in determining
probable sediment production for use in
watershed protection programs. Grass
waterways are studied from the standpoint
of establishment and maintenance and their
use coordinated with grade stabilization
structures and supporting erosion control
practices. Methods for the establishment
and maintenance of vegetation for erosion
control on areas of exposed subsoil, in-
cluding roadside areas are under develop-
ment. The integration of soil and water
management and erosion control practices
are studied on individual fields and in
farm-sized units to determine and improve
their practicability for farm use. Im-
proved techniques and devices are develop-
ed to facilitate the making of required
research measurements. The work is carried
on in carefully controlled laboratory and
fractional acre plot studies and on pri-
mary unit or field sized watersheds in
different erosion control and management
practices. Both meteorological and hydro-
logical measurements are made. The basic
data are assembled in a central statisti-
cal laboratory for placement on punch

cards for machine and graphical correlation
analysis.

(g) A universal method for estimating field
soil loss has been developed. The erosion
potential of rainfall using first order
Weather Bureau Station data has been com-
puted for about half of the humid region.
Additional data on runoff and soil loss
under different soil management methods was
secured during the year. Part of this was
secured with the recently developed field
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Trans. Amer. Geo. Un. 39(2): 285-291,
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Rainfall Erosion Research in the United
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Proc. Fifth International Congress of Agr.
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Soil-Plant Relationships Section.

(26) DRAINAGE INVESTIGATIONS IN COACHELLA
VALLEY, CALIFORNIA.

See University of California, College of
Agriculture, Division of Irrigation and
Soils, page 4.

(2172) MOVEMENT AND DISTRIBUTION OF WATER AND
SALTS IN UNSATURATED SOIL.

(b) Laboratory project.
(c) Dr. L. A. Richards, P. O. Box 672, River-
side, California.
(d) Field investigation; basic research.
(h) "Soil Moisture", L. A. Richards and S. J.
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Ogata, L. A. Richards and W. R. Gardner,
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Drying of Soils and Other Porous Media",
W. R. Gardner, Soil Sci. Soc. Amer. Proc.
23: 1959 (in press).

(2173) EVAPORATION FROM FIELD SOILS IN THE PRES-
ENCE OF A WATER TABLE.

(b) Laboratory project.
(c) Mr. Ronald C. Reeve, P. O. Box 672, River-
side, California.
(d) Experimental; applied research.
(e) A study that is being conducted at selected
field sites to develop a reliable method
for measuring evaporation from soils in
the field and to determine the applica-
bility of the theory for evaporation from
soils in the presence of a water table to
the solution of field problems.

(2648) EVALUATION OF THE LEACHING REQUIREMENT
THEORY FOR CONTROLLING SOIL SALINITY.

(b) Laboratory project.
(c) Mr. R. C. Reeve, U. S. Salinity Laboratory,
P. O. Box 672, Riverside, California.
(d) Experimental; basic research.
(e) Involves the measurement of both inflow
and outflow of both water and salt from
soil columns in lysimeters in which crops
are grown under varying water table depths
and irrigation regimes. To test the va-
lidity of the leaching requirement theory
for controlling soil salinity and to de-
termine the effects of soil salinity and
water table conditions on the growth of
crops.
(g) Experimental results add support to the
leaching requirement theory.

(2900) ENTRY OF WATER INTO SOILS.

(b) Laboratory project.
(c) Dr. W. R. Gardner, P. O. Box 672, River-
side, California.
(d) Theoretical and experimental; basic re-
search.
(e) The diffusion equation is applied to the
movement of water into soil. The effect
of water content and soil properties on
intake rates is determined. The influence
of exchangeable sodium and salinity of
irrigation water is also included.
(h) "Solutions and Tests of the Diffusion
Equation for the Movement of Water in
Soil", W. R. Gardner, and M. S. Mayhugh,
Soil Sci. Soc. Amer. Proc. 22:197-201,
1958.
"The Effect of Electrolyte Concentration
and Exchangeable Sodium Percentage on the
Diffusivity of Water in Soil", W. R.
Gardner, M. S. Mayhugh, J. O. Goertzen,
and C. A. Bower, (in preparation).

WATERSHED TECHNOLOGY RESEARCH BRANCH.

(150) EXPERIMENTAL WATERSHEDS STUDIES.

See also Stanford University Project 1946,
page 67.

(b) Cooperative with State Agricultural Experi-
ment Stations, Soil Conservation Service,
U. S. Weather Bureau, U. S. Geological
Survey, U. S. Bureau of Reclamation, U. S.
Bureau of Public Roads, Stanford University,
University of Iowa, St. Anthony Falls Hy-
draulic Laboratory, Central and Southern
Florida Flood Control District, and the
Wisconsin Valley Improvement Company.
(c) Mr. Austin W. Zingg, Watershed Technology
Research Branch, Plant Industry Station,
Beltsville, Maryland.
(d) Experimental; field and laboratory; for
design of Watershed Protection and Flood
Prevention Projects and general informa-
tion in planning farms for soil and water
conservation.
(e) Rainfall and runoff are measured on water-
sheds ranging from 1 to 75,000 acres. In
addition to rainfall and runoff measure-
ments, studies are made on small Govern-
ment-operated areas of evapotranspiration,
moisture storage, moisture transmission
through the soil, hydrologic effect of
physiography, tillage, and ground surface
conditions, vegetal covers and soils and
geology, and the effect of conservation
farming on runoff, erosion and the hydro-
logic performance of underlying aquifers,
as well as the characteristics of flood
runoff from agricultrual watersheds. Hy-
drologic records of various kinds are
being obtained on some 130 watersheds at:
Safford and Tombstone, Arizona; Ft. Lauder-
dale and Vero Beach, Florida; Watkinsville
Georgia; Iowa City, Iowa; College Park and
Hagerstown, Maryland; East Lansing, Michi-
gan; Oxford, Mississippi; McCredie,
Missouri; Hastings, Nebraska; Newell,

South Dakota; Albuquerque and Santa Rosa, New Mexico; Cohocton and Dutchess County, New York; Coshocton, Ohio; Stillwater, Oklahoma; Riesel (Waco), Texas; Blacksburg, Virginia; Moorefield, West Virginia; Colby, Fennimore and LaCrosse, Wisconsin; Montpelier, Vermont. Other studies include (1) analysis and interpretation of accumulated records and (2) development of procedures for generalizing synthetic unit hydrographs for watersheds primarily under 3000 acres in size and (3) unit established at Lincoln, Nebraska cooperatively by U. S. Soil Conservation Service, U. S. Bureau of Reclamation and U. S. Agricultural Research Service to develop methods for estimating the influence of watershed protection programs upon water yields.

(g) Processing of the large backlog of accumulated hydrologic data has been continued. During 1958 a publication entitled "Annual Maximum Flows From Small Agrigultural Watersheds in the United States" was distributed. Tabular data in this publication includes the maximum discharge for each year and the annual maximum volume for periods of 1, 2, 6, and 12 hours and 1, 2, and 8 days for each of more than 300 experimental watersheds. This publication is a supplement to the document entitled "Monthly Precipitation and Runoff From Small Agricultural Watersheds in the United States" distributed in 1957. Summarization for the third document to be entitled "Selected Runoff Events" from approximately 50 watersheds is in process. It will give precipitation and runoff detail for selected major storm events on each of the watersheds. With the completion of the last publication, processing of the large backlog of hydrologic data will be substantially completed. Only data from a few watersheds requiring special studies for weir calibrations, etc. will remain. The detailed data for substantially all watersheds is available to all users at the offices of the various project locations. No further processing and distribution in quantity of data obtained prior to 1955 will be necessary after the third publication is completed. Some progress has been made in the analysis of data. Riesel, Texas analysis resulted in development of a promising method of estimating antecedent soil moisture for use in the prediction of runoff by means of rainfall runoff relationships. At Coshocton, Ohio it has been found that of the water infiltrating into the small upland fields about 11 inches reappears as streamflow below drainage areas of about 1,000 acres, thus demonstrating the importance of the underlying aquifers in the functioning of watershed protection measures. Analysis of data from small gaged watersheds in California resulted in a method for predicting the magnitude and frequency of flows from ungaged upstream watersheds in certain areas in that State. Studies of records from experimental watersheds in Texas, Nebraska, and Ohio have shown that, in periods of

unusually heavy rainfall in these areas, the effects of conservation practices on volumes of storm runoff are relatively insignificant once the soil profile is thoroughly wetted. At the Tombstone, Arizona experimental watershed, where the 60 square mile watershed is served by about one raingage per square mile and where coverage has been made with the radar equipment of the Institute of Atmospheric Physics, studies have shown that the average diameter of "single cell" storm areas is less than a mile. This finding is of considerable significance in understanding the rainfall patterns and rainfall-runoff relations in the Southwest. From the data of several experimental watersheds in Arizona, New Mexico, and Colorado a method was developed for synthesizing stream flow hydrographs for small arid land watersheds. The Cooperative Water Yield Procedures Study at Lincoln, Nebraska, initiated in 1957, was continued. This study has in some instances made clear the need for longer and more detailed hydrologic records and data.

Additional watersheds have been instrumented on range land areas near Newell, South Dakota; on mixed use areas in the Piedmont Area and Ridges and Valleys Area in Virginia; on pasture near Moorefield, West Virginia in the shale area; and on mixed land use areas near Danville, Vermont. (Headquarters for the Vermont work were moved from Montpelier to Danville). Collection of hydrologic records were reinitiated on a 4380 acre watershed at Riesel, Texas.

(h) "Leaching Loss", F. R. Dreibelbis and J. L. McGuinness. What's New in Crops and Soils, 10(7): 24,44 (1958).
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"Antecedent Soil Moisture Index from Daily Precipitation", M A. Hartman, R. W. Baird, J. B. Pope, and W. G. Knisel. Research Report No. 312. July (1958).

"Runoff -- How Fast and How Much", J. B. Burford and J. H. Lillard, Soil Conservation, 24-4:81-83 (11-1958). Paper presented before meeting of Soil Conservation Society of America by R. V. Keppel and Joel E. Fletcher at Asheville, N. C., Oct. 1958.

(1723)   THE HYDRAULICS OF CONSERVATION STRUCTURES.

See St. Anthony Falls Hydraulic Laboratory Projects Nos. 111, 1168, 1398, 1929, page 62; 2386, page 63; and 2860, page 65.

(b)   Cooperative with the Oklahoma and Minnesota Agricultural Experiment Station, the St. Anthony Falls Hydraulic Laboratory, and Illinois State Water Survey, Urbana, Ill.

(c)   Mr. Austin W. Zingg, Watershed Technology Research Branch, Plant Industry Station, Beltsville, Maryland.

(d)   Experimental; applied research for development and design.

(e)   Research dealing with the design, construction, and testing of structures for controlling and conserving soil and water are carried out under this project. Field studies are made to determine the causes of deterioration of drainage ditches, terrace outlets, and hydraulic structures that have failed in service. Laboratory experiments in methods of preventing such deterioration are supplemented by field tests of those measures or devices that appear promising. Models of hydraulic structures are built and tested in the laboratory; and when the design has been developed to seemingly satisfactory operation, full-scale structures are tested before they are recommended for field use. At the Stillwater, Oklahoma Outdoor Hydraulic Laboratory tests are being made to establish friction coefficients of various crops for use in the Manning channel flow formula, and studies are being continued on the use of highway culverts for measuring flow rates. At the St. Anthony Falls Hydraulic Laboratory studies were continued on the capacity and performance of the hood inlet to the closed conduit spillway and on the hydraulic design characteristics of drain tile. Cooperative studies on drop inlets were initiated with the Illinois State Water Survey at Urbana, Illinois.

(g)   Investigations of a drop inlet entrance and a combination anti-vortex baffle and debris guard for the entrance were carried out at the Outdoor Laboratory at Stillwater, Okla. The tests were run on a 30-inch square drop inlet entrance to a 24-inch diameter closed conduit spillway. The combination anti-vortex baffle and debris guard consisted essentially of an 8-foot square wood box with 2-foot sides, inverted over the drop inlet, and with the lower sides of the box supported one foot below the crest of the drop inlet. A wood grid prevented trash from entering the inverted box from the bottom. This design is in current use by the Soil Conservation Service in Oklahoma. Tests showed that, when clean, the guard had little adverse effect on the weir coefficient. However, when trash had accumulated about the guard, there were substantial reductions in discharge. Complete information on the tests is being distributed in a Research Report.

The theory and results of tests conducted at the St. Anthony Falls Laboratory on closed conduit spillways were assembled in a four-volume publication which has been supplied to pertinent Soil Conservation Service offices and is available for all agencies and individuals interested in closed conduits. Studies of the hood drop inlet for closed conduit spillways were initiated at the St. Anthony Falls Hydraulic Laboratory. This inlet consists of a drop box which discharges through a hood entrance to the conduit. In the study, the premise is that the drop box will control the head and the hood entrance insure a full flowing conduit. Preliminary tests show that the performance of the spillway was related to both the size and height of the drop inlet. Further tests are necessary to develop recommendations for the best dimensions of the various elements. At the outdoor hydraulic laboratory near Stillwater, Oklahoma, further information was obtained for design of diversion and terrace channels to carry specified flows when planted to crop vegetation. Using two channels of 0.1 percent slope and row direction parallel to the channel length axis, tests were conducted to determine differences in retardance values of wheat at heading stage due to row spacing. Manning's N values were 0.38 for 7-inch

row spacing and 0.20 for 14-inch spacing at flows of 0.25 cfs/foot of width. At 1.5 cfs/ft of width, both conditions had N values of about 0.16. Applicability of the "N vs VR" method of design developed at Stillwater was further tested using the same two channels, one planted in short "common lespedeza" and the other in medium length "weeping lovegrass." Analyses of these data are not complete, but a report covering the 16 different experiments during the last 4 years is under preparation for release within the next several months. Model studies were conducted to test the suitability of selected road culverts for use in streamflow measurement. It was found that a combination of a small V notch and the culvert entrance made a satisfactory control for both low and high flows. The culvert capacity was reduced 5 percent or less depending upon the height and location of the V notch. This may have an important bearing on lessening costs of flow measurements.

Studies are being initiated in cooperation with the Illinois State Water Survey Division at Urbana on horizontal circular plate anti-vortex devices on drop inlets. The experimental apparatus has been designed and is being installed. Plans for the experimental program have been completed and the models are under construction.

(h) "Hydraulics of Closed Conduit Spillways - Part X, The Hood Inlet", F. W. Blaisdell and C. A. Donnelly. Tech. Paper No. 20, Series B. University of Minnesota, St. Anthony Falls Hyd. Lab., April (1958).
"Hydraulics of Closed Conduit Spillways - Parts II through VII. Results of Tests on Several Forms of the Spillway", F. W. Blaisdell. Tech. Paper No. 18, Series B, University of Minnesota, St. Anthony Falls Hydr. Lab. March (1958).
"Hydraulics of Closed Conduit Spillways - Part VIII, Miscellaneous Laboratory Tests; Part IX, Field Tests", F. W. Blaisdell, Tech. Paper No. 19, Series B by University of Minnesota, St. Anthony Falls, Hydr. Lab. March (1958).
"Hydraulics of Closed Conduit Spillways - Part I Theory and Its Application", F. W. Blaisdell, Tech. Paper No. 12, Series B by University of Minnesota, St. Anthony Falls Hydr. Lab. Revised, Feb. (1958).

(2175) SEDIMENTATION IN RESERVOIRS, STREAMS AND VALLEYS.

(b) Cooperative with State Agricultural Experiment Stations in Mississippi, Nebraska and New York, with the Univ. of Mississippi and with Massachusetts Institute of Technology at Boston, Massachusetts.

(c) Mr. Austin W. Zingg, Watershed Technology Research Branch, Plant Industry Station, Beltsville, Maryland.

(d) Experimental; field and laboratory, for design of Watershed Protection and Flood Prevention Projects and general information in planning farms for soil and water conservation.

(e) Field and laboratory studies are made to determine sediment sources in watersheds, the character and amount of sediment carried out of watersheds, the nature and rate of movement in channels, the nature and rate of streambank erosion, and the nature and rate of deposition of sediment in channels, on flood plains and in reservoirs and harbors. Field studies generally are confined to watersheds of less than 100 square miles in area. Evaluation studies are made of various types of control measures to determine their effectiveness in reducing sedimentation damages. The work is oriented to meet the immediate and specific needs for information for planning and design of watershed treatment programs in connection with soil conservation and flood prevention work. Studies are being carried on from field headquarters at Oxford, Miss.; Lincoln and Hastings, Neb.; and East Aurora, New York.

(g) Computations based on surveys of soils and land use, indicate an average annual gross erosion rate of about 14 tons per acre on a sub-watershed of 518 acres in the Pigeon Roost Creek Experimental Watershed, near Oxford, Mississippi, while 3.4 tons per acre were measured as the sediment yield from this area during the first year of sediment sampling, suggesting a sediment delivery rate of about 24 percent for this sub-watershed. During the same year the sediment yield from a sub-watershed of 35.6 square miles in size was 7.4 tons per acre. These are some of the first data to become available from the recently expanded research location in Mississippi, and although not conclusive with respect to long-term trends, they do indicate something of the magnitude of sediment quantities delivered to downstream points.

Resurveys of selected gullies in Lafayette, Carrol and Tallahatchie Counties, Miss., indicate 1 to 9 inches erosion per year on the bare area above catchment structures. This is considerable variation from 2-inch-per-year rate commonly used in estimating this type of erosion for design of sediment storage requirements in flood-water detention structures in the Loess Hills and Terraces Problem Area. Further refinement in gully classification is needed for determining the significance of gullies as sediment sources.

Streamgaging and stream bed observations on Pigeon Roost Creek have revealed a very pronounced discontinuity in the depth-versus-flow relationship. At one of the gaging stations, for instance, there are two distinct stage-discharge relationships which overlap at stages between 4 and 5 feet. Within this transition range of stage the flow at times may be twice what it is at other times at the same gage height, with no perceptible change in stream cross-sectional area. The discontinuity is clearly due to much lower resistance to flow at some stages than at

other and appears to be related to the type of sand dune formations on the stream bed. It has not been possible thus far to collect a sufficient number of sediment samples to describe changes in sediment load with respect to the stage hydrograph but the phenomena of the shifting rating curve may prove to be an important point in understanding process of sediment movement in sand bed channels. Ten stock ponds in the Pieree, South Dakota Land Utilization Area, were resurveyed during the past year to determine sediment yield from their watersheds since the Soil Conservation Service survey of June 1945. Precipitation and rainfall intensity data for the period 1939 through 1955 have been plotted and studied for relating sediment yield to precipitation parameters.

Sedimentation surveys were made on 8 stock water ponds in the Bluestem Hills Problem Area near Emporia, Kansas, in cooperation with the Soil Conservation Service to establish a base for estimation of sediment yields from various range sites in this area.

Studies to compile information on the volume-weight of reservoir sediment were continued in Illinois and Kansas. The radioisotope sediment densitometer developed by the Bureau of Reclamation under auspices of the Federal Interagency Committee on Water Resources, Sedimentation Subcommittee, was field tested on Sabetha Reservoir in Kansas for comparison with the standard mechanical sediment sampler. Some operational difficulties were encountered but the experience indicated that an instrument embodying a source of nuclear radiation can be used successfully in measuring the specific density of reservoir sediments. Further work along this line is projected.

About seven miles of Buffalo Creek channel, near Buffalo, New York, were investigated in connection with periodic appraisal of the effectiveness of stone riprap on this stream as a means of streambank erosion control. Areas of bank erosion and damage to revetments were measured, classified as to extent and located relative to stream bends. Deposition areas were also noted and their positions located with respect to the descriptive elements of channel geometry. The results were summarized with observations of other years and presented in a technical paper.

Studies on the variation of fluid shear stress along the perimeters of channels of varying alignment were initiated under a research contract with Massachusetts Institute of Technology. This research is designed to provide basic information on the distribution and magnitude of forces which cause stream channel erosion and to develop improved criteria for designing channel stabilization measures. The investigation is being carried on primarily by means of model studies in simulation of conditions encountered along Buffalo Creek Channel.

(h) "Needed Research in Sedimentation", by

W. C. Ackermann. Trans. AGU 38: 925-927 (1957).

"Importance of Sheet Erosion as a Source of Sediment", L. M. Glymph, Jr. Trans. AGU 38: 903-907 (1957).

"Preliminary Report on the Stage-Discharge Relationship for Pigeon Roost Creek Near Byhalia, Mississippi", Bruce R. Colby. Research Report No. 311. July (1958).

WESTERN SOIL AND WATER MANAGEMENT RESEARCH BRANCH.

(151) LINING OF IRRIGATION CANALS AND RESERVOIRS.

(b) Laboratory project; Agricultural Research Service, Utah State University, and Bureau of Reclamation cooperating.

(c) Dr. C. W. Lauritzen, Agricultural Research Service, Box 177, College Hill, Logan, Utah.

(d) Experimental; basic and applied research.

(e) Linings for irrigation canals and reservoirs are being tested to develop more effective and lower cost methods of reducing seepage losses in irrigation systems. The investigation includes: (1) Evaluation of physical properties of lining materials; (2) model testing of linings in an outdoor laboratory; and (3) field testing at selected sites to determine relative durability under varying subgrade and climatic conditions.

(g) A built-up asphalt lining, consisting of alternate layers of sprayed asphalt and treated jute burlap, has shown good durability as an exposed lining. Installation costs vary with site conditions but have been lower than costs for concrete or prefabricated asphalt linings. Installations have been made at a number of locations to test durability under widely varying climatic conditions. Additional installation to extend the range of test site condition are planned.

(h) "Built Up Asphalt Linings for Canals and Reservoirs", C. W. Lauritzen and F. W. Haws, American Society of Agricultural Engineers paper, December, 1957.

(2177) WATER REQUIREMENTS IN IRRIGATED AREAS OF THE PACIFIC SOUTHWEST.

(b) Laboratory project, cooperative with Western States' Agricultural Colleges, State Engineers, Soil Conservation Service, and Bureau of Reclamation.

(c) Mr. Harry F. Blaney, Room 1131, Bartlett Bldg., 215 W. 7th Street, Los Angeles, California.

(d) Field experiments and office analysis.

(e) (1) To determine the consumptive use of water by agricultural crops and native vegetation and water requirements for irrigated crops. (2) To compile and prepare for publication available data relating to irrigation requirements and consumptive use as determined by field experiments. (3) To estimate water requirement from climatological and other data.

(g) Normal rates of consumptive use and irrigation water requirements have been

estimated and provisional reports prepared for several western states and Colorado River Basin. These values have been computed by the Blaney-Criddle formula: $U = KF$. Where U is a consumptive use in inches, K is an empirical coefficient based on experimental measurements and F is a factor determined from monthly mean temperatures and percent day-time hours.

(2179) EVAPORATION AND CONSUMPTIVE USE OF WATER INVESTIGATIONS IN THE SAN FRANCISCO BAY AND ADJACENT AREA.

(b) Laboratory project, cooperative with Div. of Water Resources, State of California; and the Corps of Engineers, San Francisco Bay District, U. S. Army.
(c) Mr. Dean C. Muckel, P. O. Box 180, Berkeley, California.
(d) Field investigation.
(e) To determine rates of evaporation from fresh water surfaces, the consumptive use of fresh water by marshland vegetation (tules and cattails), and the consumptive use of water by salt grass at varying depths to water table in the San Francisco Bay and adjacent areas.

(2180) EVAPORATION LOSSES FROM RESERVOIRS.

(b) Laboratory project, cooperative with the State of California and County Flood Control Districts.
(c) Mr. Harry F. Blaney, Room 1131, Bartlett Bldg., 215 W. 7th Street, Los Angeles, California.
(d) Field investigation.
(e) To determine evaporation losses from reservoirs and lakes in California and compile and prepare for publication reliable evaporation and related data measured since 1945 in cooperation with the State Engineer of Calif. Field measurements are being made in cooperation with the State and local agencies on fifteen stations ranging in elevation from 240 feet below sea level at Salton Sea to 9,194 feet at Kaiser Pass in the Sierra-Nevada Mountains.
(g) Monthly evaporation from pans, temperature, humidity, wind movement, and precipitation are being compiled for the various stations. Evaporation from Lakes' surface is being computed by reduction factors. In the mountain areas, records are being kept at Shaver Lake (elevation 5,376 feet); Huntington Lake (elevation 6,954 feet); Florence Lake (elevation 7,345 feet); Kaiser Pass (elevation 9,194 feet).

(2181) STORAGE OF WATER UNDERGROUND FOR IRRIGATION IN CALIFORNIA.

(b) Laboratory project.
(c) Mr. Leonard Schiff, P. O. Box 513, 3813 Chester Avenue, Bakersfield, California.
(d) Experimental applied research.
(e) To determine the factors affecting the percolation rate on water-spreading areas, and to devise ways and means to increase the percolation rate. In some soils the percolation rate decreased during spreading, and the objectives are to determine the cause of the decrease and to find practical methods of maintaining the high initial rates. Field tests are being made on test ponds and strips.
(h) "Some Methods of Alleviating Surface Clogging in Water Spreading with Emphasis on Fillers", Leonard Schiff and C. E. Johnston, American Geophysical Union Transactions 39:2, p. 292-297, April, 1958.

(2185) SPRINKLING AS A METHOD OF APPLYING WATER TO IRRIGATED FARM LANDS, ITS PROBLEMS AND LIMITATIONS.

(b) Laboratory project.
(c) Mr. C. H. Pair, P. O. Box 835, Boise, Idaho.
(d) Experimental; applied research.
(e) The objectives of this study are: (1) To obtain more precise information for the design, layout, installation and operation of sprinkler irrigation systems on various soil types, slopes and crops under various weather conditions; (2) to determine the effect of sprinkling upon various soils and crops; (3) to determine the economic limitations in the use of sprinkler irrigation systems; and (4) to assist in the development and testing of better sprinkler equipment and more efficient operating procedures. Work is continuing on items (1) and (2) of (e) along with testing pressure regulating valves for use in sprinkler systems.
(h) "Design is Important with Sprinklers", Idaho Farmer, p 4, June, 1958.

(2279) LABORATORY AND FIELD STUDY ON THE VORTEX TUBE SAND TRAP.

(b) Colorado Agricultural Experiment Station and Agricultural Research Service, USDA.
(c) Mr. A. R. Robinson, Colorado State Univ., Fort Collins, Colorado.
(d) Experimental; applied research; field evaluation; for design.
(e) Tests will be continued on methods and designs of sand traps. Tests have been completed on full scale vortex tubes using laboratory facilities. Efficiencies of trapping sediment under various conditions are being computed. Tubes of different shapes and sizes were tested. Field evaluations of existing sand trap installations are being planned.
(g) Tubes of different shapes seem to operate equally well. The critical points of design seem to be the size and length of tube. The efficiency of trapping varies with the velocity of flow and the size of material being moved.
(h) Report in progress.

(2649) DEVELOPMENT OF DRAINAGE DESIGN CRITERIA FOR IRRIGATED LANDS.

(b) Laboratory project, cooperative with Colorado State University.

(c) A. R. Robinson, R. W. Nelson, R. E. Brooks, Agricultural Research Service, Colorado State University, and N. A. Evans, Colorado Agricultural Experiment Station, Fort Collins, Colorado.

(d) Experimental; applied research for field design.

(e) Both field and laboratory studies are being made to determine the relationship of discharge, farm water supply, physical features of the drain systems, and drainage characteristics of the soil. Another objective is to check the theoretically derived relationships between soil drainage properties and the shape of the water table after drainage. Work is underway to determine if a detailed knowledge of the geometry and hydraulic conductivities of the soil system in a small area can be extrapolated to a large area to enable the rational design to be made. This study makes use of electric analog technique.

(g) Present indications are that a relationship exists between the variables listed in (e) so that the water yield from a drainage system can be predicted with reasonable accuracy. An electronic computer is being utilized to determine relative hydraulic conductivities over an area of known geometry and piezometric head distribution.

(h) "Drainage Research in Colorado", N.A. Evans and A. R. Robinson, ASAE paper, Dec., 1957. "Laboratory Research and Interceptor Drains", Jack Keller and A. R. Robinson, ASCE, Irrigation and Drainage Division paper, June, 1958. "Measurement of Hydraulic Conductivity in Unstable Soils with the Piezometer Method", R.W. Nelson, ARS Special Report, Oct., 1958.

(2650) EFFECT OF WATER TABLE DEPTH ON IRRIGATION REQUIREMENTS AND YIELD OF LAHONTAN ALFALFA.

(b) Laboratory project, cooperative with Nevada Agricultural Experiment Station.

(c) Mr. Victor I. Myers, Nevada Agricultural Experiment Station, Reno, Nevada.

(d) Experimental; applied research.

(e) The water use and growth of alfalfa as related to varying water table depths, soil texture and irrigation regimes are being evaluated in field lysimeters.

(2651) DRAINAGE INVESTIGATIONS IN THE NORTH SHORE AREA OF CARSON LAKE, NEVADA.

(b) Laboratory project, cooperative with Nevada Agricultural Experiment Station, Soil Conservation Service and Truckee-Carson Irrigation District.

(c) Mr. Victor I. Myers, Nevada Agricultural Experiment Station, Reno, Nevada.

(d) Field investigation; applied research.

(e) Drainage investigations are being conducted in an irrigated area north of Carson Lake to determine the causes for drainage problems in the study area and to develop improved equipment and procedures for conducting investigations and methods for alleviating drainage problems.

(2652) UTILIZATION OF AVAILABLE WATER SUPPLIES IN THE COLORADO RIVER BASIN OF NEVADA.

(b) Laboratory project, cooperative with Nevada Agricultural Experiment Station and the Soil Conservation Service.

(c) Mr. Victor I. Myers, Nevada Agricultural Experiment Station, Reno, Nevada.

(e) A study to determine the present disposition of water in the Colorado River Basin within Nevada and to evaluate the potential water supply available for beneficial use in this basin.

(2653) CONSUMPTIVE USE, WATER SUPPLY AND IRRIGATION STUDIES IN SANTA BARBARA COUNTY, CALIFORNIA.

(b) Laboratory project, cooperative with the U.S.B.R., the U.S.G.S., and the Santa Barbara County Water Users Association.

(c) Mr. Paul Nixon, USDA Agricultural Research Service, Lompoc, California.

(d) Basic and applied research.

(e) Objectives are: (1) To obtain basic data on consumptive use of water by irrigated crops and native vegetation; (2) to determine the contribution of rainfall and return waters from irrigation to the ground water supply; (3) to make irrigation efficiency studies to improve irrigation practices.

(2901) LABORATORY STUDY OF GRAVEL FILTER DESIGN FOR IRRIGATION WELLS.

(b) Agricultural Research Service, U.S.D.A. cooperative with Colorado State University.

(c) Mr. E. Gordon Kruse, Agricultural Research Service.

(d) Experimental; applied research.

(e) Laboratory studies are being conducted to: (1) Determine the relationship of pack-aquifer ratios and pack and aquifer gradations for stable conditions, and (2) develop generalized criteria for the selection and placement of gravel pack material.

(g) Preliminary results indicate pack-aquifer ratios ranging from 4 to 12 are satisfactory for uniform materials. Non-uniform gravel packs make it possible to use larger pack-aquifer ratios.

(2902) DEVELOPMENT AND IMPROVEMENT OF WATER MEASURING DEVICES.

(b) Colorado Agricultural Experiment Station, Agricultural Research Service, USDA.

(c) Mr. A. R. Robinson, Agricultural Research Service, Colorado State University, Fort Collins, Colorado.

(d) Experimental; applied research.

(e) The present phases of this project are concerned with the development and calibration of trapezoidal measuring flumes. It is anticipated that flumes of this design will find wide use for both irrigation and general hydrologic measurements.

(g) Preliminary tests have shown that these flumes may be superior to those with

rectangular cross-sections. They will operate under higher degrees of submergence without connections to the free-flow relationships being necessary. The general shape tends to more closely fit that of a natural or irrigation channel so that construction problems are simplified.

(h) "Trapezoidal Flumes for Open Channel Flow Measurement", A. R. Robinson and A. R. Chamberlain, ASAE paper, December, 1958.

3209) CONSUMPTIVE USE OF WATER BY CROPS IN ARIZONA.

(b) Cooperative with the Arizona Agricultural Experiment Station.
(c) Mr. Leonard J. Erie and Mr. Karl Harris, P.O. Box 2324, Phoenix, Arizona.
(d) Experimental, field research.
(e) The objectives of this project are to: (1) Determine consumptive use of new crops; (2) Keep consumptive use measurements up to date as varieties and production changes take place and; (3) Develop better information on peak period uses and to obtain soil moisture tensions at certain stages of plant development.

(3210) RECHARGE OF UNDERGROUND AQUIFERS USING GRAVEL FILLED SHAFTS.

(b) Cooperative with the Calif. Agr. Exp. Sta. and the Calif. Dept. of Water Resources.
(c) Mr. Eldred S. Bliss, P.O. Box 513, 3813 Chester Avenue, Bakersfield, California.
(d) Experimental, field research.
(e) Project objectives are: (1) To determine the feasibility of injecting water directly into aquifers through gravel filled shafts as a means of recharging underground reservoirs; (2) to study the factors affecting the injection rate through such shafts; (3) to study how clogging can be prevented or alleviated.
(h) "Infiltration and Permeability under Prolonged Submergence as Influenced by Chemical Characteristics of Water", E. S. Bliss, C. E. Johnson and Melvin Jons, Paper, Western Society of Soil Science Meeting, Logan, Utah, June, 1958.

(3211) THE RATE OF ADVANCE OF IRRIGATION WATER IN FURROWS AS A FUNCTION OF MEASURABLE PHYSICAL FACTORS.

(c) Mr. H. Schull, Southwest Irrigation Field Station, Brawley, California.
(d) Experimental, field research.
(e) The project has as its purposes: (1) To develop a mathematical expression, either numerical or graphical, from which the rate of advance of irrigation water down furrows may be accurately predicted; (2) to outline a procedure by which the expression developed may be utilized in the design of furrow irrigation systems.

(3212) THE HYDRAULICS OF CYLINDER INFILTROMETERS.

(b) Cooperative with the Department of

Irrigation, University of California, Davis, California.
(c) Mr. Charles T. Bourns, Department of Irrigation, University of Calif., Davis, Calif.
(d) Experimental, field research.
(e) The objectives are: (1) To determine the hydraulics of flow from cylinder infiltrometers; (2) to evaluate and describe the necessity for use of buffer zones both in uniform and stratified soils as related to depth and method of installation; (3) to evaluate the effects of various procedures or techniques of installation and of test conditions on the hydraulics of flow from cylinder infiltrometers.

(3213) DEVELOPMENT OF A DEVICE FOR FIELD MEASUREMENT OF HYDRAULIC CONDUCTIVITY OF SOIL STRATA.

(b) Cooperative with Calif. Dept. of Water Resources, Soil Conserv. Serv. and Irrigation and Soil Conserv. Districts.
(c) Mr. W. W. Donnan and Mr. V. S. Aronovici, Pamona Irrigation Laboratory, Pamona, Calif.
(d) Experimental, applied research.
(e) The research objectives of this project are to develop a relatively simple field device for use in measuring hydraulic conductivity of soil beneath a water table and to test the device under field conditions. Methods and techniques for use in the field are to be developed.
(h) "Drainage of Agricultural Lands Using Interceptor Lines", W.W. Donnan, ASCE Irrigation and Drainage Division paper, June, 1958.

(3214) BASIN IRRIGATION SYSTEMS FOR EROSION CONTROL AND WATER CONSERVATION ON THE IRRIGATED LANDS OF WESTERN NEBRASKA.

(b) Project cooperative with the Nebraska Agricultural Experiment Station.
(c) Mr. N. P. Swanson, 201 Agr. Engrg. Bldg., Univ. of Nebraska, Lincoln, Nebr.
(d) Experimental, field research.
(e) The objectives of the study are: (1) To determine the design requirements for a basin irrigation system on a field slope of three percent or more, to prevent damage to the irrigation system and eliminate erosion from high intensity rains of a 5-year frequency; (2) to measure intake rates, rates of advance, irrigation application efficiencies and distribution efficiencies with various crops at different times during the growing season and; (3) to determine what facilities are needed to dispose of the excess precipitation.

(3215) DETERMINATION OF THE QUANTITY AND EFFECTS OF PLAYA LAKE SEDIMENTS RETAINED IN MULTIPLE PURPOSE WELLS USED FOR GROUND WATER RECHARGE AND IRRIGATION IN THE HIGH PLAINS OF TEXAS.

(b) Cooperative with the High Plains Underground Water Conservation Dist. No. 1, Texas Agr. Exp. Sta. and the Soil Conservation Service.

(c) Mr. M.E. Jensen and Mr. W. Clyma, USDA Southwestern Great Plains Field Station, Bushland, Texas.

(d) Experimental, field research.

(e) The primary objectives of the study are: (1) To determine the quantity of sand, silt and clay entering recharge wells during the recharge operation from Playa lakes; (2) to determine the quantity of sand, silt and clay pumped from multiple-purpose wells during the pumping cycle of a recharge operation and; (3) to determine the changes in specific yield of study wells resulting from retained sediments.

(h) "What Happens to Sediments in Playa Lake Waters when used for Underground Recharge in Multipurpose Wells", M.E. Jensen and W. Clyma, publication in the Cross Section (Texas Hi-Plains Underground Water Conservation District Paper).

(3216) PERFORMANCE OF SUBSURFACE DRAINAGE INSTALLATIONS IN THE LOWER RIO GRANDE VALLEY OF TEXAS.

(b) Cooperative with the Texas Agr. Exp. Sta., Soil Conservation Serv. and the Lower Rio Grande Valley Soil Conservation Districts.

(c) Mr. L. R. Ussery, Texas Agr. Ext. Sta., P.O. Box 157, Weslaco, Texas.

(d) Experimental, field research.

(e) The purpose of the study is to measure the influence of drains on depths to and fluctuation of ground water tables. Actual field data will be related to present design criteria and empirical drain spacing formulas.

(3217) HYDROLOGIC STUDIES OF GROUND WATER IN RED RIVER VALLEY OF NORTH DAKOTA.

(b) Project cooperative with the North Dakota Agricultural Experiment Station.

(c) Mr. Rome Mickelson, Henry Bldg.,Room 19, P.O. Box 806, Grand Forks, North Dakota.

(d) Field research.

(e) The objectives of the study are: (1) To determine the water table levels in a segment of the problem area; (2) to evaluate artesian and downward flow condition in the area; (3) to determine the direction of ground water flow and extent and benefits of natural and artificial drains existing in the area; (4) to study ground water quality in observation wells in the area and; (5) to study and analyze the physical and chemical properties of soils in the area as related to the water transmissibilities of the soil substrata.

(3218) SOIL EROSION AND ROUGHNESS CHARACTERISTICS UNDER FURROW IRRIGATION.

(b) Project cooperative with the Washington Agricultural Experiment Station.

(c) Mr. S. J. Mech, Irrigation Experiment Station, Prosser, Washington.

(d) Field research.

(e) The influence of soil management and water intake on erosion under furrow irrigation is being studied. Some of the variables being considered are cropping practices, moisture levels and slope. The variation of the roughness coefficient (Manning N) is being studied.

(f) Active.

(g) "Influence of Soil Management and Water Intake on Erosion under Furrow Irrigation", S. J. Mech, ASAE paper, June, 1958.

U. S. DEPARTMENT OF AGRICULTURE, FOREST SERVICE, Alaska Forest Research Center.

(2654) EFFECT OF LOGGING ON PHYSICAL CHARACTERISTICS OF SALMON STREAMS IN SOUTHEAST ALASKA.

(b) Laboratory project.

(c) Mr. R. F. Taylor, Forester in Charge, Alaska Forest Research Center, P.O. Box 740 Juneau, Alaska.

(d) Field investigation; applied research.

(e) In developing the timber resources of the region, it is essential that adequate steps be taken to safeguard the important fisheries resource. The objective is to determine whether logging, carried out in accordance with provisions required by the Forest Service to protect salmon spawning streams, causes physical changes to the watershed and stream regimen which might be harmful to the stream for salmon protection. The following factors are being investigated: (a) Changes in the stream regimen; (b) erosion and sedimentation; (c) stream channel change; (d) accumulation of debris in streams; (e) change in stream bottom material; and (f) water temperature and pH.

(g) The first, or calibration, phase of this study has resulted in information on the hydrological characteristics of undisturbed streams in a glaciated region with heavy precipitation.

(h) "Effect of Rainfall on Stream Flow in Southeast Alaska", L.W. Zach, Alaska Forest Research Center Technical Note No. 4, 3 pp., 1950.
"The Relationship Between Precipitation and Stream Flow on a Typical Southeast Alaska Stream", G.A. James, Alaska Forest Research Center Technical Note No. 24, 3 pp., 1955.
"The Physical Effect of Logging on Salmon Streams of Southeast Alaska", G.A. James, Alaska Forest Research Center Station Paper No. 5, 49 pp., 1956.

U. S. DEPARTMENT OF AGRICULTURE, FOREST SERVICE, California Forest and Range Experiment Station.

(261) WATERSHED MANAGEMENT RESEARCH, SOUTHERN CALIFORNIA.

(b) Laboratory project.

(c) Dr. R. Keith Arnold, Director, California Forest and Range Experiment Station, P. O. Box 245, Berkeley 1, California.

(d) Experimental; field investigations; basic and applied research.

(e) Purposes are (1) to determine how watersheds function: what happens to the precipitation, and how water and soil movement are influenced by conditions of vegetation, soil, geology, and topography; and (2) to develop methods of watershed management, including treatment of areas denuded by fire, to insure maximum yield of usable water and satisfactory flood runoff and soil erosion control. Major work center is the San Dimas Experimental Forest situated in the San Gabriel Mountains of southern California. Here rainfall and runoff are measured on two major drainage areas, on 10 large and 7 small watersheds within these areas, and on 24 experimental plots. Sedimentation is measured from the major drainages, small watersheds, and plots. Vegetation cover on the watersheds is mostly mature brush or chaparral, unburned for 39 years or more. However, in 1953 about one-third of one large watershed was burned-over by wildfire and in 1938 one-fourth of another large watershed, 3 small watersheds, and 9 plots were denuded by wildfire. Fifteen other plots are equipped to obtain detailed information on the disposition of rainfall from annual grass, native scrub oak-chaparral, and 30-year-old Coulter pine plantation. Twenty-six large lysimeters furnish comparisons of water use and surface runoff control by five species of native shrubs, one species of pine, and a bunch-grass associateion. Climatic data are obtained from several meteorological stations. Measurements to determine kinds, rates, and volume of soil movement (soil, rock, and organic debris) are made at eight study sites on brush covered slopes in the Los Angeles River watershed. After normal erosion rates have been established, the above sites will be used to evaluate effects of promising cover improvement practices upon soil stability.

(g) New tests of applied watershed management to increase water yield from mountain wild lands were carried forward on the San Dimas Experimental Forest. Vegetation is being changed on selected portions of two calibrated watersheds. Two adjacent watersheds are being mainatained as untreated controls. In Monroe Canyon, a watershed of 875 acres, the trees and large shrubs on about 15 acres of the woodland-riparian zone along the main channel were removed, stumps were poisoned, and the remaining broad-leafed vegetation was sprayed with silvicides. About 65 additional acres of canyon bottom vegetation is being treated similarly during the current winter. In 100-acre Bell watershed No. 2, 40 acres of brush on the side slopes having soil over 2-1/2 feet deep was sprayed with silvicides by helicopter. Good coverage and excellent leaf kill was accomplished but it is expected additional annual sprayings will be required to kill the resistant brush species. Preliminary observations indicate that the partial removal of woodland-riparian vegetation in Monroe Canyon increased summer streamflow. A test to compare soil moisture measurement with a neutron probe, Colman electrical resistance units, and gravimetric sampling was conducted at the San Dimas lysimeters. The homogeneous soil in these tanks provides ideal test conditions. Total water content in six feet of soil under grass cover as determined by the three methods referred to above was 17.7, 17.7, and 17.6 inches respectively. These results indicate the accuracy of the new neutron probe technique. A study in brush-covered plots before and after killing the shrubs with 2,4,5-T has shown that evaporative losses were greatly reduced as a result of the treatment. The brush was dense scrub oak-chaparral with a good litter cover on 12 feet of soil. Available moisture at the start of the wet season and annual rainfall were nearly the same during each of the years immediately before and after treatment. Water losses were reduced to about one-half during the wet (winter) season and to about one-third during the dry (summer) season by killing the brush. Average daily evapo-transpiration was reduced from 0.046 to 0.024 and from 0.052 to 0.018 inches per day for the wet and dry seasons respectively. Studies of soil erosion (soil, rock, and organic debris) were made during 5 years on brush-covered slopes in the San Gabriel Mountains. Debris moving down the slopes was caught in troughs placed on contour and flush with the ground surface. Amounts and rates of debris movement varied widely between seasons and sites. The primary debris sources contributing to sediment problems in the Los Angeles River drainage proved to be the steep southerly slopes above rejuvenated stream channels (channels in which down-cutting has been renewed by geologically recent uplift of the mountain fault block). These slopes produced an average of 4.3 tons of material per acre annually. Dry season (summer and fall) movement averaged about twice that of the wet season (winter) during the period of study.

(h) "Research by the U. S. Forest Service, San Dimas Research Center", by P. B. Rowe, Proceedings, Conference on Sediment Problems in California, Committee on Research in Water Resources, University of California, Berkeley, California, pages 23-25, Nov. 26-27, 1956.
"More Good Water-Research at San Dimas Experimental Forest Applying Fundamentals to Entire Watersheds," by Walt Hopkins, Calif. Forest and Range Exp. Station, Misc. Paper No. 22, 6 pp., illus., March 1958.
"Reversal Indicator for a Water Leval Recorder," by Lowell A. Andrews, Engineering News-Record, June 19, 1958.
'Growth of Native and Exotic Plants Under Controlled Temperatures and in the San Gabriel Mountains California," by Henry Hellmers and William C. Ashby, Ecology 39 (3): 416-428, July 1958.

"From Forest Influences to Applied Water-shed Management in Southern California," by Walt Hopkins, J. D. Sinclair, and P.B. Rowe. To be published in Proceedings, 1958 Annual Meeting Society of American Foresters.
"Tests of Applied Watershed Management to Increase Water Yield - San Dimas Experiment-al Forest," by P. B. Rowe. To be published in Proceedings of Second Annual Meeting, Arizona Watershed Program.
"Summer Slides and Winter Scour - Dry Wet Erosion in Southern California Mountains," by H. W. Anderson, G.B. Coleman, and P. J. Zinke, California Forest and Range Experi-ment Station Technical Paper No. 144, 1958.
"Improved Determination of Rainfall Rates in Mountain Watersheds." (Abstract) Bull. Amer. Meteorol. Soc. 39(3): 176, 1958, by E. L. Hamilton.

(2415) WATERSHED MANAGEMENT RESEARCH, NORTHERN CALIFORNIA.

(b) Laboratory project.
(c) Dr. R. Keith Arnold, Director, Calif. For-est and Range Expt. Sta., P.O. Box 245, Berkeley 1, California.
(d) Experimental; field investigations; basic and applied research.
(e) The aim is to develop a hydrologic base for land management decisions. The hydrologic effects of wildfires, of attempts at con-version of brushlands to grass, and of log-ging and other land uses are to be evaluated. Present studies emphasize development of methods of management of high elevation snowpacks for maximum control and yield of water. Major work center is in Berkeley with 18 studies being conducted throughout northern California in the headwaters of the Kings, American, Yuba, Truckee, and Feather Rivers. At Teakettle Snow Labora-tory in the Kings River Basin five small watersheds are under calibration for evalua-tion of streamflow and sedimentation.
In the Onion Creek Watersheds in the Ameri-can River Basin, five streams are being gaged and sediment measured. Snow accumu-lation and soil moisture are being measured in logged and unlogged forest and in brush areas, at both Onion Creek and Castle Creek. Castle Creek in the Yuba River Basin is being gaged, suspended sediment measured, and basic snow physics studies are under way. Daily meteorological measurements are being taken at three stations and radiation and snow physics at the headquarters sta-tion.
At Sagehen Creek in the Truckee River Basin sediment and streamflow and their effects on fishlife are being studied in coopera-tion with the Department of Zoology, Univ. of Calif. Also the effects of conversion of brushfields to forest are being studied. At Swain Mountain Experimental Forest in the Feather River Basin snow and soil mois-ture are being measured in forests to be cut in strips and blocks this year. In all, snow accumulation is being measured at 68 special snow courses, soil moisture at 56

plots.
(g) Electronic computer was used to test vari-ous measures of forests as they affect snow accumulation. The measures tested ranged from a single-valued index of forest cover (cover density) to 7-variable expression of the same forest cover. The evidence was that forest variables were improved when we specifically designed them to index the separate effects of forests on solar radia-tion received at the snow surface, back radiation from the trees, and interchange of energy between forests, clouds and sky. Many of the forest effects are not linear; forest effects are much better indexed when this is taken into account in the analysis. Tests were made of ways of simplifying snow sampling at snow courses. For the test course the Onion Creek course we found that the median snow water equivalent of five points was found to be practically as good a measure of snow at snow course as is the mean of 17 points, both in estimating the "true" mean of the course and for predict-ing the flow of a nearby stream.
Evaporation from snow was measured in small polyethyline pans near Wishon Dam in the Kings River Basin. Evaporation for the winter 1957-58 was 2.3 inches for a large exposed open area and 0.2 inches for small forest openings; 2.2 inches of condensation was measured under forest canopies.
Snow measurement in red fir stands at Swain Mountain Experimental Forest showed most snow left on June 4-5, 1958 in small forest openings, next most in mixed old and young forests, next most in open old red fir, and lesser amounts in denser stands and a large opening; no snow was left in an open snow course.
A study of the relation of sediment produc-tion of 75 watersheds to soil erodibility and other sediment causes was started. Measurements of summer soil moisture losses at the 56 forest and brush plots were made using the nuclear soil moisture device. With two complete outfits one was always in operation.
(h) "Progress in Snow Management Research in California," Henry W. Anderson, 26th Annual Western Snow Conference Proc. 1958.
"Progress Report 1957-58, Cooperative Snow Management Research," Henry W. Anderson, Calif. Forest and Range Expt. Sta. 56 pp. illus., processed. June 30, 1958.
"Rain-Snow Flood Sources, Meteorologically Defined," Henry W. Anderson, (Abstract). Bull. Amer. Meteorological Soc. 39(3): 174-5, 1958.
"Forest Effects on Floods in the Northwest," Henry W. Anderson and Robert L. Hobba, (Abs-tract), Trans. Amer. Geophys. Union 39: 504 1958.
"Forest Shade Related to Snow Accumulation," Henry W. Anderson, Raymond M. Rice and Allan J. West, 26th Annual Western Snow Conference Proc. 1958.
"Decrease in Lightning-Caused Forest Fires Through Cloud Seeding," Arnold Court, (Ab-stract). Bull. Amer. Meteorological Soc.

