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**HYDRAULICS RESEARCH**  
**SUMMARY OF RESEARCH PROJECTS**

**PREPARED FOR**  
**"HYDRAULIC RESEARCH IN THE UNITED STATES"**  
**NATIONAL BUREAU OF STANDARDS**  
**1958**



**CIVIL ENGINEERING SECTION**  
**COLORADO STATE UNIVERSITY**  
**FORT COLLINS, COLORADO**

**DECEMBER**  
**1957**

**CER 57 ARC 35**

ENGINEERING RESEARCH

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HYDRAULIC RESEARCH  
Summary of Research Projects  
Civil Engineering Section  
Colorado State University

Prepared For  
"Hydraulic Research in the United States"  
National Bureau of Standards  
1958

Fort Collins, Colorado  
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HYDRAULIC RESEARCH

Summary of Research Projects

Civil Engineering Section

Colorado State University

The summary on 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

(55) SNOW COURSE MEASUREMENTS AND FORECAST ANALYSIS

- (b) Soil and Water Conservation Research Branch, Colorado Agricultural Experiment Station, Bureau of Reclamation, State Engineer of New Mexico, and State Engineer of Wyoming.
- (c) H. J. Stockwell
- (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) W. E. Code
- (d) Field investigation
- (e) This is a continuing project. Work consists of semi-annual measurements of the water table in about 260 observation wells in 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 being coordinated with the Ground Water Branch, U.S.G.S.
- (f) Active
- (g) Water tables have declined significantly in all areas in the last 3 years of subnormal precipitation.
- (h) A manuscript is being prepared for a Station bulletin on the work to date which started in 1929. Graphs of water table fluctuations will be shown.

(1074) HYDRAULICS OF STILLING BASINS

- (b) U. S. Bureau of Public Roads
- (c) G. L. Smith
- (d) Experimental; applied and fundamental
- (e) To obtain generalized design information for stilling basins utilizing the principle of vertical dissipation of kinetic energy of flowing water and

control of scour by well graded aggregate. The stilling basin constitutes a pre-shaped scour hole in a simulated stream bed in which various quantities of graded aggregate are placed.

(f) Active

(g) Initial studies using two-dimensional jets have been completed, as well as circular non-submerged jets, both vertical and cantilevered. The variables considered were the depth of pool, the fall velocity of the erodible material, the size of jet, the momentum of the jet. The depth and volume of scour depends upon the depth of water in the stilling basin, the size or momentum of the jet, and the size and gradation of the bed material. Pit-run, graded rip-rap proved to be much more effective than any size of rip-rap of a narrow size range. Prototype installations were made for the two-dimensional case in the field in 1955 and the various design factors studied. Qualitatively these confirm the experimental results. For the three-dimensional case, the method of placement and location of rip-rap relative to the location of the impinging jet at bed surface have been investigated in a model. The dimensions of a pre-shaped scour hole for the case of the cantilevered circular jet have been determined from experimental data.

(h) "Recent Developments in the Design of a Simple Overfall Structure," by D. E. Hallmark and M. L. Albertson, January 1956.

"Stabilization of Thompson Lake Outlet Channel," by T. T. Williams, Master's Thesis, November 1956.

"Principles of Energy Dissipation in Erosion-Control Structures," by M. L. Albertson and G. L. Smith, January 1957. Colorado State University, Civil Engineering Department Report CER57MLA4.

"An Analysis of Scour Below Culvert Outlets," by G. L. Smith, Master's Thesis, June 1957.

(1567) BEHAVIOR OF SEAPLANE HULLS IN SIMPLE SEAS

(b) Bureau of Aeronautics, Navy Department

(c) E. F. Schulz

(d) Experimental; applied research

(e) Two model seaplanes were towed at different headings to a simple wave front. The responses of the model to the waves were measured from movies taken from the front and side during the experiments.

(f) Completed

(g) The important parameters determining operating in the pre-hump speed ranges were the effective towing ratio, relative hull length and damping ratio. Increasing the hull length-to-beam ratio from 8 to 12 improves the seaworthiness of the seaplane.

