

INVENTORY OF RESEARCH
IN
WATER POLLUTION AND RELATED FIELDS

COLUMBIA BASIN AND PACIFIC COAST STATES

1963

Compiled by
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U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service
Pacific Northwest Water Laboratory
Corvallis, Oregon

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PREFACE

This is the sixth annual inventory of research on water pollution and related subjects prepared and distributed by the Portland, Oregon office of the Division of Water Supply and Pollution Control, U. S. Public Health Service. Initially, these inventories covered only those projects under way in the Pacific Northwest. The area covered was expanded in 1961 to include the states of Alaska, Arizona, California, Idaho, Montana, Oregon and Washington and the western portion of British Columbia. The 1963 inventory covers this area in addition to the states of Hawaii and Wyoming.

Many of the projects listed in 1962 were not completed in that year and, consequently, are again contained in this inventory with any change in status indicated. A considerable number of new projects are also listed.

Material for these inventories has been supplied by the various individuals and organizations conducting the studies. Every effort has been exerted to make the information contained herein as accurate as possible. If significant errors have been made, they will be corrected, if they are called to the attention of the compiler.

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RESEARCH PROJECT INVENTORY

Index No.

ALASKA

U. S. DEPARTMENT OF AGRICULTURE, NORTHERN FOREST EXPERIMENT STATION, JUNEAU

- 1 SUSPENDED SEDIMENT LEVEL AND CHARACTER IN LOGGED AND UNLOGGED STREAMS OF SOUTHEAST ALASKA. R. M. Hurd. Location--Vicinity of Hollis, Prince of Wales Island, Alaska. To determine: (1) The levels of suspended sediment in logged and unlogged streams of southeast Alaska; (2) How levels change with stream discharge; (3) How suspended sediment level in a logged stream changes as the watershed recovers from logging; (4) How the organic/inorganic sediment fraction changes as a watershed is logged or recovers after logging. A continuing project. Supported by U. S. Forest Service funds.

ARIZONA

ARIZONA STATE UNIVERSITY, TEMPE

- 2 ENGINEERING BIOASSAY DEVELOPMENT. J. W. Klock. Supported by Public Health Service (NIH) Grant of \$23,729. Grant started on May 1, 1962 and will end April 30, 1964.
- 3 INFLUENCE OF MONOMOLECULAR FILMS ON WIND-GENERATED WATER WAVES. P. F. Ruff. Starting date, July 1, 1962; termination date, September 30, 1964. Supported by U. S. Bureau of Reclamation, \$20,000.
- 4 STUDIES ON WATER AVAILABILITY AND PLANT GROWTH. D. O. Robinson. A part-time, unsponsored project which was continued in 1963.
- 5 WASTE WATER RECLAMATION. J. W. Klock, with the cooperation of Maricopa County Health Dept., U. S. Public Health Service, Del E. Webb, Inc., and Citizens Utility. Project started July 1962; to terminate in June 1965. Supported by Bureau of Reclamation, \$4,000 a year.

- 6 DEVELOPMENT OF AN AUTOMATIC WIND-REGULATED SYSTEM OF APPLYING LONG-CHAIN ALCOHOL-WATER SUSPENSIONS ON WATER SURFACES TO REDUCE EVAPORATION. C. O. Reiser. Project started September 1, 1963; to terminate November 1, 1965. Supported by U. S. Bureau of Reclamation, \$30,000.
- 7 LIMNOLOGY INVESTIGATION IN ARIZONA. Gerald Cole and W. T. Barry. Started September 1, 1962; to terminate August 31, 1965. Supported by National Science Foundation funds, \$46,000.

U. S. DEPARTMENT OF AGRICULTURE, ROCKY MOUNTAIN FOREST AND RANGE EXPERIMENT STATION, ARIZONA STATE UNIVERSITY, TEMPE

- 8 RELATION OF SPECIES TO SOIL TEXTURE AND SALINITY AND WATER TABLE HEIGHT. J. S. Horton and J. L. Gary. Objectives: To obtain information on soil characteristics and water table depth as they relate to distribution and development of phreatophyte vegetation. Terminated in 1963. Supported by Federal funds.
- 9 COMPARISON OF INFRARED GAS ANALYZER WITH OTHER METHODS OF MEASURING EVAPOTRANSPIRATION. J. S. Horton and J. P. Decker. Objectives: To compare several methods (infrared analyzer, weighing lysimeter, volume lysimeter, etc.) for measuring evapotranspiration. Terminated in 1963. Supported by Federal funds.
- 10 EFFECT OF BRUSH CONTROL ON EVAPOTRANSPIRATION AT NATURAL DRAINAGE WATERSHEDS. P. Ingebo and C. P. Pase. Objectives: To evaluate the results of converting a mixed shrub-grass cover to native perennial grasses in terms of water and sediment yields. Continued in 1963. Supported by Federal funds.
- 11 EFFECT OF TIMBER HARVEST ON WATER YIELD IN MIXED CONIFER FOREST. L. R. Rich. Salt River Valley Water Users' Association cooperating. Objectives: To determine what influence advanced timber management practices have on sediment production and water yields. Continued in 1963. Supported by Federal funds.
- 12 STREAMFLOW CHARACTERISTICS OF CHAPARRAL WATERSHEDS. G. E. Glendening, P. Ingebo and C. P. Pase. Prescott National Forest cooperating. Objectives: To determine the relationships between individual sample watersheds, under present conditions, with respect to water and

sediment yields, in anticipation of later watershed treatment comparisons. Continued in 1963. Supported by Federal funds.