39(3): 179, 1958.
"Selection of Best Snow Course Points,"
Arnold Court, 26th Annual Western Snow Con-
ference Proc. 1958.
"Watershed Management - An Annotated Bibli-
ography of Erosion, Streamflow, and Water
Yield Publication by the California Forest
and Range Expt. Sta." Clark H. Gleason, CF
and RES Tech. Paper 23, 79 pp. illus.,
January, 1958.
"Soil Vegetation Survey of a Central Sierra
Snow Zone Watershed," Robert E. Nelson,
Calif. Forest and Range Expt. Sta. Misc.
Paper 21, 43 pp. illus. December, 1957.

U. S. DEPARTMENT OF AGRICULTURE, FOREST SERVICE,
Intermountain Forest and Range Experiment Station.

Inquiries concerning the following projects should
be addressed to Mr. Reed W. Bailey, Director, Inter-
mountain Forest and Range Experiment Station, Ogden,
Utah.

(2903) STUDIES OF HYDROLOGIC PROCESSES ON FOREST,
BRUSH, AND RELATED RANGELANDS IN CENTRAL
AND NORTHERN UTAH AND SOUTHWESTERN IDAHO.

(b) Laboratory project.
(d) Experimental and field investigations;
basic and applied research.
(e) Studies include the determination of varia-
bility and probability of amount, rate,
duration, time of occurrence, and depth-
area and depth-area-intensity relations of
gross rainfall and snowfall; determination
of forces and factors affecting water con-
tent, accumulation, movement, and melting
of snow; determination of forces, factors,
and soil profile characteristics affecting
the capacity of soil and rock mantles to
absorb and store soil water and the extent
to which storage functions can be altered
by modifying the soil, vegetation, and as-
sociated soil organisms and animals; deter-
mination of forces and factors involved in
water loss by evaporation and evapotranspi-
ration processes and the effects of alter-
ing vegetation and site conditions on these
processes.
(g) Maintained seasonal records at 20 rainfall
recording stations and on three snow courses
and yearlong precipitation records at eight
stations in northern Utah. Records show a
marked correlation between increases in
elevation and precipitation: from 21 inches
at 4,300 feet to 53 inches at 8,000 feet.
Operated ten precipitation storage gages,
ten seasonal and one yearlong recording
rain gage, and conducted snow surveys at
five locations in central Utah. Analyses
of snow accumulation data in northern Idaho
show that maximum snow water equivalent ac-
cumulation increases with and is most in-
fluenced by elevation. Significantly lower
amounts of water accumulate under increas-
ing densities of forest canopy. Snowpack
water equivalent on north aspects exceeds
that on south exposures. A sine curve on

which north aspects are represented by the
high point of inflection and south aspects
by the low point describes these relation-
ships. Evapotranspiration losses in moun-
tain-brush for one year exceeded that of
aspen by 1.5 inches based on the depletion
of soil mantle moisture at the end of the
growing season.

(2905) IMPROVED WATERSHED MEASUREMENTS AND EVALUA-
TION TECHNIQUES FOR FOREST, BRUSH, AND
RELATED RANGELANDS.

(b) Laboratory project.
(d) Experimental and field investigations;
basic and applied research.
(e) This study is to develop and test an in-
strument to detect and record the occurrence
of free-water in snow and its ponding on
the soil surface during the snowmelt period.
(g) A successfully operating instrument was
constructed and tested in a limited number
of situations.

(2907) METHODS OF PREVENTING WATERSHED DETERIORA-
TION ON OPERATED FOREST, BRUSH, AND RE-
LATED RANGELANDS IN IDAHO AND MONTANA.

(b) Laboratory project.
(d) Experimental and field investigations;
basic and applied research.
(e) Studies to develop, apply, and evaluate the
hydrologic and soil stabilizing effects of
modified logging practices and improved
post-logging measures on sediment produc-
tion from operated ponderosa pine forests
on granitic soils in southwestern Idaho
and on peak flow discharges and sediment
production in dense snowpack forests in
northern Idaho and Montana.
(g) Sediment production measurements over a 4-
year period show that careful road location
coupled with adequate safeguards in skid-
trail stabilizing treatments apparently
will permit logging operations consistent
with good watershed management in areas of
loose granitic soils on steep topography.
In 16 logged compartments the areal extent
of logging disturbance ranged from 3.6 to
9.1 percent of the total areas. Haulroads
constituted 58 percent of the disturbed
area, skidtrails 29 percent, and landings
13 percent.

(2908) METHODS OF REHABILITATING FLOOD AND SEDI-
MENT SOURCE AREAS ON DAMAGED FOREST, BRUSH,
AND RELATED RANGELANDS.

(b) Laboratory project.
(d) Experimental and field investigations;
basic and applied research.
(e) Studies to develop and evaluate methods and
techniques of controlling excessive surface
runoff and sheet and rill erosion from
seriously depleted or inadequately protect-
ed sloping forest, brush, and related range-
lands; and to develop and evaluate methods
of stabilizing eroding cut and fill slopes
bared by construction or other disturbances
to lessen sediment production.

(g) Following treatments of contour trenching, fertilization, and reseeding, ground cover re-establishment showed marked improvement in southern Idaho. Game-proof exclosures on depleted and eroding range in Montana were established to test the effects of natural recovery of vegetation, contour trenching and reseeding, and reseeding without trenching. Soil movement plots equipped with catchment tanks were installed. Analyses of records from 16 plots for the past 11 years show that overland flow is related inversely to ground cover, and sediment eroded is directly related to the amount of overland flow. These new data confirm earlier findings that ground cover densities of 65 percent or more are required to prevent soil erosion and hold runoff to a safe level of about 5 percent under the impact of major summer storms.

(h) "Parrish Canyon, Utah: A lesson in Flood Sources", Richard B. Marston, Jour. of Soil and Water Cons. 13: 165-167, 1958. "The Davis County Experimental Watershed Story", R. B. Marston, Intermountain Forest and Range Experiment Station Publication. Processed 37 pp. 1958.

(2909) METHODS OF IMPROVING WATER YIELDS FROM FOREST, BRUSH, ALPINE, AND RELATED RANGE-LANDS.

(b) Laboratory project.

(d) Experimental and field investigations; basic and applied research.

(e) Studies to develop and evaluate methods of converting vegetation types on well-drained slopes to increase amount or improve timeliness of water yields, without accelerating erosion, increasing flood and sediment discharges or impairing water quality; to develop and evaluate methods for artificially controlling snow accumulation snd melt to improve timeliness of water yields from subalpine range areas.

(g) Continued calibration of paired watersheds for the vegetation conversion study. A snowdrifting fence constructed in the subalpine zone induced snowdrifts that persisted 10 days later than undrifted adjacent snowfields. The induced drift was short and mounded in appearance, which suggests that variable cross-winds may have reduced its length.

U. S. DEPARTMENT OF AGRICULTURE, FOREST SERVICE, Northeastern Forest Experiment Station.

Inquiries concerning the following projects should be addressed to Dr. Ralph W. Marquis, Director, Northeastern Forest Experiment Station, 102 Motors Avenue, Upper Darby, Pennsylvania.

(656) WATERSHED MANAGEMENT RESEARCH, DELAWARE-LEHIGH-EXPERIMENTAL FOREST, PENNSYLVANIA.

(b) Laboratory project; in cooperation with the Pennsylvania Dept. of Forests and Waters and U. S. Geological Survey.

(d) Field investigation; basic and applied research.

(e) A study was started in 1948 on the Delaware-Lehigh Experimental Forest, Monroe County, Pa., to determine the water economy for a 1,530-acre watershed covered with scrub oak. The cover is now being converted by planting and fire protection to conifers and the effect on water relations is being measured.

(g) A 5-year planting program was started in 1956. The watershed was calibrated on the basis of the first six years' daily climatic and streamflow record by relating monthly, seasonal, and annual discharge to rainfall and air temperature. A paper describing these relationships is in preparation.

(966) WATERSHED MANAGEMENT RESEARCH, POCONO EXPERIMENTAL FOREST, PENNSYLVANIA.

(b) Laboratory project.

(d) Field investigation; basic and applied research.

(e) Studies have been started on the Pocono Experimental Forest, Wayne County, Pa., to determine effects of forest management practices and logging operations upon the quantity and quality of water yielded by a small watershed. Installations have been established to measure precipitation, streamflow and rainfall interception.

(1187) FROST STUDIES IN THE NORTHEASTERN UNITED STATES.

(b) Laboratory project.

(d) Field investigation; applied research.

(e) To determine the effect of land use and condition upon type and depth of frost formation. Periodic observations of frost type and depth, snow depth, and water content were made on 186 plots throughout the Northeast during the winters 1950-51 and 1951-52.

(f) Completed.

(h) "Influence of Land Use and Forest Conditions on Soil Freezing and Snow Depth," Robert S. Pierce, Howard W. Lull, Herbert C. Storey, Forest Science 4: 246-263, 1958.

(1188) WATERSHED MANAGEMENT RESEARCH, FERNOW EXPERIMENTAL FOREST, WEST VIRGINIA.

(b) Laboratory project.

(d) Field investigation; basic and applied research.

(e) Studies were started in 1951 on the Fernow Experimental Forest, Tucker County, W. Va., to determine the effect of different levels of cutting practices, different logging methods, and different forest uses upon water quantity and quality. Nine watersheds have been equipped with streamgaging stations and rain-gages.

(g) Following six years of record taking, and analysis for calibration, treatment of one group of five watersheds was started in May 1957.

Treatments will be completed in 1958 and the study to determine their effect on streamflow.

(h) "Calibration of Five Small Forested Water-sheds," K. G. Reinhart, Trans. Amer. Geo. Union 38: 933-936, 1958.

(2419) WATERSHED MANAGEMENT RESEARCH, HUBBARD BROOK EXPERIMENTAL FOREST, NEW HAMPSHIRE.

(b) Laboratory project.
(d) Field investigation; basic and applied research.
(e) The objective is to determine the effect of forest type, condition, and treatment on quantity and quality of streamflow. Studies are conducted in plots and experimental watersheds on the 7500-acre experimental forest in the White Mountains at West Thornton, New Hampshire.
(g) Three weirs have been constructed and cli-matic stations established.
(h) "How Type of Soil Frost Affects Infiltra-tion," George R. Trimble, Richard S. Sartz, Robert S. Pierce, Jour. Soil and Water Conserv. 13: 81-82.

(2910) WATERSHED MANAGEMENT RESEARCH, LEADING RIDGE WATERSHED, PENNSYLVANIA.

(b) Laboratory project, in cooperation with the School of Forestry, Pennsylvania State University and the Pennsylvania Department of Forests and Waters.
(d) Field investigation; basic and applied research.
(e) A cooperative study was started in 1957 to determine the effect of forest cover and treatment on quantity and quality of streamflow in the oak-hickory type in Pa., and to study associated and basic soil-water relationships.
(g) Three experimental watersheds have been selected, weirs have been constructed, and a climatic station established.
(h) "Forest Watershed Management Research in the Ridge and Valley Section of Penn.," Irvin C. Reigner, William R. Byrnes, E. F. McNamara, Northeastern Forest Expt. Sta. 7 pp., 1958.

U. S. DEPARTMENT OF AGRICULTURE, FOREST SERVICE, Pacific Northwest Forest and Range Experiment Station.

Inquiries concerning the following projects should be addressed to Mr. R. W. Cowlin, Director, Pacific Northwest Forest and Range Experiment Station, P.O. Box 4059, Portland 8, Oregon.

(969) EFFECT OF LOGGING, CLEARCUTTING AND OTHER FOREST OPERATIONS ON STREAMFLOW.

(b) Laboratory project.
(d) Field investigation; applied research.
(e) H. J. Andrews Experimental Forest, McKenzie River drainage, west central Oregon. Stream-flow from three small experimental watersheds in virgin Douglas-fir has been measured for five years by means of trapezoidal flume stream gates. These observations provide a pretreatment calibration which will be carried on for three years or more. Planned treatments will test effect of two systems of timber cutting on water yield and erosion.

In 1960 it is planned to construct roads in one of the three watersheds to supply information on sediment yields. Survey for these roads began in 1957 and the timber sold in 1958.

Bull Run watershed in cooperation with City of Portland Water Bureau. Pretreatment calibration measurements now being taken on three small watersheds within the Bull Run watershed, source of Portland's water sup-ply. Cover is virgin Douglas-fir. Stream-flow is being measured by trapezoidal flumes. Results of this study will help determine the future management policy on the watershed.

(2911) INFLUENCE OF FOREST COVER ON INTERCEPTION OF PRECIPITATION.

(b) Laboratory project.
(d) Field investigation; applied research.
(e) H. J. Andrews Experimental Forest. A study of interception in old-growth Douglas-fir was begun in the summer of 1957. Net pre-cipitation is measured by moving rain gages located at six representative sites; measurements of gross precipitation are being made in adjoining cutover areas.

(2187) EFFECT OF CATTLE GRAZING ON EROSION.

(b) Laboratory project.
(d) Field investigation; applied research.
(e) Starkey Experimental Forest and Range, northeast Oregon. Study to determine the effect of heavy, moderate and light graz-ing on erosion, sediment production and runoff. Sediment catchment basins have been constructed in small drainages, one in each of six pastures in which are tested three rates of grazing and two systems of management: deferred-rotation and season-long use. Major effect on erosion will be determined by volume of sediment accumulat-ed in the basins. Study now in its fourth year.

(2912) EFFECT OF LOGGING ON EROSION.

(b) Laboratory project.
(d) Field investigation; basic and applied research.
(e) Wenatchee River drainage, central Washing-ton. Soils derived from three major parent materials were sampled and are being ana-lyzed to determine their basic physical and chemical characteristics. Parent materials are Swauk sandstone, basalt and granite.

(3219) INFLUENCE OF OPENINGS IN CONIFEROUS FOREST ON SNOWMELT.

(b) Laboratory project.
(d) Field investigation; applied research.
(e) Northeastern Oregon. A study to relate maximum snow accumulation and rate of snow melt to several physiographic and vegetative factors. Fifty plots in each of two elevational ranges (4000-5000 ft. and 5000-6000 ft.) studied in the winter of 1957-58.

(3220) EVAPORATION SUPPRESSION.

(b) Laboratory project.
(d) Field investigation; applied research.
(e) A study to test the efficacy of hexadecanol in reducing evaporation. Two standard Weather Bureau pans used; one treated, the other a control.
(f) Completed.
(g) Hexadecanol reduced evaporation by 4.2 percent during the spring and summer months near Portland, Oregon.

(3221) EROSION FROM TRACTOR SKID ROADS.

(b) Laboratory project.
(d) Field investigation; applied research.
(e) A study in southwest Oregon to relate erosion and runoff from tractor skid roads in logged forests to several soil, physiographic and climatic variables. The essential purpose of the study is to determine under what conditions tractor logging results in excessive erosion.

U. S. DEPARTMENT OF AGRICULTURE, FOREST SERVICE, Rocky Mountain Forest and Range Experiment Station.

Inquiries concerning the following projects should be addressed to Mr. Raymond Price, Director, Rocky Mountain Forest and Range Experiment Station, Room 221 Forestry Building, Fort Collins, Colorado.

(376) WATERSHED MANAGEMENT RESEARCH, MANITOU EXPERIMENTAL FOREST.

(b) Laboratory project.
(d) Field investigations; applied research.
(e) Studies of the influence of grazing, timber cutting, and revegetation of depleted watershed lands upon water supplied, erosion and sedimentation, to solve problems in management of watershed lands of the Rocky Mountain Front Range such as: (1) Runoff and erosion from natural storms on bunchgrass plots; (2) runoff and erosion from natural storms on young pine plots; (3) effect of type conversion on runoff and erosion from small watersheds; (4) effect of logging intensities on snow accumulation in ponderosa pine-Douglas fir type; and (5) characteristics of runoff from cloudburst storms on a large watershed.
(h) Annual report, 1957, Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado.

(377) WATERSHED MANAGEMENT RESEARCH, FRASER HYDROLOGIC LABORATORY.

(b) Laboratory project.
(d) Field investigations; applied research.
(e) (1) To determine influence of lodgepole pine and spruce-fir forests and of the management of these forests on the yield of water. (2) To evaluate the alpine snowfields of the Colorado Rockies with respect to their contribution to summer streamflow. (3) To measure the rate of snow accumulation in natural catchment basins under alpine conditions. This is the pretreatment calibration of a series of drift sites, part of which will be supplemented by drift fences at a later date to test the effectiveness of such structures in enlarging and deepening such alpine snow drifts.
(g) The cutting and removal of half of the timber from one 714-acre watershed was completed in 1956. Eighty percent of this treatment was complete in 1955. For the years 1956 and 1957 the increase in water yield attributable to the timber harvest was 30 percent or 240 acre-feet. The 3 years of 1956-58, taken together, show no statistically confirmable affect on the annual peak rate of discharge. The following data were taken for the third summer on an alpine snowfield in the Front Range of Colorado: Water equivalent, rate of depletion and relation between depletion rates and weather factors. A study of the moisture exchange between an alpine snow surface and the atmosphere showed that under conditions prevailing during the last of August 1957, the snow pack gained moisture at the rate of 1,300 gallons of water per acre of snow per week. This study also showed a close agreement between the volume of melt water as computed from ablation and density and that measured from plastic lysimeters. A repeat of this experiment during very dry weather in July 1958 showed a net loss from the snow of about 1600 gallons on water per acre of snow per week. In neither case did moisture exchange exceed 4 percent of the total weight of snow available for ablation.
(h) Annual report, 1957, Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado.

(657) WATERSHED MANAGEMENT RESEARCH, TEMPE, ARIZONA.

(b) Laboratory project.
(d) Experimental; basic and applied research.
(e) The purpose is: (1) To study the disposition of rainfall as influenced by watershed vegetation; (2) to determine the influence of various types of forest and grassland vegetation as well as vegetation modified by cultural treatment such as grazing and timber harvest, on streamflow, water use, water loss, and erosion and sediment yield; (3) to determine for phreatophytic vegetation (water-loving plants) the amount of water used, methods for reducing water use by phreatophytes or for replacing them with more useful plants; and (4) for mixed conifer and chaparral types of vegetation to

determine the hydrologic characteristics of natural watersheds and the effect of cover modification upon water yields, soil stability and other resource values.

At Sierra Ancha Experimental Watersheds in central Ariz., rainfall, runoff, and erosion are measured on three watersheds in the pine-fir vegetation type at high elevation, on two watersheds in the ponderosa-chaparral type, and from four watersheds in the grassland-chaparral type at intermediate elevation, and on nine small watersheds in the semidesert-chaparral type at low elevations. Water use by different types of plants in various soils is studied on eleven large lysimeters. Three watersheds have also been established in the pure ponderosa pine type and two in the mixed conifer type to test the effects of logging practices upon water yield and soil stability. Gaging stations for four watersheds in the pure chaparral type are also available to evaluate watershed-game interrelations. One cluster of two watersheds and another cluster of three watersheds are available for testing the effect of manipulating chaparral cover. Supplemental studies are determining the proper use of chemicals, fire and mechanical treatment for manipulating shrub in the type. Ecology of Tamarix pentandra is under investigation. Germination, seedling survival, and rate of spread studies were continued. A field apparatus employing the infrared analyzer for detecting moisture has been used for detailed measurements of evapo-transpiration of phreatophyte types.

(g) Pine-fir, bottom vegetation was removed on 80 acres of an experimental watershed. The cleared area was planted to perennial grass in the interest of comparing consumptive use from forest and grassland types. Chaparral watersheds were found to yield streamflow from February until May. Sporadic, intermittent small flows following rains during July, Aug., and Sept., produced gravel loads indicating up to 200-300 cubic yards per section. Sampling in representative Arizona chaparral stands indicates total shrub canopy densities ranging from 40 to 65 percent; with shrub live oak (Quercus turbinella) making up from 55 to 80 percent of the total shrub cover. Sprouting rarely occurs from tamarisk roots; therefore, if plants are initially cut below the root crown, sprouting will be avoided. This fact is of considerable importance in mechanical clearing.

(h) "An Infrared Apparatus for Measurement of Transpiration", by J. P. Decker and J. D. Wein, in Symposium for Phreatophytes by Phreatophyte Subcommittee of PSIAC, 1958, (Processed).

(1969) WATERSHED MANAGEMENT RESEARCH, ALBUQUERQUE, NEW MEXICO.

(b) Cooperative study with Bureau of Land Management and Geological Survey.
(d) Applied research.

(e) Evaluation of range-watershed conditions on small watersheds in the San Luis drainage of the Rio Puerco. Three contiguous watersheds, ranging from 338 to 555 acres located about 8 mi. north of the San Luis community and west of the Rio Puerco main channel provide the study area. Water and sediment inflow are measured in small reservoirs formed by earthen dams. Precipitation amounts and vegetation changes are periodically measured over the watersheds. The preliminary survey and investigation phase is completed; and watershed boundary fences installed and four years of data have been collected under uniform grazing conditions during the six month over-winter period (Nov.1 to May 1). Soil elevation measurements have been obtained on the three watersheds for purposes of determining soil losses from the alluvial soils. Rising stage sediment samplers have been installed on the three watersheds.

(h) Annual reports of the Rocky Mountain Forest and Range Experiment Station.

(1971) WATERSHED MANAGEMENT RESEARCH, GRAND JUNCTION, COLORADO.

(b) Laboratory project, in cooperation with Bureau of Land Management, Bu. of Reclamation, USGS, and Fish and Wildlife Service.
(d) Experimental; applied research.
(e) To determine the effect of exclusion of livestock grazing on erosion and runoff from semidesert lands in western Colorado.
(g) Pretreatment measurements were made in 1953 and '54 of infiltration and erosion, using the Rocky Mtn. infiltrometer. Measurements during the treatment period started in 1958 and will be continued at 5-yr. intervals.

(2420) WATERSHED MANAGEMENT RESEARCH, GRAND JUNCTION, COLORADO.

(b) Laboratory project.
(d) Field investigation; applied research.
(e) To compare the amount of soil moisture withdrawal under aspen, spruce, and mixed grass-weed type. Measurements were taken in 1955, 1957 and 1958. Three sites were sampled in each type. Seven gravimetric samples were taken at random on a 30-ft grid superimposed on each site. Samples were taken approximately July 1 and Nov.1, the difference in water content representing gross use by vegetation. Water use values will be adjusted for current precipitation. Samples were taken in 1-ft increments to a depth of 8 ft.
(g) Preliminary findings are as follows:

| Year | Inches of Water Used* | | | | |
	Aspen	Spruce	Idaho fescue	Thurber fescue	Mixed grass-weed
1955	20.94	15.30	10.14	9.86	-
1957	17.14	13.70	-	-	9.34

*Based on sites where moisture content was at or above wilting point both spring and fall.

(h) Annual reports of the Rocky Mountain Forest and Range Experiment Station.

(2188) WATERSHED MANAGEMENT RESEARCH, ALBUQUERQUE, NEW MEXICO.

(b) Laboratory project.
(d) Applied research.
(e) Soil moisture studies. Colman soil electrical units were installed at 3-inch depth intervals from the 1-1/2 inch soil depth to bedrock or to a depth beyond any anticipated moisture penetration. Recording and standard gages were used to measure precipitation. Moist pinyon-juniper zone (17-inch annual precipitation). A record of precipitation and soil moisture was maintained under three ground-cover conditions; under pinyon trees and in a woodland opening; in grassland; and in a bared area kept free of vegetation by chemical spraying. Dry pinyon-juniper-sagebrush zone (13-inch annual precipitation). A record of precipitation and soil moisture was maintained under four conditions: native sagebrush under protection from livestock grazing; and in crested wheatgrass under 25 percent utilization, under 75 percent utilization, and under full protection from cattle grazing.
(f) Field study terminated at Pine Flat (moist pinyon-juniper zone) on July 1, 1958, and at Cebolla Mesa (dry pinyon-juniper sagebrush zone) in the Spring of 1958.
(h) Annual reports of the Rocky Mountain Forest and Range Experiment Station.

(2657) WATERSHED MANAGEMENT RESEARCH, GRAND JUNCTION, COLORADO.

(b) Laboratory project.
(d) Field investigation; applied research.
(e) To determine the effect of range conditions and related factors on sediment production and runoff on three mountain grassland water-sheds in western Colorado. Range condition is being measured by means of 20 or more 3-step transects on each watershed. Ninety degree V-notch weirs are used to gage the watersheds which vary in size from 86 to 272 acres. Water samples are taken several times daily during snowmelt and periods of storm runoff for determination of suspended sediment; bed load is measured in the weir ponds.
(h) Annual Reports of the Rocky Mountain Forest and Range Experiment Station.

(2658) WATERSHED MANAGEMENT RESEARCH, RAPID CITY, SOUTH DAKOTA.

(b) Laboratory project.
(d) Experimental; basic and applied research.
(e) (1) To determine how heavy grazing of bluegrass range in the Black Hills has influenced soil structure. The study involves measurement of bulk density and pore space of soil inside and outside of livestock enclosures. (2) To study basic soil-water relationships under dense ponderosa pine in the Black Hills and to determine how

thinning influences amount of water available for streamflow. The study involves measurement of precipitation in the open, throughfall precipitation under thinned and unthinned pine, stem flow, and soil moisture. (3) To establish Black Hills precipitation and streamflow characteristics from existing records.
(f) Active; Items 1 and 3 data being prepared for publication, item 2 continuing.
(h) Annual Report, 1957, Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado.

(2913) BEAVER CREEK WATERSHED PROJECT.

(b) Laboratory project, cooperative with Coconino National Forest, Flagstaff, Arizona.
(d) Field investigation; basic research.
(e) Calibration of 12 small watersheds, 6 in ponderosa pine type, 3 in alligator juniper type, and 3 in Utah juniper type. A newly designed modified trapezoidal Venturi flume is being used to measure discharge from these steep ephemeral streams. Precipitation measurements are being taken.
(g) The following amounts of precipitation were measured on the watersheds:

Water Year	Type		
	Ponderosa Pine	Alligator Juniper	Utah Juniper
1957	31.54	23.91	20.63
1958	36.95	29.00	22.87

(h) Annual Report, 1957, Rocky Mountain Forest and Range Experiment Station, pp. 16-18.

(3222) BEAVER CREEK WATERSHED PROJECT.

(b) Laboratory project, cooperative with Coconino National Forest, Flagstaff, Ariz.
(d) Field investigation; basic research.
(e) Study of the disposition of precipitation in the Utah juniper type, including measurements of precipitation, interception, surface runoff, and soil moisture budget by stand density class.

(3223) WATERSHED MANAGEMENT RESEARCH FORT COLLINS, COLORADO.

(b) Rocky Mountain Forest and Range Expt. Sta.
(e) A physical evaluation of mechanical erosion control practices, established on the Trout Creek Watershed, Salida District, San Isabel National Forest, Colo., on depleted lands in the Colorado Front Range. The following soil associations are represented: Edloe-Stecum association derived from granite, Chubbs-Laporte (limestone), Trout Creek-gano-Heath (shale and sandstone), Buena Vista-Rods-Outcrop (Trachyte).
(g) Exploratory studies finished. The main field investigations will start in spring 1959.

(3224) BEAVER CREEK WATERSHED PROJECT.

(b) Laboratory project, cooperative with

Coconino National Forest, Flagstaff, Ariz.
(d) Field investigation; basic research.
(e) Rainfall interception by nine densities of pole-size ponderosa pine.
(f) Completed.
(h) Report in preparation.

U. S. DEPARTMENT OF AGRICULTURE, FOREST SERVICE, Southeastern Forest Experiment Station.

(380) WATER RESOURCE AND WATERSHED MANAGEMENT RESEARCH.

(b) Laboratory project. For general public use and information.
(c) Mr. J. F. Pechanec, Director, Southeastern Forest Experiment Station, U. S. Forest Service, P. O. Box 2570, Asheville, N. C.
(d) General investigation of forest influence in the southeastern United States, including fundamental hydrologic research and applied research in watershed management.
(e) To determine the effect of forest vegetation and land management practices on the components of the hydrologic cycle, including the effects on water yield and quality. To develop methods of watershed management which will result in the greatest benefit from the land and water resources of the southeastern United States.
Most of the experiments and hydrologic data collection is carried out on the 5600-acre Coweeta Hydrologic Laboratory, located in the zone of maximum precipitation in the eastern United States (Nantahala Range of the Southern Appalachians). Eighteen individual watersheds whose streamflow is being continuously gaged provide the basis for the experimental program. The laboratory has 10 recording and 61 non-recording (standard) rain gages, 1 recording groundwater well, 4 recording hydrothermographs, 1 recording anemometer, and 1 evaporation pan. Water samples for quality analysis are collected from selected watersheds on a daily and storm period basis.
On the Calhoun Experimental Forest, near Union, S.C., research is concerned with the problems and factors involved in rehabilitating Piedmont soils. Studies include measurement of the soil moisture regime under different cover types, and different densities of vegetation, hydrologic properties of forest soils, and index values of runoff and sediment production from several small watersheds. The forest has 5 recording and 15 standard rain gages as well as a standard Weather Bureau weather station.
Research projects include: (1) Evapotranspiration from forest land, hydrologic effects of reducing basal area 50 percent, (2) rehabilitation treatment of experimental watersheds formerly used in studies of mountain farming, woodland grazing, and exploitive mountain logging, (3) type conversions on drained slopes, (4) precipitation network requirements for small Southern

Appalachian watersheds, (5) soil moisture regime in relation to evapotranspiration, and (6) operating forest pilot watersheds to demonstrate proper location and layout of logging roads.
(g) Studies of woodland grazing, mountain farming and improper logging have demonstrated the extremely detrimental effects of poor land management on water quality and storm peaks. Ten to fifteen years data furnish information on the time required for adverse effects to show up. Various types of forest cuttings on selected watersheds have yielded information on annual and seasonal water balance, storage and depletion of groundwater, and the use of water by forest vegetation. For example, removing all forest vegetation from a small watershed gave increases in streamflow equivalent to 60 percent of the average pre-treatment flow, with increases gradually subsiding as the forest regrew.
Piedmont studies are showing that the organic layers of forest soil are a valuable diagnostic tool for timber and watershed management. Also through studies of soil moisture under different types of cover, information is being obtained regarding consumptive use of water, percolation rates, and seasonal storage potentials of forest soils.
(h) "Pine and Hardwood Forest Water Yield" by John D. Hewlett. Jour. Soil and Water Conservation, v. 13, No. 3, May 1958.
"Timber, Water and Stamp Creek" by P. E. Black and P. M. Clark. Southeastern Forest Expt. Sta. 1958. (Processed).
"Interception in an Old-Field, Cove-Hardwood Stand" by P. E. Black. Manuscript in preparation, 1958.
"Moisture Held in Pine Litter" by Louis J. Metz. Jour. Forestry v. 56, No. 1, Jan. 1958.
"The Calhoun Experimental Forest" by Louis J. Metz. Southeastern Forest Expt. Sta. (1958). (Processed).

U. S. DEPARTMENT OF AGRICULTURE, FOREST SERVICE, Southern Forest Experiment Station.

Inquiries concerning the following projects should be addressed to Mr. Philip A. Briegleb, Director, Southern Forest Experiment Station, 2026 St. Charles Avenue, New Orleans 13, Louisiana.

(2914) WATERSHED MANAGEMENT RESEARCH, Tallahatchie Research Center, Oxford, Mississippi.

(b) Laboratory project, in cooperation with Soil Conservation Service, Agricultural Research Service, and Univ. of Mississippi.
(d) Field investigation of runoff and erosion from small experimental watersheds on forest and potential forest lands; basic and applied research.
(e) A total of 12 small natural headwater catchments, two to four acres in size, have been installed in batteries of three to determine

runoff and erosion from old fields, deplet-
ed upland hardwoods, mature upland hardwood-
pine, and loblolly pine plantations. The
watersheds will be calibrated some years
before treatments are applied. Related
studies include soil moisture-tree growth
relationships.

(g) Watershed studies - operative only one full
year. Radial growth of shortleaf pine cor-
related with number of days after start of
spring growing season and available mois-
ture in upper four feet of soil.

(h) "Soil Moisture Content and Shortleaf Pine
Radial Growth in North Mississippi," D. C.
McClurkin, Forest Science 4(3): 232-238,
1958.
"Hydraulic Inserter for Soil Moisture Units,"
J. L. Thames, Soil Science 86(3):156-159,
1958.

(3225) WATERSHED MANAGEMENT RESEARCH, CENTRAL
OZARKS RESEARCH CENTER, HARRISON, ARKANSAS.

(b) Laboratory project, in cooperation with
Soil Conservation Service and Univ. of Ark.

(d) Field investigations of hydrologic effects
of land conversion from hardwood forest to
native range, applied research.

(e) Duplicate runoff plots 12 x 100 feet were
installed on woodland not grazed, woodland
grazed, and woodland converted to range by
aerial spraying and grazed. The study will
measure effects of conversion and grazing
on runoff and erosion, changes in litter-
humus character, soil moisture, and surface
soil physical properties.

(3226) SOIL MOISTURE RESEARCH, VICKSBURG RESEARCH
CENTER, VICKSBURG, MISSISSIPPI.

(b) Waterways Expt. Sta., Corps of Engineers,
U. S. Army.

(d) Field and laboratory investigations, basic
and applied research on factors affecting
soil moisture.

(e) Project is aimed at development of a soil-
moisture prediction method based on field
studies throughout the United States and
possessions. Present studies include re-
finement of prediction methods, environ-
mental factors, problem soils, and methods
and techniques.

(g) A workable soil-moisture prediction method
has been developed for use in vehicle traf-
ficability ratings without previous contact
with the soil.

(h) "Summary of the Development of a Soil Mois-
ture Prediction Method," by Arthur W.
Krumbach and Forest W. Stearns, Vicksburg
Research Center, Southern Forest Experiment
Station, 40 pp., Nov. 1957.

U. S. DEPARTMENT OF THE ARMY, CORPS OF ENGINEERS,
Beach Erosion Board.

Inquiries concerning the following projects should
be addressed to the President, Beach Erosion Board,
5201 Little Falls Road, Washington 16, D. C.

(181) EQUILIBRIUM PROFILE OF BEACHES AND STUDY OF
MODEL SCALE EFFECTS.

(b) Laboratory project.
(d) Experimental.
(e) Equilibrium beach profiles will be deter-
mined experimentally for waves up to 6 feet
in height in a prototype tank; the waves
will be modeled at a 1 to 10 scale in small
laboratory tanks for various median diameter
sand sizes to determine scale effect.

(g) Some light specific gravity material (coal)
has been obtained for use in a small wave
channel in tests of beach deformation under
wave action to compare with large scale
tests using sand in the large tank. The
specific gravity of the coal (average 1.5)
has been modeled by the settling velocity
relationship to give corresponding charac-
teristics of the material in the large tank.

(660) OBSERVED WAVE CHARACTERISTICS.

(b) Laboratory and field project.
(d) Field investigation; basic research.
(e) To secure a more thorough knowledge of the
characteristics of ocean waves. A number of
electrical recording wave gages have been
installed in coastal waters and these re-
cords are analyzed for significant height
and period.

(g) The new plastic wave gages, replacing neo-
prene coated aluminum channel type have
been installed for two months. Satisfactory
operation is being experienced. The new
plastic gage at Steel Pier, Atlantic City,
New Jersey has been treated with anti-foul-
ing paint in an effort to provide longer
operating periods before sea-growth fouls
and thereby reduces the gage accuracy. A
wave spectrum analyzer utilizing a revolv-
ing tape head (rather than forming a segment
of the tape into a loop, and repeatedly
cycling the loop) is being constructed and
tested.

(h) "Hurricane Wave Station for the Gulf of
Mexico," BEB TM No. 98, June 1957.

(975) METHODS OF BY-PASSING SAND PAST INLETS.

(b) Laboratory project.
(d) Field investigation; applied research.
(e) To study methods and requirements for pump-
ing sand past inlets and to determine the
applicability of the methods in stabiliza-
tion of beaches adjacent to inlets. A
study is being made of the sand by-passing
operations carried out at Port Hueneme,
California and Lake Worth, Florida. Data
are being obtained on the operation of a
stationary sand transfer plant located on
the north jetty of Lake Worth Inlet, Fla.
These data include periodic hydrographic
surveys south and north of the inlet, wave
data, sand samples, detailed records of
pumping operations, and detailed records of
entrance channel maintenance. Additional
survey data taken at Hueneme are being ana-
lyzed and a report prepared. Study is being
made of the possibility of adapting

commercial instruments utilizing a radio-active source to measure density of material pumped in by-passing.

(976) ESTABLISHMENT OF CRITERIA FOR CONSTRUCTION OF ARTIFICIAL BEACHES.

(b) Laboratory.
(d) Theoretical; applied research.
(e) To develop criteria for construction of beaches by artificial means. The present phase of this general study involves the measurement of a natural beach slope and determines its response as a function of those forces normally incident upon the shore such as wave height and period, angle of wave approach, tide, and direction and magnitude of littoral current. By statistical methods the relative importance of the forces or combinations of forces may be evaluated.
(g) Computing machine techniques are being applied to the statistical evaluation of the importance of the forces. Preliminary results indicate that this technique for analyzing and evaluating data will determine the relative importance of the variables involved.

(977) DEVELOPMENT OF WAVE HEIGHT AND WAVE DIRECTION GAGES.

(b) Laboratory project.
(d) Experimental; development.
(e) To develop wave height and wave direction gages for use in securing accurate records of wave characteristics.
(g) The plastic type wave gages, replacing the neoprene coated aluminum channel type, have been installed in all Beach Erosion Board ocean wave gage recording stations (5 stations). The first six months of use indicate satisfactory operation.

(2190) STUDY OF EFFECT OF A GROIN SYSTEM ON THE RATE OF LITTORAL MOVEMENT.

(b) Laboratory project.
(d) Experimental; basic research.
(e) To study the effect of groins on the rate of littoral drift passing a groin system. Installation of test set-up in the Shore Processes Test Basin has been completed. Initial tests consist of waves generated at a 30-degree angle to the sand beach. Measurement of material movement is being made at the down beach end.
(g) A new series of tests, starting from a 1 on 10 beach slope, show that the drift rate along a 1 on 10 slope is about 1,200 pounds per hour before the slope has adjusted to the imposed wave conditions. After slope adjustment the drift rate is reduced to about 480 pounds per hour. These tests indicate that introduction of a small amount of clay into the beach material increases the drift rate slightly. Also the rate at which sand is fed on to the updrift end of a beach 100 feet in length affects the rate of sand movement into the traps at the

downdrift end.

(2192) REGIONAL STUDIES OF THE SOUTH SHORE OF LONG ISLAND, NEW YORK; ATLANTIC COAST OF NEW JERSEY; AND THE DELAWARE-MARYLAND-VIRGINIA SHORE LINE FROM CAPE HENLOPEN TO CAPE CHARLES.

(b) Laboratory project.
(d) Field investigations; basic research.
(e) To compile all existing factual data pertinent to shore processes on a regional scale. Report to consist of four chapters; geomorphology and shore line histories, littoral forces, littoral materials, and summary and conclusions. Subject matter to include physiography, geological development of the shore region, sources of littoral materials, waves, tides or water level fluctuations, currents, physical characteristics of the littoral materials, interrelation of sedimentary properties, relation to properties of littoral materials to position in the littoral zone, and changes in shore line configuration.
(g) All chapters for New Jersey completed except for editing. Geomorphology, shore line history, and littoral forces, of south shore of Long Island completed except for editing.

(2193) SHORE PROTECTION PLANNING AND DESIGN.

(b) Laboratory project.
(d) Design.
(e) The purpose of this project is to supplement and revise the Beach Erosion Board's Technical Report No. 4, "Shore Protection Planning and Design" as new data and techniques are developed for use in the solution of coastal engineering problems.
(g) The first addenda sheets to Technical Report No. 4 were compiled and dispatched to recipients of this report. The second addenda sheets are being compiled which include revised or supplemental data on dune stabilization, beach fill design, sand by-passing plants, forces on pilings, hurricane design data, wave run-up and overtopping data, and breakwater design data.

(2195) RE-EXAMINATION OF ARTIFICIALLY NOURISHED AND CONSTRUCTED BEACHES.

(b) Laboratory project.
(d) Field investigation; applied research.
(e) To study the behavior of beach fills placed to nourish and protect adjacent shores. A selected number of beach fills are being re-examined.
(g) Survey and sand sample data taken at Harrison County, Mississippi were analyzed to determine the behavior of beach fill placed along 25 miles of shore from an offshore borrow source. Material losses since placement of beach fill in 1951 have been slight. Shoaling of the borrow area has been slow and limited to material to silt sizes.
(h) "Behavior of Beach Fill and Borrow Area at Harrison County, Mississippi," G. M. Watts,

Beach Erosion Board Tech. Memo. No. 107, 14 pages, August 1958.

(2659) WAVE FORCES ON PILES.

    (b) Laboratory project.
    (d) Experimental; applied research, design.
    (e) To determine the nature and magnitude of forces on piles caused by breaking and non-breaking waves.
    (g) First draft of report completed. The report gives the forces on a 3-foot section of a 12-inch pipe pile caused by waves, both breaking and non-breaking. Wave periods were varied from 3.75 to 16 seconds; wave heights from 2 to 6 feet, and water depths from 5 to 16 feet. The position of the sensitive section of the pile was varied from 5.3 feet above the bottom of the wave tank to above the still water level.

(2660) WAVE TANK STUDY OF QUANTITY OF SAND IN SUSPENSION IN THE SURF ZONE (INCLUDING TEMPERATURE EFFECTS).

    (b) Laboratory project.
    (d) Experimental; basic research.
    (e) A vacuum pump type suspended sediment sampler has been used to collect suspended sand samples under various laboratory conditions of waves, water temperature and sand. A large field sampler has been used to obtain suspended samples in the prototype wave tank. The purpose of the study is to determine the relationships between wave, water, and sand characteristics and the amount of material maintained in suspension and hence available for longshore transport by currents.
    (g) A first draft of a report on suspended sampling tests through 1957 has been completed. Additional tests of temperature effects on suspended sediment were carried out during 1958. One purpose of these warm water tests was to determine the effect of sand ripples on suspended sediment. Comparison of the results of these 1958 tests and of previous cold water tests show that the shoreward displacement (creep) of sand ripples is faster in cold water than in warm water. The tests also show that coarser and heavier material is in suspension near the sand ripple crest.

(2661) WAVE RUN-UP ON SHORE STRUCTURES.

    (b) Laboratory project.
    (d) Experimental; design.
    (e) Wave run-up is determined experimentally by various waves for different types of shore structures. Effect of both structure roughness and permeability is being investigated.
    (g) A method was derived for determining wave run-up on composite slope structures and structures with berms. Relatively large-scale data are being taken (with waves about 3 to 4 feet in height) in the large wave tank on run-up on rubble structures in connection with another study. These

data will then be compared with data from small scale studies to determine the possible existence of a scale effect. Large scale tests on run-up on Lake Okeechobee Levees (see project 2917) have shown that a definite scale effect exists, at least for smooth impermeable slopes. These tests show an increase in run-up over that observed for small scale laboratory tests of up to 25% depending upon size of wave and slope.
    (h) "Wave Run-Up on Composite Slopes", Thorndike Saville, Jr., Proc. Sixth Conference on Coastal Engineering, Council on Wave Research, Engineering Foundation, 1958.

(2916) WAVE AND SURGE FORECASTING RELATIONSHIPS AND TECHNIQUES.

    (b) Laboratory project.
    (d) Theoretical; basic research.
    (e) To determine methods of predicting wave and storm surge characteristics.
    (g) Methods of developing surge predictions for hurricanes have been reviewed, extended and summarized. Revisions to previously adopted wave forecasting relationships have been determined to better account for additional wave data. Wave records from a wide variety of locations have been utilized in a statistical analysis of the probability distributions of wave heights and wave periods; and a family of wave spectra which allows for an arbitrary linear correlation between wave height and wave period squared is suggested.
    (h) "Revisions in Wave Forecasting: Deep and Shallow Water", by C. L. Bretschneider. Proceedings Sixth International Conference on Coastal Engineering, Ch. 3, pp. 30-67, 1958.
        "Engineering Aspects of Hurricane Surge", by C. L. Bretschneider. Proceedings Technical Conference on Hurricanes, Miami Beach, Fla., American Meteorological Society, Nov. 19-20, 1958.

(2917) MODEL STUDY OF WAVE RUN-UP AND OVERTOPPING ON LAKE OKEECHOBEE LEVEES.

    (b) U. S. Army Engineer District, Jacksonville, Fla.
    (d) Model study; for design.
    (e) A 1 to 2.5 scale model of the proposed Lake Okeechobee levee design (1 on 3 and 1 on 6 slopes) has been tested under wave action up to 4 feet in height (10 feet prototype) to determine heights of wave run-up and quantities of wave overtopping for two crest elevations. Results will be compared with those in smaller laboratory flumes (1 to 30 model) to determine existence of any scale effect.
    (g) Testing has been completed, the results are being analyzed, and a report prepared. The results indicate a 10% increase in wave run-up for the 1 on 6 slope over that observed with small-scale laboratory tests, and a 20% increase for the 1 on 3 slope. A portion of this increase is due to different roughness conditions in the two laboratory

tests, the absolute roughness of both scale tests being the same, as smooth board slopes were used for both scales. A few tests were run at the large scale using the smooth slope roughened with a single layer of 0.4-mm sand to give an indication of the degree of this effect. This roughness for the 1 on 3 slope decreased the scale effect increase from 20% to 15%. The increase in scale for the large scale test was about ten times that of the small scale test and the actual prototype conditions are 2-1/2 times larger than the large scale test; consequently the run-up must again be proportionately increased to take account of this further increase in scale. Accounting for this added increase and assuming the observed roughness correction for the 1 on 3 slope applies to all slopes, and considering data previously obtained on a 1 on 15 sand beach, the results may be extended to give an increase in run-up over that observed for laboratory tests for Lake Okeechobee prototype conditions of 0% for a 1 on 15 slope, 9% for a 1 on 6 slope, 18% for a 1 on 3 slope, and 27% for a 1 on 1-1/2 slope. Prototype conditions for which these increases would be applicable are for waves of about 8 to 10 feet in height. The tests indicate the existence of a very large scale effect for overtopping measurements, amounting to an average increase of 40% for some of the large scale tests. The scale effect for overtopping generally increases with a decrease in overtopping rate.

(3227) DEVELOPMENT OF INPLACE SEDIMENT DENSITY GAGE.

(b) Laboratory project.
(d) Field, development.
(e) To develop an inplace gage to determine density of material under water in shoal areas (navigation channels, reservoirs, etc.).
(g) A gage has been developed consisting of a probe housing a radioactive source and a counter. The gage has been field tested in several areas, and performed satisfactorily. A report is being prepared.

(3228) MODEL TESTS OF WAVE SETUP ON BEACHES.

(b) Laboratory project.
(d) Experimental; basic research.
(e) To relate increase in water level at the shore due to wave action alone to the incident wave characteristics and shore hydrography.
(g) Laboratory data taken on a relatively gentle slope (about 1 on 70) show a wave setup as great as 3 feet for 30-foot waves. Data on steeper slopes (1 on 3 and 1 on 6) show no wave setup at all. Tests are continuing on intermediate slopes.
(h) "Model Study of Wave Setup Induced by Hurricane Waves at Narragansett Pier, Rhode Island", John C. Fairchild, The Annual Bulletin of the Beach Erosion Board,

Office, Chief of Engineers, July 1958.

U. S. ARMY ENGINEER DISTRICT, CORPS OF ENGINEERS, Portland, Bonneville Hydraulic Laboratory.

Inquiries concerning Projects Nos. 405, 406, 407, 2662, 2665, 2666, 2919, 2920, 2921, and 3229 should be addressed to District Engineer, U. S. Army Engineer District, Walla Walla, Bldg. 602, City-County Airport, Walla Walla, Wash., and Projects Nos. 1462, 1466, 3230, and 3231 should be addressed to District Engineer, U. S. Army Engineer District, Portland, 628 Pittock Block, Portland 5, Oregon.

(405) GENERAL MODEL STUDY OF ICE HARBOR DAM, SNAKE RIVER, WASHINGTON.