(h) "Model Tests to Predict the Seaworthiness of Seaplane Hulls," by E. F. Schulz, Colorado State University, Civil Engineering Department Report CER57EFS1, 60 p., January 1957.

"Development of a Basin for Investigation of the Seaworthiness of Model Seaplane Hulls," by E. F. Schulz, Colorado State University, Civil Engineering Department, 54EFS11, 40 p., March 1954.

(1570) FLOW PATTERNS ON LANDING IMPACT OF SEAPLANES

(b) Bureau of Aeronautics, Department of the Navy

(c) E. F. Schulz

(d) Experimental

(e) To record the force-time history of the impact of V-wedges with angles of dead rise from  $3^{\circ}$  to  $50^{\circ}$ , and two "constant force" hulls. To record the flow field development by photographic means as the wedges are dropped into a tank of bentonites, or zero-buoyancy bubbles, and water.

(f) Completed

(g) The force-times histories have been recorded, and indicate the earlier work along similar lines by MIT and Colorado State University employed too small a tank. Bentonite proved unsatisfactory as a material for use in obtaining photographs of the flow field. Computations of the apparent mass as a function of immersion depth for various

V-wedges are being completed. Zero buoyancy bubbles located in the water of the drop-tank permitted photographs of the path lines of the bubbles to be made for each impact of a V-wedge.

- (h) "Deceleration During Impact of Seaplane Hulls on a Water Surface," by Bernard d'Utruy, August 1957. Master's Thesis.

Report to sponsor in progress.

(1837) SEALING OF IRRIGATION CANALS BY BENTONITE SEDIMENTING

- (b) U.S.D.A. Agricultural Research Service, U.S.D.I. Bureau of Reclamation, various irrigation companies and districts.
- (c) R. D. Dirmeyer, Jr.
- (d) Applied research and development, both laboratory and field investigations
- (e) The sedimenting method involves the use of bentonite suspensions in water. The sealing is accomplished by the bentonite seeping into the cracks and voids of the pervious canal bed material. The technique depends greatly upon field conditions of each specific case. Most recent developments show the possibility of introducing various chemical products to supplement, or even in lieu of, the bentonite.
- (f) Active

(g) Varying degrees of success have been achieved, ranging from no reduction to 90% reduction in seepage. Further results await evaluation of improved techniques and long-term effectiveness. In most installations the amount of water saved even during only the first season has more than paid for the operation costs.

(h) "Report of Sediment Lining Investigations Fiscal Year 1956," by R. D. Dirmeyer, Jr., Colorado State University, Civil Engineering Department Report CER56RDD17, August 1956.

"Use of Colloidal Clay Sediments in Sealing Irrigation Canals," by R. D. Dirmeyer, Jr., International Commission on Irrigation and Drainage, Third Congress, R.5, Question 7, pp. 7.76-7.96, February 1957.

(1838) BEHAVIOR OF MODEL SHIP HULLS IN AN OBLIQUE SEA SYSTEM

(b) David Taylor Model Basin through the Office of Naval Research, Department of the Navy

(c) E. F. Schulz

(d) Experimental; applied research

(e) A five-foot model tanker was towed at five different headings to a simple wave front. The responses of the model to the waves were measured from movies taken from the front and side during the experiments.

(f) Completed

(g) The important parameters affecting the model motions were found to be the effective tuning ratio and the relative wave length. Amplitudes of motion were found to be as much as five times greater than the associated wave function when the tuning ratio was near unity. For a particular tuning ratio the amplitude parameters increased with increasing wave length up to approximately twice the hull length.

(h) "Model Tests with a Tanker in Oblique Seas," by E. F. Schulz, T. T. Williams and R. M. Ralston, Colorado State University, Civil Engineering Department Report CER57EFS2, 56 p., January 1957.

"Development of a Facility for Testing the Performance of Ship Hulls in Oblique Seas," by E. F. Schulz, Colorado State University, Civil Engineering Department Report 54EFS10, 39 p., March 1954.