- 13 EFFECT ON STREAMFLOW OF CONVERTING WHITE FIR TO PERENNIAL GRASS. L. R. Rich. Salt River Valley Water Users' Association cooperating. Objectives: To determine how different kinds and amounts of vegetation influence water and sediment yields by replacing the white fir with perennial grass. Continued in 1963. Supported by Federal funds.
- 14 MEASUREMENT OF EVAPOTRANSPIRATION IN THE FIELD WITH INFRARED GAS ANALYZER. J. S. Horton and J. P. Decker. Objectives: To make direct estimates of annual evapotranspiration with natural stands of tamarisk Bermuda grass, seep-willow, arrow-weed, and other phreatophytes. Terminated in 1963. Supported by Federal funds.
- 15 STREAMFLOW AND SEDIMENT PRODUCTION IN MIXED CONIFER--WILLOW CREEK. L. R. Rich. Apache National Forest and Arizona Game and Fish Commission cooperating. Objectives: To determine: (1) The effect of timber management systems such as block or opening cutting of forest vegetation on water and sediment yields; and (2) The effect on water and sediment yields of water management systems such as replacing the mixed conifer forest vegetation with perennial grass or aspen. Continued in 1963. Supported by Federal funds.
- 16 SEDIMENT PRODUCTION IN RELATION TO LOGGING PONDEROSA PINE ON CASTLE CREEK. L. R. Rich. Apache National Forest cooperating. Objectives: To determine what influence Forest Service methods of harvesting ponderosa pine timber have on water and sediment yields. Continued in 1963. Supported by Federal funds.
- 17 EFFECT OF COVER CHANGES IN CHAPARRAL ON SEDIMENT--3-BAR, G. E. Glendening, P. Ingebo and C. P. Pase. The Tonto National Forest, Salt River Valley Water Users' Association and the Arizona Fish and Game Commission are cooperating in this project. Objectives: To determine the effects of wildfire on streamflow and sediment yields from the granite-soiled 3-Bar Chaparral watersheds; and the influence thereon of the natural return of brush cover, with and without reseeding, and with and without sprout control. Continued in 1963. Supported by Federal funds.
- 18 SEDIMENT FROM SEMI-DESERT GRASS AND SHRUB WATERSHEDS--SUMMIT. L. R. Rich. Objectives: To determine the effect of amounts, rates and seasonal distribution of precipitation

on runoff and sediment yields from the small, steep, and highly erodible granitic watersheds under mixed semi-desert grass and shrub cover. Continued in 1963. Supported by Federal funds.

- 19 A COMPARISON OF WATER AND SEDIMENT YIELDS ON THE BASE ROCK LYSIMETERS. G. E. Glendening and C. P. Pase. Objectives: To compare water yield and soil stability of a stand of the introduced Lehmann lovegrass, a stand of native curly mesquite grass, and a natural semi-desert grass--half-shrub type. Continued in 1963. Supported by Federal funds.
- 20 CHANGES IN VEGETATION, LITTER AND SEDIMENT YIELD FOLLOWING STRIP BURNING IN CHAPARRAL. C. P. Pase, G. E. Glendening and P. Ingebo. Objectives: To evaluate effect of prescribed cool-season burning of contour strips in chaparral on vegetation, grass sediment yield, and soil moisture disposition. Continued in 1963. Supported by Federal funds.
- 21 HYDROLOGIC CHARACTERISTICS OF CHAPARRAL. P. Ingebo. Objectives: To determine seasonal and total water yield in relation to precipitation pattern and other site factors. Continued in 1963. Supported by Federal funds.

U. S. DEPARTMENT OF AGRICULTURE, ROCKY MOUNTAIN FOREST AND RANGE EXPERIMENT STATION, ARIZONA STATE COLLEGE, FLAGSTAFF

- 22 SEDIMENT MOVEMENT FROM CHANGES IN PONDEROSA PINE (BEAVER CREEK). Objectives: To determine changes in streamflow sediment concentrations as a result of land practices on pine watersheds. Terminated in 1963.
- 23 SEDIMENT MOVEMENT FROM CLEARING JUNIPER (BEAVER CREEK). Objectives: To determine changes in streamflow sediment concentrations as a result of clearing juniper. Terminated in 1963.
- 24 PRECIPITATION AND STREAMFLOW IN PONDEROSA PINE TYPE (BEAVER CREEK). Objectives: (1) The precipitation gages are being maintained primarily for evaluation and correlation of precipitation data with runoff, erosion, sedimentation, and soil moisture, and to obtain a pattern of rainfall intensities, frequencies, duration, and distribution on the small pine watersheds on Beaver Creek; (2) To collect

stream discharge data from small pine watersheds for the purpose of evaluating the effects of various forms of land management on streamflow. Terminated in 1963.