(b) U. S. Army Engineer District, Walla Walla, Corps of Engineers, Walla Walla, Wash.
(d) Experimental; for design.
(e) A 1:100-scale, undistorted, fixed-bed model reproduces 2.7 miles of the Snake River at the dam site. The proposed structures include a 6-unit powerhouse (3-unit initial installation), 10-bay (tainter-gate controlled) spillway, 86- by 675-foot navigation lock and facilities for migrant fish. The latter include two fish ladders, 16 ft. wide on north bank and 24 ft. wide on south bank, and a powerhouse collection system. Auxiliary flow for both ladders and collection system will be provided by low-head pumps. Studies will be made to determine flow conditions during various construction stages and with proposed structures installed.
(f) Tests completed.
(g) Tests of first-step cofferdam were completed. Results indicated that realignment of upstream corner of cofferdam would reduce backwater effect and lower water-surface elevations along face of cofferdam. Movable bed studies were made to assist in estimating amount and location of erosion in prototype. Effect of rock groins along river bank opposite cofferdam were investigated as an aid to fish migration during first-stage construction. General flow conditions were observed with the proposed structures installed. Three tailrace alignments were investigated and tests were made to determine best alignment of north fish ladder wall. Two-foot sills installed in end bays of spillway provided downstream flow at spillway entrances to fishways. Second-stage cofferdam tests showed that realignment of downstream leg of cofferdam improved conditions for fish passage and reduced velocities along toe of downstream fill. Conditions for fish passage at low flows were improved by additional forebay excavation and using skeleton units to pass a portion of river flow. Tests of final design structures were made to provide project operating data. Uniform spillway operation produced the best over-all conditions. Tests of several designs of the river outlet to navigation lock were made to

determine probable wave heights and tail-
water variation during lock emptying.
- (h) Five memorandum reports have been issued;
others are in preparation.

(406) MODEL STUDY OF ICE HARBOR SPILLWAY, SNAKE
RIVER, WASHINGTON.

- (b) U. S. Army Engineer District, Walla Walla,
Corps of Engineers, Walla Walla, Wash.
- (d) Experimental; for design.
- (e) The 1:40-scale model consists of a 3-bay
section of the 10-bay spillway. Tests were
made to determine hydraulic performance of
the proposed spillway and stilling basin
and to develop revisions in design that
would improve performance or reduce con-
struction and maintenance costs.
- (f) Tests completed.
- (g) Satisfactory design of spillway and still-
ing basin and determination of crest rating,
pressure data, and method of gate operation
were accomplished.
- (h) Memorandum reports are in preparation.

(407) MODEL STUDY OF ICE HARBOR NAVIGATION LOCK,
SNAKE RIVER, WASHINGTON.

- (b) U. S. Army Engineer District, Walla Walla,
Corps of Engineers, Walla Walla, Wash.
- (d) Experimental; for design.
- (e) Two models are being used to test perform-
ance of the proposed design for the hydrau-
lic system and develop modifications for
improvement if necessary. A 1:25-scale
model will reproduce the 86- by 675-foot
lock chamber, culvert systems, and portions
of the upstream and downstream approach
channels. A 1:16-scale model of a single
lateral culvert of the lock filling system
was used to determine designs that will
produce uniform flow distribution from the
culvert ports.
- (g) Offsets in lateral culvert walls were re-
vised to improve flow distribution. Con-
struction of lock model was completed and
tests begun. At maximum initial head, 103
ft, the lock chamber fills in approximately
11 min and empties in 13 min with a 4.0-
min filling valve schedule and 2.2-min
emptying valve schedule. Maximum hawser
forces of 4 to 6 tons, depending on reso-
nance, have been observed with 11 040-ton
barge tow at maximum initial head. Posi-
tive pressures exist downstream from the
filling valves. Final design tests are in
progress.
- (h) Memorandum reports are in preparation.

(1462) GENERAL MODEL STUDY OF THE DALLES DAM,
COLUMBIA RIVER, OREGON AND WASHINGTON.

- (b) U. S. Army Engineer District, Portland,
Corps of Engineers, Portland, Oregon.
- (d) Experimental; for design.
- (e) A 1:80-scale, undistorted, fixed-bed model
reproduced 2.7 miles of the Columbia River
at the dam site. The original layout con-
sisted of a circular-arc, 30-bay spillway,
a 22-unit powerhouse, and 86- by 675-foot

navigation lock, a rock-fill nonoverflow
section, and facilities for passing fish
over the dam. Maximum head was 90 feet.
Revised layout had a straight 23-bay spill-
way. Purposes were to study the structures
alignment and flow conditions affecting
navigation, power generation, cofferdam
placement, rock-fill dam construction, and
fish passage.
- (f) Tests completed.
- (g) Four major layout plans were tested and the
most economical plan that effected satis-
factory hydraulic conditions was selected.
Tests indicated ability to reduce length of
spillway and to reduce forebay excavation
by 30 feet. Data relative to water-surface
elevations and velocities in the tailrace,
and the effects of excess fill placed in
the forebay have been obtained. Flow con-
ditions during various stages of construc-
tion and with the project completed have
been observed with special attention given
to navigation and fish migration problems.
Tests were conducted to compare flow con-
ditions in model and prototype with the
1957 peak discharge of 643,500 cfs when all
flow was through spillway. Test was re-
peated with five powerhouse units operating,
expected installation at time of 1958 high
water. Additional studies of flow condi-
tions in downstream approach to navigation
lock were made with extensions to contract
plan guard wall of 200, 400, and 600 feet.
- (h) Thirty memorandum reports have been issued;
one is in preparation.

(1466) MODEL STUDY OF THE DALLES DAM NAVIGATION
LOCK, COLUMBIA RIVER, OREGON AND WASHINGTON.

- (b) U. S. Army Engineer District, Portland,
Corps of Engineers, Portland, Oregon.
- (d) Experimental; for design.
- (e) A 1:25-scale model of the 86- by 675-foot
lock chamber including its culvert systems
and portions of the upstream and downstream
approach channels was reproduced. Maximum
lift is 90 feet. Studies were made of vari-
ous types of filling and emptying systems
to determine the most advantageous design
from the standpoints of rate of operations,
degree of turbulence, and economy. The
several proposed plans included lateral
culverts within the lock chamber combined
with several locations of intake ports,
longitudinal culverts, and outlet ports.
- (f) Tests completed.
- (g) Designs have been selected for all features
of the lock. A valve-opening schedule of
4 minutes resulted in a filling time of
12.5 minutes and a maximum hawser force of
8 tons without supplemental use of the up-
stream lock tainter gate. The lock emptied
in 16 minutes. Studies have shown that
staggered valve operation will reduce maxi-
mum hawser stresses. Operational tests of
the final design were made with several
heads and barge positions using a 4-minute
valve-opening schedule. One combination
of head and barge position corresponds to
conditions of prototype tests performed in

December 1957.

(h) Seven memorandum reports have been issued; one is in preparation.

(2662) GENERAL MODEL STUDY OF JOHN DAY LOCK AND DAM, COLUMBIA RIVER, OREGON AND WASHINGTON.

(b) U. S. Army Engineer District, Walla Walla, Corps of Engineers, Walla Walla, Washington.

(d) Experimental; for design.

(e) A fixed-bed model constructed to an undistorted 1:80-scale will reproduce the Columbia River from Mile 213.7 to 216.8. The structures will be at approximately Mile 215.6. Investigation of flow conditions will be conducted for construction stages and for completed project in the interests of design, navigation, fish migration, and power.

(g) First-stage cofferdam tests indicated that cofferdam should be raised to protect against 700,000 cfs design flow; one cell could be eliminated at downstream end of cofferdam; and one cell should be added at upstream end to protect the toe of the upstream fill. Second-stage cofferdam studies are in progress.

(h) Memorandum reports are in preparation.

(2665) MODEL STUDY OF ICE HARBOR POWERHOUSE INTAKE GATES, SNAKE RIVER, WASHINGTON.

(b) U. S. Army Engineer District, Walla Walla, Corps of Engineers, Walla Walla, Wash.

(d) Experimental; for design.

(e) The 1:25-scale model contains a test unit consisting of intake and scroll case with emergency closure gates and gate slots. The middle closure gate is reproduced in plastic with a synchronous-motor-operated lifting mechanism to simulate prototype operating speed. Provision was made to measure pressures on the gate lip with several lip designs. Tests are being made to determine the gate design producing the least downpull force during emergency closure.

(g) Tests have been made on a 1:25-scale model of one unit of Chief Joseph powerhouse to correlate model downpull forces on intake gate with tests made at Chief Joseph powerhouse during 1955. Correlation was made to obtain a basis for evaluating tests of Ice Harbor powerhouse intake gates. The powerhouse intake gate for Ice Harbor Project has been tested with 12- and 20-inch lip extensions and with 30- and 45-degree lips.

(h) Memorandum report on Chief Joseph tests has been issued. Report of Ice Harbor tests is in preparation.

(2666) MODEL STUDY OF ICE HARBOR DAM FISH LADDERS, SNAKE RIVER, WASHINGTON.

(b) U. S. Army Engineer District, Walla Walla, Corps of Engineers, Walla Walla, Washington.

(d) Experimental; for design.

(e) A 1:10-scale model reproduces a 41-pool tangent of the 1 on 16 slope, 24-foot-wide, south fish ladder in addition to the 6-pool orifice control section of the south fish ladder. Investigations are concerned with fish ladder surge and its elimination and the size and locations of orifices in the control section (no overflow) to function with a 5-foot change in pool elevation without creating undesirable flow conditions. Model was modified to include 16-foot-wide orifice control section and pools of 16-foot-wide 1 on 16 slope fish ladder to check design of orifice control section and determine flow characteristics in typical fish ladder pool.

(g) Results with 24-foot-wide fish ladder indicated that surge would occur within operating range of fish ladder unless a weir crest approximating a sharp edge was used. Surge was reduced with a contracted weir. Uniformity of heads in control section was obtained by varying the spacing of orifices in alternate baffles. Flow conditions in typical pool of 16-foot-wide ladder were satisfactory and plunging flow continued to a head of approximately 15 inches on a weir. Uniformity of heads in control section of 16-foot-wide ladder was obtained by varying the spacing of the two orifices in each baffle. Model was revised to reproduce 16-foot-wide, 1 on 10 slope fish ladder. Flow patterns in typical pools were observed and surge studies made. Tests are in progress to determine effect of reducing length of weir in 16-foot-wide fish ladder.

(h) Two memorandum reports have been issued; others are in preparation.

(2919) MODEL STUDY OF CHANNEL IMPROVEMENT PLANS, PALOUSE RIVER, COLFAX, WASHINGTON.

(b) U. S. Army Engineer District, Walla Walla, Corps of Engineers, Walla Walla, Wash.

(d) Experimental; for design.

(e) A 1:40-scale flume model will be used to determine the extent of channel enlargement and modification, levees, flood walls, and revetments necessary to protect the town of Colfax, Washington, from the following higher-than-record discharges: 14,500 cfs in the South Fork, 16,800 cfs in the Palouse River above the mouth of the South Fork, and 28,000 cfs in Palouse River below the mouth of the South Fork. Space limitations require sharply curved channels of varying cross section which are further restricted by bridge piers at several locations.

(g) Model design and construction were continued.

(2920) MODEL TESTS OF SERVICE GATE SEALS, EAGLE GORGE DAM, GREEN RIVER, WASHINGTON.

(b) U. S. Army Engineer District, Seattle, Corps of Engineers, Seattle, Washington.

(d) Experimental; for design.

(e) A square bulb, "J" type rubber seal with and without a brass chafing strip cast into the bulb was tested to determine: (1) Maximum satisfactory clearance between retainer bar and sealing plate; (2) maximum seal and

support plate clearance that will be closed by the force from the top seal; and (3) friction factors. Heads of 100, 150, and 200 feet were tested.

(g) Apparatus for determining seal clearances was constructed and tests made. It was found that 1/2-in. clearance could be used betwen the retainer bar and seal plate. To prevent leakage around the side seal at its point of intersection with the top seal it was found necessary to eliminate clearance between the side seal and support plate. Friction tests performed by Los Angeles District Laboratory indicated that friction factors were higher for the brass-clad seal.

(h) Memorandum report is in preparation.

(2921) MODEL STUDY OF ICE HARBOR SPILLWAY STOP LOG, SNAKE RIVER, WASHINGTON.

(b) U. S. Army Engineer District, Walla Walla, Corps of Engineers, Walla Walla, Wash.
(d) Experimental; for design.
(e) A 1:20-scale model of a single bay of Ice Harbor spillway dam will be installed in an existing Laboratory flume. Structural features of stop log will be reproduced and facilities will be provided for direct measurement of hydraulic load on stop log as it is lowered into place in high velocity flow.
(g) Design was completed.

(3229) MODEL STUDY OF SPILLWAY FOR JOHN DAY DAM, COLUMBIA RIVER, OREGON AND WASHINGTON.

(b) U. S. Army Engineer District, Walla Walla, Corps of Engineers, Walla Walla, Wash.
(d) Experimental; for design.
(e) A 1:41.14-scale model of three bays of the spillway dam will be used to determine the hydraulic characteristics of the proposed spillway and stilling basin and to develop revisions in design to improve performance or reduce construction costs.
(g) Design and construction of model were completed.

(3230) MODEL STUDY OF NAVIGATION CHANNEL IMPROVEMENT AT BONNEVILLE DAM, COLUMBIA RIVER, OREGON AND WASHINGTON.

(b) U. S. Army Engineer District, Portland, Corps of Engineers, Portland, Oregon.
(d) Experimental; for design.
(e) A 1:130-scale, undistorted, fixed-bed model reproduces 5.6 miles of the Columbia River at the dam site. The original layout includes existing structures and river bed (survey made in summer and fall of 1958). Tests will be made to study methods of improving navigation conditions in the approaches to Bonneville Lock.
(g) Model design and construction were initiated.

(3231) MODEL STUDY OF COUGAR DAM OUTLET STILLING BASIN, SOUTH FORK, McKENZIE RIVER, OREGON.

(b) U. S. Army Engineer District, Portland,

Corps of Engineers, Portland, Oregon.
(d) Experimental; for design.
(e) A 1:25-scale model includes 1045 feet of 13.5-ft-dia. regulating tunnel, portal and transition to 20-ft-wide open concrete chute, transition from chute to 30-ft-wide stilling basin through 150-ft-radius bucket and 1500 feet of downstream channel and overbank topography. Tests are being made to check the adequacy of the original design and develop modifications if required.
(g) Flow conditions in tunnel and through portal and transition to 20-ft-wide chute were satisfactory for the design flow of 6000 cfs. However, the 30-ft-wide stilling basin did not dissipate the energy of the flow sufficiently to prevent considerable wave run-up on riprapped walls of the downstream channel. Various baffle sizes, arrangements, and positions and designs of end sill have been investigated to reduce wave run-up. Tests are in progress with a 50-ft-wide stilling basin.

U. S. ARMY ENGINEER DISTRICT, CORPS OF ENGINEERS, St. Paul.

IN COOPERATION WITH ST. ANTHONY FALLS HYDRAULIC LAB.

Inquiries concerning the following projects should be addressed to the District Engineer, U. S. Army Engineer District, St. Paul, Corps of Engineers, 1217 U. S. Post Office and Custom House, St. Paul 1, Minn.

(985) FILLING AND EMPTYING SYSTEMS FOR HIGH-LIFT LOCKS.

(b) Office, Chief of Engineers, U. S. Army, Washington, D. C.
(d) Experimental; applied research.
(e) To develop adequate criteria for the design of filling and emptying systems for high-lift locks. Tests will be conducted in prototype locks, in model locks for definite projects, and in a general lock model simulating a maximum lift of 150 feet.
(f) Discontinued; the project has been transferred to the U. S. Army Engineer Waterways Experiment Station.
(g) Construction of a recorder unit for use on prototype lock studies was started. Work was limited to units for measurement of pressure and stage. These measurements will be transmitted by means of a compressed air medium and an electronics system to the recorder unit.

(2923) FILLING AND EMPTYING SYSTEMS FOR WALTER F. GEORGE LOCK, CHATTAHOOCHEE RIVER.

(b) U. S. Army Engineer District, Mobile, Ala.
(d) Experimental; for design.
(e) The Walter F. George lock will be 82 feet wide by 450 feet long with a lift of 88 ft. The filling and emptying systems include sill intakes, side-wall culverts, a split system of chamber laterals, and discharge

outlets located riverward of the lock and downstream from the spillway section of the dam. Because of poor foundation material at the site, lock culverts will not be located at a low elevation relative to the downstream pool. It is planned to have the culverts submerged only 8 feet below tailwater.

A section of the culvert at the valve was tested in a pilot model at a scale of 1 to 24.24 to determine whether the culvert immediately downstream should be modified to alleviate low pressures. The complete hydraulic system was tested in a general model at a scale of 3 to 100.

(f) Tests completed.

(g) Tests in the general lock model indicated that the lock could be filled in 13 min. and that the maximum hawser pull on a tow would be 5 tons. The size of the culvert downstream from the filling valves was not changed. Negative pressure in each sidewall culvert, which had occurred when the filling valve was partially open, was raised to positive by a reduction in capacity of the chamber lateral system and by having the region of low pressure located near the first chamber lateral. A partial recirculation occurred during the period of critical pressures. Vortex action in the upper approach was stopped by fins located perpendicular to the flared guard wall. Hoisting forces were measured on a tainter valve in the pilot model. The effect on force of variations in the size of the gap at the top seal of the valve was determined.

(2924) MODEL STUDY OF FILLING AND EMPTYING SYSTEMS FOR BARKLEY LOCK, CUMBERLAND RIVER.

(b) U. S. Army Engineer District, Nashville, Tenn.

(d) Experimental; for design.

(e) The Barkley lock will be 110 feet wide and 800 feet long with a dual culvert system and a maximum lift of 73 feet. Intake port manifolds will be located in the upstream approach walls and bottom lateral culverts in the lock chamber. Both culverts will discharge into the stilling basin of the adjoining spillway. Tests in the model, built to a scale of 3 to 100, determined the adequacy of the hydraulic system and developed necessary improvements.

(f) Tests completed.

(g) Model tests indicated that at the normal lift of 57 feet the lock could be filled in 11.5 minutes and emptied in 13 minutes with a maximum of about 5 tons hawser pull on barge tows in the lock and with satisfactory conditions in the hydraulic system. Two methods were used to eliminate negative pressures downstream from the filling valves in the partially open position. A relatively slow valve time of 8 minutes built up the chamber water surface and the downstream culvert pressure, and the location of each filling valve near the first chamber lateral caused a partial

recirculation and pressure rise.

U. S. DEPARTMENT OF THE ARMY, CORPS OF ENGINEERS, Waterways Experiment Station.

Inquiries concerning the following projects should be addressed to The Director, Waterways Experiment Station, Corps of Engineers, P. O. Box 631, Vicksburg, Mississippi.

(218) CONDUIT INTAKE MODEL TESTS.

(b) Office of the Chief of Engineers, Dept. of the Army, Washington, D. C.

(d) Experimental; applied research.

(e) Scale models are being used for a general study of the hydraulic characteristics of entrance curves for (1) a gated tunnel having a rectangular entrance with floor at same elevation as approach channel (entrance flared in three directions), and (2) a rectangular conduit in which parallel side walls are extended upstream from the entrance and only the roof is flared (entrance floor at same elevation as approach channel). Tests involve determination of pressures and discharge coefficients. A study of rectangular conduits with entrance flared in four directions has been completed. Tests are in progress on an entrance in which only the roof is flared.

(g) In the investigation of entrances flared in three directions best performance was obtained with an entrance, designated as type L, the upstream portion of which follows the elliptical curve

$$\frac{X^2}{D^2} + \frac{Y^2}{(0.32\,D)^2} = 1$$

while the downstream portion followed the curve,

$$\frac{X^2}{D^2} + \frac{Y^2}{(0.16\,D)^2} = 1$$

where D is the dimension of the conduit in the direction concerned.

(236) MISSISSIPPI BASIN MODEL.

(b) Office of the Chief of Engineers, Dept. of the Army, Washington, D. C.

(d) Experimental; for design.

(e) The project provides for construction and operation of a model of the Mississippi River Basin including the Mississippi, Ohio, Missouri, White, Arkansas, and Red Rivers, and their principal tributaries. All existing and proposed flood-control reservoirs, dikes, floodwalls, and other pertinent works will be reproduced. The model area comprises 200 acres, and measures 4,500 feet east and west, and 3,900 feet north and south. Completed construction consists of the Upper Mississippi River from Hannibal, Missouri, to Helena, Arkansas; the Missouri River from Sioux City, Iowa, to the mouth; the Arkansas River from Blackburn Dam Site,

Oklahoma, to Pine Bluff, Arkansas; the Ohio River from Louisville, Kentucky, to the mouth; the Cumberland River from Old Hickory Dam, Tennessee, to the mouth; and the Tennessee River from Pickwick Dam to the mouth. The topography of the streams and flood plains are being reproduced to a horizontal scale of 1:2,000 and vertical scale of 1:100. Water-surface elevations are measured by electrically operated stage devices with the recorders located in central control buildings. Stream flow is introduced and controlled by automatic instruments called inflow controllers. The model was designed to aid in the development of coordinated basin-wide plans for flood control and operation of flood-control structures.

(g) The extent of model operation each year is determined by the testing programs requested by Districts and Divisions that have operable sections on the model. Tests were conducted during the current year for the U.S. Army Engineer Divisions, Missouri River, Ohio River, and Lower Mississippi Valley. Verification tests of the Missouri, Ohio, Tennessee, and Mississippi Rivers were conducted, and some special tests made to determine the effects of installing a highway fill in the flood plain of the Mississippi River near St. Louis, Missouri.

(425) COMPREHENSIVE MODEL STUDY, DELAWARE RIVER, PENNSYLVANIA.

(b) District Engineer, U. S. Army Engineer District, Philadelphia, Corps of Engineers, Philadelphia, Pennsylvania.
(d) Experimental; for design.
(e) To develop and test plans for reduction of shoaling in several ranges of the navigation channel, the entire Delaware River estuary from the Atlantic Ocean to Trenton is reproduced in the model which is of the fixed-bed, silt-injection type, with scale ratios of 1:1,000 horizontally and 1:100 vertically. Tides and tidal currents are reproduced by automatic tide generators. Observed prototype salinities are reproduced in the Delaware Bay portion of the model, and provisions made for the injection of silt, and for measuring silt deposits. Studies are also made of salinity intrusion and the dispersion and dilution of wastes discharged into the estuary.
(f) Active.
(g) Proposed channel realignments in three reaches of the river above Philadelphis were tested by observing surface and subsurface current directions and shoaling characteristics in each. It was concluded that the channel alignments in each reach should be selected primarily on the basis of construction costs and proximity of navigation facilities to the channel. Should these considerations be equal for all plans tested for each area, one realignment in each reach appeared to afford a slight advantage over the others.
(h) "Delaware River Model Study; Report No. 3,

Effects of Proposed Channel Enlargement between Philadelphia and Trenton; Appendix A: Tests of Alternate Alignments of Specific Reaches and Closure of Burlington Island Back Channel." U. S. Army Engineer Waterways Experiment Station Technical Memorandum No. 2-337 (in publication). (Will be available on loan.)

(674) MODEL STUDIES OF FORT RANDALL DAM, MISSOURI RIVER, SOUTH DAKOTA.

(b) District Engineer, U. S. Army Engineer Dist., Omaha, Corps of Engineers, Omaha, Nebraska.
(d) Experimental; for design.
(e) A 1:100 comprehensive model was used to determine effects on velocities of depth and curvature of the approach channel; to investigate flow over the chute-type, taintergate-controlled spillway, and develop a good stilling basin design; and to study flow conditions in the exit area. A 1:50 outlet stilling basin model was used: To develop a satisfactory stilling basin below the eight 28-foot-diameter conduits which were being used for diversion during construction and which will eventually be incorporated in the powerhouse substructure; to verify the design of the stilling basin for the four 22-foot-diameter flood-control conduits to insure satisfactory operation under present and future tailwater conditions; and to determine the limit of required tailrace paving and the necessity for bank protective works by study of currents and wave action. A 1:25 intake and flood-control conduit model was used to determine the character of flow for various reservoir levels; measure loss coefficients of the intake structure; investigate pressures in the transition section; and determine the effects of partial gate operation upon downpull and oscillation of the gates and upon air requirements.
(f) Completed.
(h) "Spillway and Outlet Works for Fort Randall Dam, Missouri River, South Dakota; Hydraulic Model Investigation," final report in publication. (Will be available on loan.)

(993) CAVITATION RESEARCH.

(b) Office of the Chief of Engineers, Department of the Army, Washington, D. C.
(d) Experimental; applied research.
(e) The cavitation characteristics of such elements as baffle piers, steps in stilling basins, spillway and conduit gate slots, and offset joints are studied in either a vacuum tank or a variable-pressure, closed-jet water tunnel. A review of literature is under way to evaluate the many variables that affect cavitation results.

(994) EFFECTS OF MODEL DISTORTION.

(b) Office of the Chief of Engineers, Department of the Army, Washington, D. C.
(d) Experimental; applied research.
(e) A general study was made to determine the

hydraulic effects of various types and degrees of model scale distortion on velocity distribution and other hydraulic conditions, with the ultimate aim of establishing limits of permissible distortion for the various types of models. Tests are in progress of a rectangular flume having a 90-degree bend with provisions for changing the vertical scale to provide a distortion of 0 to 10.

(998) STUDY OF WAVE FORCE ON BREAKWATERS.

(b) Office of the Chief of Engineers, Department of the Army, Washington, D. C.
(d) Experimental; applied research.
(e) A general investigation of wave phenomena and resulting forces is to be conducted in a wave tank to develop formulas, supported by experimental data, from which wave pressures on impervious surfaces, vertical and inclined, can be determined.

(999) STABILITY OF RUBBLE-MOUND BREAKWATERS.

(b) Office of the Chief of Engineers, Department of the Army, Washington, D. C.
(d) Experimental; applied research.
(e) Rubble-mound structures are studied in a 5- by 4- by 119-foot wave tank to develop formulas, supported by experimental data, from which the design of safe and economical breakwaters can be determined. In addition to quarry stone, tetrapods, tetrahedrons, tribars, and other specially molded armor units are being studied.
(g) The results of stability tests in pell-mell-placed protective cover layers of quarry stone, tetrapods and tribars are represented with very good accuracy by the formula

$$W_r = \frac{\gamma_r \, H^3}{K_\Delta \, (S_r - 1)^3 \cot \alpha}$$

where W_r is weight of individual armor units, γ_r is the specific weight of the armor units, H is height of selected design wave, S_r is the specific gravity of armor units relative to the fluid in which the structure is located (γ_r/γ_w), α is the angle of the breakwater face, measured from the horizontal, and K_Δ is a dimensionless coefficient.
(h) "Design of Quarry-stone Cover Layers for Rubble-Mound Breakwaters; Hydraulic Model Investigation," U. S. Army Engineer Waterways Experiment Station Research Report 2-2, July 1958. (Available on loan or for purchase at 75 cents per copy.)

(1002) EFFECTS OF SCALE AND OPERATING TECHNIQUES ON HARBOR WAVE ACTION AND BREAKWATER MODELS.

(b) Office of the Chief of Engineers, Department of the Army, Washington, D. C.
(d) Experimental; applied research.
(e) Tests are conducted in flumes and harbor model basins to obtain information that

will allow more accurate determination of optimum scales for wave models, and the effects of different scale and operating techniques on the accuracy of model results. The efficiency of flexible-element wave filters is being investigated to facilitate continuous operation of wave flumes. Resonant chambers for harbor entrances and attenuation of waves in a three-dimensional model are being studied.

(1004) INSTRUMENTATION.

(b) Office of the Chief of Engineers, Department of the Army, Washington, D. C.
(d) Experimental; development.
(e) Various types of measurement and control equipment for use in hydraulic studies are being developed. These include equipment for measuring direction of water flow and an acoustic flow meter.
(f) Inactive.

(1207) MODEL STUDY OF PENSTOCK INTAKE AND SLUICE COASTER GATES.

(b) Office of the Chief of Engineers, Department of the Army, Washington, D. C.
(d) Experimental; applied research.
(e) A general study of relative merits of various penstock intake and sluice coaster gate lip shapes, seals, and recesses is being conducted. The investigation includes determination of downpull effects of changes in gate lip shape, length and shape of seals, size and shape of the recess in the face of the dam, and need for an air vent in the entrance. The 1:20 model of the sluice coaster gate is being tested in combination with a typical sluice which includes a slide gate, standard entrance curves conforming to the elliptical equation

$$(x^2/D^2) + (y^2/(D/3)^2) = 1.$$

(1211) MODEL STUDY OF HOOSIC RIVER, NORTH ADAMS, MASSACHUSETTS.

(b) District Engineer, U. S. Army Engineer Dist., New York, Corps of Engineers, New York, N.Y.
(d) Experimental; for design.
(e) A 1:30 model was used to verify the hydraulic design for improvement of certain sections of the North and South Branches of Hoosic River in North Adams, Massachusetts, and to determine whether changes should be made for safety, increased efficiency, or economy. The flow in the major portion of these channels will be below critical depth. The model was used to check such design features as channel alignment, transitions, superelevation in bends, characteristics of weirs, stilling basins, drop structures, the treatment of intakes and outlets, wall heights, and elevations of bridges.

(1212) MODEL STUDIES OF OUTLET WORKS, OAHE DAM, MISSOURI RIVER, SOUTH DAKOTA.

(b) District Engineer, U. S. Army Engineer

District, Omaha, Corps of Engineers, Omaha, Nebraska.

(d) Experimental; for design.

(e) Hydraulic performance of the outlet works for Oahe Dam was studied on three models: A 1:60 model reproducing the downstream ends of the six 18.25-foot-diameter outlet tunnels, the stilling basin, and portions of the discharge and pilot channels; a 1:25 model of the portion of one tunnel upstream of the central control shaft, including the intake; and a 1:25 model of one of the control shafts, containing tandem vertical-lift gates, and the tunnel downstream therefrom.

(g) A two-stage stilling basin utilizing a 22-foot-high weir was developed for dissipation of flows from the six tunnels. Hydraulic conditions were suitable for a single stage basin but foundation conditions dictated use of the two-stage basin with its lower walls. Tests demonstrated undesirable conditions to be caused by flow down the bulkhead slot in the intake structure and resulted in provisions being made for sealing this slot. The horizontal curve in the upstream section of tunnel did not cause sufficient unequal flow distribution to create problems in the control section. Consideration was given to use of a gate having upstream seals in tunnels 5 and 6 which are to provide fine regulation. However, uncertainties as to possible harmful effects of violent vortex action in the gate slots led to adoption of a downstream seal gate with a 45-degree lip.

(h) Final report in preparation.

(1467) ANALYSIS OF HYDRAULIC EXPERIMENTAL DATA (MODEL AND PROTOTYPE) AND DEVELOPMENT OF DESIGN CRITERIA.

(b) Office of the Chief of Engineers, Department of the Army, Washington, D. C.

(d) Analytical (model and prototype) and field investigations; for design.

(e) A general study to develop, analyze, and disseminate to Corps of Engineers establishments, hydraulic design criteria to insure adequate capacity, economy of construction, and safe and satisfactory operation. Criteria are developed from model and prototype tests relating to the design of spillways, outlet works, gates and valves, channels, and navigation structures. Program also includes prototype tests in cooperation with other Corps of Engineers establishments.

(g) "Hydraulic Design Criteria" charts have been prepared on torque and discharge coefficients for butterfly valves, friction factors for concrete-lined channels, and hydraulic forces on vertical lift gates. Design aid charts have also been prepared on sequent depths for rectangular channels and the effects of altitude on barometric pressure. Prototype measurements were made of piezometric pressures along the Enid Dam flood control conduit, sluice gate vibration at Pine Flat Dam, and miter gate operating forces at Cheatham Lock.

(h) "Velocity Forces on Submerged Rocks," "Prototype Spillway Crest Pressures, Chief Joseph Dam, Columbia River, Washington," and "Index to Hydraulic Articles, 'Civil Engineering,' 1930-1955," U. S. Army Engineer Waterways Experiment Station Miscellaneous Papers 2-265, 2-266, and 2-291, issued in April, July, and Oct. 1958, respectively. (Available on loan.) "Hydraulic Design Criteria" Issue No. 8. (Available for purchase in limited quantities.)

(1474) OPERATING FORCES OF MITER-TYPE LOCK GATES.

(b) Office of the Chief of Engineers, Department of the Army, Washington, D. C.

(d) Experimental; applied research.

(e) A general study to collect basic data on operating forces of miter-type lock gates and to determine the effect of various elements upon these forces is being conducted in a 1:20 model. A lock chamber 110 feet wide is reproduced with provisions for varying the length up to 600 feet on each side of the gate. Forces required for operation of miter gates were measured for variations of the following elements: gate leaves, speeds and accelerations of operation, submerged depths, recess shapes, bottom clearances, chamber lengths, and nonsynchronous operation of gate leaves. Variations in the type linkage driving the gate were also investigated.

(g) Three types of linkages were used in determining the operating forces of miter-type lock gates: the Panama Canal, the Ohio River, and the modified Ohio River linkages. In all tests the maximum recorded torque occurred as the gates entered the mitered position in the closing cycle. The Ohio River linkage developed torques greater than did the other two linkages. The maximum torques of the modified Ohio and Panama linkages were practically equal which seems logical since both linkages have no angularity between strut and sector arms in the mitered position.

In all tests, the recorded torques decreased as the submergence was lowered by 1/2-foot increments from 4.0 feet to 1.0 foot in the models.

The recorded torques decreased as the time of operation was increased in increments of 6.7 seconds from 10.1 and 13.4 seconds to 40.2 seconds.

The effect of chamber length for the modified Ohio River linkage was determined by varying the model length from 15 to 30 feet in the 5-foot increments. In general the torque decreases as the chamber is lengthened. In model tests the effect of wave action upon torque was negligible except for the 30-foot chamber where waves of small amplitude but great length caused torques equal to or greater than those recorded as the gates entered the mitered position.

Barges simulating a 9-foot draft were installed at 25, 50, 75, and 100 feet below the gates in the 600-foot chamber of the

modified Ohio River linkage. The barges aided in reducing wave action and torques as the gates entered the mitered position.

(1475) SIPHON ACTION AT PUMPING PLANTS.

(b) Office of the Chief of Engineers, Department of the Army, Washington, D. C.

(d) Experimental; applied research.

(e) This study is being conducted to aid in developing design criteria for pumping plants that depend on development of siphonic action in the discharge side of the pumps in order to yield the required discharge. Full-size models of a 6-inch and 12-inch plastic discharge line were tested. Variables investigated during the tests were: rates of flow, water levels in the discharge side of the pumps, slope and length of the riverward leg, and venting conditions at the crown.

(f) Testing completed.

(h) Final report in preparation.

(1735) MODEL STUDY OF WAVE RUN-UP ON SHORE STRUCTURES.

(b) Resident Member, Beach Erosion Board, Corps of Engineers, Washington, D. C.

(d) Experimental; applied research.

(e) Tests are being conducted in a wave flume, using a scale of 1:17, to investigate the relation between water level, crown elevation, wave height, wave period, and beach slope and wave run-up on selected types of shore structures used to prevent erosion caused by wave action.

(f) Suspended.

(g) Tests of the vertical-wall structure indicate that small changes in wave period do not affect appreciably the height of wave run-up. Also, test data indicate that increasing the depth of water at the top of the beach (base of structure) has little effect on the height of wave run-up. For wave steepness values (H/L) between 0.01 and 0.11 relative run-up values decrease from about 3.5 to 0.7. Methods of determining run-up on composite slopes (including slopes with berms) were developed. Run-up on rubble slopes was found to decrease with an increase in either roughness or permeability for the conditions tested. A scale effect is indicated by the large-scale tests, run-up and overtopping being larger than values predicted from small-scale tests.

(1738) MODEL STUDY OF GATES AND STILLING BASIN, GREENUP LOCKS AND DAM, OHIO RIVER.

(b) District Engineer, U. S. Army Engineer District, Huntington, Corps of Engineers, Huntington, West Virginia.

(d) Experimental; for design.

(e) A 1:25 section model reproducing 400 feet of the approach area, a portion of the spillway crest and stilling basin, and 800 feet of the exit area was used to examine the hydraulic performance of the spillway weir and stilling basin. Additional phases

of the study involved measurements of hydraulic forces acting on a submergible-type spillway tainter gate and a girder-type emergency gate in the lock, both constructed to a scale of 1:25.

(f) Testing completed.

(g) Tests indicated a stilling basin consisting of a horizontal apron with a single row of baffle piers and a stepped end sill to be the most satisfactory of the basins investigated. Maximum bottom velocities in the exit area below this basin did not exceed 4 feet per second for normal tailwater conditions. Tests of the submergible tainter gate revealed satisfactory performance of the original design. Maximum downpull on the gate was approximately 100 kips and no uplift forces were recorded. Maximum vertical displacement of the gate was in the range of 0.15 inch (prototype) at random frequencies in the range of 0.0 to 2.0 cycles per second. Tests of the emergency lock gate revealed unsatisfactory performance for the curved crest gate of original design. At high tailwater conditions, the gate oscillated violently in a vertical direction and was uncontrollable. Of the many revisions to the emergency gate tested, the most satisfactory consisted of a triangular-crest-shaped gate with a 1-on-3 sloping upstream crest. This gate was stable throughout the range of operation and tailwater. Maximum downpull was in the range of 215 kips and maximum uplift was about 50 kips. Vertical displacement of this gate was about 0.16 inch (prototype) with random frequencies in the range of 1.0 to 2.5 cycles per second.

(h) Final report in preparation.

(1739) MODEL STUDY OF GATE AND STILLING BASIN, MARKLAND LOCKS AND DAM, OHIO RIVER.

(b) District Engineer, U.S. Army Engineer Dist., Louisville, Corps of Engineers, Louisville, Kentucky.

(d) Experimental; for design.

(e) A 1:25 section model reproducing 400 feet of the approach area, a portion of the spillway crest and stilling basin, and 800 feet of the exit area was used to examine the hydraulic performance of the spillway weir and stilling basin. A second phase of the study involved measurements of hydraulic forces acting on a submergible-type spillway tainter gate.

(f) Tests completed.

(g) Tests indicated that a stilling basin consisting of a sloped apron with a single row of baffle piers and a dentated end sill performed most satisfactorily of the various basins investigated. Maximum bottom velocities in the exit below this basin did not exceed 6 feet per second for normal tailwater conditions. Tests of the submergible-type tainter gate revealed that the original design gate performed satisfactorily. Maximum downpull on the gate was about 100 kips and no uplift forces were recorded. Maximum vertical displacement of the submergible

gate was in the range of 0.22 inch (proto-
type) and random frequencies in the range
of 0.0 to 3.0 cycles per second were en-
countered.

(h) Final report in publication.

(1979) MODEL STUDY OF STILLING BASIN, BULL SHOALS
DAM, WHITE RIVER, ARKANSAS.

(b) District Engineer, U.S. Army Engineer Dist.,
Little Rock, Corps of Engineers, Little
Rock, Arkansas.

(d) Experimental; for design.

(e) The spillway was constructed with a stepped-
type stilling basin designed to spread the
jets issuing from the conduits. After a
period of operation the steps were damaged
by cavitation. A 1:12 model was used to
develop a satisfactory method of repairing
the basin for conduit discharges; a 1:50
section model was used to check the perform-
ance of the modified basin with spillway
discharges.

(f) Completed.

(g) The most feasible measures developed in the
models to prevent further damage to the
stilling basin consisted of an upward-slop-
ing ramp replacing the first three of the
four steps of the horizontal basin, but
with it installed the original 4-foot-high
end sill did not satisfactorily dissipate
conduit-flow energy. With an adequate end
sill height (10 or 12 feet), a row of 8-
foot-high baffle piers and a short apron
just below the original basin were neces-
sary to prevent erosion of the exit channel
at low flows.

(h) "Stilling Basin Modifications, Bull Shoals
Dam, White River, Arkansas." U.S. Army
Engineer Waterways Experiment Station Tech.
Report No. 2-488, Nov. 1958. (Available on
loan.)

(1982) MODEL STUDY OF OLD RIVER LOW-SILL CONTROL
STRUCTURE, OLD RIVER, LOUISIANA.

(b) President, Mississippi River Commission,
Corps of Engineers, Vicksburg, Mississippi.

(d) Experimental; for design.

(e) The Old River low-sill control structure
will control flow into Old River, which
links the Mississippi and Atchafalaya Riv-
ers, so that Mississippi River flows will
be divided between the lower reaches of the
Mississippi and Atchafalaya. Flow through
the structure will be regulated by eleven,
multiple-leaf, vertical-lift gates. Tests
of a 1:36 model were made to study the
over-all performance of the structure with
special attention to flow conditions at the
abutments and the effectiveness of the
stilling basin in dissipating energy under
all tailwater conditions.

(h) Final report in preparation.

(1980) MODEL STUDIES OF TABLE ROCK DAM, WHITE
RIVER, MISSOURI.

(b) Dist. Engineer, U.S. Army Engineer District,
Little Rock, Corps of Engineers, Little Rock,

Arkansas.

(d) Experimental; for design.

(e) A 1:50 section model of the stilling basin
was used to determine the adequacy of the
basin for spillway flow, and a 1:12 model of
one conduit and about 150 feet of the still-
ing basin width was used for tests of the
basin under conduit flow. Current patterns
and velocities around the training walls
and in the powerhouse area were studied in
a 1:100 general model. A 1:20 conduit mod-
el was used to develop an effective outlet
portal.

(f) Completed.

(g) Tests showed that stilling basin action
under spillway flow would be improved by
alterations in the size and arrangement of
the baffle piers. One training wall can be
made 10 feet lower and as much as 50 feet
shorter without affecting basin action ma-
terially. With the low tailwaters that will
be present during conduit discharges, the
jet emerging from the conduits was poorly
dispersed and the baffle piers were subject-
ed to relatively high velocities. Increas-
ing the flare of the side walls at the out-
let and use of upward sloping deflector and
splitter blocks in the portal improved flow
conditions. Serrations in the spillway
bucket were tested but did not contribute
materially to stilling action; therefore,
the conduit outlet portals were made flush
with the adjacent surfaces of the spillway
bucket.

(h) "Spillway and Conduits for Table Rock Dam,
White River, Arkansas; Hydraulic Model In-
vestigation,"final report in publication.
(Will be available on loan.)

(1984) MODEL STUDY OF CONTROL GATE FOR TUNNEL NO.
4, FORT PECK DAM, MISSOURI RIVER, MONTANA.

(b) Dist. Engr., U.S. Army Engr. Dist., Garri-
son, Corps of Engrs., Riverdale, North Dak.

(d) Experimental; for design.

(e) Tests to study methods of eliminating cavi-
tation on the port liner and vibration of
the cylinder gate in the main control shaft
of tunnel No. 4 were conducted on a 1:25
model. Discharge capacities, pressures,
air demand, and gate vibration were deter-
mined for the existing cylinder gate instal-
lation.

(f) Completed.

(g) The most satisfactory alterations to the
existing structure consisted of addition of
a 12- or 15-inch offset below the discharge
ports with six 12-inch-diameter vents below
the offset. This design eliminated the
negative pressures noted in the port areas
of the existing structure, and greatly im-
proved pressure conditions in the area be-
low the offset. Pressure surges at the cy-
linder gate also were reduced.

(h) "Control Gate Tests for Fort Peck Dam Tun-
nel 4, Missouri River, Montana; Hydraulic
Model Investigation," final report in pub-
lication. (Will be available on loan.)

(1985) DEVELOPMENT OF TURBULENCE METER.

(b) Office of the Chief of Engineers, Department of the Army, Washington, D. C.
(d) Experimental; development.
(e) The investigation is being conducted to develop instruments that will: (1) Indicate the speed and direction of fluid currents at shallow depths and high velocities; (2) receive signals from (1) and separate them into (a) instantaneous velocity and direction, (b) mean velocity and direction, and (c) the root-mean-square deviations from the mean.
(f) Temporarily suspended.

(1986) SALT WATER INTRUSION AND RELATED PHENOMENA.

(b) Committee on Tidal Hydraulics, Corps of Engineers (correspondence should be addressed to Mr. C. F. Wicker, Chairman, Committee on Tidal Hydraulics, U.S. Army Engineer Dist., Philadelphia, Corps of Engineers, Philadelphia, Pennsylvania).
(d) Experimental; applied research.
(e) To determine the effects of salinity and related phenomena on the vertical distribution of currents and shoaling characteristics in estuaries, tests are being made in a lucite flume 327 feet long, 1.5 feet deep, and 0.75 foot wide. One end of the flume is connected to a 25-foot-square tidal basin in which any desired tide may be produced and in which the salinity may be controlled. The opposite end is connected to a fresh-water source. Combinations of tidal range, tidal period, source salinity, mean depth, and fresh-water inflow are studied. A total of five tests were made during the year. The results are being analyzed; however, no conclusions have been reached at this time.

(1987) MODEL REPRODUCTION OF PROTOTYPE EROSION BELOW STILLING BASINS.

(b) Office of the Chief of Engineers, Department of the Army, Washington, D. C.
(d) Experimental; applied research.
(e) Initially, the investigation to develop a model technique for simulating scour below stilling basins will be conducted on a model of a selected dam with provisions for studying sands of different sizes in the channel below the stilling basin. Later, models with two or more different linear scales will be constructed to verify findings using suitable bed materials.

(1988) WATER TEMPERATURE EFFECTS ON BED FORMS AND ROUGHNESS.

(b) Office of the Chief of Engineers, Department of the Army, Washington, D. C.
(d) Experimental; applied research.
(e) A laboratory flume, in which water temperatures can be varied to simulate normally experienced summer and winter temperatures, is being constructed for investigating the effects of water temperature on stream-bed forms and roughness of various types of bed materials.

(2426) MODEL STUDY OF NAVIGATION LOCK, PORT ALLEN, LOUISIANA.

(b) President, Mississippi River Comm., Corps of Engineers, Vicksburg, Mississippi.
(d) Experimental; for design.
(e) A new channel in the Gulf Intracoastal Waterway from Indian Village to Port Allen, Louisiana, includes a navigation lock in the Mississippi River levee at that point. Several designs for the lock ports were tested in a preliminary culvert and single port model constructed to a 1:25-scale ratio. The major investigations were conducted in a 1:25 model reproducing 150 feet of upstream approach, intake manifolds, 1,250 feet of lock chamber, culverts, lateral ports, outlet manifolds, and 1,000 feet of downstream topography.
(f) Completed.
(g) Revised designs were developed for the intake and discharge manifolds. A 2-foot-deep recess was installed in front of each of the 46 lock chamber wall ports to reduce hawser stresses during filling operations. A two-speed valve schedule for filling, and a single-speed valve schedule for emptying the lock were developed. The final design permits the lock to be filled or emptied under all possible head conditions (including a maximum head differential of 45 feet) with hawser stresses within the 5-ton limit. At average operating head (11 feet), the filling time with tow in lock chamber will be 6 or 7 minutes; emptying time, approximately 6 minutes.
(h) "Port Allen Navigation Lock, Gulf Intracoastal Waterway, Plaquemine-Morgan City Route, Louisiana; Hydraulic Model Investigation," final report in publication. (Will be available on loan.)

(2427) MODEL STUDY OF OUTLET WORKS, ABIQUIU DAM, RIO CHAMA, NEW MEXICO.

(b) Dist. Engr., U.S. Army Engr., Dist., Albuquerque, Corps of Engineers, Albuquerque, New Mexico.
(d) Experimental; for design.
(e) A 1:20 model reproduced the 12-foot-diameter outlet tunnel including the control section consisting of twin gate passages and a flip-bucket energy dissipator. Of particular interest were the transitions between the rectangular gate passages and the circular tunnel.
(f) Testing completed. Final report in preparation.

(2428) MODEL STUDY OF SAVANNAH HARBOR, GEORGIA.

(b) District Engineer, U.S. Army Engineer Dist., Savannah, Corps of Engineers, Savannah, Ga.
(d) Experimental; for design.
(e) The investigation is being conducted in a model which reproduces the following: (1) That portion of the Atlantic Ocean, adjacent to the harbor entrance, from Caliboque Sound on the north to Wassaw Sound on the south; (2) the Savannah River and its flood plain

121

to the head of tide at Ebenezer Landing;
and (3) that portion of the Intracoastal
Waterway which crosses the area included in
the model. The model is of fixed-bed con-
struction with scale ratios, model to pro-
totype, of 1:800 horizontally and 1:80 ver-
tically. Automatic tide generators are
used to reproduce tides and tidal currents
throughout the harbor, and salt water is
used in the model ocean to reproduce the
effects of density difference on current
velocities and distributions. Shoaling
studies are made by injecting finely ground
gilsonite into the model to reproduce the
patterns of shoaling as observed in the
prototype, following which the effects of
proposed improvement plans on shoaling pat-
terns may be observed and evaluated. Stud-
ies are also made of the effects of pro-
posed improvement plans on dispersion and
dilution of contaminants discharged into
the harbor.

(g) Tests of plans designed to reduce shoaling
in the harbor, or to shift the location of
major shoals to areas where dredged spoil
disposal can be accomplished without diffi-
culty, indicate that diversion of fresh
water would greatly reduce shoaling, and
off-channel sediment traps, used in con-
junction with tide gates, would be effec-
tive in localizing shoaling, thus reducing
maintenance dredging costs.

(2429) MODEL STUDIES OF THE CORNWALL ISLAND AND
BARNHART ISLAND-LAKE ST. FRANCIS REACHES,
ST. LAWRENCE RIVER.

(b) District Engineer, U.S. Army Engineer Dist.,
Buffalo, Corps of Engineers, Buffalo, N. Y.

(d) Experimental; for design.

(e) Two fixed-bed models were used to study
plans for navigation improvement in the
lower portion of the International Rapids
section of the St. Lawrence River. A 1:100
model of the Cornwall Island Reach repro-
duced all features of the river from just
below the tailrace of the proposed Barnhart
Island powerhouse to about the mid-point of
Cornwall Island, and included portions of
both the north and south Cornwall Island
channels, Polly's Gut, and the entrance to
Grass River locks. A model of the Barnhart
Island-Lake St. Francis Reach, built to
scales of 1:300 horizontally and 1:100 ver-
tically, reproduced a greater area upstream
and downstream of Cornwall Island. Both
models were used to study navigation con-
ditions in the approach to the Grass River
locks, proposed plans for excavations in
both Cornwall Island channels to effect
navigation improvement in South Channel,
and to determine conditions that will be
encountered by navigation during the con-
struction of the project features in the
Cornwall Island Reach.

(f) Tests completed.

(g) A satisfactory navigation channel and
stage-construction steps covering various
work phases were developed.