(1839) THEORY AND DESIGN OF STABLE CHANNELS IN ALLUVIAL MATERIALS

(b) Cooperative project sponsored by U.S.G.S., Corps of Engineers, U.S.B.R., Colorado State University and the University of Wyoming

(c) D. B. Simons

(d) Experimental (based on field data), basic research

(e) This project involves a field study of stable channels in alluvial material. The purpose of the research

is to investigate the validity of the regime theories as developed in India; to investigate, expand, and possibly improve the tractive force method of stable channel design; and to relate the regime theories to the tractive force theory insofar as possible.

- (f) Completed
- (g) The usefulness of the regime and tractive force theories was verified. The range of applicability to design of both theories was expanded. Methods of combining the more useful concepts of each of these theories and applying them to design problems are illustrated. Problems that will require further study are cited.
- (h) "Theory and Design of Stable Channels in Alluvial Material," by D. B. Simons, Ph. D. Dissertation, 1957.

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

- (b) U. S. Bureau of Public Roads
- (c) H. K. Liu
- (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 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 abutments. The experimental work is conducted in a 160 ft. long, 8 ft. wide flume. Both the sediment and the water are recirculated in this system. A uniform flow is established before the abutments are in place. 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 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. Methods of analyzing data include a using energy and momentum principle; dimensional analysis; and empirical correlation.

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

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

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

- (c) A. T. Corey
- (d) Experimental and theoretical
- (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) Active
- (g) It has been found that in the soils studied there is a critical depth of water table. When the water table is above this depth, the rate of evaporation differs slightly from that of a free water surface. At evaporation rates of 1-inch per day or less, the critical depth can be related to moisture release curves obtained on these soils, the critical depth being approximately equal to the air-entry pressure of the soil-water system expressed as a head of water. At very high rates of evaporation the critical depth is substantially less than the air-entry pressure. Theory has been developed to explain these results. It has also been found that with the water table at a specified

depth (other than at the surface) the rate of evaporation increases with radiant energy input until a maximum is reached. Additional increments of radiation decrease the evaporation rates. An attempt is being made to explain this phenomenon.

- (h) "Effect of Depth of Water Table on Evaporation from Fine Sand," by Robert W. Staley, Master's Thesis, 1957.

A Doctoral Dissertation is now in preparation by Richard A. Schleusener.

(2278) METHODS OF GENERATING A COMPLEX SEAWAY FOR MODEL STUDIES

- (b) Navy Department through David Taylor Model Basin
- (c) R. E. Glover
- (d) Theoretical investigation of requirements for generating a specified confused sea
- (e) Present model basin wave generators are generally arranged for the production of long-crested waves. These may be regular or irregular in form. It is known, however, that storm seas are, or may be, of short-crested types. The development of means for generating a short-crested confused sea in a model basin is needed to permit model testing under conditions representing storm conditions. It is the objective of this project to develop ways of producing such model seas.

- (f) Active
  - (g) Some wave generator arrangements for producing short-crested seas of simple types have been devised.
  - (h) "Wave Motion Produced by Linear Wave Generators," by R. E. Glover, Technical Report No. 1, December 1956.  
"First Approximation to a Confused Sea in a Circular Model Basin," by R. E. Glover, Technical Report No. 2, January, 1957, Colorado State University, Civil Engineering Department Report CER57REG13.  
"Brief Note on Mechanical Means of Generating a Confused Sea," by R. E. Glover, Technical Report No. 3, January 1957, Colorado State University, Civil Engineering Department Report CER57REG14.
- (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 30.
- (2510) STUDY OF LOW LEVEL TURBULENCE
- (b) Air Force Cambridge Research Center, Laurence G. Hanscom Field, Bedford, Massachusetts
  - (c) J. E. Cermak
  - (d) Experimental and theoretical; fundamental
  - (e) A wind tunnel having a test section 6- X 6-ft. square and 80 ft. long with various arrangements of heating

and cooling surfaces is being designed and constructed. An experimental study using the equipment of project (1566) is being conducted to determine the effect of roughness upon the characteristics of a turbulent boundary layer formed over a rough, plane, heated boundary.