UNIVERSITY OF ARIZONA, TUCSON

Note: The following projects were selected from "List of Current Research in Water Resources at the University of Arizona," January, 1963.

- 25 SALINE WATER DEMINERALIZATION. C. N. Hodges, J. E. Groh and T. L. Thompson. To develop and evaluate a solar-powered demineralization system. Supported by the Office of Saline Water, U. S. Department of Interior.
- 26 SOLAR EVAPORATION OF SALINE WATERS UNDER VACUUM. D. H. White and I. Shaheen. Solar evaporation of saline or brackish waters in pressures below atmospheric and corresponding operating temperatures of evaporation and condensing in the range of 60 to 120° F. Supported by University funds in initial phases.
- 27 THE VALUE OF WATER FROM FORESTED WATERSHEDS IN CENTRAL ARIZONA. M. M. Kelso, Lawrence Mack and David Worley. The goal of this research is to determine the value of surface water from watersheds. Supported by the Southwest Forest & Range Experiment Station and the University Agricultural Experiment Station.
- 28 DETERMINING AND SHARING COSTS AND BENEFITS FROM DEVELOPMENT OF THE CENTRAL ARIZONA WATERSHED. M. M. Kelso. To advance a theory by which to determine the economic feasibility of watershed management programs. Supported by Agricultural Experiment Station, Rocky Mountain Forest & Range Experiment Station and Arizona Water Resources Committee.
- 29 THE BIOCHEMICAL OXYGEN DEMAND OF ALGAL SUSPENSIONS. Q. M. Mees and S. J. Dea. The effect of algae on the BOD determination. An M.S. degree project. Supported by National Institutes of Health and Civil Engineering Department.
- 30 ALKYL BENZENE SULPHENATE REMOVAL IN RAW SEWAGE STABILIZATION LAGOONS. Q. M. Mees and W. B. Dendy. An M.S. degree project. Supported by National Institutes of Health and Pima County Sanitary District.

- 31 NATURAL SEALING POTENTIAL OF RAW SEWAGE STABILIZATION LAGOONS. Q. M. Mees and S. A. Deming. A field and laboratory study of theory and design. An M.S. degree project. Supported by National Institutes of Health and Pima County Sanitary District.
- 32 OXIDATION PONDS FOR THE TREATMENT OF RAW SEWAGE IN THE SOUTH-WEST. Q. M. Mees and E. W. Dooley. A study of design criteria and efficiency. An M.S. degree project. Supported by National Institutes of Health.
- 33 SURVIVAL OF PATHOGENS IN SEWAGE STABILIZATION PONDS. Q. M. Mees and J. R. Hensley. A study of the ability of amoeba, intestinal flagellates and ova of helminths to survive the stabilization process. Supported by National Institutes of Health and Arizona Department of Health.
- 34 FLOW PATTERNS IN A STABILIZATION LAGOON. Q. M. Mees and W. C. Pisano. An M.S. degree project. Supported by University Civil Engineering Department and Pima County Sanitary District.
- 35 RADIOCARBON AS A TRACER IN WATER SUPPLY PROBLEMS. P. E. Damon, J. W. Harshbarger, J. Sigalove, A. Long and Fred Cagle. A study of radiocarbon in groundwater. Supported by the University and Research Corporation.
- 36 DEVELOPMENT OF HYDRAULIC MODELS ANALOGOUS TO SUBSURFACE GEOLOGIC CONDITIONS FOR STUDYING AND DEMONSTRATING THE CHARACTERISTICS OF GROUNDWATER MOVEMENT. J. H. Lehr and J. J. Wright. The use of hydraulic models of subsurface strata as a means of studying groundwater movement. Supported by National Science Foundation.
- 37 REDUCTION OF EVAPORATION LOSSES BY USING MONOMOLECULAR FILMS. C. B. Cluff, S. D. Resnick and Howard Goldstein. To develop techniques by which to determine the effectiveness of monomolecular films and improve methods of applying same. Supported by the Agricultural Experiment Station and U. S. Bureau of Reclamation.
- 38 INVESTIGATION OF SITES, METHODS, AND AQUIFER DETERIORATION CONTROL, AND EFFECTS OF ARTIFICIAL GROUNDWATER RECHARGE OF ALLUVIAL BASINS TYPICAL OF THE ARID SOUTHWEST. L. G. Wilson and S. D. Resnick. Includes the effect of recharge on bacteria applied. Supported by Agricultural Experiment Station.