(h) Preparation of final report in progress.

(2431) MODEL STUDIES OF STILLING BASIN, WARRIOR
DAM, WARRIOR RIVER, ALABAMA.

(b) District Engineer, U.S. Army Engineer Dist.,
Mobile, Corps of Engrs., Mobile, Alabama.

(d) Experimental; for design.

(e) Two section models were used to study the
hydraulic characteristics of the spillway
and stilling basin designs for this pro-
posed navigation structure: (1) A 1:20 mod-
el reproducing 400 feet of the approach
area, a portion of the spillway crest, left
embankment, and stilling basin (2 full gate
bays and adjacent half bays), and 800 feet
of the exit area; and (2) a 1:60 model of
the center section of the spillway and
stilling basin reproducing one full gate
bay and adjacent half bays. The studies
were particularly concerned with length and
elevation of stilling basin, type and spac-
ing of baffle piers, end sill height, and
riprap protection below stilling basin.

(f) Completed.

(g) The model test revealed that, although the
performance of the spillway and stilling
basin as originally designed was generally
satisfactory, some improvements could be
effected. Tests on the 1:20 model indicat-
ed that flow at the upstream abutment of
the spillway was improved by addition of a
curved training wall. The capacity of the
original spillway crest was found to be in
close agreement with the computed capacity.
However, the use of straight-line construc-
tion (revised design) gave similar discharge
capacity and effected economies in construc-
tion.
The most satisfactory stilling basin design
consisted of a horizontal apron with two
rows of baffle piers and a stepped end sill.
Tests of the stilling basin training wall
indicated that the wall height can be re-
duced 10 feet, and the radius of its curved
downstream end can be reduced 15 feet with-
out affecting flow conditions below the
structure. Tests also were conducted with
the curved portion of the wall removed en-
tirely, and little change in flow conditions
was noted. However, erosion at the end of
the straight wall was somewhat greater than
with the flared walls. Tests indicated
that the riprap blanket below the end sill
can be horizontal and shortened 14 feet.
Bottom velocities measured in the approach
to the spillway revealed a need for some
riprap protection immediately upstream from
the structure.
Hydraulic forces measured on one of the
spillway tainter gates revealed maximum up-
lift and downpull values of about 8 kips.
Visual observation revealed no vibration of
the model gate. Tests of stop logs to be
used for emergency gate repairs and in
passing drift indicated that they will
create no adverse conditions in the still-
ing basin.

(h) "Stilling Basin for Warrior Dam, Warrior
River, Alabama; Hydraulic Model Investiga-
tion." U.S. Army Engineer Waterways Expt.
Station, Tech. Report No. 2-485, July 1958.

(Available on loan.)

(2432) MODEL STUDIES OF WALTER F. GEORGE (FORMERLY FORT GAINES) LOCK AND DAM, CHATTAHOOCHEE RIVER, GEORGIA.

(b) District Engineer, U.S. Army Engineer Dist., Mobile, Corps of Engrs., Mobile, Alabama.
(d) Experimental; for design.
(e) Two models were used to study the hydraulic characteristics of the spillway and stilling basin, orientation of spillway and powerhouse in the river channel, excavation required above and below powerhouse and spillway, and the alignment and location of the lock from the standpoint of satisfactory entrance conditions. A 1:80 model reproduced the entire problem area, including 1,500 ft of the approach area, the spillway, and navigation lock and 3,500 ft of the exit area; and a 1:40 model of the center section of the spillway and stilling basin reproduced one full gate bay and adjacent half bays.
(f) Completed.
(g) The orientation and alignment of the lock, dam, and powerhouse were found to be satisfactory. The spillway as originally designed was not as efficient as computations had indicated, and an underdesigned weir was developed that provided the desired capacity. A split-level stilling basin that takes advantage of natural foundation conditions was demonstrated to provide as satisfactory stilling action as the original level, horizontal basin. Tests showed that one stilling basin training wall could be eliminated and the height and length of the other considerably reduced. Economies in the excavation of the exit area were also found to be feasible.
(h) "Walter F. George Lock and Dam, Chattahoochee River, Alabama and Georgia; Hydraulic Model Investigation", final report in publication. (Will be available on loan.)

(2434) MODEL STUDY OF VERMILION BAY, LOUISIANA.

(b) Department of Public Works, State of La.
(d) Experimental; for design.
(e) Vermilion Bay, on the Louisiana coast, is connected with the Gulf of Mexico through the deep and narrow channel of Southwest Pass, and is part of a bay system consisting of East Cote Blanche, West Cote Blanche, and Atchafalaya Bays. The Vermilion River and several smaller streams flow into Vermilion Bay, but their combined discharges are too small during the summer to prevent intrusion of saline Gulf waters into the bay through Southwest Pass, thus ruining the bay for irrigation purposes. On the other hand, because of barrier reefs and the discharge of the Atchafalaya River, the waters of East Cote Blanche, West Cote Blanche, and Atchafalaya Bays are fresh enough for irrigation purposes during most of the year. The plan of improvement contemplates closure of Southwest Pass in an attempt to bring the salinity of Vermilion

Bay into agreement with that of the other bays.
A fixed-bed model, to linear scales of 1:100 vertically and 1:2,000 horizontally, reproduced a part of the Gulf of Mexico, Vermilion, East Cote Blanche, West Cote Blanche, and Atchafalaya Bays, and portions of the tributary streams. Provisions were included for reproducing salt-water, as well as fresh-water, flow.
(f) Completed.
(h) "Effects of Proposed Closure of Southwest Pass on the Regimen of Vermilion Bay, La.; Hydraulic Model Investigation", final report in publication. (Will be available on loan).

(2673) MODEL STUDIES OF BARKLEY LOCK AND DAM, CUMBERLAND RIVER, TENNESSEE.

(b) District Engineer, U.S. Army Engineer Dist., Nashville, Corps of Engrs., Nashville, Tenn.
(d) Experimental; for design.
(e) A 1:120 model, reproducing the Cumberland River from mile 29.4 to 32.2, the lock, dam, and powerhouse, is being used to investigate flow characteristics in the approaches to the lock. A 1:36 model, reproducing the riverward downstream lock wall including the culvert manifold which discharges into the spillway stilling basin, a discharge manifold discharging through the stilling basin, five spillway bays, 324 feet of approach channel, and 596 feet of exit channel, was used to investigate flow characteristics in the stilling basin and exit channel. The proposed design for the lock filling and emptying system was tested in a 1:33 model simulating the upper approach channel, intake manifolds in both walls serving culverts 16 feet square, lateral culvert diffusers in the lock chamber floor, and port manifolds in the spillway stilling basin for discharging flow from both culverts. The emergency lock gate is being studied in a 1:25 model which reproduces the gate, gate sill, and portions of the upstream lock approach and the lock chamber downstream from the gate. This model will be used to determine: (1) Hydraulic forces on and stability of the gate under various flows including free flow over the lock miter sill; (2) hydrostatic forces on the gate in various positions; (3) gate wheel reactions and sill roller reactions at given positions; and (4) head loss through the bridge decking.
(g) A satisfactory stilling basin and lock culvert discharge manifold were developed.

(2674) MODEL STUDY OF CALUMET RIVER LOCK, SOUTH CHICAGO, ILLINOIS.

(b) District Engineer, U.S. Army Engineer Dist., Chicago, Corps of Engrs., Chicago, Ill.
(d) Experimental; for design.
(e) The Calumet River Lock in South Chicago is part of a project for widening and deepening the Calumet-Sag Channel, and important link in the Great-Lakes-to-the-Gulf-Waterway. The lock will be 1,000 feet long,

110 feet wide, and will provide a depth of
12 feet over the sills. Normal lifts will
be of the order of 5 feet; however, extreme
conditions can produce head differentials
as great as 9 feet. Also, normal opera-
tion will require lifts from the navigation
pool to lake elevation but reversal in head
during periods of low lake level is possi-
ble. Filling and emptying of the lock will
be accomplished between the leaves of sec-
tor gates, supplemented by loop culverts
around the lakeside sector gates. Filling
and emptying characteristics were studied
on a 1:20 model which reproduced the imme-
diate approaches and entire lock. Provi-
sions were made for mechanical operation
of the sector gates and automatic record-
ing of pertinent data.

(f) Completed.

(g) A schedule of operation for combined cul-
vert and sector-gate filling was developed
which permits the lock to be filled in
about 6.5 minutes, with hawser forces less
than the 5-ton limit, under a normal head
(5 feet), and in about 8.5 minutes with
maximum hawser stresses of 6.4 tons under
maximum (9 feet) head. The lock can be
emptied through the sector-gate center
opening in 6.4 minutes, with a maximum haw-
ser stress of 4.2 tons, under a 5-foot
head. Under reverse head conditions, the
lock can be filled satisfactorily through
the sector-gate center opening if the gates
are stopped 2 minutes after they have
started opening. However, this results in
a long filling time which can only be
shortened by permitting hawser stresses of
7 or 8 tons.

(h) "Filling and Emptying Characteristics of
Calumet River Lock, Calumet-Sag Project,
Illinois; Hydraulic Model Investigation,"
final report in publication. (Will be
available on loan.)

(2675) MODEL STUDIES OF DARDANELLE LOCK AND DAM,
ARKANSAS RIVER, ARKANSAS.

(b) District Engineer, U.S. Army Engineer Dist.,
Little Rock, Corps of Engineers, Little
Rock, Arkansas.

(d) Experimental; for design.

(e) Three models are being used for the in-
vestigation. A 1:120 model reproduces the
structures and 4,000 ft of approach channel
and 8,000 ft of exit channel. The approach
channel is molded in concrete to overburden
contours while the exit channel is molded
in concrete to bedrock contours but has the
overburden topography molded in pea gravel
to facilitate revision of the channel con-
figuration. Currents are measured around
the lock approaches for all arrangements
of structures; forces against barge tows in
the lock approaches are recorded; and some
type of lightweight material is introduced
into the model to reveal sedimentation
tendencies. A 1:50 section model reproduc-
ing one full and two adjacent half bays of
the spillway and stilling basin is being
utilized for studies of the adequacy of the

weir and stilling basin design. This model
has a glass side so that flow patterns can
be observed directly. A 1:25 model repro-
ducing 700 feet of upstream lock approach
channel, the guide wall, the lock culvert
intakes, the lock culverts through the fill-
ing valves, and three adjacent spillway
bays (the downstream portions of the lock
culvert and lock chamber are reproduced
schematically) is being used to develop a
satisfactory lock intake system and approach
channel. Provisions were made for mechanical
operation of the culvert valves and auto-
matic recording of pertinent data.

(g) Tests in the general model have established
the best relative locations for the lock,
spillway, and powerhouse and the best lock
wall arrangement. Stilling basin length
and end-sill height and two crest pier nose
designs were investigated in the section
model. A satisfactory lock intake design
has been developed in the 1:25 model, but
vortex conditions in the approach channel
have not been completely eliminated.

(2678) MODEL STUDY OF LOCKS AND DAM NO. 41, LOUIS-
VILLE, KENTUCKY.

(b) District Engineer, U.S. Army Engineer Dist.,
Louisville, Corps of Engineers, Louisville,
Kentucky.

(d) Experimental; for design.

(e) A fixed-bed, 1:120 model reproduces a six-
mile reach of the Ohio River including ad-
jacent overbank areas, the locks and dam
structures, and all bridges and other struc-
tures that might affect flow conditions.
Investigations are being made to: Deter-
mine the effects of location, size, and
alignment of the dam on stages and currents
in the upper pool; determine the effects of
location, size, and alignment of a new ap-
proach channel on navigation and surge con-
ditions; determine the best location for a
new navigable span on the Pennsylvania Rail-
road bridge; determine a method of operat-
ing the dam for optimum navigation condi-
tions; study navigation conditions in the
lower approach as affected by flow through
dam, powerhouse, and lock-emptying system;
and provide a means for navigation inter-
ests to satisfy themselves as to the ac-
ceptability of the proposed plan by observ-
ing the model in operation.

(g) Tests indicate that replacing the two pro-
posed beartraps with a gated structure
would have no effect on flow conditions.
The effect on flood stages of raising the
dam 2 ft would be small.

(2679) MODEL STUDY OF PANEL GATES, OLD RIVER OVER-
BANK STRUCTURE.

(b) President, Mississippi River Commission,
Corps of Engineers, Vicksburg, Mississippi.

(d) Experimental; for design.

(e) The Old River overbank structure will help
to control diversion from the Mississippi
River to the Atchafalaya River during flood
stages. The structure will consist of a

low weir with crest elevation of 52.0 msl surmounted by piers and panel gates for controlling discharge. The spillway will contain 73 gate bays with clear widths of 44 feet. Each bay will be fitted with 15 panels measuring 2 ft 10-1/2 inches by 18 ft. The panels will be hinged to the superstructure above the weir and will seal against the weir at the lower ends. The gates will be operated by a crane cable attached to the lower ends of the panels. A 1:8 section model of the spillway and stilling basin, reproducing one full bay and about 36 percent of each of the two adjacent bays, was used to determine the maximum lifting cable stresses that may be induced under any of the possible operating conditions, to measure the maximum hinge pin reaction, to observe whether the panels will seat properly when operated in flowing water, and to determine the effectiveness of the stilling basin under maximum flood conditions.

(f) Completed.

(g) Tests confirmed the computed cable stresses, and revealed a maximum hinge pin stress of 40,300 pounds on the left pin of the center panel when all panels to either the right or left of the center panel were raised. The panels tended to float at the larger openings. Stilling basin action was improved by relocating the baffle piers downstream from their original position.

(h) "Old River Overbank Structure, Forces on Panel Gates; Hydraulic Model Investigation," final report in publication. (Will be available on loan.)

(2680) MODEL STUDY OF HURRICANE TIDES IN NARRAGANSETT BAY, RHODE ISLAND.

(b) Division Engineer, U.S. Army Engineer Div., New England, Corps of Engrs., Boston, Mass.

(d) Experimental; for design.

(e) A fixed-bed model, 1:1,000 horizontally and 1:100 vertically, reproduces all of Narragansett Bay and an adjacent portion of the Atlantic Ocean. An automatic tide generator reproduces normal tides throughout the model, and a separate, manually operated generator reproduces hurricane tides of the desired characteristics at the bay entrance. Numerous barrier plans for prevention of hurricane-tide damage have been proposed. The relative and absolute effectiveness of these plans in reducing hurricane-tide elevations throughout the bay system were determined and the effects of the best plan on such important factors as tidal circulation, pollution, salinity, and shoaling for normal conditions are under investigation. Fresh water only was used in the model during tests of the proposed barrier plans, but both salt and fresh water are being used in the tests to determine the effects of the best barrier plan on all significant factors for normal conditions. Model appurtenances consist of automatic tide gages to record both hurricane-tide and normal-tide elevations at critical points, record-

ing salinity meters, recording dye meters for observing pollution and/or flushing characteristics, current velocity meters, and equipment for simulating shoaling of the channels and other navigation facilities.

(g) Results of supplementary tests to determine the effects of the most satisfactory plan developed for reducing hurricane-tide heights in the bay area on salinity, pollution, and shoaling indicated that: (1) Salinities would be slightly reduced at the surface and increased at the bottom; (2) the plan would have no measurable effect on shoaling within the bay system; and (3) pollutants discharged into surface strata would move downstream more rapidly than under existing conditions, while those discharged at or near the bottom would move downstream more slowly than under existing conditions.

(2681) LARGE SCALE TESTS OF RUBBLE-MOUND BREAKWATERS.

(b) Office of the Chief of Engineers, Department of the Army, Washington, D. C.

(d) Experimental; applied research.

(e) Tests are being conducted by the Beach Erosion Board, under the supervision of the Waterways Experiment Station, to investigate the effects of model scale on the results of experimentally determined criteria for the design of rubble-mound breakwaters. Stability tests will be made of breakwater slopes of 1 on 1-1/2 and 1 on 2-1/2, using wave periods of 3.36, 5.60, and 7.87 seconds. Tests in the Beach Erosion Board wave flume (15 ft by 20 ft by 635 ft) are being conducted using a linear scale of 7.5 to 1 based on the tests conducted in the Waterways Experiment Station 5- by 4- by 119-foot wave flume. Stability tests have been conducted in the Waterways Experiment Station small wave flume (1 ft by 1.5 ft by 94 ft) using a scale of 0.5 to 1 based on tests conducted in the 5- by 4- by 119-ft wave flume. Therefore, data on the stability of rubble-mound breakwaters will be available for three different linear scales, 0.5 to 1, 1 to 1, and 7.5 to 1.

(2682) SACRAMENTO BARGE CANAL LOCK MODEL STUDIES, SACRAMENTO RIVER, CALIFORNIA.

(b) District Engineer, U.S. Army Engineer, Dist., Sacramento, Corps of Engrs., Sacramento, California.

(d) Experimental; for design.

(e) The Sacramento Barge Canal Lock is part of the proposed improvement for the Sacramento River Deep Water Ship Canal. The project plan consists of (a) a deep water channel from Suisan Bay to Washington Lake, 30 ft deep at mean low water, 200 feet wide in tangents, and 300 ft wide in curves and through existing channels, (b) a 70-acre, 30-foot-deep harbor at Lake Washington, (c) a connecting barge canal from Washington Lake to Sacramento River, 13 ft deep and 120 ft wide with a navigation lock 86 by

600 ft, and a combination highway and railroad bascule bridge. The maximum anticipated lock lift is 21.1 ft. A minimum depth of 13 ft is provided over the upper and lower gate sills. Because of the possibility of a reversal of head, sector gates were selected for the lock and also are to be used as the means of filling and emptying the lock. Flow will pass directly into or from the lock between the gate leaves as they are opened. In addition the gate leaves and recesses have been designed so that flow will pass between the faces of the leaves and the walls of the recesses, thereby providing three flow passages at each end of the lock. The immediate approaches and entire lock were reproduced in a 1:20 model. Provisions were made for mechanical operation of the sector gates and automatic recording of pertinent data.

(f) Tests completed.

(g) A sector-gate-opening schedule was developed which reduced longitudinal hawser stresses on a 4-barge tow to about 5 tons for normal lifts of 12 ft or less and 6 tons for a maximum lift of 21 ft. The time of filling for a full range of heads varied from 9.6 to 10.2 minutes. Emptying the lock was less critical than filling and a single rate of operation was found to be satisfactory. Emptying could be accomplished for all tows under a full range of heads in 12.8 minutes with hawser stresses of less than the 5-ton limit.

(h) Final report in preparation.

(2683) MODEL STUDY OF SURGES, LONG SAULT CANAL, ST. LAWRENCE RIVER.

(b) District Engineer, U.S. Army Engineer Dist., Buffalo, Corps of Engrs., Buffalo, New York.

(d) Experimental; for design.

(e) Surges that could occur in the intermediate pool of Long Sault Canal between Eisenhower and Grass River Locks through accidental failure of the upstream lock (Eisenhower Lock) gates were studied in a fixed-bed model built to linear scale ratios of 1:200 horizontally and 1:100 vertically. The model reproduced all pertinent features of the portion of Long Sault Canal extending from just upstream of Eisenhower Lock to the downstream end of the Grass River Lock. Included in the model were Eisenhower and Grass River Locks, Dike No. 6, and the 18,000-foot-long intermediate pool.

(f) Completed.

(g) Tests showed that the maximum height of the surge above normal pool elevation would be 4.5 feet at the downstream lock when closing of the emergency lift gate of Eisenhower Lock was started 10 minutes after the miter gates failed and closure was completed in 19 additional minutes. For these conditions, the design height of the Grass River Lock walls is adequate to contain the surges produced. However, if water were prevented from flowing onto overbank areas adjacent to the canal, surges at Grass River Lock would increase to 14.4 ft above

normal pool elevation.

(h) "Surges in the Intermediate Pool of Long Sault Canal, St. Lawrence River; Hydraulic Model Investigation." U.S. Army Engineer Waterways Experiment Station Technical Report 2-489, Nov. 1958. (Available on loan.)

(2685) MODEL STUDY OF WAVE ACTION, SUPERIOR ENTRY, DULUTH-SUPERIOR HARBOR, LAKE SUPERIOR.

(b) District Engineer, U.S. Army Engineer Dist., St. Paul, Corps of Engrs., St. Paul, Minn.

(d) Experimental; for design.

(e) A 1:150 fixed-bed model reproduces all the navigation approach channel and harbor breakwater structures as well as the inner harbor dock area serving Superior, Wisconsin, and includes adjacent lake and shoreline areas to permit reproduction of storm waves from all critical directions. Investigations are being made: to determine the reasons for the wind-wave problems that exist and cause ship damage in the vicinity of the Superior Entry; and to develop the most effective remedy possible so that navigation and docking hazards now prevailing will be adequately remedied.

(g) Results of a wave-refraction study indicate that storm directions between N54°E and N62°30'E are critical for this harbor. Tests performed to date show that severe wave action now obtains along the Great Northern Railway ore docks during storms from these directions. Remedial plans studied involve detached breakwaters at two separate plan locations. Each of these plans had its southeast limit 300 ft southeast of the center line of the navigation approach channel. The southeast limit of the inner breakwater is located 2,100 ft lakeward and the southeast limit of the outer breakwater is located 2,800 ft lakeward of the existing harbor entrance. Preliminary analysis of test results indicates that if the inner breakwater location is suitable from the standpoint of navigation, a breakwater section about 1,150 ft in length will provide adequate protection to the harbor. However, if the outer breakwater location is selected, the breakwater length required will be approximately 1,350 feet. Plan alignments resulted from analyses which established minimum volume of material with respect to length.

(2686) MODEL STUDY OF WOONSOCKET FALLS DAM, BLACKSTONE RIVER, RHODE ISLAND.

(b) Division Engineer, U.S. Army Engineer Div., New England, Corps of Engrs., Boston, Mass.

(d) Experimental; for design.

(e) A 1:50 fixed-bed model reproduced the Blackstone River from about 1,600 ft above to about 600 ft below the dam, and included provisions for measuring pressures on the downstream side of the dam. The flood-control project channel improvement include reconstruction of the dam and rock excavation between the toe of the dam and a bridge just downstream to minimize submergence of

the dam. Tests were made to check the design for the reconstruction, determine the most effective plan for the rock excavation, determine head losses in the reach above the dam, adequacy of the channel upstream of the dam, and capacity of the bridge openings downstream.
(f) Completed.
(g) Model tests indicated that the original design would provide adequate protection against the design flood. It was found that the proposed design would result in less head loss below the dam and under the South Main Street bridge than had been computed, resulting in lower water-surface elevations upstream of the dam for the design discharge. Tests also showed that the amount of rock excavation below the dam could be reduced without affecting water-surface elevations above the dam, and that the head losses between the dam and the bridge could be increased appreciably before flood stages upstream of the dam would be affected seriously. Although the design of the improvement plan within the reach was controlled to a large extent by existing structures, any improvement that could be effected in the banklines immediately upstream of the dam would tend to improve flow distribution over the dam and lower headwater elevations.
(h) "Blackstone River Flood-control Project at Woonsocket, Rhode Island; Hydraulic Model Investigation." U.S. Army Engineer Waterways Experiment Station Technical Report No. 2-468, December 1957. (Available on loan.)

(2925) ULTRASONIC FLOW MEASUREMENT.

(b) Office of the Chief of Engineers, Department of the Army, Washington, D. C.
(d) Experimental; for design.
(e) Various types of ultrasonic equipment will be investigated in a 24-inch by 14-inch conduit, with full and partial flow, to determine the relative accuracy of each type. Tests to date have been concerned with the adjustment and modification of test equipment.

(2926) FLOOD-CONTROL MODEL, LOWER MISSISSIPPI RIVER.

(b) President, Mississippi River Commission, Corps of Engineers, Vicksburg, Mississippi.
(d) Experimental; for design.
(e) The Mississippi River flood-control model is of the fixed-bed type with a horizontal scale of 1:2,000 and a vertical scale of 1:100, and reproduces the Mississippi River from Helena, Arkansas, to Donaldsonville, Louisiana, the Arkansas-White, Yazoo, and Red-Ouachita backwater areas, the Old River channel from Angola to Barbre Landing, Louisiana, the Atchafalaya River and Basin to the Gulf of Mexico, and the Morganza and West Atchafalaya Floodways. Tests were conducted to determine the effects of side-channel closures on slopes

and velocities within the main channel, and on water-surface elevations upstream during floods.
(f) Inactive.

(2927) MODEL STUDY OF NAVIGATION CONDITIONS, TROY LOCK AND DAM, HUDSON RIVER, NEW YORK.

(b) District Engineer, U.S. Army Engineer Dist., New York, Corps of Engrs., New York, N. Y.
(d) Experimental; for design.
(e) Navigation conditions at Troy Lock are adversely affected by the facts that the lock and dam are the upper limit of tidewater in the Hudson River, and a branch of the Mohawk River enters the Hudson in an upstream direction just above the lock. Tests to determine the most effective and economical plan for eliminating the hazardous navigation conditions at the upper entrance to the lock were conducted in a 1:100 model of the pertinent reach of the Hudson and the lower 1,800 feet of the Mohawk branch. The model included the lock and dam, all bridge piers within the model limits, and sufficient overbank area to reproduce flood flows. A remote-controlled towboat with tow was used to determine the effect of currents on tows entering and leaving the locks.
(f) Testing completed.
(g) Tests indicated that plans for the improvement of navigation in the upper approach should include the removal of the west guide wall, increase in the length of the guard wall, and the lowering of the top elevation of the ports in the guard wall.
(h) Preparation of final report in progress.

(2928) MODEL STUDY OF LOWER REACHES, ARKANSAS RIVER NAVIGATION PROJECT.

(b) District Engineer, U.S. Army Engineer Dist., Vicksburg, Corps of Engrs., Vicksburg, Miss.
(d) Experimental; for design.
(e) Several alternate routes have been proposed for the lower 54 miles of the navigation project between Pine Bluff, Arkansas, and the Mississippi River. A fixed-bed model with scales of 1:600 horizontally and 1:100 vertically, and reproducing pertinent portions of the Mississippi River channel, the White River channel, and the Arkansas River channel, and adjacent overbank areas, will be used to determine the effects of stage fluctuations, overbank flow, channel alignments, and other hydraulic features on the proposed routes for the lower reaches of the navigation channel and on the location and alignment of the entrance from the Mississippi River. The investigation will also serve to determine the necessity for special studies in connection with the project.
(f) Suspended.

(2929) MODEL STUDY OF NEW RICHMOND LOCKS AND DAM, OHIO RIVER.

(b) District Engineer, U.S. Army Engineer Dist.,

Huntington, Corps of Engineers, Huntington, West Virginia.

(d) Experimental; for design.

(e) A 1:120 model reproducing three miles of the Ohio River and the main and auxiliary locks together with the dam structures was used to: determine the best arrangement of the locks and appurtenant walls; study approach conditions under various river flows and methods of operation of dam control gates; develop modifications required to overcome any undesirable conditions; and demonstrate to navigation interests the acceptability of the proposed design from a navigation standpoint.

(f) Testing completed.

(g) Results indicate that the locks and lock walls could be moved 50 feet landward without affecting navigation conditions within the approaches.

(h) Preparation of report in progress.

(2930) MODEL STUDIES OF SPILLWAY AND STILLING BASIN, LOCK, AND NAVIGATION CONDITIONS, JACKSON LOCK AND DAM, TOMBIGBEE RIVER, ALA.

(b) District Engineer, U.S. Army Engineer Dist., Mobile, Corps of Engineers, Mobile, Alabama.

(d) Experimental; for design.

(e) Four models were used to develop profiles and capacities of a fixed-crest and a gated spillway, dimensions of the stilling basins below each, to study currents and velocities in the lock approaches, and to investigate the lock filling and emptying system and effect of lock operation on conditions in the approaches. A 1:36 model of a section of the approach area, fixed-crest spillway, stilling basin, and exit area, and a 1:50 model of a like section of the gated spillway were tested. Navigation conditions at the locks were investigated in a 1:120 model of a 2.2-mile reach of the river including the lock and dam and approach channels. The effects of currents and velocities on tows entering or leaving the lock were observed, and modifications in lock or channel configurations were tested to modify any undesirable conditions noted. A 1:25 model of the complete filling and emptying system with an outlet system discharging riverward of the lock was used to study various locations, designs, and numbers of lock chamber wall ports. Filling and emptying times were determined, and culvert pressures, surging, hawser stresses, and vibration of the valves were measured.

(f) Tests completed.

(g) The original designs of the gated and fixed-crest spillways were satisfactory. A horizontal stilling basin with sloped end sill was selected for the gated spillway; because of the relatively deep tailwater below the fixed-crest spillway, no basin is required. Tests in the navigation model showed that navigation within the approaches to the locks would be satisfactory but that some dredging along the left bank would be required to improve navigation conditions

for tows passing over the fixed-crest weir. Studies in the lock model showed that the lock can be filled in 11 minutes with tows in the chamber, and in 8 minutes with no tows, and emptied in 9.5 minutes. Hawser stresses were less than the 5-ton limit, and turbulence during filling was not objectionable.

(h) Final reports in preparation.

(2931) MODEL STUDY OF SOUTHWEST PASS, MISSISSIPPI RIVER.

(b) District Engineer, U.S. Army Engineer Dist., New Orleans, Corps of Engineers, New Orleans Louisiana.

(d) Experimental; for design.

(e) To determine the effectiveness of proposed improvement works (jetty extensions, channel realignments, and contraction works) in eliminating or reducing the periodic maintenance now required in order for deep-draft vessels to navigate the jetty and bar channels of Southwest Pass; the lower 12 miles of the Pass and the adjacent area of the Gulf of Mexico are reproduced in a fixed-bed model to scale ratios of 1:500 horizontally and 1:100 vertically. Tides, tidal currents, littoral currents, and wave action in the Gulf of Mexico, and salt- and fresh-water flows in Southwest Pass and the bar channel are reproduced in the model. Shoaling studies are made by introducing various mixtures of plastic materials into the model to simulate prototype shoaling materials and thus reproduces in the model the patterns and distribution of shoaling that occur in the prototype.

(g) Tests of proposed plans for reducing shoaling in the jetty and bar channels indicate that plans involving a curved realignment to the jetty channel, and plans involving relocating the bar upstream from ends of the jetties, would greatly reduce or eliminate shoaling for the existing depth of -35 feet. However, these plans would not be as effective for the authorized project depth of -40 feet without additional works in Southwest Pass.

(2932) MODEL STUDY OF HUDSON RIVER, NEW YORK.

(b) District Engineer, U.S. Army Engineer Dist. New York, Corps of Engrs., New York, N. Y.

(d) Experimental; for design.

(e) A fixed-bed model, 1:100 vertically and 1:1,000 horizontally, is being used to determine the source of material shoaling the Hudson River in the vicinity of Edgewater and Weehawken piers and the most effective means of reducing or eliminating this shoaling. The model reproduces Upper and Lower New York Bays, Raritan Bay, Hudson River to Hyde Park, East River to Throg's Neck, and tributaries flowing into the modeled bodies of water. Provisions are made to reproduce tides, fresh-water discharge, salinity intrusion, and shoaling.

(g) Tests made to date indicate that excessive shoaling in the navigation channels of

Hudson River, including the Edgewater-Weehawken channel, is attributable to (1) a predominance of upstream flow along the bottom, for all fresh-water discharges up to and including 30,000 cubic feet per second, from the Battery to or upstream from the George Washington Bridge, which causes a progressive upstream movement of sediment, and (2) the effects of the Hudson River, together with the restricted cross section at the George Washington Bridge, the combination of which tends to locally destroy the progressive upstream movement of sediment, thus resulting in a high shoaling rate. Tests of improvement plans indicate that a sediment basin in the upstream portion of the Edgewater-Weehawken channel would be effective in localizing shoaling, a similar basin in the 48-foot project channel would not be very effective in reducing shoaling elsewhere, and closure of the Hudson River to westward flow would reduce shoaling in the Hudson River navigation channels.

(2933) STUDY OF HARBOR DESIGN.

(b) Office of the Chief of Engineers, Department of the Army, Washington, D. C.
(d) Experimental; applied research.
(e) A testing program is being prepared to determine general criteria for designing harbors and harbor works to obtain optimum protection from wave action. Program will include both wind waves and seiches, and wave refraction and diffraction as applied to harbor and breakwater planning will be investigated.

(2934) DESIGN OF RUBBLE WAVE ABSORBERS.

(b) Office of the Chief of Engineers, Department of the Army, Washington, D. C.
(d) Experimental; applied research.
(e) Rubble wave absorbers are to be studied in a wave flume to determine criteria for the design and construction of such structures. The study will include investigation of the effects of slope and shape of face of the structure, and size, shape, volume, and porosity of materials on the wave-absorbing characteristics of the structure.

(2935) MODEL STUDY OF BUFFALO HARBOR, LAKE ERIE.

(b) District Engineer, U.S. Army Engineer Dist., Buffalo, Corps of Engineers, Buffalo, N. Y.
(d) Experimental; for design.
(e) A 1:125 model was used to determine (1) the feasibility of relocating the navigation approach channel to the harbor, and (2) whether a detached breakwater is necessary to reduce storm-wave action at the proposed new entrance of the approach channel. The model reproduced about 13.2 square miles, including nearly all of Buffalo Harbor and sufficient adjacent lake area to permit reproduction of storm waves from all critical directions.

Currents caused by discharge from Lake Erie into Niagara River are simulated.
(f) Tests completed.
(g) Tests performed to date indicate that a detached breakwater about 1,800 feet in length having its southeast limit along the west edge of the proposed navigation approach channel, about 2,500 feet lakeward of the outer harbor breakwater, will provide adequate protection to the harbor against storm-wave action.
(h) Final report in preparation.

(2936) MODEL STUDY OF BARCELONA HARBOR, LAKE ERIE.

(b) District Engineer, U.S. Army Engineer Dist., Buffalo, Corps of Engineers, Buffalo, N. Y.
(d) Experimental; for design.
(e) The site of the proposed harbor, located on the south shore of Lake Erie, is exposed to waves from west-southwest clockwise to north-northeast. A fixed-bed, 1:68 model was used to develop a system of breakwaters to protect pleasure and fishing craft from these wind-generated waves. The model reproduces a sufficient area in the harbor vicinity, upshore and downshore and lakeward, to permit generation of waves. Various breakwater schemes were installed in the model and wave heights measured. Currents generated by waves breaking near the navigation opening were studied.
(f) Tests completed.
(g) Tests indicate that wave action in the protected area is appreciably lessened by reducing the width of the navigation opening from the proposed 200 ft to 150 ft. Also it was determined that an arrowhead-type breakwater system would provide adequate protection for small craft, but the west leg should be realigned, and the east leg shortened 200 feet from that originally proposed.
(h) Final report in preparation.

(2937) MODEL TESTS OF CULVERT TAINTER VALVES FOR NEW LOCK NO. 19, MISSISSIPPI RIVER, KEOKUK, IOWA.

(b) District Engineer, U.S. Army Engineer Dist., Rock Island, Corps of Engineers, Rock Island, Illinois.
(d) Experimental; for design.
(e) Flow through the 14.5- by 14.5-foot longitudinal culverts in each wall is regulated by reverse tainter valves. Trial operation in the prototype disclosed that when the valves are operated at greater than two-thirds angular opening, a pulsating load is transmitted through the strut arm, resulting in reversal of load on the gear train of such severity that remedial action is necessary if normal valve operation to the completely open position is to be tolerated. A 1:12 model was utilized to determine causes of hydraulic downpull, uplift, and load pulsations and to develop modifications which would reduce these hydraulic loads to acceptable magnitudes.
(f) Inactive pending results of field tests on

proposed modifications.

(g) Modifications to structural members of the valve resulted in elimination of load reversals on the hoist and reduction in load variations.

(2938) MODEL STUDY OF SPILLWAY, TOWNSHEND DAM, WEST RIVER, VERMONT.

(b) District Engineer, U.S. Army Engineer Dist., Garrison, Corps of Engineers, Riverdale, North Dakota.

(d) Experimental; for design.

(e) A 1:50 model reproducing a portion of the spillway approach channel, a section of the dam, the spillway and its outlet channel, and the outlet tunnel, including intake and outlet, was used to: (a) calibrate the side-channel spillway and determine the effectiveness of its upstream portion; (b) study flow conditions in the approach, over the spillway, and in the outlet channel; (c) determine the effect of submergence of the crest on the discharge; (d) determine the minimum amount of rock excavation necessary in the approach area; (e) determine if the spillway channel wall properly confines the flow to the discharge channel; (f) study the effects of tunnel discharges downstream of the dam; and (g) determine the water-surface profiles throughout the model.

(f) Completed.

(h) "Spillway and Outlet Works, Townshend Dam, West River, Vermont; Hydraulic Model Investigation," final report in publication. (Will be available on loan.)

(2939) MODEL STUDY OF STILLING BASIN, EAST BARRE DAM, WINOOSKI RIVER, VERMONT.

(b) District Engineer, U.S. Army Engineer Dist., New York, Corps of Engrs., New York, N. Y.

(d) Experimental; for design.

(e) A 1:8 model that reproduced the downstream end of the outlet tunnel, the outlet portal, stilling basin, and about 80 ft of the outlet canal was used to study means of increasing the discharge capacity of the existing East Barre Dam so that it will pass safely a maximum probable flood of 900 cubic feet per second based on recently revised meteorological and hydrological data.

(f) Completed.

(g) Tests revealed the existing stilling basin to be inadequate for discharges greater than 450 cubic feet per second. Satisfactory performance was obtained by widening the downstream end of the basin by increasing the flare of the side walls, deepening it about 5 ft, adding a row of 2.67-foot-high baffle piers, and terminating the basin with a stepped rise to the exit channel. These revisions increased the length of the basin by 11.5 ft.

(h) "Outlet Works Stilling Basin, East Barre Dam, Winooski River, Vermont; Hydraulic Model Investigation," final report, U. S. Army Engineer Waterways Experiment Station

Miscellaneous Paper 2-293, November 1958. (Available on loan.)

(2940) MODEL STUDY OF SPILLWAY, McGEE BEND DAM, ANGELINA RIVER, TEXAS.

(b) District Engineer, U.S. Army Engineer Dist., Fort Worth, Corps of Engineers, Fort Worth, Texas.

(d) Experimental; for design.

(e) To verify spillway discharge coefficients and computed length of weir, tests were conducted on a 1:12 model of a section of the spillway and approach and exit areas.

(f) Completed.

(g) Two basin designs for the spillway weir were tested, one having a 30-foot-wide paved surface providing a two-way road across the spillway, and the other a 15-foot-wide, one-way road, paved surface. In both designs the upstream edge of the paved surface formed the crest line and was 0.5 foot higher than the downstream edge. Flow conditions were satisfactory and capacity was slightly greater than had been computed with both designs. The greater slope of the 15-foot-wide weir probably caused the discharge coefficient at heads up to 4 feet to be slightly greater than that of the wider weir. At heads greater than 5 feet, a more favorable coefficient was obtained with the wider weir; this is attributed to use of a 1-on-4 sloping upstream face with this weir. Tests indicated that erosion of the exit channel, expected under relatively high flows, will not affect the capacity of the structure.

(h) "Spillway for McGee Bend Dam, Angelina River, Texas; Hydraulic Model Investigation." U. S. Army Engineer Waterways Experiment Station Miscellaneous Paper No. 2-264, April 1958. (Available on loan.)

(2941) MODEL STUDIES OF KEYSTONE DAM, ARKANSAS RIVER, OKLAHOMA.

(b) District Engineer, U.S. Army Engineer Dist., Tulsa, Corps of Engineers, Tulsa, Oklahoma.

(d) Experimental; for design.

(e) Several models are being used to determine: the adequacy of design of the stilling basin, weir, and training walls; the best spacing for the nine flood-control sluices; and the alignment and outlet design of the sluices. A 1:100 general model is being used to study flow patterns in the approach and exit channels, develop a satisfactory alignment of the right training walls, and determine the required spacing of the flood-control sluices. A 1:36 spillway section model is being used for the stilling basin and sluice alignment tests. Final refinements in the sluice outlet design, if needed, will probably be developed in an existing conduit model at a scale of about 1:20 or 1:25.

(g) The section model tests established the height, location, and spacing of the baffles; the height and location of the end sill; the elevation of the basin floor; and

the shape of the conduit outlets. Satis-
factory flow conditions around the abutments
and training walls have been established
by revisions developed in the general model.

(2942) OLD RIVER ROCK-FILL CLOSURE DAM MODEL
STUDIES.

(b) District Engineer, U.S. Army Engineer Dist.,
New Orleans, Corps of Engineers, New
Orleans, Louisiana.
(d) Experimental; for design.
(e) Initial closure of the present Old River
channel will be accomplished by dumping
rock, weighing more than two tons, into low
velocity water. A 1:10 section model re-
producing 100 ft of the length of the fill
was used to test the stability of the down-
stream slope under critical flow conditions
and to determine the maximum amount of
seepage that will occur. Carefully graded
limestone rock with a specific weight of
about 168 pounds per cubic foot was used
in the tests.
(f) Completed.
(g) Minimum section required for stability was
determined. Seepage data were obtained.
(h) Final report in preparation.

(3232) MODEL STUDY OF FILLING AND EMPTYING SYSTEM,
OLD RIVER LOCK, LOUISIANA.

(b) President, Mississippi River Commission,
Corps of Engineers, Vicksburg, Mississippi.
(d) Experimental; for design.
(e) Old River lock will be 1,250 by 75 ft with
a minimum depth of 13 ft over the sills.
Under normal operating conditions, lifts
are not expected to exceed 15 ft but pro-
visions were made for a lift of 32 ft which
could occur with the low-sill control
structure inoperative. Manifold intakes
in the approach walls lead to longitudinal
wall culverts which discharge into the lock
chamber through side ports at the bottom
of the chamber. The discharge manifold
consists of two floor laterals with side
ports from each of the two longitudinal
wall culverts. Reverse tainter valves are
used for flow regulation. A 1:25 model
was used to study the hydraulic character-
istics of the filling and emptying system.
(f) Tests completed.
(g) Optimum number and location of ports, valve
schedules, and manifold designs were de-
termined.
(h) Final report in preparation.

(3233) MODEL STUDY OF SPILLWAY BULKHEADS, GREENUP
DAM, OHIO RIVER.

(b) District Engineers, U.S. Army Engineer
Districts, Huntington and Louisville, Corps
of Engineers, Huntington, West Virginia,
and Louisville, Kentucky.
(d) Experimental; for design.
(e) A 1:25 model of a solid, girder-type bulk-
head with upstream and downstream skin
plate and lifting beam was used to deter-
mine the vertical forces acting on the

bulkhead and lifting beam as they are low-
ered in flowing water.
(f) Tests completed.
(g) The bulkheads and lifting beam when tested
as single units were unsatisfactory. Force
variations as the bulkhead neared the spill-
way sill resulted in vertical oscillation
of the bulkhead. However, when four bulk-
heads were coupled as a unit as proposed
for prototype usage, satisfactory perform-
ance obtained. Downpull forces did not ex-
ceed 25 kips with the bulkheads vented and
85 kips with no venting of the bulkheads.
The unit was stable for all conditions in-
vestigated.
(h) Final report in preparation.

(3234) MODEL STUDY OF PASNY INTAKE, NIAGARA RIVER.

(b) District Engineer, U.S. Army Engineer Dist.,
Buffalo, Corps of Engineers, Buffalo, N. Y.
(d) Experimental; for design.
(e) The hydraulic investigation of the PASNY
intake structure was conducted on an exist-
ing model used previously to study the de-
velopment of power and the preservation and
enhancement of the scenic spectacle at
Niagara Falls. The model was constructed
to linear scale ratios, model to prototype,
of 1:360 horizontally and 1:60 vertically
and reproduced that portion of the Niagara
River from the Falls upstream to and includ-
ing part of Lake Erie.
(f) Completed.
(g) Tests showed that the proposed PASNY intake
would not affect the distribution of flow
between the American and Canadian channels
around Grand Island and between the Ameri-
can and Canadian Falls. Flow velocities in
the vicinity of the intake would be slight-
ly increased.
(h) Preparation of final report in progress.

(3235) MODEL STUDY OF PIKE ISLAND LOCKS AND DAM,
OHIO RIVER.

(b) District Engineer, U.S. Army Engineer Dist.,
Pittsburgh, Corps of Engrs., Pittsburgh, Pa.
(d) Experimental; for design.
(e) A 1:120, fixed-bed type, comprehensive
model, reproducing about 4 miles of the
Ohio River and the locks and dam structures,
will be used to select the most favorable
site location by studying approach condi-
tions under various river flows, and to de-
velop modifications required to overcome
any undesirable conditions at selected site.

(3236) MODEL STUDY OF MAXWELL LOCKS AND DAM,
MONONGAHELA RIVER, PENNSYLVANIA.

(b) District Engineer, U.S. Army Engineer Dist.,
Pittsburgh, Corps of Engrs., Pittsburgh, Pa.
(d) Experimental; for design.
(e) A 1:120 fixed-bed type, comprehensive model,
reproducing about 2.5 miles of the Mononga-
hela River and the locks and dam structures,
will be used to study approach conditions
under various river flows and methods of
operation of control gates; to determine

effects of design modifications; to develop modifications required to overcome any undesirable conditions; and to demonstrate to navigation interests the acceptability of the proposed design from a navigation standpoint.

(3237) MODEL STUDY OF OUTLET WORKS, BLACK BUTTE DAM, STONY CREEK, CALIFORNIA.

(b) District Engineer, U.S. Army Engineer Dist., Sacramento, Corps of Engineers, Sacramento, California.
(d) Experimental; for design.
(e) A 1:16 model, reproducing 160 ft of the tunnel, the energy dissipator, irrigation diversion outlets, and 560 ft of the exit channel, is being used to determine: (a) The most economical dimensions for the combination energy dissipator and irrigation diversion structures; (b) the extent of armor plating required at the south side canal intake slot for protection against cavitation forces; (c) the inside dimensions and lip elevation of a flip bucket that will give a satisfactory flow and erosion pattern in the downstream exit channel; (d) pressures on the irrigation outlet gates; and (e) the effect of irrigation diversion schemes on flow conditions with and without diversion.
(g) The performance of the energy dissipator as originally designed was not satisfactory in that a partial hydraulic jump formed in the bucket over a wide range of flows. Energy dissipation in the partial jump was incomplete and high velocities boiled over the bucket lip. Proper flip bucket action developed only at very high heads.

(3238) MODEL STUDY OF EUFAULA DAM, CANADIAN RIVER, OKLAHOMA.

(b) District Engineer, U.S. Army Engineer Dist., Tulsa, Corps of Engineers, Tulsa, Oklahoma.
(d) Experimental; for design.
(e) A 1:36 section model, reproducing one full bay and two flanking half bays of the 520-foot-long, gated spillway, the horizontal stilling basin, and approach and exit channels, will be used to determine the adequacy of design of the stilling basin elements, and to investigate pressure conditions on the spillway crest.

(3239) MODEL STUDY OF SPILLWAY CREST GATE, STILLING BASIN, AND BULKHEAD, NEW CUMBERLAND LOCKS AND DAM, OHIO RIVER, PENNSYLVANIA.

(b) District Engineer, U.S. Army Engineer Dist., Pittsburgh, Corps of Engrs., Pittsburgh, Pa.
(d) Experimental; for design.
(e) A 1:25 section model reproducing 400 feet of the approach area, a portion of the gated spillway crest and stilling basin, and 800 ft of the exit area is being used to examine the hydraulic performance of the spillway weir and stilling basin. A second phase of this study involves measrements of hydraulic forces acting on a

submergible-type spillway tainter gate. A 1:25 model of a truss-type bulkhead with an upstream skin plate and lifting beam is being used to determine the vertical forces acting on the bulkhead and lifting beam as they are lowered in flowing water.
(g) Stilling basin tests revealed unsatisfactory basin action for certain tailwater conditions. Alteration to the baffle piers and end sill had no apparent effect in improving performance, but unsatisfactory basin action could be avoided by proper gate operation. The submergible-type spillway tainter gate performed satisfactorily, downpull forces did not exceed 70 kips, and maximum vertical displacement of the gate was approximately 0.05 inch (prototype). Random frequencies in the range of 0.0 to 1.5 cycles per second were encountered. Tests of the bulkhead indicated that the original design bulkhead and lifting beam are satisfactory for all conditions investigated. Maximum hydraulic forces ranged from 250 kips downpull to 50 kips uplift. The bulkhead and lifting beam were very stable with no tendency for vertical movement.

(3240) MODEL STUDY OF CANACADEA CREEK, HORNELL, NEW YORK.

(b) Department of Public Works, State of New York.
(d) Experimental; for design.
(e) A highway bridge is proposed for construction across Canacadea Creek just upstream from the existing Seneca Street bridge. In order to pass flood flows under the new bridge, the existing Seneca Street weir, located just upstream from the existing bridge, should be removed and a similar structure constructed just upstream from the proposed bridge. Principal problems to be resolved by the model study are determination of the optimum crest elevation for the replacement weir and the need for superelevation of the channel bottom in a bend downstream of the bridge.

(3241) MODEL STUDY OF SEICHE ACTION, DULUTH-SUPERIOR HARBOR, LAKE SUPERIOR.

(b) District Engineer, U.S. Army Engineer Dist., St. Paul, Corps of Engrs., St. Paul, Minn.
(d) Experimental; for design.
(e) To determine whether a practical plan can be developed for reducing the resonant response to lake seiches that occurs in Duluth-Superior Harbor and entrance channels, tests will be made on a fixed-bed model constructed to scales of 1:1,000 horizontally and 1:100 vertically. Waves and currents will be simulated.

(3242) MODEL STUDY OF CONNEAUT HARBOR, OHIO, ON LAKE ERIE.

(b) District Engineer, U.S. Army Engineer Dist., Buffalo, Corps of Engineers, Buffalo, N. Y.
(d) Experimental; for design.