(f) Active

(g) Final phases of the wind tunnel construction are in progress. Considerable data on the turbulent boundary layer formed over a rough, plane, heated boundary has been obtained using the same experimental equipment as for Project 1566.

(2511) IRRIGATION WATER APPLICATION AND DRAINAGE OF LANDS IN  
THE UPPER COLORADO RIVER BASIN

(b) Colorado Agricultural Experiment Station and U.S.D.A.

(c) N. A. Evans

(d) Field investigation and experimental, applied and basic  
research

(e) Drainage and reclamation of typical western valley irrigated lands. Investigational techniques and procedures for analysis of groundwater problems are being developed. The hydraulics of a drainage well system have been analysed.

(f) Active

(g) The geophysical technique of electrical resistivity has been used with excellent results in stratum

investigation. Successful performance of a drainage well has been found to depend very largely upon openings in a confining clay stratum. Drainage by pumping has been found to be economical under the prevailing conditions.

(2512) MODEL STUDIES FOR BOCONÓ DAM, VENEZUELA

- (b) Tipton and Kalmbach, Inc., Denver, Colorado
- (c) A. R. Chamberlain
- (d) Experimental; applied research
- (e) The purpose of this investigation is to obtain information concerning the action of water flowing over and through the proposed dam and appurtenant structures. This includes: (1) design and construction of models in accordance with proposed designs; (2) qualitative investigation of the flow characteristics over the spillway and through the outlet works; (3) calibrating the spillway and obtaining a rating curve for discharges released under radial gates at various openings; (4) a study of a stilling basin and secondary dam design to obtain satisfactory energy dissipation, and check the height of guide walls provided; (5) study of the flow pattern and pressure distribution at the ends of the river outlets opening to the downstream face. A large scale model will be specially built for this study, and

(6) study the effect of stilling basin operation on pressure variations in the draft tubes which discharge into the stilling basin.

(f) Active

(g) A general model has been constructed to a scale of 1:49.2. The design of the stilling basin, secondary dam, and downstream gravel apron has been finalized, based on observations of the model performance. Alterations have also been made in the crest, piers, and ends of the spillway to improve flow conditions.

(h) "Interim Report on Model Studies for Bocono' Dam," Colorado State University, Civil Engineering Department Report CER57ARC28, October 1, 1957. Not available for outside distribution.

(2513) FLOW MEASURING DEVICES

(b) Rocky Mountain Forest and Range Experiment Station

(c) A. R. Chamberlain

(d) Experimental; applied

(e) The purpose of the initial phases was to test a 1/6 scale model of a modified WSC flume, to determine its suitability and calibration curve for applications at flow measuring stations along steep (5%) channels of ephemeral streams. The scope of the research has been expanded to include a generalized series of tests

which should result in complete design criteria for trapezoidal open channel flumes.

- (f) Active
- (g) Experiments completed on the initial phases. The experiments for the generalized cases mentioned above have not been completed as yet.
- (h) "Preliminary Model Tests of a Flume for Measuring Discharge of Steep Ephemeral Streams," by A. R. Chamberlain prepared for the Rocky Mountain Forest and Range Experiment Station, February 1957, Colorado State University, Civil Engineering Department Report CER57ARC12.

(2514) FUNDAMENTAL INVESTIGATION OF ALLUVIAL CHANNEL ROUGHNESS

- (b) U. S. Geological Survey
- (c) D. B. Simons
- (d) Experimental; basic
- (e) This study involves a detailed analysis of the mechanics of bed roughness and sediment transport in alluvial channels. The first phase of the investigation deals primarily with evaluation of resistance to flow in alluvial channels. This phase of the problem is currently being studied in a recirculating laboratory flume 8 ft. wide and 150 ft. long. Upon completion of the laboratory study the results will be modified by a field study to suit field conditions.