BRITISH COLUMBIA

CANADIAN DEPARTMENT OF AGRICULTURE, SUMMERLAND

- 39 EFFECTS OF TIME AND PLACE OF SAMPLING ON QUALITY OF IRRIGATION WATER FROM MOUNTAIN STREAMS. J. C. Wilcox. Location--Okanagan Valley, B. C. Started in 1956 and continuing. Supported by funds of the Department.
- 40 QUALITY OF PRESENT AND POTENTIAL SOURCES OF IRRIGATION WATER IN SOUTHERN BRITISH COLUMBIA. J. C. Wilcox. Some 200 samples have been collected and analyzed. Started in 1956 and continuing. Supported by Department funds.
- 41 SUITABILITY FOR IRRIGATION OF WATER FROM LAKES AND STREAMS IN THE SOUTHERN INTERIOR OF BRITISH COLUMBIA. J. C. Wilcox and J. L. Mason. Results published in Canadian Department of Agriculture Publication No. 1179 (1963).

FISHERIES RESEARCH BOARD OF CANADA, BIOLOGICAL STATION,
NANAIMO

- 42 MULTIVARIATE ANALYSIS OF ENVIRONMENTAL RESPONSE DOMAINS. D. F. Alderdice. Publication: "Some Effects of Simultaneous Variation in Salinity, Temperature and Dissolved Oxygen on the Resistance of Young Coho Salmon to a Toxic Substance," by D. F. Alderdice. Jour. Fisheries Research Board of Canada, Vol. 20, No. 2, pp. 525-550, 1963. Second paper (Ph.D. thesis--same author--same title) in preparation. This is a general topic and work in this field is scheduled to continue for 10 years. Supported by Federal Government.
- 43 TRACING SEWAGE AND INDUSTRIAL WASTES IN THE SEA USING RHODAMINE B DYE. M. Waldichuk and J. R. Markert. Started April, 1961; continued in 1963 on small scale. Funds from Research Board, \$5,000.
- 44 TOXICITY OF MALATHION TO YOUNG COHO SALMON. D. F. Alderdice. Location--Biological Station, Nanaimo, B. C. Completed. Publication being prepared. Supported by Research Board.
- 45 SEPARATION OF KRAFT (SULFATE) PULP MILL EFFLUENT INTO CHEMICALLY DIFFERENT FRACTIONS AND TESTING TOXICITY OF SAME USING DAPHNIA IN BIOASSAY. A. E. Werner. Location--Nanaimo, B. C. A study is being made of the toxicity to

Daphnia of the organic sulphur compounds and their oxidation products in black liquor (Kraft). Terminated; manuscript prepared. Supported by Canadian Federal Government, \$5,000.

- 46 TOXICITY OF KRAFT UNBLEACHED EFFLUENT FRACTIONS TO DAPHNIA PULEX. A. E. Werner. Location--Biological Station, Nanaimo, B. C. A study of pure sulphur compounds known to be present in Kraft pulp mill effluents. Completed. Paper published: "Sulphur Compounds in Kraft Pulp Mill Effluents," by A. E. Werner. Canadian Pulp & Paper Industry, Vol. 16, No. 3, pp. 35-43, 1963. Supported by Research Board.
- 47 SEDIMENTATION IN ALBERNI HARBOUR. A. E. Werner, J. R. Markert and J. H. Meikle. Location--Alberni Harbour (Port Alberni, B. C.). The project has been initiated to investigate the deposition of particulate materials from pulp mill wastes in an estuarine environment. Sediment collectors are held at 14 stations in Alberni Harbour and the collected samples of sediment are removed once monthly. Physical and chemical analyses are performed on the samples. So far there has been great variability in deposition of sediments in the harbour, both in space and time, with greatest deposition occurring in the vicinity of the pulp mill and the mill sewer outfall. Started April, 1963; program will continue for a two-year period at least. Supported by Canadian Federal Government, \$10,000.
- 48 SAMPLING AND ANALYSIS OF GASES PRODUCED IN BOTTOM DEPOSITS. A. E. Werner, J. R. Markert and J. H. Meikle. Location--Alberni Harbour (Port Alberni, B. C.). Deposition of fibrous materials in the section of Alberni Harbour nearest the pulp mill has resulted in organic decomposition in the bottom muds and evolution of gases. A sampling apparatus has been designed to collect this gas for analysis. Preliminary analyses using gas chromatography and an Orsat-type gas analyzer showed the presence of a large concentration of methane (65.4 - 79.4%), small quantities of hydrogen, and up to 8.5% hydrogen sulphide. Started April, 1963. Supported by Canadian Federal Government, \$2,000.
- 49 FOAMS IN BLEACHED KRAFT PULP AND NEWSPRINT MILL EFFLUENTS. M. Waldichuk and J. R. Markert. Started July, 1962. Terminated. Paper, "Foams in Kraft Pulp and Newsprint Effluents," submitted for publication. Supported by funds from the Canadian Government.
- 50 PHENOL DISTRIBUTION IN A MARINE INLET RECEIVING PETROLEUM REFINERY WASTES. M. Waldichuk. Location--Burrard Inlet,

Vancouver, B. C. A continuing project. Supported by the Canadian Federal Government, \$1,500.