(e) A 1:125 fixed-bed model will be used to determine the influence of seiche currents individually and in combination with short-period wind-wave action in causing damage to ships navigating or berthed in Conneaut Harbor (located on the south shore of Lake Erie about 30 miles southwest of Erie, Pa.). The model reproduces about 7.3 square mi. including all the area within the harbor and sufficient adjacent lake area to permit reproduction of storm waves from all critical directions. A circulating system installed in the model will permit simulation of currents through and past the harbor which result during periods of seiche on the lake.

(3243) MODEL STUDY OF LOCKS AND DAM NO. 4, MONONGAHELA RIVER.

(b) District Engineer, U.S. Army Engineer Dist., Pittsburgh, Corps of Engrs., Pittsburgh, Pa.
(d) Experimental; for design.
(e) A 1:120 fixed-bed, comprehensive model, reproducing about 2.5 miles of the Monongahela River and the locks and dam structures will be used to determine the effects of modifications to the existing locks and dam on navigation conditions, and to develop modifications required to overcome any undesirable conditions.

(3244) MODEL STUDY OF COLUMBIA LOCK AND DAM, CHATTAHOOCHEE RIVER.

(b) District Engineer, U.S. Army Engineer Dist., Mobile, Corps of Engineers, Mobile, Ala.
(d) Experimental; for design.
(e) A 1:100 fixed-bed-type, comprehensive model, reproducing about 1.5 miles of the Chattahoochee River and the lock and dam structures will be used to study navigation conditions within the lock approaches and the head on lower lock gate during lock-emptying operations, and to develop modifications required to overcome any undesirable conditions found. The following two section models are also being used in the investigation to develop final spillway profiles and stilling basin dimensions: a 1:36 model of the fixed-crest spillway reproducing 250 feet of the approach area, a 36-foot-wide portion of the spillway and stilling basin, and 300 ft of the exit area; and a 1:27.2 model of the gated spillway, 400 ft of the approach area, a portion of the spillway crest and stilling basin (one full gate bay and two half piers), and 400 ft of the exit area.

U. S. DEPARTMENT OF THE ARMY, CORPS OF ENGINEERS, Office of the Chief of Engineers.

3245) FLOOD VOLUME STUDIES.

(b) Office, Chief of Engineers, Department of Army, Washington, D. C.
(c) District Engineer, U.S. Army Engineer Dist.,

Sacramento, California.
(d) Theoretical Investigations; basic research.
(e) Procedures and generalized criteria are developed which will facilitate rapid and relatively accurate determinations of flood volume frequencies where recorded data are unavailable to support separate frequency determinations. Special emphasis is being placed on low-flow frequency analysis. Procedure development will include synthetic determinations for ungaged areas.
(h) "Analysis of Flood Frequencies by Seasons", by Sacramento District, Technical Bulletin No. 1, October 1954.
"Coordination of Flood Volume Frequency Statistics", by Sacramento District, Technical Bulletin No. 2, July 1955.
"Flood Volume Frequencies for Pacific Coast Streams," by Sacramento District, Technical Bulletin No. 3, March 1956.
"Ten-Year Storm Precipitation in California and Oregon Coastal Streams", Sacramento District, Technical Bulletin No. 4, May 1957.
"Long-Duration Runoff Volumes", by Sacramento District, Tech. Bulletin No. 5, July 1958.
"Stream Flow Volume-Duration-Frequency Studies", by Wash. Dist., Tech. Report No. 1, June 1955.

(3246) RUNOFF FROM SNOW MELT.

(b) Office, Chief of Engineers, Dept. of the Army, Washington, D. C.
(c) Division Engineer, U. S. Army Engineer Div., North Pacific, Portland, Oregon.
(d) Theoretical investigations; basic research.
(e) Research studies involving application of an electronic computer (IBM 650) in the forecasting of flow of streams in which snow melt is a dominant factor. Derivations of basin runoff storage constants in areas of heavy snow accumulation will be used in developing procedures for routing snow melt contributions by means of the 650 computer in connection with day to day regulation of multi-purpose reservoir projects.
(h) "Snow Hydrology," prepared by the U. S. Army Engineer Division, North Pacific Div., June 1956.

(3247) DEVELOPMENT OF HYDROLOGIC EQUIPMENT.

(b) Office, Chief of Engineers, Department of Army, Washington, D. C.
(c) Director, Waterways Experiment Station, Vicksburg, Mississippi.
(d) Field and laboratory investigations; basic research.
(e) Development or adaption of instruments and equipment for hydrologic purposes, including radio facilities, when such needs cannot be satisfactorily met through normal procurement and contracting procedures. Information is assembled regarding characteristics and costs of equipment available for hydrologic use, and investigations are conducted to improve or adapt available

equipment to meet hydrologic requirements. Involves development of a precipitation gage capable of several months unattended operation in remote areas where rain and snow data are required promptly for use in reservoir regulation. Also involves development of a water stage keyer device for use in remote unattended stations requiring very little power. The keyer is required to convert water stage readings into a form suitable for automatic radio transmission.

(h) "Development of Hydrologic Equipment," U.S. Army Engineer Division, Ohio River, Technical Bulletin No. 1, June 1957.
"Telemetering Hydrologic Data," by Francis P. Hanes, Journal of the Waterways and Harbors Div., ASCE, Vol. 83, No. WW3, Sept. 1957.
"Operating Characteristics of Keyer P-8," Waterways Experiment Station, CW-173 Project Bulletin 58-2, June 1958.

(3248) FREEBOARD CRITERIA FOR DAMS AND LEVEES.

(b) Office, Chief of Engineers, Department of Army, Washington, D. C.
(c) Division Engineer, U.S. Army Engineer Div., Missouri River, Omaha, Nebraska.
(d) Theoretical Investigations; basic research.
(e) Development of rational procedures and generalized criteria for use in estimating freeboard requirements for dams and levees, giving due consideration to wind characteristics, configuration and depth of water body involved, characteristics of embankment affected, and other important factors. Generalized charts will be prepared from which design wind conditions over water surfaces may be obtained. Pertinent problems will be reviewed, factors that govern freeboard determinations will be discussed, and procedures and criteria will be proposed for use in estimating freeboard allowances.

(3249) RESERVOIR WATER LEVEL RECORDER.

(b) Office, Chief of Engineers, Department of Army, Washington, D. C.
(c) District Engineer, U.S. Army Engineer Dist., Sacramento, California.
(d) Field and laboratory investigations; basic research.
(e) Development of a more accurate and satisfactory method of measuring and recording water levels at high dams, in order to facilitate more accurate measurement of low-flow releases. The principal problem is to overcome substantial measurement errors occasioned by differences in water temperature in recorder wells of high dams and coincident temperatures at various levels in the reservoir. Studies will include (1) design standards to insure provision of sufficient intakes to keep the differential between reservoir levels and stilling wells insignificant, (2) installation of a circulating device in the stilling well to insure that temperatures in the

well will closely approximate reservoir temperatures, (3) simultaneous measurement of water temperatures in stilling well and reservoir, and the determination of necessary correction factors, and (4) improvement of means of making accurate reservoir level measurements without use of stilling wells.

U. S. DEPARTMENT OF COMMERCE, BUREAU OF PUBLIC ROADS.

(1074) HYDRAULICS OF STILLING BASINS.

Cooperative with Colorado State University. See page 13.

(1945) ESTIMATING RAINFALL INTENSITY FROM TOPOGRAPHIC PARAMETERS.

Cooperative with Stanford University. See page 67.

(2066) STUDY OF OPEN CHANNEL RESTRICTIONS IN A SLOPING FLUME.

Cooperative with Colorado State University. See page 13.

(2320) A STUDY OF THE FLOW CHARACTERISTICS OF HIGHWAY CULVERTS.

Cooperative with Iowa Institute of Hydraulic Research. See page 33.

(2435) HYDRAULICS OF PIPE CULVERTS.

Cooperative with National Bureau of Standards. See page 135.

(2540) SCOUR AT BRIDGE CROSSINGS.

Cooperative with Iowa Institute of Hydraulic Research. See page 33.

(2604) FULL-SCALE TEST OF CONCRETE PIPE.

Cooperative with St. Anthony Falls Hydraulic Laboratory. See page 63.

(2767) EDUCATIONAL FILMS ON OPEN CHANNEL FLOW.

Cooperative with Colorado State University. See page 17.

(2839) HYDRAULICS OF RIVER FLOW UNDER ARCH BRIDGES.

Cooperative with the Oregon State College. See page 56.

(3041) MAGNITUDE AND FREQUENCY OF FLOODS IN ARID AND SEMI-ARID AREAS.

Cooperative with Colorado State University. See page 19.

(3140) HYDRAULIC CHARACTERISTICS OF THE FALL CREEK FISHWAY.

Cooperative with the Oregon State College.
See page 56.

(3166) HYDRODYNAMICS OF FLOW INTO CURB INLETS.

Cooperative with Stanford University. See
page 68.

U. S. DEPARTMENT OF COMMERCE, NATIONAL BUREAU OF
STANDARDS, Fluid Mechanics Section.

Inquiries concerning the following projects should
be addressed to the Chief, Fluid Mechanics Section,
National Bureau of Standards, Washington 25, D. C.

(159) MODEL LAWS FOR DENSITY CURRENTS.

(b) Waterways Experiment Station, Corps of
Engineers, Department of the Army.
(d) Theoretical and experimental; basic and
applied research.
(e) To determine model laws for models involv-
ing the motion of stratified liquids. The
two major problems are (1) the motion of a
heavy liquid initially confined in a "lock"
when released into a long channel contain-
ing a stationary lighter liquid, and (2)
the motion of a heavy liquid from a "sea"
into a long channel with either still or
flowing lighter liquid.
(h) "Form Characteristics of Arrested Saline
Wedges," by Garbis H. Keulegan, NBS Report
5482, October 4, 1957.
"The Motion of Saline Fronts in Still Wa-
ter," by Garbis H. Keulegan, NBS Report
5831, April 1, 1958.
"The Mixing Action of Wind Induced Waves,"
by Garbis H. Keulegan (in preparation).

(1478) WIND WAVES.

(b) Office of Naval Research, Department of the
Navy.
(d) Experimental and theoretical; basic re-
search.
(e) Includes mathematical and experimental
studies of (1) wind tides (setup), (2)
growth of wind waves, and (3) surface trac-
tion of wind on wavy surfaces.

(2435) HYDRAULICS OF PIPE CULVERTS.

(b) Bureau of Public Roads.
(d) Experimental; applied research.
(e) To determine hydraulic characteristics of
various types of culvert entrances and to
develop inlets of improved design.

(2436) FLOW OVER HYDROPHOBIC MATERIALS.

(b) Office of Naval Research, Department of the
Navy.
(d) Experimental; applied research.
(e) To determine augmented dissipation of hy-
drophobic disks and plates oscillated in
various fluids.

(3250) INERTIAL FORCES IN UNSTEADY FLOW.

(b) Office of Naval Research, Department of the
Navy.
(d) Experimental; basic research.
(e) Determination of inertia and drag coeffi-
cients of cylinders and plates when sub-
jected to a varying monotonically varying
flow.

U. S. DEPARTMENT OF COMMERCE, WEATHER BUREAU.

Inquiries concerning Projects Nos. 1011, 1015, 1744,
1745, 1751, 2437, 2440, 2441, 2442, 2443, 2943,
2944, 2945 and 3251, should be addressed to Mr.
William E. Hiatt, Chief, Hydrologic Services Div.,
U. S. Weather Bureau, Washington 25, D. C.

(1011) SHORT RANGE SNOWMELT FORECASTING.

(b) Laboratory project.
(d) Field investigation; operation and applied
research.
(e) To develop relations between streamflow
resulting from melting snow and appropriate
meteorological parameters using a statisti-
cal approach.
(g) Testing has been limited due to scarcity of
required data.

(1015) MEASUREMENT OF EVAPORATION.

(b) Laboratory project.
(d) Theoretical and field investigation; ap-
plied research.
(e) Studies are directed toward the derivations
of reliable procedures for estimating
evaporation from reservoirs (existing and
proposed) and land surfaces, utilizing
readily available meteorological data and
pan evaporation observations.
(g) Water-loss project at Lake Mead applying
methods and techniques developed at Lake
Hefner has been completed and the final
report has been published. This project,
like the Lake Hefner study, was a coopera-
tive investigation involving Bureau of
Reclamation, Navy, Geological Survey and
Weather Bureau.
Another such study was made at Felt Lake,
on contract with Stanford University, and
the observational program has been com-
pleted. These data have been analyzed and
a report is being prepared for publication.
An average annual lake evaporation map was
prepared for the Delaware River basin area
and will be published in the Hydrologic
Investigations Atlas series of the U. S.
Geological Survey.
An evaporation atlas is being prepared for
the United States. The atlas will include
maps of (1) average annual Class A pan
evaporation, (2) October-May Class A pan
evaporation as percent of annual, (3) aver-
age annual free-water (lake) evaporation,
(4) October-May free-water evaporation as
percent of annual, (5) annual Class A pan
coefficients, and (6) coefficient of varia-
tion for Class A pan evaporation.
Evaporation studies are being made at the

Silver Hill Observatory, Md. An insulated BPI pan has been installed to study the transfer of heat from the pan to the ground; heat flux plates have been attached to the standard BPI pan in order to obtain a continuous record of the heat flux. Class A pans made of monel metal and stainless steel are being compared with the standard galvanized iron pan.

A study of evapotranspiration has been initiated. The purpose is to develop an accounting method for estimating soil-moisture deficiency. Test on two basins has indicated that the soil-moisture deficiency provided an improved antecedent index for rainfall-runoff relations. The procedure is being tested on a third area and then a report will be prepared.

(1744) DEVELOPMENT OF RIVER FORECASTING METHODS.

(b) River Forecast Centers for: Ohio River Basin, Cincinnati, Ohio; Susquehanna and Delaware River Basins, Harrisburg, Pa.; Lower Missouri River Basin, Kansas City, Mo.; Tennessee River Basin, Knoxville, Tenn.; Columbia River Basin, Portland, Ore.; Middle and Upper Mississippi River Basin, St. Louis, Mo.; Arkansas and Red River Basins, Tulsa, Okla.; New England and Hudson River Basins, Hartford, Conn.; South Atlantic and East Gulf Basins, Augusta, Ga.; and Middle Atlantic Basins, Washington, D. C.

(d) Theoretical and field investigation; operation and applied research.

(e) The purpose of these investigations is to develop modern river forecast procedures for all ranges of flow for various streams of each basin. Procedures include: (1) Rainfall-runoff relations involving consideration of the physics of soil moisture, vegetative reception, transpiration, evaporation and geological features of the basins; (2) snowmelt forecasting relations involving consideration of the physics of snow and heat transfer; (3) unit hydrographs; and (4) streamflow routing procedures, based upon adaptations of basic hydraulic principles, using electronic or mechanical analogues.

(g) Forecasting procedures have been developed for key points; refinement of these procedures and development for other basins are under way.

(1745) WATER SUPPLY FORECASTS FOR WESTERN UNITED STATES.

(b) Work being conducted in following field offices: River Forecast Center, Portland, Oreg.; Water Supply Forecast Unit, Salt Lake City, Utah; River Forecast Center, Kansas City, Mo., and Weather Bureau Office, Sacramento, California.

(d) Theoretical and field investigation; operation and applied research.

(e) The purpose of these investigations is the development of precipitation-runoff relations for water supply forecasting utilizing statistical methods to correlate precipitation during the winter with runoff during the melting season.

(g) Water Supply Forecasts are prepared for about 350 points in the Western United States. These forecasts of water-year and residual flow are released in Monthly Water Supply Forecast Bulletins, January through May. This research program is of a continuing nature designed to improve and extend the present forecasting service.

(1751) MAXIMUM STATION PRECIPITATION.

(b) Corps of Engineers, Department of the Army.
(d) Analysis of data.
(e) Tabulations of maximum recorded 1-, 2-, 3-, 6-, 12-, and 24-hour precipitation, for automatic recording rain gage stations, by states.
(h) Twenty-one states completed and published as parts of Weather Bureau Technical Paper No. 15; California, Arkansas, Texas and Minnesota in process.

(1993) PRESSURE JUMP LINES.

(b) Laboratory project.
(c) Dr. Morris Tepper, Office of Meteorological Research, U. S. Weather Bureau, Washington 25, D. C.
(d) Theoretical and field investigation; basic and applied research.
(e) Investigate the properties of and the mechanisms producing pressure jump lines in the atmosphere. These lines, identified by means of discontinuities in microbarograms, have been found to be correlated very stongly with severe local storms. The study is based on (1) observational data collected from a special field program, and (2) theoretical models in which the pressure jump line is interpreted as a gravity wave propagating on an inversion surface between stratified atmospheric layers.
(g) Medium scale atmospheric disturbances (Mesostructures) are consistently found which are well ordered and move with chronologic continuity from one hour to the next. Local weather is directly associated with the passage of these mesostructures.
(h) "History and Measurement of the Two Major Scottsbluff Tornadoes, June 27, 1955," by W. H. Hoecker, Jr., accepted for publication in the Bulletin of the American Meteorological Society.
"Mesoanalysis of a Tornado-Producing Situation in Texas, May 25-26, 1955," by W. Smith accepted for publication in the Bulletin of the American Meteorological Society.
"Squall Lines, Pressure Jump Lines and Atmospheric Gravity Waves," by M. Tepper, Swiss Aero Review, January 1958.
"Tornadoes," by M. Tepper, Scientific American, May 1958.
"Mesometeorology - the Link Between the Macroscale Atmospheric Motions and Local Weather," by M. Tepper, in publication, the Bulletin of the American Meteorological

Society.

(437) UNITED STATES STORM CHARACTERISTICS PROJECT.

(b) Soil Conservation Service, Department of Agriculture.
(d) Theoretical and field investigation; applied research and design.
(e) Studies to provide rainfall data for design criteria in estimating required capacities of hydraulic structures. Work includes: (1) Development of a generalized relationship between depth, area, duration and frequency for areas up to 400 square miles, durations of 20 minutes to 24 hours, and return periods from 1 to 100 years; and (2) development of a generalized portrayal of the probable maximum precipitation for areas up to 400 square miles, and durations up to 24 hours in the United States west of longitude 105.
(h) "Rainfall Intensity-Frequency Regime - Part I - The Ohio Valley" (actually the quadrangle bounded by longitude 80 and 90 W, and latitude 35 and 40 N.), U.S. Weather Bureau Technical Paper No. 29. Part 2 is Southeastern United States; part 3 is Middle Atlantic Region, part 4 will be Northeastern United States, and part 5 will be Great Lakes Region.

(438) STORM TIDE PREDICTIONS.

(b) Laboratory projects.
(c) Mr. D. Lee Harris, Scientific Services Div., U. S. Weather Bureau, Washington 25, D. C.
(d) Theoretical and field investigation; basic and applied research.
(e) The differences between the observed and predicted tides during storms are being studied with the goal of improving the accuracy of storm tide forecasting.
(g) Empirical methods of forecasting these inundations are being developed and used in the Weather Bureau's hurricane and storm warning service. Continued improvement in these forecasts is expected to result from this research.
(h) "The Hurricane Surge," by D. Lee Harris, Proceedings of Sixth Conference on Coastal Engineering, pp 96-114, 1958.
"Ocean Surface Waves Produced by Some Recent Hurricanes," by Arthur Pore, Monthly Weather Review, Vol. 85, pp 385-392.
"Hurricane Audrey Storm Tide," by D. Lee Harris, National Hurricane Research Project Report No. 23, Washington 25, D. C.

(2440) REGIONAL FREQUENCIES OF SELECTED HURRICANE CHARACTERISTICS.

(b) Corps of Engineers, Department of Army.
(d) Theoretical and field investigation; applied research and design.
(e) Collection, analysis, and presentation of available observations pertinent to hurricane minimum pressure, direction of movement, speed, wind-structure and other characteristics, and their relationship to each other, over Atlantic and Gulf of Mexico

waters adjacent to coasts.
(f) Completed.
(h) Report to sponsor in preparation.

(2441) HURRICANE RAINFALL AND ITS QUANTITATIVE FORECASTING.

(b) Corps of Engineers, Department of the Army.
(d) Theoretical and field investigation; applied research and design.
(e) Collection, analysis, and effective presentation of existing data on hurricane rainfall and development of methods of forecasting the intensity and quantity of rainfall from future hurricanes for design of protective works, planning of evacuation procedures, etc.

(2442) HURRICANE WIND ANALYSIS.

(b) Corps of Engineers, Department of Army.
(d) Theoretical and field investigation; applied research and design.
(e) Development of methods for obtaining detailed wind speeds and directions in hurricanes just above the sea-surface indirectly from available data, which is mostly on land. Also construction by indirect means of detailed analyses of the winds over specific areas of the sea where the energy of the wind develops waves and tides damaging to specific coastal areas.

(2443) RADAR-RAINFALL PROJECT.

(b) Laboratory project in cooperation with Univ. of Miami, Coral Gables, Fla., and Texas A and M College, College Sta., Texas.
(d) Experimental operation.
(e) Integration of the instantaneous PPI scope image over time by photographic process to provide a pattern of accumulated rainfall over an area that can be calibrated with key rainfall observations for the period of integration. To be used in flood forecasting with other radar intelligence.
(h) "Applications of Radar Weather Observations to Hydrology," by Stuart G. Bigler and Richard D. Tarble, Texas A and M Research Foundation, College Station, Texas, Nov. 1957.
"Use of Radar in Field of Hydrology," by Richard D. Tarble and Leslie F. Conover. Proceedings, Sixth Weather Radar Conference (Supplement), Cambridge, Mass., 1957.
"The Use of Radar in Determining Flood Potential Precipitation Areas," by Richard D. Tarble and Stuart G. Bigler. Paper presented at 158th National Meeting of the American Meteorological Society, Monterey, California, June 1957.

(2943) RADAR BEACON FOR REPORTING RAINFALL.

(b) Laboratory project.
(d) Experimental; development.
(e) A compact device capable of being installed in relatively remote areas within line of sight of a radar. Activated by a tipping bucket rain gage and pulse signal from the

radar, instrument transmits delayed pulse which appears on radarscope indicating accumulated amounts of precipitation. Additional investigations underway for applying beacon principle to the reporting of river and tide stage, and radioactive snow water equivalent gage.

(g) Initial field installation now operational, additional beacons being built.

(h) "The Use of a Radar Beacon for Reporting Precipitation", by Richard D. Tarble and Dewey R. Soltow, paper presented at Annual Spring Meeting of American Geophysical Union, Washington, D. C., May 1958.

(2944) PROBABLE MAXIMUM PRECIPITATION OVER CALIFORNIA BASINS.

(b) Corps of Engineers, Dept. of the Army.

(d) Design and applied research.

(e) Estimate of probable maximum precipitation over basins in California based on simple model of wind flow up orographic slopes, checked against December 1955 flood-producing storm, combined with non-orographic storm precipitation.

(g) Estimates furnished sponsor. Methods being refined.

(2945) MECHANICAL FLOOD ROUTING ANALOGUE.

(b) Laboratory project.

(d) Field investigation; operation and applied research.

(e) A mechanical analogue has been developed which will solve flood routing based on a variable lag and variable storage factor (K). The analogue can be operated by one person and the size is such that it can be placed on a desk.

(g) The pilot model has been constructed and will be tested thoroughly in order to determine refinements necessary.

(h) "Mechanical Analogs and Graphical Flood Routing," by Max A. Kohler, Proceedings of the American Society of Civil Engineers, Journal of Hydraulics Division, Paper No. 1585, April 1958.

(3251) RAINFALL DISTRIBUTION AS DETERMINED BY RADAR.

(b) U.S. Geological Survey.

(d) Experimental; applied research.

(e) Using time-lapse film of the radar PPI scope, various methods of determining the areal distribution of rainfall intensity are being tested. A 50-square-mile basin, heavily instrumented with recording rain gages, is used as a control basin. To be used for flood forecasting and storm studies.

(g) Radar intelligence can considerably improve the estimates of areal distribution of rainfall over large areas. Special techniques will have to be developed for areas as small as 50 square miles or less.

U. S. DEPARTMENT OF THE INTERIOR, GEOLOGICAL SURVEY.

(690) DISCHARGE THROUGH MULTIPLE OPENINGS.

(b) Laboratory project.

(c) Mr. H. J. Tracy, U. S. Geological Survey, Atlanta, Georgia.

(d) Experimental; applied research.

(e) Laboratory studies to define the distribution of flow through multiple bridge openings with any given natural distribution and varied number, size, and location of openings.

(g) Laboratory tests and analyses completed; report in preparation.

(1221) STEADY STATE ELECTRIC FLOW NET MODELS.

(b) Laboratory project.

(c) Mr. R. R. Bennett, U. S. Geological Survey, Washington 25, D. C.

(d) Applied research.

(e) Preparation of electric flow net models using graphite paper, conductive paints, etc. Includes design and construction of a variable resistor grid analogous plotter.

(1755) CHARACTERISTICS OF SAND CHANNEL STREAMS.

(b) Laboratory project.

(c) Mr. R. W. Carter, U. S. Geological Survey, Washington 25, D. C.

(d) Field investigation; applied research.

(e) Compilation and analysis of the data collected in a 1,900-foot reach of the Elkhorn River in Nebraska to evaluate bed roughness, extent of scour and fill, and sediment movement.

(h) Report in preparation.

(1764) COMBINED PHYSIOGRAPHIC AND HYDRAULIC STUDIES.

(b) Laboratory project.

(c) Dr. Luna B. Leopold, U. S. Geological Survey, Washington 25, D. C.

(d) Field and office research.

(e) Hydraulic and physiographic factors controlling slope and pattern of natural river channels.

(1995) COMPARATIVE STUDY OF SOIL MOISTURE EQUIPMENT.

(b) Laboratory project.

(c) Mr. Irwin Remson, U. S. Geological Survey, Trenton, N. J.

(d) Field investigation; applied research.

(e) A comparative study of all commercially available instruments for measuring soil moisture, possible design of new instruments.

(1998) DEVELOPMENT OF INSTRUMENTS AND TECHNIQUES FOR SUBSURFACE EXPLORATION OF GROUND WATER.

(b) Cooperative with the State of Arizona.

(c) Mr. H. E. Skibitzke, U.S. Geological Survey, Tucson, Arizona.

(d) Applied research.
(e) To adapt instruments and techniques for solving problems of the occurrence of water in alluvial fill; including electrical resistivity methods, electric logging, and deep well current meters.

(2000) GHYBEN-HERZBERG LENS.

(b) Laboratory project.
(c) Mr. Dan A. Davis, U. S. Geological Survey, Honolulu, T. H.
(d) Field investigation.
(e) Study of ground-water body in marine islands, to determine the relationship of fresh water storage to the geology of the island, rainfall, head, tidal fluctuations, leakage, and draft.

(2444) REDESIGN OF PRICE CURRENT METER (INSTRUMENT DEVELOPMENT).

(b) Laboratory project.
(c) Mr. A. H. Frasier, Equipment Development Laboratory, U.S. Geological Survey, 1509 Hess Street, Columbus 12, Ohio.
(d) Development.
(e) To design a vane-type rotor for the Price current meter that can be mass-produced with identical rating calibration and be affected little or not at all by vertical velocity components and proximity to the water surface.
(g) Type and shape of rotor has been selected.

(2447) RECORDING CONDUCTIVITY OF WATER.

(b) Laboratory project.
(c) Quality of Water Branch, USGS, Washington, D. C.
(d) Laboratory and field study; applied research.
(e) Study of performance and utilization of a meter for determining and recording conductivity of water in a stream under field conditions.
(f) Inactive.
(h) "A Study of the Field Performance of a Continuous Conductivity Recorder," by J. D. Weeks, open file release.

(2687) AQUIFER ANALYTICAL METHODS.

(b) Laboratory project.
(c) Mr. R. H. Brown, U.S. Geological Survey, Washington, D. C.
(d) Analytical; applied research.
(e) To develop more versatile and comprehensive methods of determining and evaluating aquifer and ground-water reservoir hydrologic characteristics.

(2688) MECHANICS OF AQUIFERS.

(b) Laboratory project.
(c) Mr. J. F. Poland, U. S. Geological Survey, Sacramento, California.
(d) Field investigation; basic and applied research.
(e) To determine the principles and factors involved in the strain, deformation, and compaction of water-bearing rocks resulting chiefly from changes in hydrologic environment.

(2689) DIFFUSIONAL PROCESSES AND HYDRODYNAMICS OF SALT-FRESH WATER INTERFACE IN AQUIFERS.

(b) Laboratory project.
(c) Mr. H.H. Cooper, U.S. Geological Survey, Tallahassee, Florida.
(d) Field and laboratory investigation; basic and applied research.
(e) To determine the factors affecting the distribution of salt water in coastal aquifers subject to salt water encroachment.

(2690) MICROSCOPIC FLOW THROUGH POROUS MEDIA.

(b) Laboratory project.
(c) Mr. E. S. Simpson, U.S. Geological Survey, Mineola, L. I., New York.
(d) Laboratory investigation; basic research.
(e) To determine the factors affecting the pattern of microscopic flow of water and other liquids through porous media.
(h) Report now being written.

(2691) ARTIFICIAL RECHARGE THROUGH WELLS.

(b) Cooperative with Arkansas Agricultural Expt. Sta. and Corps of Engineers, U. S. Army.
(c) Mr. P. E. Dennis, U.S. Geological Survey, Little Rock, Arkansas.
(d) Field investigation; applied research.
(e) Study of the physical and chemical factors affecting the introduction of water in aquifers through recharge wells.

(2692) ANALOGUE COMPUTER FOR ANALYSIS OF GROUND-WATER FLOW SYSTEMS.

(b) Laboratory project.
(c) Mr. H E. Skibitzke, U.S. Geological Survey, Tucson, Arizona.
(d) Theoretical study and instrument development.
(e) Development of the physical and mathematical theory of ground-water flow systems and construction of an analogue computer for analyzing ground-water flow systems under transient conditions.
(g) Basic analog unit completed.

(2694) FLOW OF WATER OVER WEIRS AND SPILLWAYS.

(b) Laboratory project.
(c) Prof. C. E. Kindsvater, Georgia Institute of Technology, Atlanta, Georgia.
(d) Library search, re-analysis and correlation of published data, plus some original research.
(e) A comprehensive study of the discharge characteristics of practical forms of weirs and spillways. Objectives include the publication, in generalized form, of available experimental data.
(h) "Discharge Characteristics of Rectangular Thin-Plate Weir," by Carl E. Kindsvater and Rolland W. Carter, Paper 1453, Journal of Hydraulics Division, Proceedings of

American Society of Civil Engineers, Dec. 1957.
"Discharge Characteristics of Broad-Crested Weirs," by H.J. Tracy, Circular 397, U. S. Geological Survey, 1957.

(2695) CONTINUOUS DISCHARGE RECORDS IN TIDAL STREAMS.

(b) Laboratory project.
(c) Mr. R.A. Baltzer, U.S. Geological Survey, 408 Capital Savings and Loan Building, Lansing 68, Michigan.
(d) Theoretical and applied research.
(e) The objective of this study is to develop methods of obtaining continuous discharge records in tidal streams. Equations developed from theoretical considerations will be checked by field observations.
(g) Several sets of field data are now being used to verify the theoretical results.
(h) Report in preparation.

(2698) EVALUATION OF EFFECT OF CHANNEL STORAGE ON PEAK DISCHARGE.

(b) Laboratory project.
(c) Mr. W.D. Mitchell, U.S. Geological Survey, Champaign, Illinois.
(d) Analytical and experimental.
(e) The objective of the project is to develop parameters that describe channel storage effectively in an areal correlation of peak flow.
(h) Report in preparation.

(2699) UNIFORM FLOW IN OPEN CHANNELS.

(b) Laboratory project.
(c) Mr. H.J. Tracy, U.S. Geological Survey, Atlanta, Georgia.
(d) Theoretical and experimental; basic research.
(e) A comprehensive laboratory study of uniform flow in open channels.
(g) Data collection is in process.

(2700) PARAMETERS CONTROLLING THE SHAPE AND PATTERN OF NATURAL STREAM CHANNELS.

(b) Laboratory project.
(c) Mr. M. G. Wolman and Dr. L. B. Leopold, U.S. Geological Survey, Washington 25, D.C.
(d) Basic research.
(e) The effect of discharge, load, grain size, and slope will be studied in a small channel free to adjust both bed and side walls.
(h) Report in preparation.

(2701) SEDIMENT TRANSPORT INVESTIGATIONS.

(b) Field project (cooperative with Bureau of Reclamation).
(c) Mr. D.M. Culbertson, U.S. Geological Survey, Lincoln, Nebraska.
(d) Field observations and theoretical analysis.
(e) Field and theoretical investigations of the methods, equipment, and computations used for determining sediment movement and the theory of sediment transport. Specifically

included are studies on sampling techniques; the effect of water temperature on sediment transport; the relationship of roughness to sediment discharge, slope, and width-to-depth ratio; the effect of Kolk action on the vertical distribution of velocity and sediment; the revaluation of Von Karman's Universal Constant of momentum exchange for sediment-laden flow; the influence of suspended sediment on vertical distribution of velocity; the influence of ice cover on sediment transport; the influence of cobble-bed streams on total sediment transport; and other related sediment transport problems.
(g) Evaluation of the equal-transit-rate (ETR) method of measuring suspended-sediment discharge indicates the method is satisfactory when properly used. Tests of a new (petrolatum-type) surface bed-material sampler give results that compare favorably with the core-type of sampler. The modified Einstein procedure is adequate for computing total load when water temperature is near freezing. In general low values of roughness are associated with low temperatures and high sediment loads on Middle Loup River at Dunning, Nebraska.
(h) "Investigations of Some Sedimentation Characteristics of a Sand-bed Stream," by D. W. Hubbell and others, open file release. One additional report completed, to be published in the near future.

(2702) ROUGHNESS AND WATER-SEDIMENT MOVEMENT IN ALLUVIAL CHANNELS.

(b) Laboratory project.
(c) Dr. D. B. Simons, Geological Survey, Colo. State University, Fort Collins, Colorado.
(d) Basic and applied research.
(e) Attention is currently directed to the determination and correlation of factors which influence water-sediment movement and roughness in alluvial channels under selected laboratory conditions. Subsequent studies will be conducted for the purpose of defining (1) variation in roughness properties with the range in standard deviation and skewness exhibited by bed material in natural streams; (2) influence of fine suspended sediments on roughness and sediment transport; (3) relation of these findings to channel geometry; and (4) adaptation of findings to conditions in natural streams.
(h) Progress report in preparation.

(2703) EVAPORATION SUPPRESSION.

(b) Work coordinated with, and executed in conjunction with that of the Southwest Research Institute and various local groups.
(c) Mr. G. E. Harbeck, U. S. Geological Survey, Denver, Colorado.
(d) Basic and applied research.
(e) Evaporation from test reservoirs, both with and without monomolecular surface films, is being measured. Laboratory tests will be made to determine the effects of

monomolecular films on emissivity and re-
flectivity and on the vertical humidity
profile.

(2947) STUDY OF AGGRADATION AND DEGRADATION IN
ALLUVIAL CHANNELS.

(b) Laboratory project.
(c) Dr. Lucien M. Brush Jr., U.S. Geological
Survey, Washington 25, D. C.
(d) Basic research.
(e) A study of channel and hydraulic parameters
associated with aggradation and degradation
in Muddy Creek, near Baggs, Wyoming.

(2948) ANALOGUE MODEL ANALYZER FOR STEADY-STATE
GROUND-WATER FLOW PROBLEMS.

(b) Laboratory project.
(c) Mr. R.W. Stallman, U.S. Geological Survey,
Washington 25, D. C.
(d) Theoretical study and instrument develop-
ment.
(e) Design and development of a variable-
resistance grid analyzer for use in ana-
lyzing steady-state ground-water flow pro-
blems in which the transmissibility varies
in space.
(g) Basic unit completed.

(2949) ULTRASONIC FLOW METER.

(b) U. S. Geological Survey.
(c) Mr. R.W. Carter, U.S. Geological Survey,
Washington 25, D. C.
(d) Experimental; equipment development.
(e) The objective is to investigate the feasi-
bility and build one meter to measure dis-
charge in a natural stream by ultrasonic
means.
(g) Feasibility study completed.

(2950) SEDIMENT TRANSPORT AND CHANNEL ROUGHNESS
IN NATURAL AND ARTIFICIAL CHANNELS.

(b) Laboratory project.
(c) Mr. Thomas Maddock Jr., U.S. Geological
Survey, Washington 25, D. C.
(d) Basic research.
(e) Field and laboratory studies, original and
other investigations will be analyzed in
terms of sediment movement, channel rough-
ness, shear distribution in channel prism
and other effects on shape of natural
channels.
(h) Report in preparation.

(3252) INTERRELATIONS OF LANDFORM MORPHOLOGY,
DIRECT STREAM RUNOFF AND GROUND WATER
DRAINAGE.

(b) Laboratory project.
(c) Dr. Charles W.C. Carlston, U.S. Geological
Survey, Washington 25, D. C.
(d) Basic research.
(e) Evaluation on the effects of geology on
drainage density and groundwater drainage;
the effects of relief on runoff character-
istics; and the relations of drainage
density to direct runoff and ground water

drainage.
(h) Report in preparation.

(3253) CHANNEL STABILITY IN AN EPHEMERAL STREAM.

(b) Laboratory project.
(c) Dr. Luna B. Leopold, U.S. Geological Survey,
Washington 25, D. C.
(d) Field investigation; basic research.
(e) In an ephemeral stream (arroyo), measure-
ments are being made on the following:
stress on rocks during a flow, extent of
scour and fill, location of bars, and
cross-sections at certain locations.

(3254) DISPERSION IN NATURAL STREAMS.

(b) Atomic Energy Commission.
(c) Mr. R. G. Godfrey, U.S. Geological Survey,
Washington 25, D. C.
(d) Field and analytical studies.
(e) To measure and relate dispersal patterns to
channel geometry, fluid properties, and
flow characteristics.
(g) Initial field tests in progress.

(3255) ELECTROMAGNETIC FLOW METER.

(b) U. S. Geological Survey.
(c) Mr. R.W. Carter, U.S. Geological Survey,
Washington 25, D. C.
(d) Instrumentation.
(e) To redesign, adapt, and repackage the
electromagnetic flow meter currently used
by the U.S. Navy to measure velocities in
an open channel.
(g) The Navy instrument has been field tested.

(3256) EFFECT OF ROUGHNESS CONCENTRATION ON OPEN
CHANNEL FLOW.

(b) Laboratory project.
(c) Mr. J.H. Koloseus, U. S. Geological Survey,
Iowa City, Iowa.
(d) Analytical and experimental.
(e) To investigate the effect of bed roughness
on open channel flow by increasing the con-
centrations of 3/16-inch cubes cemented on
the flume floor.
(g) Laboratory tests in progress.

(3257) MEASUREMENT OF TOTAL SEDIMENT DISCHARGE OF
COARSE SEDIMENTS.

(b) Laboratory project.
(c) Mr. D. W. Hubbell, U. S. Geological Survey,
Lincoln, Nebraska.
(d) Analytical; applied research.
(e) A review of the types of equipment current-
ly used to measure sediment moving as bed
load and the preparation of a report cover-
ing criteria for sampler design and use.

(3258) TRANSIENT FLOW IN A POROUS MEDIUM.

(b) Laboratory project.
(c) Mr. W. O. Smith, U. S. Geological Survey,
Washington 25, D. C.
(d) Theoretical and experimental; basic re-
search.

(e) To determine validity of Darcy's law under
non-steady state conditions of flow.
(f) Laboratory apparatus under development.

(3259) FLOW THROUGH UNSATURATED POROUS MEDIA.

(b) Laboratory project.
(c) Mr. A. I. Johnson, U.S. Geological Survey,
Denver, Colorado.
(d) Experimental and theoretical; basic and
applied research.
(e) To determine by hydraulic model experiments
the liquid flow pattern resulting from flow
from a simulated disposal pit at the sur-
face to the water table.
(f) Laboratory apparatus constructed; prelimi-
nary tests run.

(3260) SOIL-MOISTURE EQUIPMENT.

(b) Laboratory project.
(c) Mr. A. I. Johnson, Chief, Hydrologic Labo-
ratory, U.S.G.S., Denver, Colorado.
(d) Laboratory and field investigation; applied
research.
(e) Laboratory model and field comparative
study of techniques and of various com-
mercially available instruments for meas-
uring soil moisture. New equipment may
also be designed as result of study.
(g) Field and laboratory calibrations of neu-
tron meter, tensiometers, moisture blocks
and sampling equipment. Design of some
new equipment. Library research.
(h) "References on Soil-Moisture Measurement
Under Field Conditions," by A.I. Johnson
(mimeo.)

(3261) MODEL STUDY FOR SALT WATER DIFFUSION.

(b) Laboratory study.
(c) Mr. A. I. Johnson, Chief, Hydrologic Lab.,
U.S.G.S., Denver, Colorado, or Mr. H. H.
Cooper, Jr., Research Engineer, U.S.G.S.,
Tallahassee, Florida.
(d) Experimental; applied research.
(e) Model study is being used to study diffu-
sion at the interface between fresh and
salt water. Variable movement of interface
simulates effects of various amplitudes and
periods of tidal action.
(g) Design and construct plastic model and con-
ductivity-recording equipment; one test run
with fine-sand size glass beads completed.

(3262) SMALL-DIAMETER OBSERVATION-WELL EQUIPMENT
AND TECHNIQUES.

(b) Laboratory project.
(c) Mr. A. I. Johnson, Chief, Hydrologic Lab.,
U.S.G.S., Denver, Colorado.
(d) Laboratory and field investigation; applied
research.
(e) Design and evaluate equipment for record-
ing depth-to-water in small-diameter wells;
test in model well in laboratory and on
ground-water wells under field conditions.
(g) Design and construct model well; construct
small-diameter observation wells in field;
design and construct equipment to be

adapted to water-stage recorders on small-
diameter wells; evaluation on model well in
progress.
(h) "Powered Float for Recording Water Levels
in Wells of Small Diameter," by F.C.Koopman
and W. N. Palmquist, Water Resources Bul-
letin (Internal publ.).

(3263) SPECIFIC YIELD AND RELATED PROPERTIES.

(b) Cooperative with the State of California.
(c) Mr. A. I. Johnson, Chief, Hydrologic Lab.
U.S.G.S., Denver, Colorado.
(d) Laboratory and field investigation; basic
and applied research.
(e) Theoretical laboratory and field study of
specific yield, and related properties,
such as moisture equivalent, field capacity
moisture tension, relative permeability
and time-drainage relationships, as related
to ground-water storage. Evaluation of
existing, and possible development of new,
methods for determining these properties.
(g) Library research; laboratory study in pro-
gress or completed of factors affecting
column drainage, centrifuge moisture
equivalent, moisture tension and relative
permeability.
(h) The following reports are in process of
review:
"Specific Yield and Related Properties -
An Annotated Bibliography, Part I," A. I.
Johnson, D. A. Morris and R. C. Prill.
"Specific Yield and Related Properties -
Research Progress Report, July 1, 1957 -
June 30, 1958," A.I. Johnson, R.C. Prill
and D. A. Morris.

(3264) SUBSURFACE EXPLORATION EQUIPMENT AND
TECHNIQUES.

(b) Laboratory project.
(c) Mr. A.I. Johnson, Chief, Hydrologic Lab.,
U.S.G.S., Denver, Colorado.
(d) Laboratory and field investigation; applied
research.
(e) Evaluate and adapt subsurface exploration
equipment and techniques, such as gamma ray
and electric loggers, fluid velocity and
conductivity loggers, temperature loggers,
power augers and core samplers, for solving
ground-water occurrence problems.
(g) Portable temperature logger nearly complete
core samplers designed and commercial model
procured and compared under field condi-
tions; power augering equipment and tech-
niques evaluated; evaluation in progress of
gamma-ray, conductivity and temperature
logging equipment for salt-water encroach-
ment problems. Library research in pro-
gress.
(h) "References on Laboratory and Field Methods
in Ground-Water Hydrology," by A. I.Johnson
(mimeo.).

(3265) MOVEMENT OF WATER ABOVE THE WATER TABLE.

(b) Laboratory project.
(c) Mr. A. I. Johnson, Chief, Hydrologic Lab.,
U.S.G.S., Denver, Colorado.

142

(d) Experimental; basic and applied research.
(e) Laboratory model study of infiltration of fluids from surface pits into a thick unsaturated zone above the water table.
(g) Model tank designed and constructed; several test runs with beds of different particle size completed; library research; test runs photographed by slide and movie.
(h) Progress report in review. Silent lapse-time movie on second phase of model study completed.

JOINT INTER-AGENCY INVESTIGATION.

(2951) A STUDY OF THE DENSITY OF SEDIMENTS DEPOSITED IN RESERVOIRS.

(b) Inter-Agency Committee on Water Resources, Subcommittee on Sedimentation.
(c) U. S. Bureau of Reclamation, Denver, Colorado.
(d) Experimental; applied research and development.
(e) Development of a radio-isotope-densitometer to determine density of deposited sediments in place.
(f) Laboratory tests completed. Field tests are now being made by interested agencies.
(h) "Density Measurement of Saturated Submersed Sediment by Gamma Ray Scattering", Chemical Engineering Laboratory Report No. SI-11, U. S. Bureau of Reclamation, Denver, Colo.

U. S. DEPARTMENT OF THE INTERIOR, BUREAU OF RECLAMATION.

Inquiries concerning the following projects should be addressed to Mr. Grant Bloodgood, Assistant Commissioner and Chief Engineer, Bureau of Reclamation, Denver Federal Center, Denver, Colorado.

(1502) STABLE CHANNEL STUDIES - TRACTIVE FORCES REQUIRED TO MOVE NONCOHESIVE MATERIALS.

(f) Completed.
(h) Preparation of report suspended.

(1777) SIPHON SPILLWAY STUDIES.

(b) Laboratory project.
(d) Combined field investigation and applied research; for design.
(e) Develop an improved design for lower priming head and short priming time. Attempts will be made to design a partialization device to regulate the discharge of the siphon by means of a self-regulating air intake, thereby enabling the siphon to operate more or less continually at reduced flow rather than intermittently at full capacity.
(g) Priming head for minimum operating discharge has been reduced to 25 percent of the required in standard design; corresponding discharge is about 20 percent of standard design.
(h) "Some Experiments with Emergency Siphon Spillways", by W. B. McBirney, Paper 1807,

Journal of the Hydraulics Division, American Society of Civil Engineers, Oct. 1958. Formal report to be prepared.

(2454) GATE SLOT STUDIES.

(f) Completed.
(h) "Hydraulic Characteristics of Gate Slots", by J. W. Ball. Paper delivered at American Society of Civil Engineers convention in Portland, Oregon, June 1958. Reprints are available.

(2455) CASA COLORADO CHANNEL ALINEMENT - MIDDLE RIO GRANDE.

(f) Completed.
(h) Report in preparation.

(2457) EROSION AND TRACTIVE FORCE STUDY OF UNLINED AND EARTHLINED CANALS.

(f) Field data and laboratory testing completed.
(h) Report in preparation.

(2705) TRINITY DAM - MORNING-GLORY SPILLWAY.

(f) Both model studies completed.
(h) Reports in preparation.

(2712) VAQUERO DAM OUTLET WORKS.

(f) Completed.
(h) "Hydraulic Model Studies of Twitchell (Vaquero) Dam Outlet Works." Report Hyd-449, by D. Colgate.

(2718) TRINITY DAM OUTLET WORKS.

(f) Completed.
(h) "Hydraulic Model Studies of Trinity Dam Outlet Works", Report Hyd-439, by G. L. Beichley.

(2719) GLEN CANYON DAM SPILLWAY.

(b) Laboratory project.
(d) Experimental; design.
(e) The model, built to a scale of 1:63.5, includes the tunnel spillways on both sides of the river, the curved arch dam, the outlet works, the powerhouse and a section of the Colorado River upstream and downstream from the dam. The tunnel spillways are modeled in transparent plastic so that flow conditions can be thoroughly investigated. Other features being studied are the approach channels to the spillway, the discharge capacity of the spillways, the pressures throughout the spillways, the flip buckets and scour at the downstream portal of the tunnels, and the effect in the river when all structures are discharging.
(g) Alinements for the excavated spillway approach channels, tunnel transitions between the spillway crest and the inclined tunnel, new type flip buckets in new locations, and other recommended features and procedures have resulted from the studies.
(h) Report to be prepared.

(2724) FRICTION FACTOR TEST IN LARGE PRESSURE
CONDUITS - WEBER-COULEE SIPHON.

    (f) Completed.
    (h) Report to be prepared.

(2952) WOODSTON DIVERSION DAM - GENERAL STUDIES OF
HEADWORKS AND SLUICEWAY STRUCTURES.

    (f) Completed.
    (h) Report in preparation.

(2953) STUDIES OF WIND WAVES ON CANALS.

    (b) Laboratory and field project.
    (d) Experimental; for design.
    (e) Laboratory and field studies are being con-
ducted to develop relationships to predict
erosion produced by surface waves on canal
banks.
    (g) Waves have been measured on field canals,
and wave characteristics have been correlat-
ed with channel characteristics, and wind
velocity and direction. Tests on earth
material from one canal have been completed
in the laboratory flume, and the data have
been analyzed. Plans are being made to in-
stall wave and wind recording equipment on
a field canal.
    (h) Progress report being prepared.

(2954) GLEN CANYON TUNNEL PLUG OUTLET WORKS.

    (b) Laboratory project.
    (d) Experimental; for design.
    (e) Air and hydraulic model studies are being
made to develop the rectangular bellmouth
entrance, the alinement of the 3 conduits
containing 7-x 10.5-foot regulating slide
gates, and the shape of the flip bucket at
the end of the 41-foot diameter tunnel.
    (g) The bellmouth entrance shape and the con-
duit alinement have been established. Per-
formance is good with symmetrical or unsym-
metrical gate operation at heads up to the
maximum of 410 feet. Tests on the flip
bucket are continuing.
    (h) Report to be prepared.

(2955) CAVITATION IN SUDDEN ENLARGEMENTS DOWN-
STREAM FROM GATE VALVES.