- (f) Active
- (g) The first sequence of runs in the laboratory flume have been completed. A preliminary report based on the flume data is currently being prepared.
- (h) Progress Report: "Resistance to Flow in Alluvial Channels," by D. B. Simons and E. V. Richardson, U.S.G.S., Colorado State University, available in February 1958.

(2516) ANALYTICAL STUDY OF ALLUVIAL CHANNEL ROUGHNESS

- (b) National Science Foundation
- (c) H. K. Liu
- (d) Analytical; applied research and master's thesis
- (e) A considerable amount of field and experimental data has been gathered from many different sources. An empirical relationship between dimensionless parameters pertinent to the flow and to the sediment has been established. An attempt will be made to confirm the empirical correlation through theory and contribute towards an understanding of the mechanics of ripple formation, of the interaction between flow and sediment in alluvial channels, and to develop design formulas for alluvial channel flow which are valid for a wide range of field conditions, and which show how sediment properties influence the roughness coefficients of the conventional discharge formulas.

(f) Active

(2517) EFFECT OF WASH LOAD ON CONCENTRATION OF BED MATERIAL  
IN SUSPENSION

(b) Laboratory project

(c) A. R. Chamberlain

(d) Experimental; fundamental

(e) Using a tank with lattice-type agitator to create uniform turbulence, fine sand in the bed of the tank was carried into suspension and measurements made of concentration. A kaolin-type clay was introduced in varying concentrations and the concentration distribution of the suspended bed sand again measured. The temperature was also varied.

(f) Active

(g) Concentrations of 0.5, 1.0 and 2.0 per cent of clay were found to increase the average concentration of bed material in suspension by 5.0, 18.0, and 36.0 per cent respectively. Although this marked increase in concentration could be attributed in part to the increased viscosity due to the clay, it did not account for all the increase.

(h) "Effect of Wash Load on Suspension of Bed Material Load," by A. Hasan Makarechian, Master's Thesis, November 1956.

(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 30.

(a) PNEUMATIC CONVEYANCE OF LIVESTOCK FEEDS

(b) Colorado Agricultural Experiment Station

(c) N. A. Evans

(d) Experimental; basic research

(e) A study of the mechanics of pneumatic transport of  
livestock feeds, such as grain and concentrate  
mixtures.

(f) Active - in initial stage

(a) METEOROLOGICAL OBSERVATIONS

(b) Colorado Agricultural Experiment Station and U. S.  
Weather Bureau

(c) M. Parshall

(d) Field investigation - basic research

(e) Meteorological observations are made twice daily, as  
they have been made since 1887. The data serve  
to determine the climate of this station. The  
data are used by Experiment Station workers,  
local companies and private individuals.

Evaporation from a free water surface has been measured twice daily during the ice-free season since 1887 and is one of the longest records in the U. S. Elements observed every two hours are: air temperature, maximum and minimum temperature, wet and dry bulb temperature, terrestrial radiation temperature, soil temperatures @ 3,6,12, 24,36 and 72 inches, wind at 15 inches and 65 ft., barometric pressure, precipitation, recording of temperature, pressure and precipitation, sky cover, wind direction and evaporation to 0.001 inch water temperature and maximum and minimum water temperature during ice-free season.

- (f) Active
- (g) New high and low temperature extremes have been recorded within the past 6 years.
- (h) The data from this station are published in part in climatological data for Colorado by the U.S.W.B. There have been in the past Station Bulletins published which carry complete station data as well as standard deviations for some of the data. The last bulletin was published in 1947.
- (a) ECONOMIC EFFECT AND LEGISLATIVE IMPLICATIONS OF GROUND-WATER DEPLETION IN THE LOWER BIJOU BASIN, MORGAN COUNTY, COLORADO
- (b) Colorado Agricultural Experiment Station and U.S.D.A. Western Regional Project W-42

- (c) W. B. Code and I. P. Davis
- (d) Field investigation
- (e) This is a cooperative regional investigation in which 7 states are involved. In Colorado the project is conducted cooperatively between the Economics and Civil Engineering Sections of CSU. Each state will conduct its own study on a particular area where groundwater is being developed. The amount of water pumped from the study area in Bijou Valley was determined for 1956 in conjunction with the effect on the water table. These and other data will be used to determine the life of the supply under present conditions. Conclusions will be drawn on the economic impact on the area under present conditions and what they would have been had some specific type of legislative control been in effect.
- (f) Will be completed June 30, 1958
- (g) The water table in Bijou Valley has been receding because of over development since pumping began in 1935. The lowering was very moderate at first but as pumping expanded the rate of lowering was accelerated, particularly since 1948. A groundwater law was passed early in 1957 but there has not as yet been time for its application to this area.