- 51 LONG-TERM EFFECTS OF DISPOSAL OF SULPHITE AND KRAFT PULP MILL WASTES INTO MARINE INLETS. M. Waldichuk and others. Location --Alberni Inlet and Neroutsos Inlet on Vancouver Island. Publications: (1) M. Waldichuk, "Some Oceanographic Characteristics of a Polluted Inlet in British Columbia," Jour. Marine Research, Vol. 17, p. 536, 1958. (2) M. Waldichuk, "Some Water Pollution Problems Connected with the Disposal of Pulp Mill Wastes," The Canadian Fish Culturist, No. 31, pp. 3-34, 1962. (3) M. Waldichuk, "Water Pollution in British Columbia," Annual Review Fisheries Council of Canada, pp. 26-29, 31-33, 1962. (4) "Marine Aspects of Pulp Mill Pollution," Canadian Pulp & Paper Industry, Vol. 15, No. 6, pp. 36-50, 1962. Continuing. Supported by Canadian Federal Government, \$10,000.
- 52 INTERACTION OF GASES DISSOLVED IN WATER. A. E. Werner and M. Waldichuk. Location--Biological Station, Nanaimo, B. C. An apparatus has been built to measure the rate of reaction of oxygen and hydrogen sulphide dissolved in water. Preliminary results show that hydrogen sulphide and oxygen can coexist for some days in distilled water, but react quite rapidly in sea water. When salts of manganese and iron are added to the distilled water, the reactivity of the two gases is greatly accelerated. It is proposed to investigate the catalytic effects on this reaction of trace amounts of heavy metals in the presence and absence of complexing agents which are usually present in organic pollutants. Started January, 1963. Supported by Federal Government, \$2,000.
- 53 EFFECTS OF PULP MILL WASTES (SULPHITE) IN PORPOISE HARBOUR AND WAINWRIGHT BASIN, NEAR PRINCE RUPERT, B. C. M. Waldichuk, J. R. Markert and A. E. Werner. Located in the area adjacent to the Prince Rupert pulp mill. A study was conducted in partly land-locked marine waters receiving sulphite wastes in the Prince Rupert area. Surveys were conducted during September, 1961 and April, 1962. Very low dissolved oxygen concentrations were found. During a mill shutdown in July, 1962, there was a rapid recovery in dissolved oxygen concentrations to near-normal values. Paper being prepared for publication. Published paper: M. Waldichuk and E. L. Bousfield, "Amphipods in Low-Oxygen Marine Waters Adjacent to a Sulphite Pulp Mill," Jour. Fisheries Research Board of Canada, Vol. 19, No. 6, pp. 1163-65, 1962. Supported by Canadian Federal Government, \$5,000.

- 54 FLUSHING OF NORTHUMBERLAND CHANNEL, BRITISH COLUMBIA. M. Waldichuk, J. R. Markert and J. H. Meikle. Location--Northumberland Channel, near Nanaimo, B. C. Started September, 1955; continued in 1963. Supported by Federal Government, \$3,000.
- 55 EFFECTS OF KRAFT PULP MILL EFFLUENT ON PACIFIC OYSTERS. D. B. Quayle and Jan Flury. Location--Crofton, Ladysmith, Nanaimo, B. C. Experiments were conducted in waters adjacent to kraft pulp mills at Crofton and Nanaimo, holding trays of the Pacific oyster, Crassostrea gigas, at various distances from the outfalls. Condition factor was used as an index of effect of the kraft mill effluent on the oyster quality. A definite reduction in condition was observed over a period of two years in high concentrations of the effluent near the Harmac pulp mill, Nanaimo, compared to controls held in Departure Bay. A less conclusive effect on condition factor of oysters in test plots and commercial leases was noted over a three-year period in waters containing lower concentrations of the effluent near the Crofton pulp mill. This work was started in 1959 and terminated in 1963. Manuscript in preparation. Supported by Federal Government.

CALIFORNIA

CALIFORNIA INSTITUTE OF TECHNOLOGY, PASADENA

Note: The following project descriptions were selected from "A Report of Research and Other Activities of the Division of Engineering and Applied Science, California Institute of Technology," 1963.

- 56 COLD REGIONS ENGINEERING. R. F. Scott. A compilation of research on engineering problems associated with Arctic regions. Continued in 1963. Supported by Department of Army (Cold Regions Research & Engineering Laboratory, Hanover, N. H.).
- 57 HEAT FLOW, FREEZING AND THAWING OF SOILS. R. F. Scott. Involves the problems of depths of thaw and freeze in Arctic and temperate zone soils. Continued in 1963. Supported by Department of Army (Cold Regions Research & Engineering Laboratory, Hanover, N. H.).