    (b) Laboratory project.
    (d) Experimental; for design.
    (e) Tests are being made at heads from 200 to
400 feet to determine the critical cavita-
tion indexes for gate valves operating at
partial openings and discharging into pipe
sections 1.5, 1.75, and 2.0 times the nomi-
nal valve diameter.
    (f) Testing in progress.
    (h) Report to be prepared.

(2956) MURRUMBIDGEE-EUCUMBENE TUNNEL FIXED-WHEEL
GATE AND STILLING BASIN.

    (f) Completed.
    (h) "Hydraulic Model Studies of Tantangara Dam
Outlet Works," Report Hyd-441, by D. Colgate.

(2957) PAONIA DAM SPILLWAY AND OUTLET WORKS.

    (f) Completed.
    (h) Report in preparation.

(2958) HOLLOW-JET VALVE STILLING BASINS FOR OUTLET
WORKS.

    (f) Completed.
    (h) Report in preparation.

(2959) STILLING BASINS FOR SLIDE GATE CONTROLLED
OUTLET WORKS.

    (f) Tests in progress.
    (h) Report to be prepared.

(2960) FLAMING GORGE DAM SPILLWAY.

    (b) Laboratory project.
    (d) Experimental; for design.
    (e) A 1:36 scale model has been constructed to
develop a satisfactory approach channel,
crest section, tunnel transition and spill-
way, flip bucket, and outlet works.
    (f) Tests in progress.
    (g) A satisfactory approach channel has been de-
veloped, and good flow conditions through
the crest section and transition and through-
out the spillway have been obtained by the
use of an unusual center spillway pier.
Tests are being continued to determine other
hydraulic characteristics of the tunnel spill-
way, flip bucket, and outlet works.

(3266) GRAND VALLEY DIVERSION DAM.

    (b) Laboratory project.
    (d) Experimental; for rehabilitation of an
older type stilling basin.
    (e) A 1:30 scale sectional model of the spill-
way was constructed to study the adequacy
of several methods of placing riprap at the
end of the spillway apron to prevent possi-
ble undermining of the spillway apron.
    (f) Completed.
    (g) The tests showed that well graded riprap,
with at least 75 percent of the individual
pieces 2 feet or larger in diameter, placed
to a depth of about 4 feet would provide
adequate protection.
    (h) Memorandum report prepared.

(3267) CANAL INLET AND OUTLET TRANSITION STUDIES.

    (b) Laboratory project.
    (d) Experimental; for design.
    (e) Tests are in progress to determine the
angle of divergence or convergence from
pipe to canal or vice versa, and the effects
of the slope and elevation of the pipe with
respect to the canal.
    (g) Testing in progress.
    (h) Report to be prepared.

(3268) PRINEVILLE SPILLWAY AND OUTLET WORKS.

    (b) Laboratory project.
    (d) Experimental; for design.

(e) A 1:24 scale model has been constructed and tested to develop a single stilling basin satisfactory for both spillway and for outlet works discharges. Tests on the spillway were made to insure optimum flow conditions throughout the spillway, in the outlet conduit, and in the downstream river channel.

(f) Testing completed.

(g) A basin using two dividing walls to direct the outlet works flow through the basin was found satisfactory for either spillway or outlet works flows. Pressure cells were used to measure the pressure fluctuation acting on the stilling basin dividing walls and on the chute blocks and baffle piers.

(h) Report in preparation.

(3269) EFFECT OF SHADE PRODUCED BY SUSPENDED SEDIMENTS ON THE GROWTH OF AQUATIC WEEDS.

(b) Laboratory project.

(d) Experimental; for operation and maintenance.

(e) Three types of aquatic weeds have been grown in eight 55-gallon drums under varying concentrations of suspended sodium base bentonite. Weeds were grown in two drums containing clear water for control and comparison purposes.

(f) It is planned to make tests using a natural reservoir sediment during next growing season.

(g) Results of completed tests show that sodium base bentonite had little effect on reducing growth of the aquatic weeds tested.

(h) Progress report in preparation.

(3270) SAN ACACIA DIVERSION - HEADWORKS AND SLUICEWAY.

(b) Laboratory project.

(d) Experimental; for design and rehabilitation.

(e) A 1:20 undistorted scale, movable bed, hydraulic model is proposed to study the headworks and sluiceway. Tests will be made to determine the arrangement of structures that will reduce sediment inflow to a minimum.

(f) Model being constructed.

(3271) CHANNELIZATION IN ALLUVIAL RIVERS USING STEEL JACKS AND JETTIES.

(b) Laboratory project.

(d) Experimental; for design.

(e) Tests are being made on a 1:140 horizontal and 1:22 vertical scale movable bed model to extend studies made under project (2455). The model will have nearly constant jetty field, channel, and flood plain widths. Tieback jetties spaced at 500 feet will be compared with those of lesser spacing to determine their effectiveness.

(f) Active; model study being started.

(3272) NAVAJO DAM SPILLWAY AND AUXILIARY OUTLET WORKS.

(b) Laboratory project.

(d) Experimental; for design.

(e) A 1:48 scale model was constructed to develop the design of the spillway entrance, the spillway chute, the stilling basin, and the auxiliary outlet works tunnel junction with the spillway chute.

(f) Testing in progress.

(g) Tests are being made to correct the unequal distribution of flow entering the stilling basin. The poor flow distribution is caused by the spillway entrance shape and the steep and diverging spillway chute.

(h) Report to be prepared.

(3273) NAVAJO DAM DIVERSION AND OUTLET WORKS STILLING BASIN.

(b) Laboratory project.

(d) Experimental; for design.

(e) A 1:24 scale model was constructed to develop the stilling basin which will be used first for river diversion flows during the construction period and, second, as the permanent outlet works stilling basin.

(f) Completed.

(g) A satisfactory basin was developed for the diversion flows which could be made over into the permanent outlet works stilling basin by the addition of certain concrete features. It will not be necessary to remove first stage concrete to obtain the permanent basin.

(h) Report to be prepared.

(3274) CONSTANT HEAD ORIFICE TURNOUT.

(b) Laboratory project.

(d) Experimental; applied research for design.

(e) A 24-inch slide gate turnout is being calibrated by means of a 1:2 scale model. Design changes resulting from use of the turnout have necessitated an analysis and calibration of the variables affecting the discharge capacity.

(g) Results show that submergence of the orifice or of the upstream gate of the two-gate turnout has a major effect on the discharge coefficient. A calibration curve for a 9-cfs standard turnout and several comparative calibrations of modified turnouts have been obtained.

(h) Report in progress.

(3275) FRICTION FACTOR TESTS IN LARGE PRESSURE CONDUITS - EKLUTNA TUNNEL, ALASKA.

(b) Laboratory project.

(d) Field investigation; design.

(e) Extension of data to provide information on friction factors for smooth interior finishes of concrete that can be consistently produced with present day construction methods. Tests have been completed on a 9-foot inside diameter concrete lined tunnel. Head losses were measured over a length of 2,534 diameters. Average velocities of flow were determined from calibrated pressure taps in two turbine scroll cases.

(f) Tests and data analyses completed.

(g) Data were obtained for seven test discharges over a Reynolds Number range of

7.1×10^5 to 4.6×10^6. Friction factors computed from the Darcy-Weisbach equation ranged from 0.017 to 0.014, respectively.

(h) Report in preparation.

(3276) FOSS DAM OUTLET WORKS.

(b) Laboratory project.
(d) Experimental; for design.
(e) The design of the outlet works stilling basin was developed on a 1:15 scale model. This basin must operate satisfactorily for the high tail water which will exist during initial operation of the basin, and for extremely low tail water anticipated after degradation of the downstream channel.
(f) Completed.
(g) Special appurtenances in the basin provide satisfactory performance for a tail water range of from 7 to 24 feet.
(h) Report in preparation.

(3277) HYDRAULIC DOWNPULL ON LARGE GATES.

(b) Laboratory study.
(d) Compiling past data; for research paper.
(e) Discussed in the paper are model studies in which both the weighing method and the pressure-area computation method were used to determine hydraulic downpull. A detailed account is presented of one study in which the pressure-area computations method alone was employed. Also, methods and results of field measurements are discussed.
(f) Completed.
(h) Paper presented at ASCE convention, Portland, Oregon, June 1958.

(3278) CAVITATION OF CONCRETE SURFACE IRREGULARITIES.

(b) Laboratory project.
(d) Experimental; for research.
(e) The cavitation producing potential of concrete surface irregularities such as abrupt offsets, protruding filler material, bug holes, etc., is being investigated. The test apparatus employs full-scale velocities and pressures.
(f) Tests are continuing.

(3279) LITTLE WOOD RIVER SPILLWAY.

(b) Laboratory project.
(d) Experimental; for design.
(e) A 1:24 scale model was used to develop a riprap lined trapezoidal stilling basin.
(f) Completed.
(g) A minimum stilling basin was developed to provide satisfactory energy dissipation of a nearly horizontal jet emerging from a spillway chute located above the basin water surface level. Jet velocities ranged from 30 to 63 fps.
(h) No report available.

(3280) GLENDO DAM OUTLET WORKS.

(b) Laboratory project.

(d) Experimental; for design.
(e) A 1:18.4 scale model is being used to determine the cause of cavitation-erosion experienced on the deflector blocks and flared walls of the stilling basin, and to develop corrective measures.
(g) Preliminary tests show that cavitation was caused by excessive flare of training walls and by insufficient streamlining of the chute blocks.
(h) Report to be prepared.

(3281) ISLAND BEND CONTROL GATES.

(b) Snowy Mountains Hydro-Electric Authority, Australia.
(d) Experimental; for design.
(e) Air and hydraulic model studies are being made: (1) to develop a constricted section downstream from the gate leaf to permit control of relatively low flows under high heads, and (2) to determine the cavitation index of a fixed-wheel gate.
(g) Air tests indicate that a sharp-edged orifice is preferable to a constricted section having a curved entrance.
(h) Report to be prepared.

U. S. DEPARTMENT OF THE NAVY, DAVID TAYLOR MODEL BASIN.

Inquiries concerning the following projects should be addressed to the Commanding Officer and Director David Taylor Model Basin, Washington 7, D. C.

(709) THEORY OF WAVE RESISTANCE.

(b) Bureau of Ships; David Taylor Model Basin.
(d) Hydrodynamic research.
(e) A mathematical study of the theory of wave resistance for the purpose of establishing methods for extending the theory to the analysis of ship resistance. Studies will include the general theory of waves in liquids and will encompass a review of existing theory and comparisons with existing experimental data.
(g) A synopsis has been written on the application of theory to the calculations of wave resistance.
Calculations were made to obtain general information about wave resistance of submerged bodies of revolution. The forms considered are ellipsoids, Rankine ovoids, and a simple family of streamlined bodies. A report of this work is to be published.
(h) "The Wave Resistance of a Floating Slender Body", by W. E. Cummins, dissertation presented to American University, May 1956.

(710) RESEARCH ON MAIN INJECTION SCOOPS AND OVERBOARD DISCHARGES.

(b) Bureau of Ships; David Taylor Model Basin.
(d) Hydrodynamic research.
(e) Investigations to determine the characteristics of a broad series of injection scoops and discharges to provide design

data for use in design of future high-speed ships.

(g) An improved method for estimating the velocity profile and thickness of a ship's boundary layer is being developed.

(h) "Boundary Layer Investigation on the USS TIMMERMAN EAG152 (ex-DD828)", by C. L. Sayre, Jr. and R. J. Duerr, TMB Report 1170, to be published.
"Estimating the Thickness of the Boundary Layer on the Hull of a Ship", by C. L. Sayre, in preparation.

(711) CAVITATION RESEARCH.

(b) Bureau of Ships; David Taylor Model Basin.
(d) Hydrodynamic research.
(e) Research on the mechanism and effects of cavitation phenomena including the physics and analytical description of steady-state cavities in real and ideal fluids and investigations of the inception of cavitation, the growth and collapse processes of transient cavities, and the effects of cavitation on the forces on underwater bodies. Studies will be made on the application of linearized theory to problems in cavitation. Additional studies will be made on the effects of roughness elements on cavitation inception and of body form on cavitation and degassing. Cavitating vortex cores as produced by shear flows will be investigated. Such cavitating sources have been observed on appendages to ships and may be responsible for flow noise excitation at high speeds.
(g) In one case the excitation of vibration of a ship has been traced to cavitation on rudder. (See DTMB Report 1188).
(h) "An Investigation of Flow Excitation of Vibration of the USS FORREST SHERMAN, DD931", by M. S. Mocovsky, R. J. Duerr and D. A. Jewell, TMB Report No. 1188, August 1958.

(1506) STIMULATION OF TURBULENCE ON SHIP MODELS.

(b) Bureau of Ships; David Taylor Model Basin.
(d) Frictional resistance research.
(e) Development of a turbulence stimulating device which will insure adequate turbulence in the boundary layer over the entire length of any ship model. Empirical and theoretical studies will be conducted to evaluate the relative effectiveness of turbulence rods, trip wires, sand roughness, isolated stubs, noise makers and vibrators. Their relative effectiveness will be calculated by studying the model resistance and the character of the boundary layer flow around ship models as determined by the dye-method, the chemical compound, and the hot-wire survey method.
(f) Suspended.
(g) The work of the previous year was devoted to the study of the stimulating effect of studs and the development of the technique of the chemical compound. The effect of various stimulators on the BSRA model has been established and the evaluations work will compare the results for each stimulator

with the results obtained by the English tanks. The evaluation of the stimulators used is still continuing.

(1511) SERIES 60 SEAWORTHINESS.

(b) Bureau of Ships; David Taylor Model Basin.
(d) Experimental and theoretical.
(e) Experimental and theoretical investigation of the effect of changes in certain features of hull shape on the seaworthiness characteristics of a series of ship models. Three single screw ship forms of 0.60, 0.70 and 0.80 block coefficient have been adopted for this purpose. Tests to determine the motion and speed reduction characteristics of the 0.60 block model were completed.
(g) The phase between pitching and heaving motion affects the seaworthiness characteristics such as wetness, slamming, and speed reduction. Consequently this phase relationship was further studied both experimentally and theoretically.

(1512) EFFECTIVENESS OF BILGE KEELS.

(b) Bureau of Ships; David Taylor Model Basin.
(d) Experimental testing.
(e) Measurements of the amplitudes of roll versus rolling moment and frequency at or near resonance for a ship model with and without bilge keels; the increase in resistance of a model due to rolling and roll-induced yawing; and the lift, drag, and torque developed by fins. Data will be used in arriving at criteria for the design of fin stabilizers.
(f) Completed.
(g) Roll tests have been made in the basin on a ship model with and without bilge keels. Also, wind tunnel measurements have been made to determine the effect of variation in fin stabilizers on lift, drag, and torque characteristics.

(1514) MANEUVERING CHARACTERISTICS OF SINGLE-SCREW VESSELS.

(b) Bureau of Ships; David Taylor Model Basin.
(d) Experimental testing.
(e) Measurements of side forces on propeller, rudder, and hull of a single-screw ship model during successive phases of starting, stopping, and backing maneuvers.
(f) Inactive.
(g) A test program has been formulated. A side-force dynamometer has been designed and completed. Testing is expected to begin when priority considerations permit.

(1517) VORTEX-EXCITED BODIES IN A MOVING STREAM.

(b) Bureau of Ships, David Taylor Model Basin.
(d) Experimental; basic research.
(e) Measurements have been made of fluctuating lift and drag forces on 2 in. and 4 in. circular cylinders towed in miniature Model Basin. Further work will include wind tunnel investigations of the relationship

between Strouhal number and shape for a family of struts in an attempt to correlate wake frequency and shape parameters. In addition, an investigation will be made of the spanwise correlation of vortex shedding on circular cylinders as a function of Reynolds number.

(f) Completed. Further work being performed under new item entitled, "Hydroelastic Problems."

(g) For a rigid cylinder fluctuating lift coefficients of the same order of magnitude as the steady drag coefficient have been found in the sub-critical range of Raynolds numbers. There is evidence for lack of two-dimensionality in the vortex shedding.

(h) "Vortex-Induced Vibration Studies," by M.S. Macovsky, TMB Report 1190, July 1958.

(1521) 36-INCH VARIABLE PRESSURE WATER TUNNEL.

(b) Bureau of Ships; David Taylor Model Basin.
(d) New facility.
(e) Design and construction of a 36-inch variable pressure water tunnel for investigation of propulsion, cavitation, and noise characteristics of propellers as well as tests on sub-surface bodies. Interchangeable test sections of open and closed jet type will be provided. The maximum design speed is 85 f.p.s.
(g) Estimated completion is summer of 1959.

(1522) WAVEMAKER STUDIES.

(b) Bureau of Ships; David Taylor Model Basin.
(d) Hydrodynamic research and facility development.
(e) Theoretical and experimental studies of surface wave generators to develop criteria for the design and construction of a large-scale wavemaker installation. A program of research on wave absorbers is also underway. Prerequisite to this latter investigation is the development of practical means for evaluating the effectiveness of a given absorber.
(f) Completed.
(g) A small pilot model of a pneumatic wavemaker has been developed and successfully operated. Improvement has been made in the means of controlling amplitude and frequency of generated waves. A much larger pneumatic wavemaker has been installed in the 140-foot model basin, and has been in regular operation generating waves for ship model tests. A 51-foot wide pneumatic wavemaker has been installed in the deep water basin. A method of making measurements and determining wave absorption characteristics therefrom has been developed analytically. The accuracy with which wave height can be determined has been improved by the development of an electronic wave-height recorder which operates on a change of capacitance principle.

(1778) HYDRODYNAMIC NOISE.

(b) Bureau-of Ships; David Taylor model Basin.

(d) Hydrodynamic research.
(e) Investigations of the characteristics of underwater noise associated with various hydrodynamic phenomena such as cavitation, bubble oscillation, turbulence and splashing.
(g) Experimental and theoretical studies have been made of noise produced by cavitation, splashing, oscillating air bubbles, and turbulence.
(h) "Measurements of Noise from Cavitating Submerged Water Jets," by D. W. Jorgensen, November 1958, TMB Report 1126. "Pressure Fluctuations on a Wall Adjacent to a Turbulent Boundary Layer," by M. Harrison, TMB Report 1260, December 1958.

(1779) TURBULENT BOUNDARY LAYERS.

(b) Bureau of Ships; David Taylor Model Basin.
(d) Frictional resistance research.
(e) A theoretical and experimental investigation of the velocity profile and wall shearing stresses in turbulent boundary layer. In order to provide a simple and accurate determination of shear stress at the wall, the use of surface tube technique for measuring this characteristic has been investigated in both zero and adverse pressure gradients.

(1780) BUBBLE FLOW STUDIES.

(b) Bureau of Ships; David Taylor Model Basin.
(d) Hydrodynamic research.
(e) Theoretical computations of bubble paths for various shapes to determine points of collision and conditions for non-collision will be made. The validity of the theory will be checked experimentally in a few cases.
(h) "Motion of Rigid and Fluid Spheres in Stationary and Moving Liquids Inside Cylindrical Tubes," by W.L. Haberman and R.M. Sayre, TMB Report 1143, October 1958.

(1781) ROTATING-ARM AND MANEUVERING BASIN.

(b) Bureau of Ships; David Taylor Model Basin.
(d) New facility.
(e) Design and construction of a circular basin of 260-foot diameter with a rotating arm whose radius can be varied from 18 to 120 feet. To be used for towing tests of surface and sub-surface models. Also, design and construction of a maneuvering basin 350 feet long and 230 feet wide, equipped with traveling bridge and towing carriages, and wavemakers for the purpose of making maneuvering tests on ship models.
(g) Construction contract awarded in May 1956 with a completion date in early 1959.

(1782) SHIP MOTIONS.

(b) Bureau of Ships; David Taylor Model Basin.
(d) Applied research.
(e) Determination of ship motions in a regular seaway when coupling exists between heave and pitch. The work is to be based on the

linear theory and is a continuation of
work on uncoupled motion. It is intended
to extend the applicability of the linear
theory to a larger number of vessels of
various type.

(f) Inactive.

(1783) MATHEMATICAL SHIP LINES.

(b) Bureau of Ships; David Taylor Model Basin.
(d) Theoretical research.
(e) Development of a suitable method for the
mathematical determination of ship lines
which can be applied to a wide variety of
ship forms especially to those of modern
design.
(g) A method has been developed for the mathe-
matical fairing of graphical lines. This
is a first step toward the development of
a flexible system of mathematical ship
lines. Future work is directed toward the
development of a system of mathematical
lines which will permit the derivation of
a hull form for a given set of parameters.

(1786) STUDIES OF THE SLAMMING OF SHIPS.

(b) Bureau of Ships; David Taylor Model Basin.
(d) Experimental and theoretical.
(e) Computations and measurements of the maxi-
mum pressure and impact forces on the bot-
toms of slamming ships for the purpose of
developing design criteria to effect their
reduction.
(g) Studies with ship models were made to de-
termine hydrodynamic impact forces on
ships. Regular and confused seas were
studied to determine conditions favorable
for slamming.
(h) "Preliminary Experimental Investigation of
Slamming," by V.G. Szebehely and S. H.
Brooks, July 1952, TMB Report 812.
"Hydrodynamics of Slamming Ships," by V. G.
Szebehely, July 1952, TMB Report 823.
"Hydrodynamic Approach to the Slamming of
Ships," V.G. Szebehely, Second Midwestern
Conference on Fluid Mechanics, Proceedings,
page 89-97, 1952.
"Slamming Due to Pure Pitching Motion," by
M.A. Todd, January 1955, TMB Report 883.
"Ship Slamming in Head Seas," by V. G.
Szebehely and M.A. Todd, February 1955,
TMB Report 913.
"Model Experiments of Slamming of a Liberty
Ship in Head Seas," V.G. Szebehely and
S.M.Y. Lum, February 1955, TMB Report 914.
"Progress in Theoretical and Experimental
Studies of Ship Slamming," V.G. Szebehely.
Conference on Ships and Waves, Council on
Wave Research, 1954.
"On Slamming," by V.G. Szebehely, M.A.
Todd, S.M.Y. Lum. Seventh International
Conference on Ship Hydrodynamics, 1954.
"Slamming Pressures on Series 60 Forms,"
by M.D. Bledsoe (to be published), TMB
Report 994.
"Hydrodynamic Impact Measurements," by
V.G. Szebehely and E.E. Zarnick, First
Conference on Coastal Engineering Instru-
ments, 1955.

"Experiments on Rotational Impact," by F. N.
Schwartz and M. D. Bledsoe, TMB Report 1145
(in review).

(1788) WAX DEVELOPMENT.

(b) David Taylor Model Basin.
(d) Experimental testing.
(e) Development of a wax composition and manu-
facturing techniques for the manufacture of
ship models up to 30 ft. on water-line
length.
(f) Completed.
(g) The blend developed is entirely suited to
the climatic conditions existing in Wash.,
D.C. The strength of this material is such
that all types of models, including sub-
marines, may be constructed and handled
with no greater care than is given to corre-
sponding wood models. Ninety-one models,
varying in length between 19 and 24 ft. and
in weight between 1,000 and 4,500 lbs., and
four 30 ft. models have been successfully
manufactured and tested since the develop-
ment of this new wax blend. The introduc-
tion of wax model construction technique
has resulted in a substantial saving in
time and cost of ship model manufacturing
at TMB.
(h) The following reports are being reviewed
prior to publication:
"The Development of a N-Butyl Methacrylate
Wax Blend for Manufacturing Wax Models at
TMB," by W. Hinterthan.
"Development and Application of a Wax Com-
position for the Manufacture of Experiment-
al Ship Models," by W. Hinterthan.
"Methods to be Followed in the Blending of
Wax for TMB Wax Model Production," Memo-
randum, by W. Hinterthan.

(1789) PRESSURE DISTRIBUTION ON SHIP MODELS.

(b) Bureau of Ships; David Taylor Model Basin.
(d) Experimental and theoretical research.
(e) Measurements of pressure distribution and
resistance with photographs of wave pro-
files and flow lines for a series of ship
models. Attempt will be made to develop
methods of calculation suitable for high
speed computors.
(g) A bank of diaphragm type pressure gages
has been constructed to determine the
pressure distributions, and tests on a
specific model are in progress.

(2018) SERIES 60 - RESISTANCE OF VARIOUS RELATED
HULL FORMS.

(b) Bureau of Ships; Maritime Commission; David
Taylor Model Basin.
(d) Experimental testing.
(e) The dependance of resistance upon the coef-
ficients of hull form for a practical range
of single-screw ship forms is to be deter-
mined. The history of the project, the
scope of the proposed series is given in
(h) for Series 57. The resistance results
of the original Series 57 models were some-
what disappointing and therefore careful

thought was given to the problem of improving the original parents. As a result, new parent forms have been drawn out, together with necessary contours and models run for resistance. The new family was designated number Series 60.

(f) Completed.

(g) It is believed that the new Series 60 contours now are such as to justify their use as a starting point for future research in a number of fields. Suggestions as to such systematic research were made in the earlier paper, and include the evaluation of the effect of LCB position, L/B and B/H ratios etc.

(2019) PROPELLER EXCITED VIBRATION.

(b) David Taylor Model Basin and Society of Naval Architects and Marine Engineers.

(d) Experimental; basic research.

(e) Investigation, measurement and prediction of propeller excited vibratory forces on ship models.

(g) Development of instrumentation and testing techniques for a single screw vessel is nearing completion. During the past year tests were conducted to measure the hydrodynamic transmission to the hull of vibratory forces induced by the propeller of a model of the "Gopher Mariner." The primary objective was to refine the instrumentation and techniques sufficiently to obtain repetitive results. This has been accomplished and it should now be possible to compare the vibratory characteristics of models of similar type and dimensions. An extrapolation of data, using the third power of the linear ratio yields higher values of force than were measured in full scale trials of the Gopher Mariner. Measurement of instantaneous pressure have been made on the hull of the USS TIMMERMAN and on the hull of a 30 foot model of that vessel. Preliminary data indicates that the model measurements when similarly extrapolated also produce higher values than were measured on board ship.

(2229) NEAR SURFACE EFFECTS.

(b) Bureau of Ships; David Taylor Model Basin.

(d) Hydrodynamic research.

(e) A mathematical study of the forces and moments acting on bodies due to the proximity of a free surface. The studies will include both the case in which the surface is initially undisturbed and the case in which there are disturbances originating at a distance.

(g) Methods have been developed for computing the forces and moments acting on bodies of revolution, both due to waves generated by the body itself and to regular trains of waves.

(h) "The Forces and Moments Acting on a Body of Revolution Moving in an Arbitrary Potential Stream," by W.E. Cummins, Journal of Ship Research, Vol. 1, No. 1, 1957, TMB Report 780.

(2230) THEORY OF SEAWORTHINESS.

(b) Bureau of Ships; David Taylor Model Basin.

(d) Hydrodynamic research.

(e) A theoretical and experimental study of factors affecting the seaworthiness of ships, for the purpose of developing procedures for predicting their motion.

(g) Tests have been completed on two geometrically similar ship models of different lengths. The analysis of these tests will aid in estimating the validity of model tests for predicting full scale behavior. A ship model has been oscillated in heave and pitch to determine the dependency of the damping and added mass forces on speed, frequency and amplitude of oscillation. Comparisons will be made with theoretical methods currently used to compute these forces.

(h) "A Study of the Transient Pitching Oscillations of a Ship," Thesis, Univ. of Maryland, August 1957.

(2231) HYDRAULIC ROUGHNESS STUDIES.

(b) Bureau of Ships; David Taylor Model Basin.

(d) Frictional resistance research.

(e) Theoretical and experimental research on methods for analyzing and predicting the frictional resistance of arbitrary rough surfaces, especially the painted surfaces of ship hulls. The geometrical characteristics of arbitrary rough surfaces are to be analyzed by amplitude-frequency spectra while the hydrodynamic characteristics are to be analyzed by similarity laws.

(g) The low frequency characteristics of the roughness records necessitate the development of a low frequency spectrum analyzer. The analytical procedures for predicting the frictional resistance of arbitrary rough surfaces from similarity laws have been completed. A method has been derived for predicting full scale resistance of arbitrary rough surfaces from tests of model plates. Relations for the local skin friction and shape parameter have been derived for use in calculating the development of turbulent boundary layers in pressure gradients for rough surfaces. Boundary layer measurements are being made in a wind tunnel on randomly rough surfaces using a floating element dynamometer.

(h) "The Frictional Resistance and Turbulent Boundary of Rough Surfaces," by P. S. Granville, TMB Report 1024, June 1958.

(2232) PRESSURE AND VELOCITY DISTRIBUTIONS ON TWO-DIMENSIONAL AND AXISYMMETRIC THREE-DIMENSIONAL FORMS.

(b) Bureau of Ships; David Taylor Model Basin.

(d) Potential flow research.

(e) Investigate analytic techniques for determining the pressure and velocity distribution on two-dimensional and axisymmetric three-dimensional forms. The solution is to be amenable to coding for UNIVAC computation.

(g) An iterative solution has been developed
     and coded for the UNIVAC. The pressure
     distribution for a number of bodies whose
     pressure distribution is known have been
     completed and verified. Some difficulty is
     experienced however, with convergence in
     certain portions of the calculations.

(2233) THE STRUCTURE OF TURBULENCE IN BOUNDARY
        LAYERS AND WAKES.

(b) Bureau of Ships; David Taylor Model Basin.
(d) Turbulence research.
(e) A study to investigate the behavior of the
     basic turbulence quantities in boundary
     layer and wake flows. Investigations of
     the effect of background turbulence level
     on the turbulence characteristics of the
     wake behind two-dimensional forms and cir-
     cular disks will be continued. Systematic
     measurements of a turbulent boundary layer
     in adverse pressure gradients will be
     undertaken.
(g) Experimental results indicate that the in-
     tensity decay and width increase of the
     turbulent wake in its downstream course
     behind three-dimensional bluff bodies
     (discs and plates) are in agreement with
     those theoretically predicted. Future
     tests will be extended to include practical
     configurations which will be investigated
     in both unpowered and powered conditions.
     Measurements of a turbulent boundary layer
     in adverse pressure gradients include pre-
     cise velocity profiles, local skin-friction
     measurements with surface tubes, and hot-
     wire anemometry.

(2234) SURFACE WAKES BEHIND TOWED STRUTS.

(b) Bureau of Ships; David Taylor Model Basin.
(d) Hydrodynamic research.
(e) Research on the mechanism of plume and
     wake formation of surface piercing struts,
     including the determination of wave drag,
     spray drag, and induced drag for geometri-
     cally varied series.
(f) Inactive.
(g) Tests on a series of struts have been com-
     pleted.

(2235) LIBERTY SHIP SEAWORTHINESS.

(b) Bureau of Ships; David Taylor Model Basin.
(d) Experimental and theoretical.
(e) Thorough seaworthiness investigations of a
     Liberty Ship and a modified Liberty Ship
     Hull. The aspects of this investigation
     includes speed reduction, ship motion, and
     slamming. Model experiments have been con-
     ducted with 5-foot models in waves. This
     work will be extended to 20-foot models
     and full-scale sea trials.
(f) Inactive.

(2236) OSCILLATING PRESSURES IN THE VICINITY OF
        PROPELLERS.

(b) David Taylor Model Basin.
(d) Experimental and theoretical; applied

research.
(e) Studies of the oscillating pressures on
     boundaries and in the free space produced
     by propeller operation. The purpose of the
     work is to determine the magnitude of the
     hydrodynamic propeller excited vibratory
     forces acting on ship's hulls and the ef-
     fect of operating parameters.
(f) Completed.
(g) Experimental results have been completed.
(h) "The Measurement of Thrust Fluctuation and
     Free-Space Oscillating Pressures for a
     Propeller," by A. J. Tachmindji and M. C.
     Dickerson, DTMB Report 1107, January 1957.
     "The Measurement of Oscillating Pressures
     in the Vicinity of a Propeller," by A. J.
     Tachmindji and M. C. Dickerson, DTMB Report
     1130, April 1957.

(2237) LIFTING SURFACE THEORY OF PROPELLERS.

(b) Cooperative with Bureau of Ships.
(d) Theoretical; applied research.
(e) Studies of the corrections on lifting line
     theory which arise from the finite extent
     of the blades.
(f) Application of an approximate lifting sur-
     face theory is completed. Development of
     a rigorous theory temporarily inactive.
(g) The available results are being applied to
     propeller design methods.
(h) "Propeller Induction Factors," by W. B.
     Morgan, TMB Report 1183.

(2238) THE EVALUATION OF THE EFFECT OF SHIFTING
        THE LONGITUDINAL CENTER-OF-BOUYANCY (LCB)
        UPON THE RESISTANCE AND PROPULSIVE CHARAC-
        TERISTICS OF VARIOUS RELATED HULL FORM OF
        SERIES 60.

(b) David Taylor Model Basin.
(d) Experimental testing.
(e) Four models for each of the five block
     coefficients, to which the parent models
     were built, were constructed from the Se-
     ries 60 contours. Resistance tests were
     conducted for each of these hulls to find
     the effect on resistance of varying the
     LCB. Concurrently, the relation between
     the propulsion coefficients and LCB posi-
     tion was obtained from propulsion tests.
(f) Completed.
(g) The effect of the LCB positioning on the
     propulsive coefficients has been obtained.
     Also an optimum location of LCB for each
     block coefficient, of this series, has been
     established from the resistance character-
     istics of this hull.

(2239) PROPULSIVE CHARACTERISTICS OF VARIOUS
        RELATED HULL FORMS - SERIES 60.

(b) Bureau of Ships; Maritime Commission; David
     Taylor Model Basin.
(d) Experimental testing.
(e) The dependance of propulsion characteristics
     upon the coefficients of hull form and pro-
     peller diameter for a practical range of
     single-screw ship forms are to be determin-
     ed. Series 60 parent models are used for

this project.
  (f) Completed.
  (g) The dependance of wake, thrust deduction,
       propulsive coefficient, etc. upon the block
       coefficient, propeller diameter, trim etc.
       has been obtained.

(2462) PITCH REDUCTION STUDIES.

  (b) Bureau of Ships.
  (d) Experimental and theoretical.
  (e) To investigate the effect of horizontal fin
       appendages on the motion of surface ships
       in a seaway. A motion prediction theory is
       being developed and experimental investiga-
       tions will be conducted.
  (h) "Model Experiments with Fixed Bow Anti-
       pitching Fins," by G. P. Stefun, TMB Report
       1118, submitted to the Journal of Ship
       Research.

(2463) STUDIES OF LOW ASPECT-RATIO CONTROL SUR-
        FACES.

  (b) David Taylor Model Basin; laboratory pro-
       ject.
  (d) Experimental investigation; basic research.
  (e) Determine the aerodynamic characteristics
       of a family of low aspect-ratio control
       surfaces which can be used by the designer
       of submarines and surface ships.
       Phase I is an investigation of a family of
       all-movable control surfaces. Phase II is
       an investigation of the same family with
       plain flaps of different chord length.
  (f) Phase I, completed; Phase II, active.
  (g) The results of Phase I indicate that many
       of the aerodynamic characteristics of low
       aspect-ratio surfaces can be accurately
       predicted from lifting surface theory.
  (h) The results of Phase I and comparisons with
       lifting surface theory are presented in
       DTMB Report No. 933.

(2464) THE EVALUATION OF THE EFFECT OF CHANGING
        THE LENGTH TO BEAM (L/B) AND BEAM TO DRAFT
        (B/H) ON THE RESISTANCE CHARACTERISTICS AND
        PROPULSIVE COEFFICIENTS FOR THE VARIOUS
        RELATED HULL FORMS OF SERIES 60.

  (b) David Taylor Model Basin.
  (d) Experimental testing.
  (e) For each block coefficient (C_B) models are
       being built from the offsets of the model
       with the optimum location of the longitudi-
       nal center-of-bouyancy. This model will
       have been established by the program - "The
       Evaluation of the Effect of Shifting the
       Longitudinal Center-of-Bouyancy upon the
       Resistance and Propulsive Characteristics
       of Various Related Hull Forms of Series 60."
  (f) Completed.
  (h) "Series 60 - The Effect Upon Resistance and
       Power of Variation in Ship Proportions," by
       Dr. F. H. Todd, Mr. G. R. Stuntz, and Dr.
       P. C. Pien, Society of Naval Architects and
       Marine Engineers paper was presented during
       November 1957 meeting.

(2466) TOWING EQUIPMENT AND MOTION RECORDING

INSTRUMENTATION FOR SHIP MODEL TESTS IN
WAVES.

  (b) David Taylor Model Basin laboratory project;
       specifically for TMB's proposed Maneuvering
       Basin.
  (d) Experimental and theoretical.
  (e) The purpose of the equipment and instrumen-
       tation is respectively, to tow models in
       waves and to measure and record various
       types of model motions. Surface models will
       be tested under partially-restrained condi-
       tions, the restraints being those of yaw
       and sway; or, of yaw, sway, and roll. Mod-
       el tests will be conducted in head and
       following seas.
  (f) Specifications were completed while the de-
       sign of the equipment and instrumentation
       is being done presently.

(2467) DEVELOPMENT OF OCEANOGRAPHIC RESEARCH
        VESSEL.

  (b) Bureau of Ships; David Taylor Model Basin.
  (d) Experimental and theoretical.
  (e) Prediction and experimental determination
       of the motion of research vessel in seaway.
  (f) Completed.

(2468) EFFECT OF WAVES ON STANDARDIZATION TRIALS.

  (b) Bureau of Ships; David Taylor Model Basin.
  (d) Experimental.
  (e) To establish a method for determining the
       conditions under which standardization
       trials might be adversely affected. Experi-
       mental studies are underway on models of
       three typical vessels of varying block
       coefficients to determine the combination
       of speed, wave length and wave height which
       influence smooth water speed. As a by-
       product, this work will furnish general in-
       formation on factors governing speed reduc-
       tion in a seaway. A theoretical method has
       been developed to determine added resistance
       due to waves. It is intended to compare
       experiment with theory.
  (f) Completed.
  (h) "Speed Reduction in Waves," by Margaret D.
       Bledsoe, TMB Report 1083 (awaiting publica-
       tion).

(2469) INTERNATIONAL COMPARISON TESTS - SEAWORTHI-
        NESS.

  (b) Bureau of Ships; David Taylor Model Basin
       Laboratory project.
  (d) Experimental and theoretical.
  (e) To obtain seaworthiness information for
       comparison purposes by means of a 10 foot
       fiber glass plastic self-propelled model of
       the Series 60, 1.60 block coefficient form.
       The effect of self-propulsion on the motion
       and speed reduction characteristics of this
       model is compared with the effects previous-
       ly studied by means of a gravity type tow-
       ing arrangement. Comparison between re-
       sults obtained in three large basins (DTMB,
       Wageningen, Haslar), equipped to handle 10
       foot self-propelled models, will also be

(h) "Scale Effects on Ship Motions," by V. G. Szebehely and G. P. Stefun, TMB Report 1099, Sept. 1957.

(2470) CAVITY RESONANCE.

(b) Bureau of Ships; David Taylor Model Basin.
(d) Experimental and theoretical investigation of the excitation of cavity resonance by fluid flow.
(e) Studies to determine the mechanism of excitation of the cavity resonance by fluid flow past orifice will be undertaken. The experimental investigation will employ the low turbulence wind tunnel. The amplitude of pressure fluctuations in the cavity will be investigated as function of the size, shape and number of orifices, as well as the turbulence characteristics in the boundary layer flow.

(2471) THEORY OF CONTRA-ROTATING PROPELLERS.

(b) Cooperative with the Bureau of Ships.
(d) Theoretical; applied research.
(e) Studies of the theory of contra-rotating propellers without assumptions regarding the orientation of the resultant induced velocity.
(g) Application to open water and wake adapted propellers.
(h) "Effect of Propeller Pitch Changes on Torque Unbalance of Contra-Rotating Propellers," by W. B. Morgan, DTMB Report 1124, March 1957.

(2472) COOPERATIVE TESTS ON A VICTORY SHIP DESIGN.

(b) David Taylor Model Basin: Skin Friction Committee of the International Towing Tank Conference.
(d) Experimental testing; basic research.
(e) The investigation was authorized by the International Committee on "Scale Effect on Propellers," and on "Self-Propulsion Factors" as part of the international cooperative test program in ship basins. The International Committee will compare the results from the various basins and present a report to the coming International Conference. The tests will be carried out with a wax model of scale 1:23 equipped with different kinds of stimulators. The friction corrections will be calculated by the various basins according to their methods.
(g) The specified program of model testing has been completed. The required calculation for the power predictions have to be done before the evaluation work can proceed.
(h) Results have been reported to the International Towing Conference. A TMB Report is being prepared comparing TMB results with those of other basins.

(2473) FRICTIONAL RESISTANCE OF GEOSIM MODELS.

(b) David Taylor Model Basin; Skin Friction Committee of the International Towing Tank Conference.
(d) Theoretical; basic research.
(e) Representatives of the various towing tanks of the ITTC have been unable to agree on a friction line. The Skin Friction Committee of the ITTC was therefore directed to develop a universally acceptable "Engineering Line" for use in extrapolating from ship models to full-scale. Model resistance data for geosim series are therefore being assembled and analyzed according to each of several currently proposed friction lines. Resistance data for geosim models tested at TMB are being distributed to other basins for analysis and TMB will analyze all model data from other tanks using the Schoenherr formula.
(f) Completed.
(g) According to present status, the Schoenherr line seems to represent a reliable average friction line.

(2474) CALCULATION OF GOLDSTEIN FACTORS FOR 3, 4, 5 AND 6 BLADED PROPELLERS.

(b) Cooperative with Bureau of Ships.
(d) Theoretical; applied research.
(e) Calculation of Goldstein factors, particularly for the case of large advance ratios where the approximations made in the original equations are not valid.
(f) Completed.
(g) Application to propeller design.
(h) "The Calculations of Goldstein Factors for Three, Four, Five and Six Bladed Propellers," by A.J. Tachmindji and A.B. Milam DTMB Report No. 1034.

(2727) THE EFFECT OF HUB DIAMETER ON THE OPTIMUM DISTRIBUTION OF CIRCULATION OF PROPELLERS.

(b) David Taylor Model Basin.
(d) Theoretical; applied research.
(e) Studies of the effect of hub diameters on the optimum distribution of circulation.
(g) Calculations have been completed.
(h) "The Calculation of the Circulation Distribution for Propellers with Finite Hub Having Three, Four, Five and Six Blades," by A.J. Tachmindji and A.B. Milam, DTMB Report 1141, July 1957 and International Shipbuilding Progress, September 1957. "The Ideal Efficiency of Optimum Propellers Having Finite Hubs and Finite Number of Blades," by J. W. Shultz,Jr., DTMB Report 1148, July 1957.

(2728) SEAWORTHINESS OF U. S. COAST GUARD VESSELS.

(b) U. S. Coast Guard; David Taylor Model Basin.
(d) Experimental (research and development).
(e) Three designs for a 160 ft. Water Patrol Craft were investigated for seaworthiness characteristics. Experiments were conducted for several wave conditions in order to determine the best design with respect to amplitudes of motions and accelerations, speed reduction in waves, wetness, etc.
(g) The effect of the LCB positioning on the propulsive coefficients has been obtained.

Also an optimum location of LCB for each block coefficient, of this series, has been established from the resistance characteristics of this hull.

(h) "Series 60 - The Effect Upon Resistance and Power of Variation in LCB Position," by Dr. F.H. Todd and P.C. Pien, A Society of Naval Architects and Marine Engineers paper, May 1956.

(2729) HULL FORM RESEARCH BY USING A FLEXIBLE MODEL.

(b) David Taylor Model Basin.
(d) Development and experimental work.
(e) A flexible model which can be quickly changed to have any fullness and any shape of section area curve is to be developed first. The effect of section area curve parameters, such as t_F, t_A, C_{PF}, C_{PA}, L_E, L_x, X_F, X_A, etc., upon resistance will be systematically investigated by using this flexible model.
(g) The flexible model has been built and experimental test work begun. Thirty resistance tests have been conducted during the past fiscal year. Preliminary work with this flexible model indicates its adaptability for this work is satisfactory. An analysis of the test results has not been completed.

(2730) MOLECULAR - PHYSICAL SKIN EFFECT.

(b) David Taylor Model Basin.
(d) Experimental applied research.
(e) The frictional resistance of a "new" plate consisting of a special molecular coating will be compared with the frictional resistance of a hydraulically smooth brass plate and of a mirror smooth glass plate. The test equipment will be designed and constructed to study wave and spray formation for the determination of the true wetted surface. The plate will be tested with maximum speed of 15.0 knots and with various stimulation devices.
(g) The Nikuradse coated plates have been tested. Significant resistance differences between coated and non-coated plates have been measured on a coated brass plate and an uncoated aluminum plate. Since the contours of the leading and trailing edges of the two plates vary considerably a doubt is raised at whether the coating or the difference in the contours caused the resistance differences. A stainless steel plate having the same contours as the coated brass plate has been constructed and tested. The resistance of this plate has been obtained and the relation between the coated and uncoated plate will be the subject of an additional report.

(2962) SHIP MOTION.

(b) Bureau of Ships, David Taylor Model Basin.
(d) Field investigation (full scale trials).
(e) An account of seakeeping trials carried out jointly by the Royal Netherlands Navy and the United States Navy with three destroyers.
(f) Completed.
(g) Measurements were made of motions of slamming pressures and of stresses. These were analyzed to determine the effect of the seaway, of speed and of relative course. Evaluation of the three vessels was made based on the foregoing.
(h) Proceedings Symposium on the Behavior of Ships in a Seaway, September 7th - 10th, H. Veenman and Zonen - Wageningen.

(2963) SHIP MOTIONS.

(b) Bureau of Ships; David Taylor Model Basin.
(d) Applied research.
(e) Outline of a method for testing models in confused seas and for reducing the observed data to given standard conditions. The introduction of standard conditions is necessary for the proper interpretation of experiments and for the purpose of comparing one model against another. The method will also allow predicting the behavior of the same model in other seaways which depart not too strongly from the test conditions.
(f) Completed.
(h) Proceedings Symposium on the Behavior of Ships in a Seaway, September 7th - 10th, 1957, H. Veenman and Zonen - Wageningen.

(2966) STUDY OF BOUNDARY LAYERS OF SUBMERGED BODIES OF REVOLUTION.

(b) Bureau of Ships; David Taylor Model Basin.
(d) Theoretical and experimental basic research.
(e) Experiments have been carried out on an elongated body of revolution in 8 x 10 ft. subsonic wind tunnel. The model consists of a basic body of revolution with removable model deck, conning tower, and tail control surfaces, to simulate the geometrical form of a submarine. The measurements consisted of boundary layer survey and local skin friction measurements by surface pitot tubes at various angular locations throughout a range of speeds. Comparison is being made with full scale results.
(h) "Measurement of Boundary Layer and Local Turbulent Skin Friction on a Particular Body of Revolution," by E.Y. Hsu, TMB Report 892 (1958).

(2967) CONTROL SURFACE FLUTTER.

(b) Bureau of Ships; David Taylor Model Basin.
(d) Experimental and theoretical basic investigation.
(e) Experiments are being conducted with a flutter apparatus to determine flutter speeds as a function of inertias, spring and damping constants. The results will be compared with a simplified rudder flutter analysis which can then be applied to design procedures.
(g) Computation underway. Testing complete.
(h) "A Control Surface Flutter Study in the Field of Naval Architecture," by R. T. McGoldrick, and D.A. Jewell, DTMB Report 1222 in preparation.

(2969) FLOW STUDIES ON THREE-DIMENSIONAL FORMS.

  (b) Bureau of Ships; David Taylor Model Basin.
  (d) Experimental and theoretical basic research.
  (e) Pressure distributions and flow studies
      have been made in a wind tunnel on several
      shapes similar to those of certain sonar
      domes. Data will be used in predicting
      those conditions of ship speed, yaw and
      pitch which are conducive to cavitation on
      sonar domes.
  (h) "Pressure Distribution About Four Sonar
      Domes," by R. D. Cahn (report in prepara-
      tion).

(2970) STUDIES OF HYDRODYNAMIC LOADING ON BARE AND
       FAIRED CABLES.

  (b) David Taylor Model Basin.
  (d) Experimental investigation; basic research.
  (e) Measure the tangential and normal hydrody-
      namic forces acting on a long cylinder
      towed at various angles to the stream over
      a range of Reynolds numbers. Tests will
      be made with various degrees of roughness
      simulating stranded cable, and various
      trailing-type fairing designs.

(2971) FULL SCALE TRIAL AND MODEL PREDICTION
       CORRELATION.

  (b) Bureau of Ships; David Taylor Model Basin.
  (d) Experimental testing and re-evaluation of
      existing test data.
  (e) The accuracy of full scale power predic-
      tions from model test results depends upon
      the selection of the proper roughness allow-
      ance (ΔC_p) to be used in model calculations.
      The results of approximately 32 trial corre-
      lation tests will be analyzed and new model
      tests conducted to compile data on the
      variation of ΔC_p with ship type.
  (g) This work has been started and is scheduled
      for completion by July 1958. The presenta-
      tion of a paper to the Society of Naval
      Architects and Marine Engineers is projected.

(3282) RADIAL DISTRIBUTION OF PROPELLER THRUST
       FROM MODEL WAKE MEASUREMENTS.

  (b) Bureau of Ships; David Taylor Model Basin.
  (d) Experimental; applied research.
  (e) Information concerning the radial distribu-
      tion of thrust is needed for a propeller
      operating behind a submerged body of revo-
      lution. The results of theory and experi-
      ment are compared. The experimental thrust
      distribution was obtained from the axial
      momentum equation by applying appropriate
      corrections for slip stream rotation and
      contraction. The theoretical thrust dis-
      tribution was obtained from the circulation
      distribution of the propeller with a finite
      hub.
  (f) Completed.
  (g) The radial distribution of propeller thrust-
      load coefficient is calculated from experi-
      mental wake data obtained from towed and
      self-propulsion tests on a body of revolu-
      tion. The experimentally obtained thrust

distribution is in excellent agreement with
a theoretically calculated distribution.
Numerical integration yields a total thrust-
load coefficient which is in good agreement
with propulsion test results.
  (h) "The Radial Distribution of Propeller Thrust
      from Model Wake Measurements," by John L.
      Beveridge, DTMB Report No. 1136, October
      1958 (in preparation).