(h) A progress report was prepared by Irving P. Davis and W. E. Code and published in Colorado Farm and Home Research, Vol. 7, No. 4, January-February 1957.

(a) CURRENT METER INVESTIGATION

(b) U. S. Geological Survey

(c) A. R. Chamberlain

(d) Experimental; applied

(e) To determine the effect on the performance of various types of current meters of: (1) various 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. The purpose of the new design is to obtain a standard rotor which can be mass produced with sufficient accuracy as to eliminate individual ratings and which will have better characteristics than the Price.

(f) Active

- (a) EQUILIBRIUM CONDITIONS IN OPEN CHANNELS
  - (b) National Science Foundation and Colorado State University
  - (c) M. L. Albertson
  - (d) Experimental and theoretical; basic research
  - (e) The study consists of an analysis of data taken on open channels in both the laboratory and the field. Present emphasis is being placed upon the analysis of profiles of velocity and sediment concentration as associated with secondary circulation.
  - (f) Active
- 
- (a) OPEN CHANNEL RESEARCH - CONSTRUCTION OF A TILTING FLUME
  - (b) National Science Foundation
  - (c) A. R. Chamberlain
  - (d) Design and construction of equipment
  - (e) The above project has as its fundamental purpose the design and construction of basic equipment to be utilized in the CSU investigations in the field of alluvial channel hydraulics.
  - (f) Active
  - (g) Design of the flume has been completed. Materials for construction have been received.
- 
- (a) CALIBRATION OF TURBINE METERS FOR THE MARTIN COMPANY,  
DENVER DIVISION
  - (b) The Martin Company, Denver, Colorado
  - (c) A. R. Chamberlain

(d) Experimental

(e) The purpose of the project is to calibrate turbine-meters ranging from 3/16" to 12" in nominal size. These turbine-meters will later be used for determining flow rates of water, liquid oxygen, liquid nitrogen, RP-1 fuel and MIL-0-5606 hydraulics fluid. Two test stands have been constructed for this purpose.

(f) Active

(g) Calibration curves have been obtained for several meters to date.

(a) HYDRAULICS OF MEANDERS AND SPUR DIKES

(b) National Science Foundation

(c) A. R. Chamberlain

(d) Theoretical and fundamental

(e) This project was designed to make use of a certain number of off-campus high school and junior college teachers during the summer of 1957. The faculty members who worked on this project investigated (a) utilization of the somascope for measurement of scour around spur dikes, (b) design of a shear transducer for measuring shear along a boundary, (c) mathematical analysis of flow through trapezoidal sections, and (d) theoretical investigation of scour behavior around spur dike configurations.

(f) Active

(g) Final report in progress

(a) EDUCATIONAL FILMS

(b) U. S. Bureau of Public Roads

(c) J. R. Barton

(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

(a) MODEL STUDIES OF THE CUMBAYA PROJECT TUNNEL BY-PASS,  
ECUADOR

(b) Tipton and Kalmbach, Inc., Denver, Colorado

(c) A. R. Chamberlain

(d) Experimental; applied research, design

(e) This by-pass is needed to carry water around a hydraulic power plant when the power plant is shut down. It operates infrequently. The water passes through an inclined tunnel with a drop of approximately 200 feet. At the outlet end it enters a horizontal tunnel. The problem is to dissipate the energy as it enters the tunnel. A manifold stilling basin forces the water up as a series of jets into the bottom of the tunnel and the energy is dissipated in the overhead water.

