

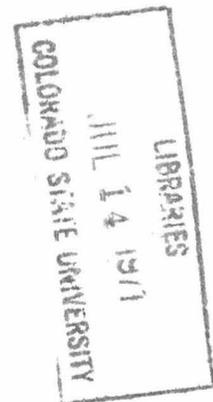
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HYDRAULIC RESEARCH
AT
COLORADO STATE UNIVERSITY

Summary of Research Projects

compiled by
A. R. Chamberlain



Civil Engineering Section
Colorado State University
Fort Collins, Colorado

December 1958

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Summary of Research Projects

The summary of each project follows this outline:

- (a) Title
- (b) Sponsors of the project
- (c) Principal investigator
- (d) Type of research, i. e., basic, applied, etc.
- (e) Description of the research
- (f) Present status, i. e., active, suspended, or completed
- (g) Results
- (h) Publications

The outline above follows that used in the Hydraulic Research Bulletin prepared annually by the National Bureau of Standards, U. S. Department of Commerce. The number preceding many of the titles is the NBS number designation.

- (55) SNOW COURSE MEASUREMENTS AND FORECAST ANALYSIS.
- (b) Soil Conservation Service, Colorado Agricultural Experiment Station.
 - (c) Homer J. Stockwell, Soil Conservation Service.
 - (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 resistance soil moisture units is being tested to determine a factor of soil moisture deficiency for water supply forecast purposes.
 - (f) Active.
 - (g) Snow measurement data are correlated with runoff. Once the relationship is established, the snow measurement data are used to predict the runoff for the coming season.
 - (h) Colorado Agricultural Experiment Station General Series Papers -- Monthly Snow Survey Reports for the Rio Grande, Colorado and Platte-Arkansas Drainage Basin.
- (821) GROUND-WATER FLUCTUATIONS AND THEIR RELATION TO PUMPING
- (b) Colorado Agricultural Experiment Station.
 - (c) M. W. Bittinger, Assistant Civil Engineer.

- (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.
- (f) Active.
- (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, Colorado State Univ. Agr. Expt. Sta. Bulletin 500-s, 34 pp., August 1958.

"Leaky Reservoir Aids Water Table", Colorado 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) G. L. Smith, Assistant Civil Engineer.
- (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.
- (f) Active.
- (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 basin 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. Report is now in preparation.
- "The Manifold Stilling Basin", by G. R. Fiala and M. L. Albertson, Colorado 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) R. D. Dirmeyer, Jr., Assistant Geological Engineer.
- (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.
- (f) Active.
- (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., Colorado State Univ., Civil Engineering Section, 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., Colorado State Univ., Civil Engineering Section, Report No. CER58RTS25, August 1958.

"Report on Laboratory Testing of the Sediment-Sealing Method", by E. C. Newman, Colorado State Univ., Civil Engineering Section, Report No. CER57ECN19, August 1957.

"Report on Laboratory Testing of the Sediment-Sealing Method", by R. T. Shen, Colorado State Univ., Civil Engineering Section, Report No. CER57RTS20, August 1957.

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

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

(c) H. K. Liu, Associate Civil Engineer.

(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 experimental work is conducted in a 150 foot long, 8 foot wide flume. Both the sediment 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 configuration and the change of bed configuration are measured throughout the testing period. The degree of contraction caused by the abutments varies from 0.5 to 0.1.

(f) Active.

(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 distribution of these three losses is known. Empirical curves were derived for estimating the maximum backwater found in the laboratory. A practical method for estimating 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.

- (h) "Backwater Effects of Bridge Piers and Abutments", by H. K. Liu, J. N. Bradley and E. O. Plate, Colorado State Univ., Civil Engineering Dept., Report CER57HKL10, October 1957.

(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) A. T. Corey, Civil Engineer.
- (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 this 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 evaporation from a given soil under prevailing ambient conditions.
- (f) Continuing.
- (g) (1) 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 moisture characteristics of the soil.