(3283) FUNDAMENTAL HYDROMECHANICS RESEARCH.

  (b) Bureau of Ships; David Taylor Model Basin.
  (d) Applied research.
  (e) Survey of work carried out under Bureau of
      Ships Fundamental Hydromechanics Research
      Program.
  (g) Survey includes results obtained during the
      period of 1952 to present.
  (h) To be published in Journal of Ship Research,
      SNAME, beginning August 1959.

(3284) HYDROFOIL SUPPORTED CRAFT.

  (b) Bureau of Ships, David Taylor Model Basin.
  (d) Experimental and theoretical applied re-
      search.
  (e) Obtain hydrofoil craft design criteria by
      determining steady and unsteady forces on
      and motions of single and multiple hydro-
      foil configurations under the influence of
      waves, ventilation, cavitation and mutual
      interference.

(3285) HYDROELASTIC PROBLEMS.

  (b) Bureau of Ships; David Taylor Model Basin.
  (d) Theoretical and experimental.
  (e) Theoretical and experimental investigations
      will be made of the interaction of fluctua-
      ting flows and the elastic motion of bodies.
      Experiments will include: correlation of
      shedding frequency and geometrical parame-
      ters of struts; span-wise correlation of
      fluctuations in flow as a function of
      Reynolds number and examination of the
      parameters affecting the elastic response
      of rudder-like forms.

(3286) THEORY OF SUPERCAVITATING PROPELLERS.

  (b) Bureau of Ships; David Taylor Model Basin.
  (d) Theoretical and experimental; applied re-
      search.
  (e) Studies and design of propellers designed
      to operate at high speeds.
  (g) The prediction and experimental confirma-
      tion of the performance of such propellers
      have been completed.
  (h) "The Design and Performance of Supercavitat-
      ing Propellers," by A.J. Tachmindji et al,
      TMB Report C-807 (Unclassified).
      "Supercavitating Flow Past Bodies with
      Finite Edge Thickness," by J.N. Newman,
      TMB Report 1081.
      "Centroid and Moments of Inertia of SC
      Sections," by W. B. Morgan, TMB Report 1193.
      "Optimum SC Section," by W. B. Morgan, TMB
      Report C-856.
      "The Design and Estimated Performance of a

155

Series of Supercavitating Propellers", by
A. J. Tachmindji and W. B. Morgan, paper
to Second Symposium on Naval Hydrodynamics,
August 1958.

(3287) EFFECT OF STERN MODIFICATION TO A SERIES
60 VESSEL, RESISTANCE POWERING, WAKE DIS-
TRIBUTION AND PROPELLER INDUCE VIBRATION.

(b) David Taylor Model Basin; Maritime Adminis-
tration.
(d) Experimental testing and evaluation of
data for basic research.
(e) Models representing specific variations in
stern shapes and designed for special in-
strumentation installation will be built.
The basic design will be the Series 60,
0.70 Block Coefficient Parent. Six other
forms will be derived having systematic
changes in section shapes (from extreme V
to extreme U) and for variation in water-
line endings (from fine to blunt). An
attempt will be made to develop formula-
tion to mathematically express the stern
variations from the parent.
(g) The basic model has been constructed and
powering data has been obtained.

(3288) SHIP STABILIZATION.

(b) Bureau of Ships; David Taylor Model Basin.
(d) Theoretical; applied research.
(e) The roll response of an AK cargo vessel
converted for use as a missile tracking
station has been simulated on an analog
computer to evaluate the stabilization
accomplished by passive anti-rolling tanks.
A description of the simulation, the ship
responses to regular wave action and some
comparison with experimental values will
be presented in the report of the study.
(f) Substantially completed.
(h) "Analog Simulation of a Passive Anti-
Rolling Tank System for a Missile Tracking
Station Vessel", (in preparation).

(3289) PITCHING MOTION OF A MARINER TYPE VESSEL
IN A STATE 5 SEA.

(b) Bureau of Ships; David Taylor Model Basin.
(d) Field investigation; basic research.
(e) Continuous time histories of pitch ampli-
tude experienced by the SS SILVER MARINER
in a state 5 sea were recorded for various
speeds in head seas and for various head-
ings at top operating speed. The result-
ant information was transformed into energy
spectra and a number of statistics that
describe the ship's pitching performance
were computed.
(g) In head seas (state 5) pitching was moder-
ate at 10 knots, increased to a maximum
at 13 knots and was least evident at top
speed, 21 knots. Bow seas (45° relative
heading to waves) produced greater pitch
amplitude than head seas and following
seas resulted in the least pitch amplitude,
for constant speed. Change of heading re-
duced pitching motion to a greater extent
than did change of speed.

(h) "Motions of the SS SILVER MARINER in a State
5 Sea", by N. H. Jasper and B. M. Wigle,
TMB Report 1067, October 1956.
"Technique for Conducting Full Scale Sea-
worthiness Trials", Ships F-56, Bureau of
Ships Technical Film Report, Feb. 1957.

(3290) THE GENERATION OF OBLIQUE WAVES IN THE
MODEL TANK.

(b) Bureau of Ships; David Taylor Model Basin.
(d) Experimental and theoretical; basic
research.
(e) The mathematics of mechanical oblique wave
generation is discussed within the frame-
work of some simplifying assumptions. The
limiting oblique angle of generation as a
function of wave length and wave generator
length is determined. The phase differences
between waves from adjacent wavemakers re-
quired to produce oblique wave fronts, for
different wavelengths are determined. A
laboratory experiment is used to illustrate
the properties of oblique waves in model
tanks. The limitations on oblique wave
generation are discussed.
(f) Completed.
(g) (a) Maximum oblique angles for the TMB
Maneuvering Basin are determined; 38° for a
wave length of 40 feet, less for shorter
wavelengths - similar results for any tank
are found; (b) direction of travel of
oblique waves relative to tank boundaries
are given as a function of phase angle;
and (c) two banks of wavemakers at right
angles to each other will under certain
conditions produce the entire range of
oblique angles.

(3291) PREDICTION OF FULL SCALE SHIP MOTIONS FROM
MODEL TESTS.

(b) Bureau of Ships; David Taylor Model Basin.
(d) Theoretical; basic research.
(e) A procedure is developed for description of
full scale ship motions in irregular seas
through knowledge gained from model tests
in oblique sinusoidal seas. Transfer func-
tions of ship motions in sinusoidal waves
are used in conjunction with an irregular
seaway synthesized from sinusoidal wave
components to yield the energy spectrum of
ship motion.
(f) Completed.
(g) The technique for synthesizing any state
of sea as a function of frequency and di-
rection is given. Methods of model testing
to obtain the transfer functions are de-
scribed. Derivation of the motion spectra
and statistics of motion are given.
(h) "On the Status of Complex Wave Generation
in Model Tanks", by W. Marks, TMB Report
1069, September 1956.

(3292) EXPLORATORY STUDIES AND PLANS AT DTMB FOR
MODEL TESTS IN 3-DIMENSIONS.

(b) Bureau of Ships; David Taylor Model Basin.
(d) Experimental; basic research.
(e) A rectangular ship model testing facility

is described. Advantages over existing methods are discussed and new problems in analysis of data are revealed.

(g) Segmented wave generators provide the ability to produce oblique waves. Programming to individual wavemakers results in generation of confused seas of almost any nature. The rectangular basin offers opportunity to test in any relative heading to the waves and even in cross seas. Problems in analysis involve determination of the seaway (in the tank) as a function of frequency and direction. Ship motions in confused seas may be random in nature and may be analyzed by spectrum methods.

(h) "On the Generation of Waves in the TMB Maneuvering Basin, Part I, Long Crested Regular Waves", by W. Marks, TMB Report 1192, 1958.

(3293) SURFACE SHIP SEAWORTHINESS SERIES.

(b) Bureau of Ships; David Taylor Model Basin.
(d) Experimental and theoretical; basic research.
(e) Various hull forms will be investigated with respect to their seakeeping characteristics in order to determine the effects of hull variations on pitch and heave amplitudes, speed in waves, wetness, etc. An attempt will be made to correlate sea behavior with basic ship parameters such as beam-draft ratio, block coefficient, waterplane area or displacement-length ratio.
(g) A preliminary study of results obtained from various model tests in waves indicates that variations in pitch and heave amplitudes among the different models can be attributed to variations of the average beam-draft ratios in the case of heave, and to variations of the modified displacement-length ratios in the case of pitch.
(h) "The Influence of Ship Form on Pitch and Heave Amplitudes", by G. P. Stefun, TMB Report 1235, September 1958.

(3294) SEAWORTHINESS OF HYDROFOIL CRAFT.

(b) Bureau of Ships, David Taylor Model Basin.
(d) Theoretical research.
(e) A theoretical study of the vertical plane motions of a hydrofoil craft in sinusoidal waves.
(g) An earlier theoretical development of the equations of motion for hydrofoil craft has been extended to include unsteadiness and non-linearities. Computer solutions have been obtained for the pitching and heaving motions in sinusoidal waves. Good agreement with an available set of experimental results have been obtained.
(h) "The Theoretical Prediction of the Longitudinal Motions of Hydrofoil Craft", by T. F. Ogilvie, TMB Report 1138, Nov. 1958.

U. S. DEPARTMENT OF THE NAVY, NAVAL BOILER AND TURBINE LABORATORY.

(2731) EFFECT OF PIPE ROUGHNESS ON ORIFICE METER ACCURACY.

(b) American Gas Association.
(c) American Gas Association, 420 Lexington Ave., New York 17, New York.
(d) Experimental; applied research.
(e) This project is under the cognizance of the A.G.A. Supervisory Committee to Study Pipe Roughness. The scope of the project is, initially, limited to investigation of the effect of pipe roughness on two-inch meter runs using water as a media.

U. S. DEPARTMENT OF THE NAVY, NAVAL ORDNANCE TEST STATION.

(2476) HYDROBALLISTICS RANGE DEVELOPMENT.

(b) Bureau of Ordnance, Department of the Navy.
(c) Commander, U. S. Naval Ordnance Test Sta., Attn: Genevieve W. Stubstad, Research Engineer, 3202 East Foothill Blvd., Pasadena, Calif.
(d) Experimental; applied research.
(e) This project is part of a coordinated program involving several laboratories. The purpose of the program is to provide numerical values of all the hydrodynamic coefficients needed to calculate the trajectory of a fully wetted missile and to evaluate the test techniques employed for coefficient determination by comparing calculated and observed trajectories. This project is concerned with developing a technique for measuring accurately the detailed fully wetted motion of free-flying momentum-propelled models as functions of time and determining the associated hydrodynamic coefficients from the observed motions.
(f) Completed.
(g) A simple hydroballistics range was established in which four degrees of freedom, including missile range and vertical position and pitch and roll, could be measured. The pure pitching motion of a neutrally buoyant theoretical missile, the Basic Finner, was recorded photographically and the associated hydrodynamic coefficients were determined by fitting the measured motion with functions generated by the EASE analog computer. The motion predicted from simple theory using water-tunnel measurements and conventional estimates of the hydrodynamic coefficients, was not in agreement with the observed experimental motion.
(h) "Pure Pitching Motion of the Basic Finner Missile", by G. W. Stubstad, China Lake, Calif., 1 October 1958. (NAVORD Report 6417, NOTS 2115.)

(3295) FORCED VENTILATION OF HYDROFOILS.

(b) Bureau of Ordnance, Dept. of the Navy.
(c) Commander, U. S. Naval Ordnance Test Sta , Attn: T. G. Lang, Code P80401, 3202 East Foothill Blvd., Pasadena, Calif.

(d) Experimental; basic research.
(e) The tests are conducted on 2- and 3-dimensional hydrofoils in the high-speed water tunnel at the California Institute of Technology. The lift, drag, moment and pressure distribution are measured as a function of the angle of attack and gas-flow rate. Various cross sections are tested and the gas is exhausted from holes of different size and shape at various locations.
(f) Continuing.
(g) Test results show that the ventilated pocket does not travel upstream of the exhaust hole unless a region of separated flow has previously existed. The lift coefficient of a 2-dimensional section can be changed as much as 0.4 with gas exhaust. The slope of the lift versus angle-of-attack curve is proportional to the ratio of the wetted perimeters of the hydrofoil cross section with gas exhaust and without. The effect of aspect ratio on the lift curve slope is the same in ventilated flow as in fully wetted flow.
(h) "Water Tunnel Tests of an NACA 0-Series Hydrofoil with Forced Ventilation", by K. Smith, T. G. Lang, D. E. `Argue. NOTS NAVORD Report in progress.

(3296) HYDRODYNAMIC DRAG OF TORPEDOES.

(b) Bureau of Ordnance, Dept. of the Navy.
(c) Commander, U. S. Naval Ordnance Test Sta., Attn: T. G. Lang, P80401, 3202 East Foothill Blvd., Pasadena, Calif.
(d) Analytical, applied.
(e) Semi-empirical relations are developed from reports of tests on the drag of a large number of torpedoes and airships. These are extended theoretically to show the effect on drag of variations in nose shape, tail shape, cylindrical length, roughness, fin size, and cutoff diameters. The study is based upon turbulent flow with no separation at the nose.
(f) Completed.
(g) At a given speed, the drag per unit volume of a fully appended torpedo decreases as the tail-cone length becomes more streamlined and as the cylindrical section length increases. The optimum is not critical.
(h) "Hydrodynamic Drag of Torpedoes", by J. D. Brooks and T. G. Lang. NOTS NAVORD 5842 of 18 February 1958.

(3297) THE DEVELOPMENT OF HYDRODYNAMIC DESIGN CRITERIA FOR ADEQUATE TORPEDO STABILITY AND RESPONSE.

(b) Bureau of Ordnance, Dept. of the Navy.
(c) Commander, U. S. Naval Ordnance Test Sta., Attn: T. G. Lang, Code P80401, 3202 East Foothill Blvd., Pasadena, California.
(d) Theoretical; applied research.
(e) The effect on torpedo stability and response of varying body shape, tail size, rudder size, weight, center of gravity, volume, and speed are studied. The conditions selected for this study are a linear

proportional control system and an instantaneous rudder deflection.
(f) Completed.
(g) By varying the tail size and rudder size of a torpedo, the stability and response can be made nearly independent of the body shape and other parameters. Criteria are obtained for determining the fin and rudder size of an arbitrary body shape in order to provide adequate stability and response.
(h) "Hydrodynamic Design Criteria for Adequate Torpedo Stability and Response", by C. W. Sweat, to be published as a NAVORD Report.

U. S. DEPARTMENT OF THE NAVY, OFFICE OF NAVAL RESEARCH.

For sponsored projects see the following:

TENNESSEE VALLEY AUTHORITY, Hydraulic Data Branch.

Inquiries concerning all TVA projects should be
addressed to Mr. Albert S. Fry, Hydraulic Data
Branch, Tennessee Valley Authority, Knoxville,
Tennessee.

Hydraulic Operations and Tests Section.

(731) SOUTH HOLSTON DAM, SURGE TANK MODEL STUDY.

(d) Experimental; for design.
(e) A 1:50 model of the penstock and surge
     chamber was used to determine (1) the ori-
     fice size and characteristic shape to pro-
     duce favorable pressure and water surface
     elevations to be expected in the surge
     chamber; and (2) the operational character-
     istics or the selected design.
(f) Model studies completed.
(g) With the proper orifice between the riser
     and the surge chamber as satisfactory re-
     sults can be obtained as with the differen-
     tial riser type of surge tank.
(h) Report in preparation.

(739) CHEROKEE DAM, SLUICE RATING.

(d) Field investigation; operation.
(e) Measurement of discharges and differential
     pressures in the sluices, supplemented by
     model test data, will be used to establish
     the discharge ratings for the eight sluices.
     Tables of discharge for any gate opening at
     any headwater elevation within the operat-
     ing range are to be prepared.

(745) FONTANA DAM, SLUICE RATING.

(d) Field investigation; operation.
(e) Model tests, checked by field measurements,
     are to be used in determining the discharge
     ratings for all anticipated operating con-
     ditions. Discharge tables for operating
     purposes will be prepared.
(f) Model studies completed.

(758) CHEROKEE DAM, PROTOTYPE CHECK TESTS.

(d) Field investigation; applied research.
(e) Periodic checks and observations will be
     made on the various hydraulic appurtenances
     to determine the operating characteristics
     of the structures and the effect of opera-

tion on the structures.
(g) Measurement of pressures in the sluice bar-
     rel have been obtained and will be compared
     with pressures obtained in model tests.
     The apron and sluice barrels were inspected
     in 1953 to determine the effect of inter-
     mittent operation during the past eleven
     years.
(h) Report in preparation.

(759) DOUGLAS DAM, PROTOTYPE CHECK TESTS.

(d) Field investigation; applied research.
(e) Periodic checks and observations will be
     made on the various hydraulic appurtenances
     to determine the operating characteristics
     of the structures and the effect of opera-
     tion on the structure.
(g) Measurement of pressures in the sluice bar-
     rel have been obtained and will be compared
     with pressures obtained in model tests.
     The apron and sluice barrels were inspected
     in 1953 to determine the effect of inter-
     mittent operation during the past ten years.
(h) Report in preparation.

(762) SOUTH HOLSTON DAM, SURGE TANK PROTOTYPE
       CHECK TESTS.

(d) Field investigation; applied research.
(e) The prototype installation was equipped to
     allow testing in a manner similar to that
     used in the model studies which established
     the design. A check on the model accuracy
     can thus be obtained.
(g) Tests made in February 1950, July and Oct.
     1958.

(1038) HALES BAR DAM, SPILLWAY APPROACH STUDIES.

(d) Experimental; for design.
(e) Tests are made on a 1:65 model to determine
     effect of the remains of cofferdam struc-
     tures upstream of the spillway on the spill-
     way discharge and to determine amount of
     the obstructions which should be removed.
(f) Model tests completed.
(h) Report completed.

(1534) FORT PATRICK HENRY DAM, SPILLWAY MODEL
        STUDIES.

(d) Experimental; for design.
(e) Tests were conducted on a 1:50 scale and
     1:112.5 scale model to determine the apron
     design, training wall dimensions, and other
     related data.
(f) Model studies completed.
(g) An apron using a single row of rectangular
     baffle blocks was developed on the 1:50
     scale model. This apron was then used in
     the 1:112.5 scale model and the necessary
     appurtenant structures developed. Of main
     interest in the developed design was the
     lack of training walls. Studies to deter-
     mine the effect of vegetative growth on the
     island areas below the spillway showed
     which areas must be kept free of growth and
     which may be allowed to grow up. Installa-
     tion completed and instruction manual

partially completed and issued.

(h) Report in preparation.

(1794) WATTS BAR LOCK PROTOTYPE TESTS.

(d) Field investigation; applied research.
(e) The prototype installation was equipped with piezometers to allow checking of culvert and port pressures and discharges. The culverts and ports were designed from model studies. Thus, measurement on the prototype would provide model-prototype verification data.
(f) Complete field tests were conducted in 1952.
(h) Reduction of data is being completed.

(1796) KINGSTON STEAM PLANT, CONDENSER WATER INTAKE TEMPERATURE STUDIES.

(d) Theoretical and field investigation; design.
(e) The condenser water intakes and outlets draw water from and discharge into Watts Bar Reservoir (Tennessee River). During the warmer portions of the year this reservoir becomes stratified and the inflowing waters pass through the reservoir as density currents. By means of theoretical considerations and field observations, the proper location and shapes for the intakes and outlets were determined and the probable intake temperature calculated.
(g) Six-point recording temperature gages were installed on the Tennessee, Clinch, and Emory Rivers and data obtained during the period of stratification in 1953 and 1954. Velocity and temperature profile measurements were made at eight sections in the Clinch and Emory Rivers for period of steady flow to define thermal density underflow. Theoretical analyses were made to show the benefits that could be derived by the installation of a submerged dam in the Clinch River below the mouth of the Emory River to divert the density underflow up the Emory River. Studies indicate that temperature reductions effected by the structures will result in coal savings of $100,000.00 annually. The cost of the structures is about $400,000.00.
(h) "Thermal Density Underflow Diversion, Kingston Steam Plant," by Rex A. Elder and Gale B. Dougherty, ASCE Proc. Paper 1583, Jour. Hydraulics Div., Vol. 84, No. HY2, April 1958.
"Thermal Density Underflow Design and Experience," by Rex A. Elder. Paper presented at Seventh Hydraulic Conference, Iowa Institute of Hydraulic Research, Iowa City, Iowa, June 16, 1958.

(1797) GALLATIN STEAM PLANT, CONDENSER WATER INTAKE TEMPERATURE STUDY.

(d) Theoretical and field investigation; design.
(e) The condenser water intakes and outlets are to draw water from and discharge into the proposed Old Hickory Reservoir (Cumberland River). The entire setup is to be analyzed to determine the type of flow conditions to be expected in the reservoir; the temperatures to be expected at the inlets; and the best design for the inlets and outlet structures.
(g) Single-point temperature recorders were installed at six stations which, in combination with turbine intake temperature recorders at three upstream dams, will be used to determine temperature increases between points on the Cumberland River for various conditions. Data are being collected and evaluated.
(h) "Thermal Density Underflow Design Experience," by Rex A. Elder. Paper presented at Seventh Hydraulic Conference, Iowa Inst. of Hydraulic Research, Iowa City, Iowa, June 16, 1958.

(2241) KINGSTON STEAM PLANT - CONDENSER COOLING WATER CONDUIT LOSS.

(d) Experimental; for design.
(e) Longitudinal interior support was required for 96-inch concrete pipe conduit. A study was made of the relative loss for a six-inch thick vertical concrete wall, I beams separated by 4-1/2 inch pipe columns and I beams separated by streamlined 4-1/2 inch pipe columns.
(f) Laboratory studies completed; partial field tests performed.

(2479) WILSON LOCK HYDRAULIC MODEL STUDIES.

(d) Experimental; for design.
(e) The new Wilson lock will be 110 feet long, 675 feet center-to-center pintles with a 100-foot maximum lift. Three models are projected: A 1:36 scale model of a single transverse lateral with 12 ports to determine proper lateral and port designs; a 1:16 scale model of lock chamber, intakes, culverts, gates, and other details to determine overall designs.
(f) Laboratory model studies completed.
(g) The basic design for the filling and emptying systems was determined from the model studies. Filling will be achieved through the use of 6 lateral culverts each containing 12 equally spaced ports 3.5 ft high by 1.5 ft wide. The upper three laterals will be fed from the landward main culvert and the lower three laterals by the riverward culvert. At minimum tailwater elevation only 23 ft of water cushion is available at the bottom of the controlling reverse-flow tainter valves. Dangerously low pressures were eliminated by use of a fast initial opening rate followed by a slow rate for the major portion of the opening and by modifications of the valve shape and of the upper seal nose design. A stepped lateral design was found necessary to produce stabl flow conditions.
(h) Report on lock filling and emptying system in preparation.

(2973) REVISION TO PRESENT WILSON NAVIGATION LOCK.

(d) Experimental; for design.
(e) Upon completion of the new Wilson Lock construction, the tailwater in the navigation canal at the dam will be lowered 10 feet. To make the present two-lift lock operable under the new conditions, the lower chamber floor will be lowered 10 feet and a new filling and emptying system provided.
(f) Model studies have been completed to determine the exact hydraulic design to be used in the renovations.
(g) The new filling system consists of a single culvert located on the longitudinal centerline of the lock with ports located near the bottom along both sides. The old valves are much above tailwater elevations; therefore, the culverts above tailwater were reduced in cross-sectional area to minimize the air entrainment problems.
(h) Report in preparation.

2974) DEVELOPMENT OF IMPACT TUBE-PRESSURE TRANSDUCER TURBULENCE PROBE.

(d) Experimental; applied research in field investigations.
(e) Development of a turbulence probe and auxiliary analog computer for field use.
(f) Development active.
(g) Based on project (578) of Mass. Inst. of Tech., a turbulence probe for use in natural streams is to be developed. An analog computer which will produce autocorrelation factors directly from the pressure cell data is also under development.

(3298) NAVIGATION PROBLEMS IN CANAL BELOW WILSON DAM.

(d) Experimental; for design.
(e) A 2-1/2-mile canal is to be deepened and realigned to provide a more adequate approach to the new lock. Steady discharges in the neighborhood of full turbine capacity cause high-velocity flow across the entrance and makes passage through a railway swing span bridge at the entrance to the canal extremely difficult. The problem is made even more acute by daily and hourly fluctuations in the flows from the turbines at the dam. A fixed-bed 1:100 undistorted scale model was used to study the proposed design. The model was studied photographically and by use of a radio-controlled tug and barge train.
(f) Laboratory model studies completed.
(g) Modifications at the canal entrance consisted of extending and broadening the downstream point of land between the canal and river, and placing six 32-foot diameter sheet-piling cells, on 57-foot centers, parallel to the river channel downstream from the railway bridge. The effect of these structures was to shield the entrance from the cross currents.
(h) "'Tidal' Navigational Problems Below Wilson Dam," by Rex A. Elder, paper presented at Annual Convention of Am. Soc. of C. E., New York City, October 1958.

(3299) WILSON POWERHOUSE EXTENSION, HYDRAULIC MODEL STUDIES.

(d) Experimental; for design.
(e) A 1:28.5 scale model of two turbine intakes and one spillway bay is to be constructed to determine: (1) If there is a possibility of air being drawn into the intakes; (2) if changes will be required in the shape of the intake mouths and trash rack arrangement to improve flow conditions; and (3) if the flow through an adjacent spillway bay will affect the flow into the intake.
(f) Model studies started.

(3300) HIWASSEE, PUMP TURBINE RATING.

(d) Field investigation; operation.
(e) Measurements of the discharge and differential pressures in the pump turbine scroll case have been used to establish the discharge rating for the pump turbine over all operating conditions. The discharge was measured by using Apalachia reservoir as a volumetric tank. Water was both pumped from the reservoir and discharged into the reservoir for a period of 12 hours. The reservoir area was obtained from aerial photographs taken at the beginning and end of each test. Five recording gages were used to measure the reservoir level. From these measurements the volume and corresponding discharge was computed.
(h) Reduction of data and report to be completed.

(3301) KINGSTON STEAM PLANT, AIR DUCT TESTS.

(d) Experimental; for operation.
(e) A 1:16 scale model of the air duct system supplying air to the furnaces of Units 5 through 9 was constructed to determine a reliable means of measuring the air flow and possible modifications which would decrease the pressure losses in the duct system. The problem was complicated by the fact that a common intake was used for ducts feeding adjacent units.
(f) Model studies completed.
(g) Adjacent duct effects were eliminated and the pressure losses reduced by installing curved vanes at the duct entrance and using a partition wall to create essentially separate air ducts.
(h) TVA report completed.

(3302) WIDOWS CREEK STEAM PLANT, AIR AND GAS DUCT TESTS.

(d) Experimental; for design.
(e) Model studies are being conducted to improve flow conditions and reduce pressure losses in the gas duct which will carry the gases from the furnace to the smoke stack for a 500-Mw unit. Calibration of the air foil metering section in the forced-draft fan inlet ducts will also be made by model studies.
(f) Work in progress.

(g) Flow conditions are being improved by use of flow straighteners and vanes.

(3303) WIDOWS CREEK STEAM PLANT, CONDENSER WATER PUMP TESTS.

(d) Field investigations; operation.
(e) Condenser water pump acceptance tests on four pumps for a 500-Mw steam turbine will be conducted to determine the flow, head, and power requirements in accordance with the latest ASME test codes for centrifugal pump and hydraulic prime movers modified to use pitometer traverses. Velocity measurements will be made in the 9-foot 6-inch square concrete pump discharge conduit.
(f) Tests to be conducted in 1960.

(3304) DIGITAL TELEMETERING SYSTEM.

(d) Experimental; development.
(e) Telemetering systems for transmitting river or lake stages have been installed at Johnsonville Steam Plant, Wilson Dam, and Savannah. System utilizes a leased telephone line up to 15 miles long. The stage is transmitted once an hour automatically and either printed out on a digital recorder or displayed on an electronic readout device. Stage may be called for at any time manually from the receiver.
(f) Installations completed.

(3305) REVERSE TAINTER VALVES.

(d) Experimental and field investigations; operation.
(e) A resumé was made of the hydraulic characteristics of the reverse tainter valves for control of flows in the navigation locks as they have been developed in the United States from model and prototype tests.
(f) Completed.
(g) The studies indicate that the valves design should have the following characteristics: (1) The valve side seals should be in contact with the side walls during the entire travel of the valve, (2) the valve should be equipped with a sharp-edged lip and a streamlined strut arm, (3) a concave side seal should be in contact with the side walls during the entire travel of the valve, (4) the upper seal nose and valve speed should be determined from model studies, (5) emergency gate slots should be sealed near the top of the culvert or slot fillers should be used so as to form a smooth culvert wall, (6) air vents should be installed when low-pressure regions cannot be economically eliminated by change in the hydraulic design.
(h) "Reverse Tainter Valves," by Rex A. Elder. Paper presented at Portland Convention, ASCE, Portland, Oregon, June 23, 1958.

Hydraulic Investigations Section.

(764) DETERMINATION OF SEDIMENT CARRIED IN SUSPENSION BY TENNESSEE RIVER AND TRIBUTARIES.

(d) Field investigation; basic research.
(e) To provide data for estimating effective life of storage reservoirs, and loss of soil from the land. Samples of water were collected periodically at stream gaging stations in the watershed, analyzed to determine the sediment content, and correlated with river discahrge to determine the suspended sediment load at each station.
(h) Report in preparation.

(765) EVAPORATION IN THE TENNESSEE BASIN.

(d) Field investigation; applied research.
(e) To provide data for estimating reservoir losses and derive a general rule, applicable to the Basin, permitting computation of evaporation from pans at six locations in Basin, together with standard meteorological readings.
(h) "Precipitation in Tennessee River Basin," published in monthly and annual bulletins.

(768) PRECIPITATION IN TENNESSEE RIVER BASIN.

(d) Field investigation; basic research.
(e) A comprehensive study of rainfall and other weather phenomena for purposes of water dispatching and improvements in water control; storm studies as related to maximum precipitation, rainfall-runoff, spillway design and operation, etc.
(h) Monthly bulletin, "Precipitation in Tenn. River Basin." Also annual summary.

(769) RESERVOIR AND STREAM TEMPERATURES.

(d) Field investigation; basic research.
(e) Study of water utilization and water movement as concerns industrial plant locations and stream pollution. Variations in temperature from surface to bottom in reservoirs throughout the year are determined by soundings, and by continuous recording gages in natural streams.

(771) GALLERY DRAINAGE IN LARGE DAMS.

(d) Field investigations; design.
(e) Weirs are placed in main galleries and drainage measured as check on tightness and stability.

(785) SEDIMENTATION OF EXISTING RESERVOIRS.

(d) Field investigation; basic research.
(e) Selected ranges in reservoirs are probed and sounded, volumetric samples are collected and analyzed, quantity and distribution of sediment are computed to determine deposition by stream, probable life of reservoir, effect of sediment storage on navigation channels and sedimentation of downstream reservoirs, and probable sedimentation in future reservoirs.

(786) WATER TRAVEL IN NATURAL STREAMS.

(d) Field investigations; applied research.
(e) Sanitary and chemical changes in water

during passage downstream are determined. A given mass of water is identified by electrical conductivity or chemical titration.

(f) No work done in recent years.

(787) MOVEMENT OF WATER THROUGH LARGE RESERVOIRS.

(d) Field investigation; applied research.
(e) Because of slow water travel, samples are collected by traverse through lake.
(f) No work done in recent years.
(g) Water entering a reservoir does not intermix with the rest of the reservoir, but remains as a density current as a result of the difference in temperature between the inflowing water and that in the reservoir. During certain seasons of the year, in Watts Bar Reservoir the cold water released from Norris Reservoir passes upstream along the bottom of the Emory River arm of the former reservoir.

Hydrology Section.

(779) MAXIMUM POSSIBLE PRECIPITATION IN TENNESSEE VALLEY.

(b) Cooperative with U. S. Weather Bureau.
(d) Theoretical; applied research.
(e) Hydrometeorological analysis of large storms with upward adjustments of controlling factors to maximum limits as applied to the Tennessee Valley and subdivisions.
(g) Results to be published as one of current series of hydrometeorological reports by the U.S.W.B. and cooperating agencies.

(780) PERIODIC EVALUATION OF GROUND-WATER STORAGE.

(d) Theoretical; operation.
(e) By analysis of current records of stream discharge, the volumes of runoff in ground-water and channel storage are determined for use in operation of multi-purpose reservoirs.
(g) Results reported monthly and weekly within the organization.

(2975) SUPPLY AND UTILIZATION OF WATER IN THE TENNESSEE VALLEY.

(c) Mr. Reed A. Elliot, Chief Water Control Planning Engineer, Tennessee Valley Authority, Knoxville, Tennessee.
(d) Assembly and analysis of basic information on water resources and uses, including field investigation of water uses for irrigation, mining operations, industry, and other purposes.
(e) All available data are being analyzed to present a comparison of the water resource of the area with the present and expected 1975 demand upon that resource. Problems of shortage and conflict are being developed and possible solutions suggested.
(g) No widespread shortages exist now or are expected by 1975, although some local shortages on smaller streams are anticipated.
(h) Report in preparation.

(3306) COOPERATIVE RESEARCH PROJECT IN WESTERN NORTH CAROLINA.

(b) Project conducted in cooperation with North Carolina State College of Agriculture and Engineering.
(d) To determine water-land relationships for some of the principal soils used for agricultural purposes in western North Carolina under important vegetative covers. Observations include rainfall, runoff, soil-moisture, potential evapotranspiration, and actual evapotranspiration.
(e) A statistically designed rotation of four covers on four small watersheds and a separate evaluation of deep-rooted crop on a fifth watershed.
(g) Results to date are summarized in annual reports on the project.
(h) "Soil Moisture Relations of Some Cultivated Mountain Soils of North Carolina", by M. J. Gilbert. Master's Thesis, North Carolina State College, Raleigh, 1953.
"A Simple Field Installation for Measuring Maximum Evapotranspiration", by M. J. Gilbert and C. H. M. van Bavel; Trans. AGU, December 1954.

(3307) PARKER BRANCH PILOT WATERSHED RESEARCH PROJECT.

(b) Project conducted in cooperation with North Carolina State College of Agriculture and Engineering.
(d) To determine the effects upon the hydrology of the watershed of an intensive farm development program designed to give the optimum economic well-being of the people using the land. Rainfall, runoff, suspended and deposited sediment are observed, periodic soils-land-use inventories are made, and records of income summaries and public and private investments are maintained.
(e) Project activities are divided into calibration, action, and evaluation phases.
(g) Results to date are summarized in annual reports on the project.
(h) "Economic Use of Agricultural Resources in Relation to Watershed Hydrology", by E. H. Lesesne and A. J. Coutu. Duplimat, TVA, June 1956.
"Economic and Hydrologic Developments in the Parker Branch Pilot Tributary Watershed Research Project", by E. L. Baum. Duplimat, TVA, October 1958.
"The Parker Branch Story." A sound motion picture prepared by N. C. State College and TVA.

(3308) WHITE HOLLOW WATERSHED.

(d) To study the effect of changes in the vegetal cover on a watershed taken out of cultivation on the hydrologic factors of runoff and soil erosion.
(e) Continuous record from 1935 of rainfall, runoff, and suspended sediment, and periodic determination of vegetal cover indexes.
(g) During the 21-year period 1935-1955, the forest cover improvement in the watershed

resulted in greater watershed protection with no measurable decrease in water yield, no change in volume of either surface runoff or ground-water runoff, marked reductions in summer peak rates of discharge with lesser reductions in winter rates, a prolongation of the period of draining of surface runoff from the channel system, and a 96 percent reduction in the sediment load.

(h) Report in preparation covering the vegetal cover improvement influences on hydrologic characteristics since 1935.
"Evaluating Effects of Land-Use Changes on Sediment Load," by A. J. Cooper and W. M. Snyder. Journal of the Hydraulics Div., Proceedings ASCE, No. HY1, February 1956.
"Hydrograph Analysis by the Method of Least Squares," by W. M. Snyder. Proceedings, ASCE, Vol. 81, Paper No. 793, Sept. 1955.

(3309)   PINE TREE BRANCH WATERSHED.

(d) To determine the effects upon the hydrology of the watershed by reforestation and erosion control measures.

(e) Continuous record from 1941 of rainfall, runoff, ground water, and sediment loads.

(g) During the 10-year period 1941-1950, the cover improvement and erosion control in the watershed resulted in a decrease in surface runoff volumes and an increase in ground-water discharges, marked reductions in summer and winter peak flood discharges, a reduction in overland surface velocities, a prolongation of the period of draining of surface runoff from the channel system, and a 90 percent reduction in the sediment load.

UNIVERSITY OF MINNESOTA, Agricultural Experiment Station.

(1929)   DRAIN TILE JUNCTION LOSSES.

Cooperative with St. Anthony Falls Hydraulic Laboratory. See page 62.

(2350)   DRAINAGE OF AGRICULTURAL LAND BY PUMPING.

(b) Laboratory project.

(c) Prof. Curtis L. Larson, Dept. of Agricultural Engineering, University of Minnesota, St. Paul 1, Minnesota.

(d) Theoretical and field investigations; applied research.

(e) The project has three phases: (1) The development of basic relations for planning pump drainage systems, (2) the study of rates of drainage, and (3) the study of factors affecting the efficiency.

(g) Expressions for the amount of storage required by automatic and non-automatic pumping plants have been developed. A new device for measuring effluent from partially filled pipes was developed in laboratory tests.

(h) "Five Years of Pump Drainage," by Curtis L. Larson, Land Improvement Magazine, Vol. 5,

No. 4, pp. 18-19, April 1958.
"Study of Pump Drainage Systems in Minnesota," by Curtis L. Larson and Deane M. Manbeck. University of Minn. Department of Agricultural Engineering Report No. 202, 20 pp., December 1958.

(2576)   CONSTRUCTION, DEVELOPMENT, AND PUMPING OF SHALLOW WELLS FOR IRRIGATION.

(b) Field project.

(c) Prof. Evan R. Allred, Dept. of Agricultural Engineering, Univ. of Minn., St. Paul 1, Minnesota.

(d) Field investigation; applied research and development.

(e) The objectives of the project are: (1) To study and develop inexpensive methods for construction of shallow irrigation wells, (2) determine hydraulic permeability and characteristics of various aquifers, and (3) to survey and determine extent and availability of shallow ground water sources for irrigation in Minnesota.

H. G. ACRES AND COMPANY LIMITED, Hydraulic Laboratory.

Inquiries concerning the following projects should be addressed to Mr. I. W. McCaig, Hydraulic Engineer, H. G. Acres and Company Limited, Niagara Falls, Canada.

(3310)   FIRST MODEL OF INTAKE FOR CHUTE-DES-PASSES HYDRO-ELECTRIC DEVELOPMENT.

(b) Aluminum Company of Canada Limited.

(d) Experimental; for design.

(e) Hydraulic model tests of intake to determine the minimum size of plug required to be blown through into the Passe Dangereuse Reservoir, and the transition and gate dimensions required downstream to control the flow of 18,000 cfs.

(f) Tests completed. Prototype under construction.

(g) The model gave the minimum size of intake plug and optimum dimensions of the transition required to distribute the water uniformly over the intake racks.

(h) Report to be submitted to the sponsor.

(3311)   SECOND MODEL OF INTAKE FOR CHUTE-DES-PASSES HYDRO-ELECTRIC DEVELOPMENT.

(b) Aluminum Company of Canada Limited.

(c) Hydraulic Engineer.

(d) Experimental; for design.

(e) Dynamic tests on model of intake plug and sump to determine the deposition pattern of rock within the sump when the plug was blown.

(f) Tests completed. Prototype under construction.

(g) The model gave the optimum shape of sump for trapping debris. It also yielded dynamic loads for use in the design of the intake structure downstream.

(h) Report to be submitted to the sponsor.

3312) THIRD MODEL OF INTAKE FOR CHUTE-DES-PASSES HYDRO-ELECTRIC DEVELOPMENT.

(b) Aluminum Company of Canada Limited.
(c) Hydraulic Engineer.
(d) Experimental, for design.
(e) Hydraulic model tests on intake plug opening to determine shape to reduce vortex formation and the size and depth of floating grid required to prevent drawdown of ice.
(f) Tests on plug shape completed but test on floating grid still active.
(g) Model gave shape of intake opening that greatly reduced vortex formation at low reservoir levels.
(h) Report to be submitted to the sponsor.

(3313) MANIFOLD AND BRANCH LOSSES.

(b) Aluminum Company of Canada Limited, Quebec Hydro-Electric Commission, Department of Trade and Commerce, Ottawa.
(c) Hydraulic Engineer.
(d) Experimental.
(e) Air model tests to find optimum manifold junction shapes to give minimum losses with five branches angled at 45 degrees, 60 degrees, or 90 degrees.
(f) Tests completed. Prototypes under construction.
(g) Tests showed that, in all cases, when the manifold was excavated in rock, the most economical arrangement utilized a constant manifold diameter, and that the optimum faired entries into individual branches approximated to the natural efflux of water from the side of a pipe.
(h) Report in preparation.

(3314) SURGE TANK MODEL, BERSIMIS NO. 2 DEVELOPMENT.

(b) Quebec Hydro-Electric Commission.
(c) Hydraulic Engineer.
(d) Experimental; for design.
(e) Tests with electronically controlled surge tank model to find the optimum size of restricted orifice and minimum surge tank diameter for stable operation with constant station load.
(f) Tests completed.
(g) The model showed that approximately 70% of the velocity head in the supply tunnel at the surge tank tee was effective in reducing the minimum area required for stability. If a smaller area was used, appreciable undamped oscillations occurred in the tank, and the magnitude of these increased with decreasing surge tank area. The maximum amplitude of the undamped oscillations was limited by friction in the surge tank orifice.
(h) "Application of Computer and Model Studies to Problems Involving Hydraulic Transients," by I. W. McCaig and F. H. Jonker, ASME Transactions Paper No. 58-A-101, 1958.

(3315) SPILLWAY MODEL, BERSIMIS NO. 2 DEVELOPMENT.

(b) Quebec Hydro-Electric Commission.

(c) Hydraulic Engineer.
(d) Experimental; for design.
(e) Model tests of bucket spillway to find minimum radius of bucket and optimum angle of jet. Tests conducted using both flume and three-dimensional models.
(f) Tests completed. Prototype under construction.
(g) The model showed that considerable economy could be effected by reducing the radius of bucket. The optimum angle for the jet was 30 degrees. The three-dimensional model showed that no channel improvements were required downstream from the spillway to prevent the bucket being submerged by the rising tailwater.

(3316) TURBULENCE STUDY.

(b) Laboratory project.
(c) Hydraulic Engineer.
(d) Experimental.
(e) Hydraulic model tests on conduit to determine pressure fluctuations at a 45-degree wye with the horizontal section flowing partly full and water entering from an inclined branch.

(3317) MODEL OF DIVERSION AT WARSAK HYDRO-ELECTRIC DEVELOPMENT, PAKISTAN.

(b) Department of Trade and Commerce, Ottawa, Canada.
(c) Hydraulic Engineer.
(d) Experimental, for design.
(e) Model tests to determine the sill level and width of gap to be left in the concrete dam for passing flood flows without flooding construction upstream or damaging uncompleted and temporary works downstream. Excessive velocities through the diversion tunnel had also to be avoided.
(f) Tests completed. Prototype under construction.
(g) The tests gave the required dimensions of the gap and showed that to avoid damaging the downstream cofferdam the gap should be as near to the left bank as possible.
(h) Report on model tests submitted to the Department of Trade and Commerce.

UNIVERSITY OF ALBERTA, Hydraulics Laboratory.

(3318) AN EXPERIMENTAL DETERMINATION OF THE FLUID PRESSURES EXERTED ON SPILLWAY FLOORS.

(b) Laboratory project.
(c) Prof. T. Blench, Department of Civil Engineering, University of Alberta, Edmonton, Alberta.
(d) Experimental; basic research; master's thesis.
(e) Observe pressure distribution on spillway floors throughout hydraulic jumps formed completely and partially on chutes of various slopes and prepare non-dimensional pressure distribution diagrams for design against hydrostatic uplift.

(f) Completed.

(g) Design diagrams were obtained for 1 upon 1,
2 and 3 slopes of chute for a useful range
of nondimensional variables. The data were
specially analyzed to compare with results
of other workers who observed jump dimen-
sions but not pressures; they were found to
agree reasonably with those results in the
zone of overlap and to extend them.

(h) "An Experimental Determination of the Fluid
Pressures Exerted on Spillway Floors," by
J. M. Wigham. Part requirement for degree
of M.Sc. from University of Alberta.

UNIVERSITY OF BRITISH COLUMBIA, Hydraulics Lab.

(1044) FRASER RIVER MODEL.

(b) Hydraulic model studies cooperative with
the Department of Public Works of Canada,
Vancouver, B. C.

(c) Prof. E. S. Pretious, Dept. of Civil Engrg.,
Univ. of British Columbia, Vancouver, Can.

(d) Experimental project to aid engineering
studies of navigation requirements involv-
ing river regulation and control.

(e) An outdoor erodible-bed tidal river model
to study methods for improving and main-
taining the navigation channels of the
Fraser River estuary. Horizontal scale
1:600, vertical scale 1:70. The model oc-
cupies approximately 4 acres of the campus
and represents the tide-water reaches of
the lower Fraser River extending from its
seaward end at the Strait of Georgia to the
head of tide water at Sumas, a distance of
approximately 60 miles. Pitt River and
Pitt Lake (30 square miles in area) are
subject to tidal influence and are included
in the model. Natural tides and river dis-
charges can be synchronized and simulated
on the model and are controlled automati-
cally by electronic servo-systems. Sand
injection can be controlled automatically
as a function of river discharge. Instanta-
neous water surface slopes can be obtained
over the whole model by automatic electri-
cally-recording point gauges situated at
controlling points. Natural river sand of
appropriate grain size is used for the bed
material.

(h) Progress and technical reports submitted
periodically to the Dept. of Public Works
of Canada.

(2737) CURVED CHANNEL FLOW.

(b) Laboratory project - financed by National
Research Council grant.

(c) Dr. A. W. Marris, Dept. of Civil Engineer-
ing, University of British Columbia,
Vancouver, Canada.

(d) Experimental; basic research.

(e) An experimental investigation of the radial
distributions of temporal mean pressure and
velocity for fully developed turbulent flow
in two closed channels, of widely differing
width to mean radius ratios, was carried

out. Each channel of rectangular cross
section was of sufficiently large depth to
width ratio that the mean flow was two di-
mensional. Measurements were made for each
channel over a wide range of flow rates.
The purpose of the study was to check, in
the case of a channel with small width to
mean radius ratio: The free vortex dis-
tribution of pressure and velocity, and a
velocity distribution developed earlier by
the author (Can. J. Physics, 34, 1134-1146,
1956), as representative of the flow, and
to investigate for the channel with large
width to radius ratio, the occurrence of
boundary layer separation at the inner wall,
and to study its effect on the velocity
and pressure profile.

(3319) PUNTLEDGE RIVER POWER PLANT AND FISH
FACILITIES.

(b) Hydraulic model studies cooperative with
the Department of Fisheries, Canada,
Vancouver, B. C.

(c) Prof. E. S. Pretious, Department of Civil
Engineering, University of British Columbia,
Vancouver, Canada.

(d) Axperimental project to test the most satis-
factory design of a stilling basin and
louver flume for salmon fry deflection, in
connection with the Puntledge River power
development on Vancouver Island, B. C.

(e) An undistorted model of the modified still-
ing basin and a proposed flume to contain
louver screens, was constructed to a scale
of 1:10, using wood, steel plastics and
glass. The model was installed in a large
concrete flume in the hydraulics laboratory
and was operated in accordance with the
Froude Law for dynamic similarity.

(f) Completed.

(g) The test results provided answers to most
of the questions concerning the over-all
hydraulic behaviour of the stilling basin
and fish facilities.

(h) A report will be prepared by the Department
of Fisheries, Canada.

(3320) PUNTLEDGE RIVER POWER PLANT AND FISH
FACILITIES.

(b) Hydraulic model studies cooperative with
the Department of Fisheries, Canada,
Vancouver, B. C.

(c) Prof. E. S. Pretious, Dept. of Civil Engrg.,
Univ. of British Columbia, Vancouver, Can.

(d) Experimental project to test the most
satisfactory design of the salmon fry by-
pass structure at the downstream end of the
proposed louver screen (already described)
in connection with the Puntledge River
power development on Vancouver Island, B.C.

(e) An undistorted model of the by-pass struc-
ture was constructed to a scale of 1:4,
using wood and plastic. The model was in-
stalled in a large steel and glass flume in
the hydraulics laboratory and was operated
in accordance with the Froude Law for dy-
namic similarity. Velocity distribution
and flow pattern studies were carried out.

(f) Completed.

(g) These supplementary tests provided more detailed information on the hydraulic behavior of the by-pass structure itself.

(h) A report will be prepared by the Department of Fisheries, Canada.

3321) HARBOUR BREAKWATER, CAMPBELL RIVER, B. C.

(b) Hydraulic model studies cooperative with the Department of Public Works, Canada, Vancouver, B. C.

(c) Prof. E. S. Pretious, Dept. of Civil Engrg., Univ. of British Columbia, Vancouver, Canada.

(d) Experimental project to determine the most satisfactory breakwater location and alinement to protect a proposed enlargement of an existing small boat harbour at Campbell River, Vancouver Island, B. C.