The problem is to determine the proper size and number of the jets and the depth of submergence.

(f) Active

(h) "Laboratory Study of a Manifold Stilling Basin," by Gene Fiala, Master's Thesis, May 1957.

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

(b) The Martin Company, Denver, Colorado

(c) A. R. Chamberlain

(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, the Maxson Ultrasonic, impact strain gauge, turbine-meters and rotameters. The fluids under consideration are water, liquid oxygen, liquid nitrogen, GP-4 fuel, RP-1 fuel and MIL-0-5606 hydraulics fluid.

(f) Active

(g) Preliminary results indicate that the viscosity of the fluid can have a very marked effect on the performance of certain types of turbine-meters. Minor variance in interior diameter of the pipelines has a negligible influence on the calibration curve.

(a) A STUDY OF SHEAR STRESS AT A FLUID-SOLID INTERFACE  
BY MEASUREMENT OF THE ELECTROKINETIC POTENTIAL

(b) Research Corporation, New York

(c) J. E. Cermak

(d) Experimental; basic research

(e) Electrokinetic potentials developed between wall electrodes at about 1-inch spacing along the length of a 1-inch diameter pipe will be recorded by an oscilloscope camera recorder. Time variation of the electrokinetic potential for laminar, transition and turbulent flow will be studied. These data will be used to obtain fundamental information on boundary shear stress.

(f) Active

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

(b) National Science Foundation

(c) A. T. Corey

(d) Experimental; basic research, theoretical

(e) The purpose of this project is to determine by experimental methods whether or not the distribution of wetting and non-wetting phases in a porous solid depends on the rate at which a wetting phase is displaced by a non-wetting phase. It is planned to obtain this information by measuring the effect

of displacement rates on the hydraulic conductivity and on the electrical conductivity of electrolytes at particular saturations of the wetting phase.

(f) Active. Equipment is being assembled.

(a) 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 31.

(a) 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.

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

- (b) Cooperative Project - WS&WM Research Branch, ARS, and  
Colorado Agricultural Experiment Station
- (c) A. R. Robinson
- (d) Experimental; applied research; field evaluation; design
- (e) 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.

(2649) DEVELOPMENT OF DRAINAGE DESIGN CRITERIA FOR IRRIGATED  
LANDS

- (b) Cooperative Project: WS&WM Research Branch, ARS, and  
Colorado Agricultural Experiment Station
- (c) N. A. Evans and A. R. Robinson
- (d) Experimental; applied research; design
- (e) Both field and laboratory studies are being made to  
determine the relationship of drain 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.

- (f) Active
  - (g) --
  - (h) "Model Study of Interceptor Drains," by J. Keller, Master's Thesis, August 1955.
- (a) LABORATORY STUDY OF GRAVEL FILTER DESIGN FOR IRRIGATION WELLS
- (b) Cooperative Project: WS&WM Research Branch, ARS, and Colorado Agricultural Experiment Station
  - (c) A. R. Robinson
  - (d) Experimental; applied research
  - (e) The objectives are: (1) to determine the relationship of pack-aquifer ratio and the pack and aquifer uniformity for stable conditions, (2) to develop generalized criteria for the selection and placement of gravel pack materials.
  - (f) Active
  - (g) Results not yet available

- (a) DEVELOPMENT AND IMPROVEMENT OF WATER MEASURING DEVICES
- (b) Cooperative Project: WS&WM Research Branch, ARS, and Colorado Agricultural Experiment Station
- (c) A. R. Robinson
- (d) Experimental; applied research
- (e) The project was initiated to improve existing devices and develop new water measuring equipment primarily for irrigation purposes. Calibrations of small Parshall flumes have been completed. Development and calibration of trapezoidal flumes is planned.
- (f) Active
- (g) Small measuring flumes of the Parshall type were designed and accurate calibrations made.
- (h) "Parshall Measuring Flumes of Small Sizes," by A. R. Robinson, Colorado State University Agricultural Experiment Station, Technical Bulletin No. 61, 1957, Colorado State University, Civil Engineering Department Report CER57ARR7.