- 58 WASTEWATER RECLAMATION BY PRESSURIZED RECHARGE OF AQUIFERS. W. R. Samples. Includes studies of the treatment necessary before injection of water into the underground and the degree of reclamation the underground might give the used water. Publication by J. E. McKee and W. R. Samples, "Sewage Reclamation by Pressurized Recharge of Aquifers," Proceedings of the U. S. Public Health Service Symposium on Groundwater Contamination, Cincinnati, Ohio, April 7, 1961. Project continued in 1963. Supported by funds from U. S. Public Health Service.
- 59 CHARACTERISTICS OF FLUID FLOW THROUGH EXPANDED POROUS MEDIA. N. H. Brooks, W. R. Samples and F. McMichael. This project has to do with problems of water filtration and seepage control in earth dams and levees and other problems involving the transport of solids in fluids. Thesis submitted for Ph.D. degree in 1963. Supported by a grant from U. S. Public Health Service.
- 60 REVISION OF WATER QUALITY CRITERIA REPORT. J. E. McKee and H. W. Wolf. Involves bringing up-to-date the report on water quality criteria. The new edition was completed in February, 1963. Supported by funds from the California Water Pollution Board and U. S. Public Health Service.
- 61 EVALUATION OF THE CLOGGING POTENTIAL OF WATER FOR GROUNDWATER RECHARGE. J. E. McKee. Study involves turbidity, suspended solids, algae concentrations, and calcium-carbonate equilibria as potential clogging parameters. Publication by J. E. McKee, "Research Needs in Groundwater Pollution," Proceedings of Symposium on Groundwater Contamination, U. S. Public Health Service, Cincinnati, Ohio, April 1961; and Journal Water Pollution Control Federation, 33, 1227 (1961). Project continued in 1963.
- 62 TURBULENCE AND PARTICLE ENTRAINMENT IN SETTLING TANKS. V. A. Vanoni. Project completed in 1963; report being prepared. Supported by funds from the U. S. Public Health Service.
- 63 40-METER PRECISION TILTING FLUME. V. A. Vanoni, N. H. Brooks and Fredric Raichlen. The design and construction of a 40-meter precision tilting flume to be used in studies of sediment transport, turbulence and diffusion, flow in channels of non-uniform roughness, flow around submerged objects, and the design of hydraulic structures. Supported by National Science Foundation.

- 64 ENERGY DISSIPATOR FOR FLOW IN SAN DIEGO OCEAN SEWAGE OUTFALL. N. H. Brooks. The purpose of this study is to provide the details for the construction of an energy dissipator in pipelines with high flow rates. Such a situation exists at the San Diego Sewage Treatment Plant which will be built on a bluff approximately 90 feet above sea level. Report completed in 1963. Supported by Holmes and Narver-James Montgomery, consulting firm, Los Angeles.
- 65 MECHANICS OF FLUID FLOW AND SEDIMENT TRANSPORT IN SAND-BED CHANNELS NEAR CRITICAL CONDITIONS. V. A. Vanoni, N. H. Brooks, J. F. Kennedy, A. J. Sutherland and Li-San Hwang. A study of problems in transport of sediment in streams of low velocity. Continued in 1963. Supported by National Science Foundation.
- 66 WASTEWATER RECLAMATION BY PERCOLATION AND GROUNDWATER MOVEMENT. J. E. McKee, K. R. Johansson, L. Hartmann, M. E. Holland and F. C. McMichael. A study of the chemical, physical and biological phenomena associated with the percolation of municipal and industrial effluents into soil and the travel of mixed effluent and other groundwater. A major problem is the biochemical stability of detergents in soils. Publication: Quarterly Reports and Annual Report, California State Water Pollution Control Board (September, 1963). Supported by California State Water Pollution Control Board and U. S. Public Health Service.
- 67 MECHANISM OF CONCENTRATION OF RADIOCESIUM AND OTHER NUCLIDES BY SEWAGE SLUDGE. A. L. Gram, III, G. J. Mohanrao and T. R. Folsom. A study for a rapid method for determining strontium-90 in water and sewage. Numerous publications. Supported by U. S. Atomic Energy Commission.
- 68 RESERVOIR STRATIFICATION. V. A. Vanoni, N. H. Brooks, D. R. F. Harleman and R. C. Y. Koh. The development of a theory for laminar flow for low and high velocity. Supported by U. S. Public Health Service.
- 69 CATIONIC PRECIPITATION OF ANIONIC DETERGENTS. W. R. Samples and H. G. Schwartz, Jr. The use of cationic materials for removal of anionic detergents as a process in sewage treatment, water purification and industrial wastes. Publication: "Removal of ABS from Waste Water Effluent," W. R. Samples, Jour. Water Pollution Control Federation, October, 1962. Supported by U. S. Public Health Service.