(e) An undistorted fixed-bed model of the harbour and off-shore ocean bed was constructed to a scale of 1:100. The bed of the model was accurately moulded with a thin layer of concrete placed on top of a compacted sand filler. The model represented an area measuring 2,000 feet wide and 3,200 feet long and provided depths from 0 to 40 feet in the prototype. It was installed in an outdoor concrete basin 40 feet long and 20 feet wide. Tests were made on different breakwater locations and alinements and the wave effects in the inner harbour were studied qualitatively for each combination to determine the best layout. The wave generator consisted merely of a wood plank 12 inches wide, 2 inches thick and 15 feet long, hinged and thus free to rotate about its lower edge. The rocking movement producing the waves was facilitated by a long handle attached to the plank. Templates for controlling wave height and length were installed close to the generator and the generator was oriented to conform to the direction of the prevailing storm-wave trains. Prototype data on wave heights and lengths were rather limited and time was not available for a complete prototype investigation. Wave reflections in the model were eliminated by absorbing the wave trains in loose gravel placed strategically along the edges.

(f) Completed.

(g) The study was successful in guiding the engineers toward a satisfactory breakwater location and alinement.

(h) A report will be prepared by the Department of Public Works, Canada.

(3322) ELECTRONIC TIDE-CONTROL EQUIPMENT, FRASER RIVER MODEL.

(b) A re-design and modification of the existing electronic control for tide generation, undertaken jointly by the Department of Electrical Engineering and the Fraser River Model Project at the University of British Columbia, and cooperative with the Department of Public Works, Canada, Vancouver, B. C.

(c) Prof. E. S. Pretious, Department of Civil

Engineering, Univ. of British Columbia, Vancouver, Canada.

(d) Improvement of electronic tide-control equipment to ensure a consistently accurate reproduction of tidal phenomena, using a simpler and more compact design.

(e) The new design utilizes a servo-driven tracking carriage which automatically follows the edge of the tide curve plotted to scale and painted on a ribbon of translucent plastic sold under the trade name of "Perfectrace." The carriage contains two panel lights, one being adjusted by a potentiometer to about one half the intensity of the other. The automatic lateral position of the carriage is such that the beam of the brighter light is partially obstructed by the edge of the tide curve, while the other beam passes through the translucent portion of the chart as it moves at the correct time scale past the light beams. Both beams are focussed by mirrors on to a photo-multiplier tube after first passing through a buzzer-operated shutter which intermittently blocks the two light beams. Any difference or imbalance between the output voltages produced by the shutter-modulated light beams, produces a tracking error signal and the servo system places the carriage in a neutral position such that these two voltages are equal, when the two light beams falling on the photo-multiplier tube are of equal intensity. This error signal is a drift-free A.C. signal, amplified by a servo amplifier to drive a two-phase A.C. servo motor which puts the carriage in the neutral position.

(f) Completed.

(g) The modification has resulted in very accurate tide reproduction, trouble-free operation and simpler adjustments.

(h) A technical note is being prepared by the Fraser River Model Office, Department of Civil Engineering, University of British Columbia, Vancouver, Canada.

(3323) CRITERIA FOR INCIPIENT MOTION OF BED SAND.

(b) Fundamental research cooperative with the Dept. of Public Works of Canada, Vancouver, B. C.

(c) Prof. E. S. Pretious, Dept. of Civil Engrg., Univ. of British Columbia, Vancouver, Can.

(d) Laboratory project to aid hydraulic model studies of river behaviour involving problems of shoal and scour with respect to training structures for navigation improvements, bridge piers, etc.

(e) Flume studies were carried out to determine the critical unit discharge as a function of depth of flow, for natural Fraser River sands, having median diameters of 0.65 mm., 0.41 mm., 0.32 mm., 0.20 mm., 0.155 mm., 0.10 mm., and 0.07mm. The depth of flow in the flume varied from 0.1 to 0.6 feet for each of the sand samples used. The tests have been limited only to the incipient motion or initial entrainment of the bed in conjunction with the critical unit discharge. The main purpose of this study was to obtain

a better knowledge of the mechanics of movement of the bed sand used as the movable-bed material in the Fraser River Model. The flow was uniform at a constant slope of 0.001.

(f) First series of tests completed. Temporarily suspended.

(g) The results obtained from these studies are of considerable help to the research workers in determining the appropriate hydraulic conditions which would have to be imposed on any movable-bed study when using a specified grade of natural Fraser River sand; thus eliminating a possible trial-and-error approach.

(h) A technical note will be prepared by the Fraser River Model Office, Dept. of Civil Engineering, University of British Columbia, Vancouver, Canada.

THE HYDRO-ELECTRIC POWER COMMISSION OF ONTARIO, Hydraulic Model Laboratory.

Inquiries concerning projects Nos. 3324 to 3335, incl., should be addressed to Mr. J. B. Bryce, Hydraulic Engineer, Hydraulic Generation Dept., 620 University Ave., Toronto 2, Ontario, Canada.

(3324) ST. LAWRENCE RIVER MODEL - OGDENSBURG TO LEISHMAN'S POINT.

(b) Ontario Hydro and Power Authority of the State of New York.

(d) Experimental; for design, development and operation.

(e) A 1:500 x 1:100 scale model of the St. Lawrence River between Ogdensburg and Leishman's Point, a distance of 16.1 miles, was constructed to determine the design of channel enlargements, the location of the Iroquois Control Dam and a plan of river control during construction of the St. Lawrence Power Project.

(f) Work is essentially completed but model is still active.

(g) Channel enlargements were developed which met the criteria stipulated by the International Joint Commission with respect to navigation and ice-forming velocities and the seaway navigation channel was located. The optimum arrangement and location for the Iroquois Control Dam was determined. A plan of river control during construction was developed.

(3325) ST. LAWRENCE RIVER MODEL - OGDEN ISLAND REACH.

(b) Ontario Hydro and Power Authority of the State of New York.

(d) Experimental; for design, development and operation.

(e) A 1:500 x 1:100 scale model of the St. Lawrence River reproducing 7.9 miles of the river between the towns of Iroquois and Morrisburg, was constructed to determine the design of channel enlargements and a plan of river control during

construction of the St. Lawrence Power Project.

(f) Work is essentially completed but model is still active.

(g) Channel enlargements were developed which met the ice-forming criteria stipulated by the International Joint Commission and a satisfactory Seaway navigation channel was located. A plan of river control during construction was developed.

(3326) ST. LAWRENCE RIVER MODEL - DEWATERING AND CLOSURE AREA.

(b) Ontario Hydro and Power Authority of the State of New York.

(d) Experimental; for design, development and operation.

(e) A 1:500 x 1:100 scale model of the St. Lawrence River reproducing 13.8 miles from Cat Island to below the powerhouses was constructed to develop plans for dewatering the Long Sault Dam and the powerhouse and to investigate conditions during the various stages of their construction.

(f) Work is completed but model is still active.

(g) Dewatering diversion channels were designed in detail and a plan of construction developed to preserve the necessary water levels for existing navigation and ensure adequate discharge capacity in the various stages of construction. Velocities in the Seaway Channel were also investigated. The Power Pool filling operation was investigated in detail.

(3327) ST. LAWRENCE POWER PROJECT - MODELS OF THE POWERHOUSE ICE SLUICES.

(b) Ontario Hydro and Power Authority of the State of New York.

(d) Experimental; for design and operation.

(e) Two 1:36 scale models were constructed of the 75-foot and 50-foot ice sluices in the powerhouse structure to determine the design of the ice chute and the rating of the drum-type gates.

(f) Work is completed and models dismantled.

(g) A hydraulic design for the ice chutes was developed which produced a satisfactory discharge of ice into the tailrace. A discharge calibration of the gates was obtained over the full operating range.

(3328) ST. LAWRENCE POWER PROJECT - SECTIONAL MODELS OF LONG SAULT AND IROQUOIS DAM.

(b) Ontario Hydro and Power Authority of the State of New York.

(d) Experimental; for design, development and operation.

(e) 1:50 scale sectional models of sluices at the Long Sault Dam and the Iroquois Control Dam were constructed in a testing flume to determine the design of energy-dissipating works and hydraulic loadings on gates.

(f) Work is completed and models discontinued.

(g) After many trials an energy-dissipater to produce a forced hydraulic jump was developed for the Long Sault Dam which

performed satisfactorily under both construction and final operating conditions. Its performance was verified in a comprehensive model. A somewhat similar energy dissipater was developed for a portion only of the Iroquois Dam as its use was required for the construction period only. Vertical hydraulic loads on the Diversion sluice-gates, tunnel port gates and spillway gates at the Long Sault Dam were measured, as were the loads on the Iroquois gates. Modifications were suggested for the Long Sault Dam ports to increase capacity and for the port gates to reduce downpull.

(3329) ST. LAWRENCE POWER PROJECT - COMPREHENSIVE MODEL OF THE LONG SAULT DAM.

(b) Ontario Hydro and Power Authority of the State of New York.
(d) Experimental; for design and operation.
(e) A comprehensive 1:80 scale model, size 52 ft x 44 ft, was constructed of the entire Long Sault Dam and the adjoining river banks, and included the river channel both upstream and downstream from the dam; its purpose was to verify the operation and performance of the complete energy-dissipating works developed in a sectional model and to obtain the discharge capacity of the diversion sluices and tunnel ports to be used during construction of the dam, and to obtain a discharge calibration of the final sluiceways.
(f) Work is completed and model removed.
(g) The model verified the satisfactory performance of the energy-dissipating works over the full range of construction and operating conditions. Modifications to the diversion channels were indicated, and the discharge capacity of the dam was obtained for each stage of construction. A calibration of the final operating sluices was obtained.

(3330) ST. LAWRENCE POWER PROJECT - COMPREHENSIVE MODEL OF IROQUOIS CONTROL DAM.

(b) Ontario Hydro and the Power Authority of the State of New York.
(d) Experimental; for design, development and operation.
(e) A comprehensive 1:80 scale model, size 130 ft x 54 ft, of the complete Iroquois Control Dam was constructed including 1 1/2 miles of river channel and the downstream approach to the Iroquois lock. Its purpose was to determine a plan of river control during construction, a plan of dewatering, the velocities at the cofferdams during their construction, verification of the performance of energy-dissipating works, and the discharge calibration of the sluiceways.
(f) Active.
(g) The dewatering plans were tested in the model, and the velocities and currents that would occur during construction of the cofferdam were determined. A plan of river control was developed to maintain satisfactory levels and navigation conditions during

the construction of the dam. The performance of the energy-dissipating works, which had been developed in a sectional model, was verified. A discharge calibration of the dam was obtained for the construction period and gate opening patterns developed. Performance data for operational use is still being obtained.

(3331) ST. LAWRENCE POWER PROJECT - MODEL OF MASSENA INTAKE.

(b) Ontario Hydro and Power Authority of the State of New York.
(d) Experimental; for design, location and operation.
(e) A 1:60 scale model, size 34 ft x 21 ft, was constructed of the Massena Intake and the upstream and downstream channels. Its purpose was to determine the alinement of the structure, the design of energy-dissipating works, the port discharge ratings, and the hydraulic loadings on both service and emergency gates.
(f) Work is completed and model removed.
(g) A satisfactory alinement of the structure was obtained to minimize downstream scour and an adequate energy-dissipating device developed at the outlet of the ports. The hydraulic performance of the submerged ports was determined and the hydraulic vertical loads on both the emergency and service gates were measured.

(3332) ST. LAWRENCE POWER PROJECT - MODEL OF POWERHOUSE WATER PASSAGES.

(b) Ontario Hydro and Power Authority of the State of New York.
(d) Experimental; for operation.
(e) A 1:36 scale model of the water passages for one of the units in the Canadian power-houses was constructed to determine the best location of piezometer connections for Gibson tests, and to determine the vertical hydraulic loads on the headgates.
(f) Work is completed and model discontinued.
(g) Locations for the Gibson Test piezometers were selected from test results and the vertical hydraulic loads on the headgates were measured for the full range of operating conditions.

(3333) ST. LAWRENCE RIVER MODEL - TAILRACE AREA.

(b) Ontario Hydro and Power Authority of the State of New York.
(d) Experimental; for design.
(e) A 1:60 x 1:80 scale model reproducing 2.5 miles of the St. Lawrence River from above the powerhouses to below Polly's Gut, has been constructed to develop the design of an economic tailrace improvement and a suitable dewatering scheme.
(f) Work essentially completed but model still active.
(g) An economic tailrace enlargement was developed in the model. A cofferdamming plan to dewater much of the enlargement area was devised and the velocities at various

stages observed.

(3334) CAMERON FALLS GENERATING STATION - UNIT NO. 7.

(b) Ontario Hydro.
(d) Experimental; for design.
(e) A 1:80 scale model of original 6 unit powerhouse and the Unit No. 7 powerhouse has been constructed to determine levels at cofferdam during construction, the aline- ment and grade of the tailrace excavation, and the design and location of the log slide.
(f) Work completed and model removed.

(3335) RED ROCK GENERATING STATION MODEL.

(b) Ontario Hydro.
(d) Experimental; for design.
(e) A 1:80 scale comprehensive model of the sluiceways, powerhouse and upstream and downstream river channel has been construct- ed to determine the dewatering arrangement for construction, velocities along coffer- dams, energy-dissipating works at the sluices, the rating of the diversion sluices, ports and sluiceways, the tailrace excavation, and location of log slide.
(f) Active.

(3336) NIAGARA POWER PROJECT - NIAGARA RIVER MODEL.

(b) Power Authority of the State of New York.
(c) Mr. J. B. McMorran, Chief Engineer, Power Authority of the State of New York, The Coliseum Tower, 10 Columbus Circle, New York 19, New York.
(d) Experimental; for design and operation.
(e) An existing 1:250 x 1:50 scale model re- producing 5 miles of the Niagara River from Buckhorn Island to below the Cataracts is being used to determine the location in de- tail of the intakes for the Lewiston Gen- erating Station, and to determine the nec- essary river excavation and improvement. This model was previously used by Ontario Hydro in the investigation of remedial works necessary for the preservation and enhancement of Niagara Falls and for the location of the intake for the Sir Adam Beck Generating Station No. 2 and the necessary river improvement.
(g) Work is largely completed but still in pro- gress.

(3337) NIAGARA POWER PROJECT - MODEL OF INTAKES.

(b) Power Authority of the State of New York.
(c) Mr. J. B. McMorran, Chief Engineer, Power Authority of the State of New York, The Coliseum Tower, 10 Columbus Circle, New York 19, New York.
(d) Experimental; for design, development and operation.
(e) A 1:60 scale model of a portion of the Niagara River and the two large submerged gathering tube intakes for the Niagara Power Project has been constructed to de- velop the detailed hydraulic design of the

intakes and to determine their operating performance.
(f) Work is largely completed but model is still active.
(g) A design has been developed which will pro- vide a minimum economic head loss and a minimum attraction for river ice.

(3338) NIAGARA POWER PROJECT - MODEL OF TRANSITION SECTION BETWEEN THE TUNNELS AND RECTANGULAR CANAL.

(b) Power Authority of the State of New York.
(c) Mr. J. B. McMorran, Chief Engineer, Power Authority of the State of New York, The Coliseum Tower, 10 Columbus Circle, New York 19, N. Y.
(d) Experimental; for design.
(e) A 1:60 scale model of 600 feet of the two approach tunnels, the transition section and 450 feet of canal was constructed to determine the design of the transition section to provide minimum energy loss.
(f) Work completed and model removed.
(g) A design was developed which produced a minimum economic head loss in the transi- tion.

LASALLE HYDRAULIC LABORATORY.

Inquiries concerning the following projects should be addressed to Mr. E. Pariset, LaSalle Hydraulic Laboratory, 0250 St. Patrick Street, Ville LaSalle, P. Q. Canada.

(2984) MODEL OF THE CHANNEL OF THE SEAWAY IN THE LACHINE RAPIDS SECTION.

(b) St. Lawrence Seaway.
(d) Model studies to verify the effects of the construction of the Seaway.
(e) The model representing a section of the St. Lawrence River at the Lachine Rapids sec- tion was built at a scale of 1/125 verti- cally and 1/200 horizontally. The purpose of the model was to check the effect of the construction of the dyke, during its dif- ferent construction phases and after com- pletion on the water-level lines in the river and to obtain the field of velocities for these cases and specially near the en- trance of the channel in Lake St. Louis.
(f) The model is completed.
(h) Report issued to sponsor.

(2985) MODEL OF THE CHANNEL OF THE SEAWAY IN THE MONTREAL HARBOUR SECTION.

(b) St. Lawrence Seaway Authority.
(d) Model studies to verify the effects of the Seaway on the hydraulic conditions in the Montreal Harbour.
(e) This model represents the St. Lawrence River at the Montreal Harbour at a scale of 1/200 horizontally and 1/125 vertically. It was built to verify the effect of the construction of the dyke of the Seaway on the water level in the Harbour. One

special point of the study was to determine the pattern of surface velocities before and after the construction of the entrance section of the Seaway in the Harbor.

(f) The model is completed.

(h) Report issued to sponsor.

2987) MODEL OF THE SPILLWAY OF THE LACHINE POWER PROJECT.

(b) Model built for the Quebec Hydro-electric Commission by Neyrpic Canada Ltd., and operated with the full collaboration of the "Ecole Polytechnique" of Montreal.

(d) The tests were carried out in order to ameliorate certain features of the design of the structure to be built in nature.

(e) The model represents three gate-ways of the spillway in a glass-flume. Special study was to be made of the form of the piers to obtain a low contraction coefficient. The main purpose of the model was to check the extent of scouring at the downstream end and to find ways of protecting the structure against undermining.

(f) Completed.

(g) A special design was made of a small basin downstream of the spillway in order to form a jump and dissipate the energy.

(h) Report issued to sponsor.

2989) GENERAL STUDY OF THE LACHINE POWER PROJECT.

(b) Quebec Hydro-electric Commission.

(d) Model tests to study the general hydraulic problems of the Lachine Power Project.

(e) The model built at a scale of 1:125 vertically, and 1:200 horizontally is used to study the problems brought about by the construction of the Project. Main problems are the determination of the river stages during the different phases of construction and after completion of the Project, the problem of the intake of the turbines and of the outlet of the draft tubes in the tailrace, and finally, the problem of the formation of an ice cover in the forebay.

(g) The study on model of the cofferdam and of the water profile during the construction phases is completed.

2990) STUDY OF THE CONSTRUCTION OF THE COFFERDAM FOR THE LACHINE POWER PROJECT.

(b) Quebec Hydro-electric Commission.

(d) Theoretical and experimental; applied research.

(e) Systematic investigations in a 11 ft wide laboratory flume to determine the size of rock necessary to advance a cofferdam by end dumping of rock. A general theory was made to determine the entrainment of material at the toe of the dyke depending upon the hydraulic characteristics of the flow. Special attention was given to closure of gaps with high velocity currents.

(g) It is found that it is possible to use this type of cofferdam for Lachine with relatively small material by a special disposal

in plan of the dykes that permits to build the cofferdam across high velocity currents.

(h) Preliminary report sent to sponsor.

(3339) THRUST EXERTED BY AN ICE COVER ON A RETAINING STRUCTURE.

(b) Quebec Hydro-electric Commission.

(d) Theoretical; applied research.

(e) Study made to determine the thrust of a parcelled ice cover on a surface retaining boom by taking all forces into account, i.e., hydrodynamics forces on the upstream edge of the cover, friction forces caused by the flow and the wind, gravity, and reaction of the shores.

(f) Completed.

(g) A general formula with charts of utilization was derived for all cases.

(h) Report issued to sponsor.

(3340) THERMAL STUDY ON ICE COVER IN RIVERS.

(b) Quebec Hydro-electric Commission.

(d) Theoretical; applied research.

(e) The study has been made to determine the following points: (1) Variation of the temperature of the water flowing under the ice cover, caused by the heat generated by friction losses, and (2) propagation of air temperature waves through the cover.

(f) Completed.

(g) This study has permitted to determine the quantity of frazil ice that could be melted in a river at a certain distance from the entrance of an ice cover. It also showed in which way the fluctuations of atmospheric temperature had to be taken into account in this calculation.

(h) Report issued to sponsor.

(3341) FORMATION OF AN ICE-COVER IN FRONT OF A DAM BY TRANSPORT OF ICE FLOES.

(b) Quebec Hydro-electric Commission.

(d) Basic research both theoretically and experimentally.

(e) To find the basic laws governing the formation of an ice-cover in front of a dam and the similitude to be used on models for ice transport. Systematic tests are made in a flume with blocks of paraffin and polyethylene. Many cases are studied which are: formation of regular ice cover, jams, hanging dams, etc. The effect of the solid discharge is taken into account.

(g) A general theory has been derived and extensive tests are being made.

(h) Preliminary reports issued to sponsor.

(3342) STUDY OF ICE SPILLWAYS FOR THE LACHINE POWER PROJECT.

(b) Quebec Hydro-electric Commission.

(d) Theoretical and experimental; applied research.

(e) A model at a scale of 1:40 was built. Three types of spillways specially designed are tried for that purpose: the rectilinear type, the shaft spillway and the shaft

spillway with a training wall acting to form a vortex.

(f) The model is in operation.

(3343) TRANSPORT OF FRAZIL ICE UNDER ICE COVERS.

(b) Quebec Hydro-electric Commission.
(d) Theoretical; applied research.
(e) A general theory was worked out starting from the laws of transport of material in suspension in turbulent flow to obtain the quantity of frazil ice that will be transported and deposited under an ice cover.
(g) The theory was applied to make calculations for the form of the ice cover in the intake channel of the Beaubarnois Power Plant. The agreement with field measurements was remarkable.
(f) Completed.
(h) Report issued to sponsor.

(3344) PRODUCTION OF ICE ON A FREE WATER SURFACE.

(b) Quebec Hydro-electric Commission.
(d) Theoretical; applied research.
(e) Establishment of a numerical and graphical method to obtain rapidly the quantity of ice formed on a free-water surface.
(f) Completed.
(h) Report issued to sponsor.

(3345) STABILITY OF THE DOWNSTREAM SLOPE OF A ROCK DYKE SUBMITTED TO A HIGH FILTRATION DISCHARGE.

(b) Quebec Hydro-electric Commission.
(d) Theoretical and experimental; basic research.
(e) Determination of the critical slope of a rock dyke for which a cave-in will occur when it is submitted to a high filtration discharge. A section of a rock dyke was reproduced in a 2.5 ft laboratory flume and a theory giving the characteristics of the seepage zone and the limit of stability of the rock at the toe of this zone was checked for different operating conditions.
(f) Completed.
(g) The experimental results agreed well with the theory.
(h) Report submitted to sponsor.

(3346) MODEL STUDY OF THE CARILLON POWER PROJECT.

(b) Quebec Hydro-electric Commission.
(d) Experimental-applied research.
(e) The model of the Ottawa River at the Carillon Site was built at a scale of 1:110 to study the hydraulic problems pertaining to the construction and operation of the Carillon project. Main problems are: study of the stages of the river during the construction of the crib type cofferdams, effect of the ice floes during spring flood on these cofferdams, economical study of the tailrace excavation, design of energy dissipation at the outlet of the spillways and effect of sudden surges on the navigation channel.

(3347) CARILLON LOCK MODEL STUDY.

(b) Quebec Hydro-electric Commission.
(d) Experimental; applied research.
(e) The model of the lock, at a scale of 1:20 is used to make the modification of the water distribution system at the bottom of the lock in order to overcome any undesirable conditions and to determine the law of operation of the gates.

(3348) MODEL OF THE HART-JAUNE DEVELOPMENT INTERMEDIATE SITE.

(b) Montreal Engineering Co., Ltd.
(d) Experimental; applied research.
(e) The model at a scale of 1:25 represents the bottom tunnel through the earth dam that will also be used as temporary diversion for the Project. The study is to determine the discharge capacity of the tunnel, and the design of the sill at the downstream end of the free-surface channel, to avoid its flooding by a jump.

(3349) MODEL STUDY OF THE HART-JAUNE STORAGE DAM.

(b) Montreal Engineering Co., Ltd.
(d) Experimental; applied research.
(e) Two models were used for the hydraulic problems brought about by the construction of this hydro-electric project. A model of one spillway pass was built in a flume to study the risks of cavitation at small openings of the gate. On the general model, at a scale of 1:60, the following problems were studied: Erosion downstream of the spillways, discharge coefficients of spillways, and minimum size of the forebay.
(f) Completed.
(h) Report submitted to sponsor.

(3350) MODEL STUDY OF THE ENLARGEMENT OF ROUND ISLAND.

(b) City of Montreal.
(d) Experimental; applied research.
(e) Study made to determine the effect on navigation in the Montreal Harbor of the enlargement of Round Island and its linkage to St. Helen Island, thus cutting the flow channel between these two islands.
(f) Completed.
(h) Report issued to sponsor.

(3351) STUDY OF AN AUTOMATIC SEWAGE REGULATOR.

(b) Laboratory.
(d) Experimental design.
(e) The problem of clogging of existing automatic sewage regulator with frequent interruption of service and the problem of both upstream and downstream level control of these types of regulators were studied theoretically and experimentally on models.
(f) Completed.
(g) A new type of automatic sewage regulator was designed, with no mechanism in sewage water and with simple control. The upstream

172

level control is made when the weight of water at a certain level on the top of the cylindrical gate closes it. The downstream control is obtained by an air vent connecting the interior of the gate with the downstream level. When the water downstream closes this air vent a vacuum is formed by air entrainment inside the gate and it closes.

(h) The gate is patented by the laboratory.

ECOLE POLYTECHNIQUE DE MONTREAL, Hydraulics Laboratory.

Inquiries concerning the following projects should be addressed to Prof. Raymond Boucher, Director, Hydraulics Laboratory, Ecole Polytechnique, 2500 Guyard Avenue, Montreal 26, Quebec, Canada.

(266) HYDRAULIC MODEL STUDIES OF DIFFERENT SPILLWAY PROFILES.

(b) Laboratory project.
(d) Experimental; applied research.
(e) In order to establish a comparison between discharge capacities of different spillway designs, systematic testing has been undertaken on scale models of existing and recommended spillway profiles. Pressure distribution on spillway faces and coefficients of discharge are determined for various heads up to the design head. The effect of gate piers of various designs is also investigated.
(g) Studies have been conducted on eight different spillway models. It is proposed to test two more profiles before this investigation is completed.

(268) CALIBRATION TESTS OF A SHARP-CRESTED PARABOLIC WEIR.

(b) Laboratory project.
(d) Experimental; applied research.
(e) To obtain the head-discharge curve and head-coefficient of discharge curve for a sharp-crested parabolic weir designed for a maximum capacity of 3 cfs. The influence of viscosity is also investigated. This weir will be utilized to measure with precision the discharge into a glass-sided channel for scale model testing and open channel flow studies.
(f) This study has become active again in order to obtain additional data needed in the study of the influence of viscosity.

(2993) HYDRAULIC MODEL STUDY OF A LOG CHUTE FOR THE MERCIER DAM, GATINEAU RIVER, QUEBEC, CANADA.

(b) Department of Hydraulic Resources, Quebec, Canada.
(d) Experimental; for design.
(e) The logs floated on the Gatineau River vary in length from 4 to 16 ft or more. The width of the existing log chute is only 12 ft, and consequently it cannot be used

efficiently for important logging operations. A 1:24 scale model has been built to investigate the most economical design of a new log chute. The model logs have been reproduced to the same scale. The roughness of the model downstream from the spillway has been adjusted to verify the slope of the water surface and the formation of jams experienced on the prototype.

(f) Completed.
(g) Two adjacent spillway-gate openings each having a width of 20 ft have been modified in order to obtain an efficient log chute. It has been found that a logway channel should be excavated in the river bed downstream from the spillway, therefore the two gate openings have been located where the excavation required will be minimum.
(h) Report has been submitted to sponsor.

(2994) HYDRAULIC MODEL STUDIES OF THE SPILLWAY FOR THE LACHINE POWER PROJECT.

(b) Quebec Hydro-Electric Commission and Neyrpic Canada Limited.
(d) Experimental; for design.
(e) A 1:74.4 scale model of three spillway gate openings has been built in a 30-in. glass-sided channel. These studies are being carried out in order to improve certain features of the design of the structure to be built in nature. The form of the pier noses has been carefully studied to obtain a low coefficient of contraction. The main purpose of these model tests was to check the extent of erosion of the river bed downstream from the spillway and to provide means of protecting the structure against undermining.
(f) Completed.
(h) Report submitted to sponsor.

NATIONAL RESEARCH COUNCIL, Division of Mechanical Engineering.

Inquiries concerning the following projects should be addressed to Dr. D. C. MacPhail, Director, Div. of Mechanical Engineering, National Research Council, Montreal Road, Ottawa, Ontario, Canada.

(2041) ST. LAWRENCE RIVER MODEL - CORNWALL ISLAND REACH.

(b) St. Lawrence Seaway Authority.
(d) Experimental project for design and development.
(e) A 1:480 by 1:96 scale model of five miles of the St. Lawrence River in the vicinity of Cornwall, Ontario, has been constructed to study in detail the navigation and power developments of the St. Lawrence Seaway and Power Project.
(g) The model is being used to study dredging procedures for the project in its advanced stage and, in particular, to determine the quantity of dredging required to maintain natural discharge distribution about Cornwall Island for various channel improvements.

173

(h) Interim reports have been submitted to the sponsor.

(3352) SAINT JOHN HARBOUR, NEW BRUNSWICK.

(b) Department of Public Works, Canada.
(d) Experimental; for harbour improvement.
(e) A survey of the harbour was undertaken during the summer of 1958 to determine the movement and properties of the water masses. On the basis of the survey data it is expected that the reasons for silting in certain areas will be found and recommendations made for improving the harbour.
(f) The survey has been completed with the exception of wave data which will be obtained during the winter.
(g) Data are being analysed and a preliminary report has been prepared for the sponsor.

(3353) LAMEQUE HARBOUR, NEW BRUNSWICK.

(b) Department of Public Works, Canada.
(d) Theoretical; for harbour improvement.
(e) On the basis of available data, recommendations were made for additional breakwaters to improve the wave protection at the entrance to a small harbor.
(f) Completed.
(g) Report issued to sponsor.

(3354) PRINCE SHOAL LIGHTHOUSE.

(b) Department of Transport, Canada.
(d) Experimental; for design purposes.
(e) A 1:50 scale model of a lighthouse base, which is proposed for Prince Shoal at the mouth of the Saguenay River, was tested in a simple wave flume to determine the best shape for minimum wave breaking and run-up. It is proposed that the base be made of steel plate, floated into position and filled with concrete. A sheet metal model was towed in the Model Basin to determine the towing stability.
(f) Completed.
(g) A report is being prepared for the sponsor.

(3355) PORT CARTIER HARBOUR.

(b) C. D. Howe Company, Montreal.
(d) Experimental; for design purposes.
(e) A 1:120 scale model of a proposed harbour, to be constructed on the north shore of the St. Lawrence River about 15 miles southwest of Seven Islands, was made to study the merits of two different designs with respect to waves under storm conditions. The location of wave absorbing beaches and a number of design details are to be studied.
(f) Testing programme starting.
(g) A report will be issued to the sponsor when the work is completed.

(3356) CHANDLER HARBOUR, QUEBEC.

(b) Department of Public Works, Canada.
(d) Experimental; for harbour improvement.
(e) A 1:100 scale model of this harbour, which is located on Chaleur Bay, has been constructed to determine the best location of additional breakwaters required to enlarge the harbour.
(f) Tests are in progress.
(g) A report will be issued to the sponsor when the work is completed.

(3357) INGALL'S HEAD HARBOUR, NEW BRUNSWICK.

(b) Department of Public Works, Canada.
(d) Experimental; for harbour improvement.
(e) This harbour, located on Grand Manan Island in the Bay of Fundy, is inadequately protected from north and northeast storms. A 1:80 scale model was constructed to study improvements to the breakwater.
(f) Project completed.
(g) A report, recommending construction of new breakwaters, has been issued to the sponsor.

(3358) ST. MAURICE RIVER MODEL.

(b) Shawinigan Engineering Company Limited, Montreal.
(d) Experimental; for river improvement.
(e) A model of a 2 1/2 mile section of the St. Maurice River, immediately below the new Beaumont power development, was constructed to scales of 1:240 by 1:80. This section of the river is to be excavated with a dragline to lower the tailwater at the powerhouse. Model tests were made to determine the best procedure for excavating, which would ensure the greatest lowering of the tailwater when the first turbine was operated, without encountering difficulties during excavation, due to hydraulic phenomena such as critical velocities, hydraulic jump, etc.
(f) Project completed.
(g) A report has been issued to the sponsor indicating the best plan of excavation.

(3359) INSTRUMENTATION FOR MEASURING FLUID PRESSURE IN SEAWAY STRUCTURES.

(b) St. Lawrence Seaway Authority.
(d) Experimental and theoretical study for design.
(e) An experimental study, coupled with a theoretical analysis of wave propagation in tubes, has been carried out on the "Air Bubbler" system.
(f) Completed.
(g) Final report issued to sponsor.

(3360) ELASTIC WAVES.

(b) Laboratory project.
(d) Theoretical and experimental study for basic research.
(e) An analysis of wave propagation in tubes. Theoretical investigation of attenuation and refraction of waves in a tube carrying a steady state shear flow.
(f) Results for quadratic steady state velocity distribution indicate unequal attenuation of incident and reflected waves. Study being continued.
(g) Preliminary report in process of preparation

3361) RESEARCH ON THE DESIGN OF FISHING BOATS.

(b) Laboratory project.
(d) Experimental and theoretical to improve design.
(e) This project is being undertaken in cooperation with the Department of Fisheries, Canada, to obtain design data for improving the design and economy of fishing craft. On the basis of model test data obtained on a typical modern West Coast combination seiner and longliner, a new model was constructed incorporating a number of advanced features.
(g) Tests on models are continuing and, in addition, theoretical studies are being made on design and economic aspects.
(h) Two papers were presented at the East Coast Fishing Vessel Conference, Department of Fisheries, Nov. 1957, and two more will be presented at the Second World Fishing Boat Congress, Rome, April 1959.

(3362) WAKE SURVEY TESTS.

(b) For Society of Naval Architects and Marine Engineers.
(d) Experimental.
(e) This study was undertaken as part of a research project sponsored by the Society of Naval Architectures and Marine Engineers. The wake velocity at the screw of a 1:40 scale model of the S.S. "Chryssi" has been measured with pitot tubes for a number of speeds and drafts with the model towed and self-propelled.
(f) The model tests are nearly completed and the results are partly analysed.
(g) A report will be issued to the sponsor on completion of the project.

ONTARIO AGRICULTURAL COLLEGE, Department of Engineering Science.

(2492) RUNOFF FROM SMALL WATERSHEDS.

(b) Laboratory project.
(c) Prof. D. F. Witherspoon, Ontario Agricultural College, Guelph, Ontario, Canada.
(d) Experimental; applied research.
(e) Relationship of precipitation and snow melt to runoff characteristics on four watersheds of twenty acres each, under various land use practices is being evaluated.
(g) Winter surface runoff from watersheds with good grass-legume cover is greater than from watersheds plowed during the winter season.
(h) "Measuring Watershed Runoff in Ontario," D. F. Witherspoon, and H. D. Ayers, Agricultural Engineering, No. 39:403-405, 411, 1958.

(2498) THE USE OF INFILTRATION DETERMINATIONS FOR RUNOFF ESTIMATES.

(b) Laboratory project.
(c) Prof. H. D. Ayers, Ontario Agricultural

College, Guelph, Ontario, Canada.
(d) Experimental; basic research, for masters thesis.
(e) The purpose of the project is to evaluate the separate factors affecting infiltration and to develop a technique for runoff estimation on a watershed utilizing infiltration data.
(h) "The Effect of the Water-Storage Capacity of the Soil on Mass Infiltration," H. D. Ayers, and V.E.A. Wikramanayake, Canadian Journal of Soil Science, No. 38:44-48, 1958.

(2739) PERMEABILITY OF THE SOIL IN THE FROZEN STATE.

(b) Laboratory project.
(c) Prof. H.D. Ayers, Ontario Agricultural College, Guelph, Ontario, Canada.
(d) Experimental; basic research, for masters thesis.
(e) Air permeabilities will be obtained of soils at various moisture content in the frozen state. The results will be used to determine if there is a correlation of moisture content and permeability of frozen soils on experimental watersheds.

(2740) MAIN TILE DRAIN SIZES FOR COMPOSITE DRAINAGE OF BROOKSTON CLAY SOIL.

(b) Laboratory project.
(c) Prof. F. R. Hore, Ontario Agricultural College, Guelph, Ontario, Canada.
(d) Field investigation; applied research.
(e) Discharge measurements from lateral tile drains in Brookston clay soil are being made to determine the proper drainage coefficient to use in the design of main tile drains and to determine the effect of lateral tile drain spacing on the drainage rate.

(3363) HYDROLOGIC CHARACTERISTICS OF ORGANIC SOIL.

(b) Laboratory project.
(c) Prof. R. W. Irwin, Ontario Agricultural College, Guelph, Ontario, Canada.
(d) Field investigation; applied research.
(e) The study is being carried out to establish criteria to be used in the development and operation of the water control program for organic soils. In the investigation, an attempt will be made to establish a hydrologic water balance for the field area by measuring, recording and analyzing so far as possible evaporation, seepage, transpiration, precipitation, water table elevation and ground water discharge through tile drains.

QUEEN'S UNIVERSITY, Hydraulics Laboratory.

(2044) ECONOMICAL CONSTRUCTION OF SAFE PULPWOOD HOLDING GROUNDS.

(b) Pulp and Paper Research Institute of Can. Ltd., 3420 University St., Montreal, Quebec,

Canada.

(c) Prof. R.J. Kennedy, Dept. of Civil Engineering, Queen's Univ., Kingston, Ontario, Can.

(d) Applied research; experimental, field and laboratory investigation.

(e) Field and laboratory model investigation of forces acting on various types of pulpwood holding grounds.

(h) "Forces in Pulpwood Holding Grounds I," R.J. Kennedy, The Engineering Journal, Jan. 1958. Reprints available from (b).

(3364) LITTORAL DRIFT AND ITS EFFECT ON THE HARBOURS ON THE NORTH SHORE OF LAKE ONTARIO.

(b) The National Research Council of Canada.

(c) Dr. Arthur Brebner, Dept. of Civil Engrg., Queen's Univ., Kingston, Ontario, Canada.

(d) Experimental and field; basic and applied research.

(e) Laboratory and field investigation of the silting of harbours due to littoral drift. Basic research on the process.

(3365) THE HYDRAULIC EFFICIENCY OF NEW AND USED ALUMINUM PIPE AND TUBING.

(b) Aluminum Laboratories Limited, P.O. Box 84, Kingston, Ontario, Canada.

(c) Dr. Arthur Brebner, Department of Civil Engineering, Queen's University, Kingston, Ontario, Canada.

(d) Field and laboratory investigations for the design of aluminum lines.

(e) Determination of the deterioration of aluminum pipe with length of service. For basis of comparison with old pipe new pipe in sizes up to 6"D has been tested with water to Reynolds 5×10^5 and with air to about Reynolds 10^7. Effect of jointing incorporated in the pipe friction factor.

(g) Corrosive attack on aluminum by various waters appears to be reduced considerably when the water is flowing and not stagnant.

(3366) THE EFFECT OF WALL ROUGHNESS ON THE CAPACITY OF PULPWOOD FLUMES.

(b) Aluminum Company of Canada, Montreal, Quebec, Canada.

(c) Prof. S.S. Lazier, Dept. of Civil Engrg., Queen's Univ., Kingston, Ontario, Canada.

(d) Field investigation.

(e) The testing of three pulpwood flumes of differing wall roughness for friction loss.

(f) Completed.

(h) "The Effect of Wall Roughness on the Capacity of Flumes," Woodlands Research Index 109, Pulp and Paper Research Institute of Canada, 3420 University Street, Montreal, Quebec, Canada.

UNIVERSITY OF TORONTO, Dept. of Mechanical Engineering.

(1298) DISCHARGE CHARACTERISTICS OF WEIR-TYPE SPILLWAYS.

(b) Laboratory project.

(c) Prof. L.E. Jones, University of Toronto, Toronto 5, Canada.

(d) Experimental; applied research for Masters thesis.

(e) A long term research carried out with a view to systematizing discharge characteristics for spillways having various pier spacings and proportions.

(g) Significant correlations obtained via special plotting techniques. Report in preparation.

(3000) STABILITY OF CANAL LININGS.

(b) Laboratory project.

(c) Prof. G. Ross Lord, University of Toronto, Toronto 5, Canada.

(d) Experimental; applied research for masters thesis.

(e) Six crushed rock sizes from 1/4 inch to 1-1/2 inch inclusive were tested on the bed of a rectangular test channel for dynamic stability.

(f) Completed.

(g) Good correlation established between rock size and competent velocity.

(h) "Stability of Canal Linings," N. A. Qazi, Masters of Sc. Thesis, University of Toronto, May 1958. (Available on loan.)

(3001) RELATIONSHIP BETWEEN EXTREME PRECIPITATION AND FLOOD FLOW IN THE TORONTO AREA.

(b) Laboratory project.

(c) Prof. L. E. Jones, Univ. of Toronto, Toronto 5, Canada.

(d) Office investigation; applied research for masters thesis.

(e) A study to correlate field data observed during Hurricane Hazel.

(f) Completed.

(g) Correlation obtained between run-off and precipitation.

(h) Report in preparation.

(3003) ROUGHNESS PHENOMENA IN OPEN CHANNEL FLOW.

(b) Laboratory project.

(c) Prof. L.E. Jones, University of Toronto, Toronto 5, Canada.

(d) Experimental; basic research for doctoral thesis.

(e) An investigation into the mechanism of open channel roughness, with ultimate reference to distorted scale models.

(3004) FLOW CONFIGURATION IN A NUCLEAR REACTOR CORE ASSEMBLY.

(b) Laboratory project.

(c) Prof. L.E. Jones, University of Toronto, Toronto 5, Canada.

(d) Experimental; applied research for masters thesis.

(e) A study involving air flow in a 10:1 scale model to determine coolant flow configuration about a typical rod cluster, with provision for simulating rod distortion.

3005) GRADING OF PARTICLE SUSPENSIONS BY CEN-
TRIFUGAL METHODS.

(b) Laboratory project.
(c) Prof. L. E. Jones, University of Toronto,
Toronto 5, Canada.
(d) Experimental; applied research for masters
thesis.
(e) A study of the dynamics of centrifugal
separation of fine particles from a liquid
carrier.

(3367) AERODYNAMIC DOWNWASH FROM CHIMNEY STACKS.

(b) Hydro-electric Power Commission of Ontario.
(c) Prof. G. Ross Lord, University of Toronto,
Toronto 5, Canada.
(d) Experimental; applied research for design.
(e) Low speed wind tunnel (4 ft by 8 ft by 36
ft long test section) designed and devel-
oped to analyze aerodynamic downwash ef-
fects for a proposed steam generation
plant. Results will permit the evaluation
of stack height necessary to restrict the
amount of pollution from stack effluents.
(f) A further extensive programme is proposed,
including model and field tests for an
existing plant.
(h) Interim reports to sponsor.

(3368) DIFFUSION OF GASEOUS PLUMES.

(b) Laboratory project.
(c) Prof. G. Ross Lord, University of Toronto,
Toronto 5, Canada.
(d) Experimental; basic research for doctoral
thesis.
(e) An investigation of the diffusion of gase-
ous plumes under various atmospheric con-
ditions.

(3369) HEAD GATE MODEL, CHUTE DES PASSES DEVELOP-
MENT, PERIBONKA RIVER, QUEBEC.

(b) Canadian Vickers, Ltd., Montreal, Canada.
(c) Prof. G. Ross Lord, University of Toronto,
Toronto 5, Canada.
(d) Experimental; for design and operation.
(e) A 1:24 scale model for investigating dy-
namic forces on vertical intake gates under
various load and operating conditions.

(h) Interim report to sponsor.

(3370) HEAD LOSS IN PIPE STRAINERS.

(b) Orr Associates, Limited, Toronto, Canada.
(c) Prof. L. E. Jones, University of Toronto,
Toronto, ·Canada.
(d) Experimental; for design improvement.
(e) Extensive tests on standard design and
various modifications of Y-type pipe
strainers of small size.
(f) Completed.
(g) Simple changes in screen shape permitted
significant improvements in performance.
(h) Reported to sponsor.

(3371) TEE LAKE OUTLET WORKS, NORTHERN QUEBEC.

(b) Morrison, Hershfield, Millman and Huggins,
Toronto, Canada.
(c) Prof. L. E. Jones, University of Toronto,
Toronto, Canada.
(d) Model and field investigation for recon-
struction design.
(e) Assessment of existing discharge capacity
and development of proper design for pro-
posed reconstruction of bridge openings.
(f) Completed.
(g) Adequate capacity obtained consistent with
existing conditions and economy of con-
struction and requirements.
(h) Reported to sponsor.

(3372) SEWER INTERCEPTING CHAMBER.

(b) Gore and Storrie, Limited, Toronto, Canada.
(c) Prof. L. E. Jones, University of Toronto,
Toronto 5, Canada.
(d) Experimental; for design and operation.
(e) An investigation on a 1:10.5 scale model,
to determine an intercepting chamber design
which would give satisfactory performance
over a wide range of design and field con-
ditions and which would permit of conven-
ient, inexpensive and trouble-free adjusta-
bility for any desired outflow distribution.
(g) A simple design of considerable promise has
been developed which will be subjected to a
greater range and variety of flow parame-
ters.
(h) Preliminary report to sponsor.

THE NATIONAL BUREAU OF STANDARDS

The scope of activities of the National Bureau of Standards at its major laboratories in Washington, D.C., and Boulder, Colorado, is suggested in the following listing of the divisions and sections engaged in technical work. In general, each section carries out specialized research, development, and engineering in the field indicated by its title. A brief description of the activities, and of the resultant publications, appears on the inside of the front cover.

WASHINGTON, D.C.

Electricity and Electronics. Resistance and Reactance. Electron Devices. Electrical Instruments. Magnetic Measurements. Dielectrics. Engineering Electronics. Electronic Instrumentation. Electrochemistry.

Optics and Metrology. Photometry and Colorimetry. Photographic Technology. Length. Engineering Metrology.

Heat. Temperature Physics. Thermodynamics. Cryogenic Physics. Rheology. Molecular Kinetics. Free Radicals Research.

Atomic and Radiation Physics. Spectroscopy. Radiometry. Mass Spectrometry. Solid State Physics. Electron Physics. Atomic Physics. Neutron Physics. Radiation Theory. Radioactivity. X-rays. High Energy Radiation. Nucleonic Instrumentation. Radiological Equipment.

Chemistry. Organic Coatings. Surface Chemistry. Organic Chemistry. Analytical Chemistry. Inorganic Chemistry. Electrodeposition. Molecular Structure and Properties of Gases. Physical Chemistry. Thermochemistry. Spectrochemistry. Pure Substances.

Mechanics. Sound. Mechanical Instruments. Fluid Mechanics. Engineering Mechanics. Mass and Scale. Capacity, Density, and Fluid Meters. Combustion Controls.

Organic and Fibrous Materials. Rubber. Textiles. Paper. Leather. Testing and Specifications. Polymer Structure. Plastics. Dental Research.

Metallurgy. Thermal Metallurgy. Chemical Metallurgy. Mechanical Metallurgy. Corrosion. Metal Physics.

Mineral Products. Engineering Ceramics. Glass. Refractories. Enameled Metals. Constitution and Microstructure.

Building Technology. Structural Engineering. Fire Protection. Air Conditioning, Heating, and Refrigeration. Floor, Roof, and Wall Coverings. Codes and Safety Standards. Heat Transfer. Concreting Materials.

Applied Mathematics. Numerical Analysis. Computation. Statistical Engineering. Mathematical Physics.

Data Processing Systems. SEAC Engineering Group. Components and Techniques. Digital Circuitry. Digital Systems. Analog Systems. Application Engineering.

● Office of Basic Instrumentation.   ● Office of Weights and Measures.

BOULDER, COLORADO

Cryogenic Engineering. Cryogenic Equipment. Cryogenic Processes. Properties of Materials. Gas Liquefaction.

Radio Propagation Physics. Upper Atmosphere Research. Ionospheric Research. Regular Propagation Services. Sun-Earth Relationships. VHF Research. Radio Warning Services. Airglow and Aurora. Radio Astronomy and Arctic Propagation.

Radio Propagation Engineering. Data Reduction Instrumentation. Modulation Research. Radio Noise. Tropospheric Measurements. Tropospheric Analysis. Propagation Obstacles Engineering. Radio-Meteorology. Lower Atmosphere Physics.

Radio Standards. High Frequency Electrical Standards. Radio Broadcast Service. High Frequency Impedance Standards. Electronic Calibration Center. Microwave Physics. Microwave Circuit Standards.

Radio Communication and Systems. Low Frequency and Very Low Frequency Research. High Frequency and Very High Frequency Research. Ultra High Frequency and Super High Frequency Research. Modulation Research. Antenna Research. Navigation Systems. Systems Analysis. Field Operations.

Hydraulic Research in the United States

Guides to projects conducted by various hydraulic and hydrologic laboratories in the United States and Canada during 1951, 1952, 1953, 1954, 1955, 1956, 1957, and 1958. Project reports cover work done at 74 private or State laboratories in the United States, 23 Federal laboratories, and 10 Canadian laboratories. These publications outline individual projects on nearly 200 subjects in the field.

Order:

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 NBS Miscellaneous Publication 208, Hydraulic Research in the United States, 1953, 215 pages. Price: $1.25.

 NBS Miscellaneous Publication 210, Hydraulic Research in the United States, 1954, 207 pages. Price: $1.25.

 NBS Miscellaneous Publication 218, Hydraulic Research in the United States, 1956, 216 pages. Price: $1.50.

 NBS Miscellaneous Publication 221, Hydraulic Research in the United States, 1957, 220 pages. Price: $1.50.

 NBS Miscellaneous Publication 224, Hydraulic Research in the United States, 1958, 168 pages. Price: $1.25.