- (2) 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 .
- (3) 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 Geophysical Union by R. A. Schleusener and A. T. Corey, 1958.

(2278) METHODS OF GENERATING A COMPLEX SEA.

- (b) David Taylor Model Basin.
- (c) Robert E. Glover, Civil Engineer.
- (d) Theoretical; applied research.
- (e) The research is directed toward the development 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.

(f) Active.

(g) A new type of wave generator was developed which promises to have the ability to produce 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 31.

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

(b) Air Force Cambridge Research Center.

(c) J. E. Cermak, Associate professor.

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

(e) Measurements of mean velocity, mean temperatures, turbulence intensities and turbulent 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 designed and partially completed.

- (f) Active.
- (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 distribution 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 B. Chanda, Ph.D. dissertation, Scientific Report No. 1, AFCRC TN-58-428 (Astia-AD 152599), May 1958. 131 pp, Report No. CER58BC21.

"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) A. R. Chamberlain, Chief, Civil Engineering Section.
- (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)
 1. A suitable stilling basin was developed for spillway flows up to 10,000m³/s.
 2. 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.
 3. The flow characteristics and pressure distribution in the vicinity of the downstream end of the river outlets were examined and found satisfactory.
 4. 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 Experiment Station, Agricultural Research Service, Colorado Agricultural Experiment Station.

- (c) A. R. Chamberlain, Chief, Civil Engineering Section.
- (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.
- (f) Active.
- (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 sub-critical 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) 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.
- (f) Active.
- (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) H. K. Liu, Associate Civil Engineer.

(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.

(2760) METEOROLOGICAL OBSERVATIONS.

- (b) Colorado Agricultural Experiment Station and U.S. Weather Bureau.
- (c) Maxwell Parshall, Assistant Professor.
- (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.
- (f) Continuing.
- (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. Regional Project W-42.
(Revised)
- (c) M. W. Bittinger, Assistant Civil Engineer.
- (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.
- (f) Active.
- (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, Colorado, Together with Comments on Applicable Types of Legislation", by W. E. Code, W-42 Progress Report, 22p. 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) A. R. Chamberlain, Chief, Civil Engineering Section.

(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) M. L. Albertson, Director, Colorado State University Research Foundation.
- (d) Experimental and theoretical; basic research.
- (f) Completed.
- (h) "Meandering Characteristics of Alluvial Rivers", by H. Naga-
bhushanaiah, Master's thesis, Colorado State Univ., May 1958.
"Secondary Circulation in Open Channels", by Y. W. Wang,
Master's thesis, Colorado State Univ., May 1958.
- (2764) DESIGN AND CONSTRUCTION OF A TILTING FLUME.
- (b) National Science Foundation.
- (c) A. R. Chamberlain, Chief, Civil Engineering Section.
- (d) Design and construction.
- (e) A 2-ft wide, $2\frac{1}{2}$ -ft deep, by 60-ft long steel-frame flume has been designed and constructed. The flume is supported so that any slope from horizontal to a maximum of about 10 per cent 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

$\frac{1}{4}$ -inch stainless steel plate.

(f) Active.

(g) Design completed and construction is nearly completed.

(2765) FLOWMETER CALIBRATION.

(b) The Martin Company.

(c) A. R. Chamberlain, Chief, Civil Engineering Section.

(d) Experimental; applied research.

(e) Calibration of turbine type flowmeters which range in size from

$\frac{3}{16}$ in. to 12 in. for the Titan ICBM program.

(f) Active.

(2767) EDUCATIONAL FILMS ON OPEN CHANNEL FLOW.

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

(c) J. R. Barton, Associate Professor.

(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.

(f) Active.

(2768) CUMBAYA BYPASS STRUCTURE.

(b) R. J. Tipton Associated Engineers, Inc., Denver, Colorado.

(c) S. Karaki, Assistant Civil Engineer.