- 70 ORGANIC CARBON DETERMINATION IN AQUEOUS SOLUTION. P. M. Augustus and W. R. Samples. A study to develop a test method for the determination of organic material in sewage and plant effluent.
- 71 STUDIES ON THE BIOCHEMISTRY OF DISINFECTION BY MONOCHLORAMINE. W. C. Boyle and K. R. Johansson. Publication: "Studies on the Biochemistry of Disinfection by Monochloramine," W. C. Boyle. Ph.D. Thesis (1963).

HUMBOLDT STATE COLLEGE, ARCATA

- 72 THE CIRCULATION, WATER QUALITY AND SEDIMENTATION OF HUMBOLDT BAY, CALIFORNIA. E. O. Salo and J. A. Gast. Started June 1, 1962; completed September 30, 1963. Field work completed; final report not yet completed. Supported by funds from the Atomic Energy Commission, \$26,600.
- 73 IMPROVEMENT OF SEWAGE OXIDATION POND EFFLUENTS BY FISH AND OTHER ORGANISMS. J. W. DeWitt, C. Hazel, E. Beilfuss and R. Ridenhour. A three-year study which began September 1, 1961. Field work completed in 1963. Supported by U. S. Public Health Service grant of \$18,000.
- 74 HUMBOLDT BAY RADIOLOGICAL SURVEY. E. O. Salo, J. A. Gast, G. H. Allen and F. Telonicher. Started 1960--continuing in 1963. Supported by Pacific Gas & Electric Co., \$10,500 per year.
- 75 PREDICTION OF ALGAL BLOOMS IN A PROPOSED SAN JOAQUIN VALLEY DRAIN. W. C. Vinyard. Students: Eugene Bowman and Jack Burnham. Location--San Joaquin Valley, San Joaquin River. Started January, 1962; to end June, 1964. Supported by Department of Water Resources, State of California, \$4,000.

LONG BEACH STATE COLLEGE, LONG BEACH

- 76 ANIMAL SUCCESSION IN NEWLY CONSTRUCTED BOAT HARBORS. Dr. D. J. Reish and students. Location--southern California. Continuing. Data being processed for publication. Supported by funds from the National Science Foundation, \$21,000.
- 77 STUDIES ON INDICATOR SPECIES OF MARINE POLLUTION. Dr. D. J. Reish and students. Starting date: February 1, 1964. Supported by funds from the National Institute of Health, \$37,000.

STANFORD UNIVERSITY, STANFORD

- 78 INFILTRATION PHENOMENA. J. B. Franzini. A four-year study started September 1961. Publication: "An Approach to the Solution of Unsteady Unsaturated Flow in Soils," by Flora Chu Wang, Civil Engineering Dept., Technical Report No. 19, Stanford University, March 1963. Supported by U. S. Public Health Service grant of \$20,000 yearly.
- 79 STUDIES ON MOVEMENT OF VIRUSES IN GROUNDWATER. R. Eliassen, W. A. Drewry and P. Kruger. From August 1963 to August 1964. Supported by U. S. Army Medical Research, \$43,300.
- 80 RECLAMATION OF REUSABLE WATER FROM SEWAGE. R. Eliassen and B. N. Wyckoff. From September 15, 1963 to September 14, 1964. Supported by U. S. Public Health Service demonstration grant, \$32,583.
- 81 ANAEROBIC WASTE TREATMENT KINETICS. P. L. McCarty and A. W. Lawrence. Started September 1, 1963; to continue until August 31, 1964. Supported by U. S. Public Health Service, \$22,890.

UNIVERSITY OF CALIFORNIA--SANITARY ENGINEERING RESEARCH
LABORATORY, BERKELEY

- 82 APPLICATION OF FOAM FRACTIONATION TO SEWAGE. P. H. McGauhey, J. F. Thomas, M. E. Stephenson and D. I. Jenkins. Location --Berkeley Campus. Project started September 1, 1963; to terminate August 31, 1964. Supported by U. S. Public Health Service, \$18,960.
- 83 BROAD CHARACTERIZATION OF IMPROVEMENT IN EFFLUENT QUALITY BY FOAM SEPARATION. P. H. McGauhey, D. I. Jenkins and D. W. Eckhoff. Location--Richmond Field Station. Project started June 28, 1963; to terminate June 27, 1964. Supported by U. S. Public Health Service, \$19,646.
- 84 ECONOMIC VALUE OF WATER QUALITY. P. H. McGauhey and Richard Frankel. Location--Richmond Field Station. Started September, 1963; to terminate August, 1964. Supported by U. S. Public Health Service and Resources for the Future, \$16,000.
- 85 THE FATE OF DETERGENTS IN SEPTIC TANK SYSTEMS AND OXIDATION PONDS. P. H. McGauhey, S. A. Klein and D. I. Jenkins. Location--Richmond Field Station. Started June 1, 1963;

to terminate May 31, 1964. Supported by Soap and Detergent Association, \$17,932.