- (d) Experimental; applied research.
 - (e) The bypass is a unique underground structure which conveys water around a powerhouse 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 submerged jets.
 - (f) Active.
 - (g) The stilling basin as designed would perform satisfactorily, however modifications are necessary in the conduit approaching the stilling basin.
 - (h) "Report on a Hydraulic Model Study of the By-Pass of the Cum-baya 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) A. R. Chamberlain, Chief, Civil Engineering Section.
 - (d) Experimental; applied.
 - (e) The purpose of the project is to carry out tests on the dynamic, kinematic and general performance characteristics of various types of flowmeters to be inserted in pipelines. The flowmeters to be considered are the Gulton, Gentile Tube, and

Maxson Ultrasonic, impact strain gauge, turbine and rotameters.

The fluids under consideration are water, liquid oxygen, liquid nitrogen, JP-4 fuel, RP-1 fuel and MIL-0-5606 hydraulic fluid.

(f) Active.

(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 MEASUREMENT OF THE ELECTROKINETIC POTENTIAL.

(b) Research Corporation of New York.

(c) J. E. Cermak, Associate Professor.

(d) Experimental and theoretical; basic research for doctoral thesis.

(e) Electrokinetic potentials between two electrodes placed in the wall of a precision glass pipe are amplified after passing through an electrometer tube circuit and displayed on an oscilloscope. The displayed 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.

(f) Active.

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

- (b) National Science Foundation.
- (c) A. T. Corey, Civil Engineer.
- (d) Experimental and theoretical; basic research.
- (e) The primary objective of this project is to determine the effect of rate of displacement on the distribution of wetting and non-wetting fluid phases in porous solids. Particular emphasis is placed on the situation occurring when a non-wetting phase displaces a wetting phase at various rates. The ultimate aim is to obtain basic information which will enable better techniques to be devised whereby field situations involving flow in porous media can be studied by laboratory models.
- (f) Active. Project is in a preliminary stage involving design of equipment and incidental experiments to characterize the porous solids employed.

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

Cooperative project; Colorado Agricultural Experiment Station and Agricultural Research Service. See U. S. Department of Agriculture, Agricultural Research Service, page 32.

(2902) DEVELOPMENT AND IMPROVEMENT OF WATER MEASURING DEVICES.

Cooperative project; Colorado Agricultural Experiment Station and Agricultural Research Service. See U. S. Department of Agriculture, Agricultural Research Service, page 32 .

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

(b) Colorado Agricultural Experiment Station.

(c) M. W. Bittinger, Assistant Civil Engineer.

(d) Experimental and field investigations; applied.

(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 irrigation wells.

(f) Active.

(g) Review of literature available indicates a wide variance in recommendations for materials in irrigation-well construction, and in maintenance methods.

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

(b) U. S. Geological Survey.

(c) A. R. Chamberlain, Chief, Civil Engineering Section.

(d) Office research; applied and basic.

(e) The purpose of the study is to bring together knowledge from the fields of diffusion of heat, mass and momentum, adsorption 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.

(f) Active.

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

(b) U. S. Navy, David Taylor Model Basin.

(c) E. Schulz.

(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 restrained 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.

(f) Active - continuing.

- (g) Activity to date has been confined to development of instrumentation. These include 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 undisturbed 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 restrained model.
- (a) 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) E. F. Schulz, Associate Civil Engineer.
- (d) Experimental; applied research.
- (e) The primary objective of this project is to impose pitching and heaving displacements (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.

- (f) Active.
 - (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 analysed and will be compared with the analytical findings of Haskind, Havelock and Grimm.
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- (a) STUDY OF ATMOSPHERIC SURFACE LAYER PHENOMENA IN A WIND TUNNEL.
 - (b) National Science Foundation.
 - (c) J. E. Cermak, Associate Professor.
 - (d) Experimental and theoretical; basic research.
 - (e) Measurements of mean velocities and mean temperatures together with turbulence intensities 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.
 - (f) Active.
 - (g) Heating of the turbulent boundary layer at low Reynolds number has been found to produce the following effects: (1) increase the coefficient of drag (2) increase the eddy viscosity (3) increase the correlation between vertical and horizontal velocity fluctuations.

- (a) SCOUR BELOW CULVERT OUTLETS.
 - (b) Association of American Railroads.
 - (c) G. L. Smith, Assistant Civil Engineer.
 - (d) Experimental and theoretical; fundamental.
 - (e) Systematic measurements were made of the velocity profile of a submerged jet impinging upon a normal boundary to determine its influence on jet diffusion. The velocity 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 stagnation to a point where the mean radial velocity is approximately zero.
 - (f) Active.
 - (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 representation of diffusion profiles for water jets.
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- (a) MAKIO DAM SPILLWAY.
 - (b) Erik Floor and Associates, Inc., Chicago, Illinois.
 - (c) S. Karaki, Assistant Civil Engineer.
 - (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.

(f) Active.

(g) Modifications to the spillway approach and chute have been made.

The choice of stilling basin has been made with modifications thereto.

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

(b) State Highway Departments of Mississippi and Alabama.

(c) S. Karaki, Assistant Civil Engineer.

(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.

(f) Active.

(g) An apparent shape and location has been determined for one set of conditions in the testing flume.

- (a) TRANSFER OF WEATHER DATA TO PUNCH CARDS
 - (b) U.S.D.A., Soil Conservation Service and U. S. Weather Bureau.
 - (c) Richard A. Schleusener, Assistant Civil Engineer.
 - (d) Experimental; applied research.
 - (e) Weather data from 15 stations in eastern Colorado are being placed on IBM punch cards for 30 years of record prior to August 1948.
 - (f) Active.
 - (g) More than half of the total of 164,000 cards have been punched. About 40 per cent of the cards have been verified and duplicate decks have been sent to the Weather Bureau.
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- (a) MAGNITUDE AND FREQUENCY OF FLOODS IN ARID AND SEMI-ARID AREAS.
 - (b) U. S. Bureau of Public Roads, Department of Commerce.
 - (c) Richard A. Schleusener, Assistant Civil Engineer.
 - (d) Experimental; applied research.
 - (e) The purpose of the study is to develop procedures for estimating the frequency and magnitude of peak rates of runoff from watersheds in arid and semi-arid areas.
 - (f) Active.
 - (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.

- (a) THEORY OF CONSOLIDATION COMBINING PRIMARY AND SECONDARY CONSOLIDATION.
- (b) National Science Foundation.
- (c) I. S. Dunn, Associate Professor.
- (d) Experimental and theoretical; basic research.
- (e) The study consists of a mathematical analysis of the effect of visco-plastic resistance on the rate of pore pressure decrease and of an experimental program to verify the mathematical results and to investigate the effect of varied load increments on the time-consolidation relationship. The mathematical analysis will be carried out by adding visco-plastic resistance terms to the basic differential equation of consolidation developed by Terzaghi and solving the resulting equation either by standard methods or by analysis of a theoretical model. The solution of this system along with the laboratory consolidation curves will be used to produce the relationships between plastic resistance and related variables such as speed of deformation and per cent of deformation.
- (f) Active.

U. S. D. A.

Agricultural Research Service

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

(b) Cooperative Project - WS and WM Research Branch, A.R.S., and Colorado Agricultural Experiment Station.

(c) A. R. Robinson.

(d) Experimental; applied research; field evaluation; 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 operating conditions are being computed. Tubes of different shapes and sizes were tested. Field evaluations of existing sand trap installations are being planned.

(f) Active.

(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.

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

- (b) Agricultural Research Service, U. S. Department of Agriculture, cooperative project with Colorado State University.
- (c) E. G. Kruse.
- (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 materials.
- (f) Active.
- (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) Laboratory project; cooperative with Colorado State University.
- (c) A. R. Robinson.
- (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.

- (f) Active.
- (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) Report in progress.