- 86 NUTRITIONAL AND DISEASE TRANSMITTING POTENTIAL OF SEWAGE GROWN ALGAE. W. J. Oswald, R. C. Cooper and J. H. Meyer. This is a project of the Sanitary Engineering Research Laboratory, the School of Public Health, and the College of Agriculture, University of California, Berkeley. Location--Engineering Field Station, Richmond, California and College of Agriculture, Davis, California. A five-year study started September 1, 1961. Continued in 1963. Supported by a Public Health Service (NIH) grant WP 26 of \$51,000.
- 87 TREATMENT OF ORGANIC INDUSTRIAL WASTES BY LAGOONING. R. C. Cooper and W. J. Oswald. A project of the Sanitary Engineering Research Laboratory, Richmond, California and School of Public Health, Berkeley Campus. May 1, 1962 to April 30, 1964. Supported by U. S. Public Health Service, \$14,100 yearly.
- 88 MICROBIOLOGICAL WASTE TREATMENT AND WATER RECOVERY IN ISOLATED SYSTEMS. W. J. Oswald and C. G. Golueke. Location--Sanitary Engineering Research Laboratory, Richmond, California. Continued in 1963. Supported by Space Physics Laboratory, U. S. Air Force Cambridge Research Laboratories, \$35,000 yearly.
- 89 COMPREHENSIVE INVESTIGATION OF SAN FRANCISCO BAY. E. A. Pearson and R. E. Selleck. Location--Sanitary Engineering Research Laboratory, Richmond, California. Project started June, 1960; to continue until June, 1966. Supported by funds from the State of California, \$123,000 yearly.

UNIVERSITY OF CALIFORNIA, WATER RESOURCES CENTER, BERKELEY

- 90 GROUNDWATER HYDROLOGY. D. K. Todd and project staff. This project was continued in 1963.
- 91 LOW FLOW CHARACTERISTICS OF THE LOST RIVER SYSTEM. G. T. Orlob and P. C. Woods. Study was prompted by potential agricultural pesticide pollution of wild fowl refuges. Started July 1, 1961; completed in 1962. Report published: "The Lost River System, A Water Quality Management Investigation," Contribution No. 68, Water Resources Center, University of California, Berkeley, February 1963. Supported by funds from Water Resources Center, \$10,500 yearly.

- 92 WATER QUALITY MANAGEMENT. G. T. Orlob and P. C. Woods. A continuing project supported by funds from the Water Resources Center, University of California, \$11,000 per year.

UNIVERSITY OF CALIFORNIA, DAVIS

- 93 INORGANIC AND ORGANIC IMPURITIES OF IRRIGATION WATERS AFFECTING SOIL PROPERTIES AND PLANT GROWTH. L. D. Doneen and J. W. Biggar. Continuing in 1963. Supported by University of California, \$15,000.
- 94 SOIL INTERACTION WITH ORGANICALLY POLLUTED WATER. J. W. Biggar, G. R. Dott and L. D. Doneen. Continuing in 1963. Supported by U. S. Public Health Service grant, \$15,000.
- 95 PREDICTING THE QUALITY OF PERCOLATING WATERS. G. R. Dott and L. D. Doneen. A continuing project. Supported by the University of California Water Resources Center and funds in the amount of \$13,500 from the Department of Water Resources, Sacramento.

UNIVERSITY OF SAN FRANCISCO, SAN FRANCISCO

- 96 SLUDGE BANK CHANGES IN A BRACKISH BAY. F. P. Filice and S. Dederian. Location--San Francisco Bay. This project started with a Public Health Service grant. Continued in 1963.

UNIVERSITY OF SOUTHERN CALIFORNIA, LOS ANGELES

- 97 INVESTIGATION OF GAS PRODUCTION WITHIN SANITARY LANDFILL. R. C. Merz. Started December 1, 1961 and will continue into 1964. Funds from California Water Pollution Control Board, \$34,000.
- 98 FACTORS CONTROLLING UTILIZATION OF SANITARY LANDFILL SITE. R. C. Merz, R. Stone, R. Rodrique and R. Beluche. Location--Walnut, California. Started May 1, 1960; will continue into 1964. Report of first three-year study is available from USC, upon request. Supported by grant from U. S. Public Health Service, \$100,000.

- 99 QUANTITY AND QUALITY OF GASES PRODUCED DURING REFUSE DECOMPOSITION. R. C. Merz and R. Rodrique. Started December 1, 1961 and will continue until June 30, 1964. Annual Report available from California Water Quality Control Board. Supported by CWQCB, \$34,000.
- 100 FACTORS CONTROLLING UTILIZATION OF SANITARY LANDFILL SITE. R. C. Merz, R. Stone, R. Rodrique and R. Beluche. Field study at Walnut, California. Started May 1, 1960 and will continue through 1964. Report of first three-year study is available from USC, upon request. Funds from U. S. Public Health Service totalling approximately \$100,000.

UNIVERSITY OF SOUTHERN CALIFORNIA--ALLAN HANCOCK FOUNDATION,
LOS ANGELES

- 101 BENTHONIC FORAMINIFERA RELATIONSHIP TO OCEAN POLLUTION. Dr. O. L. Bandy (from June, 1962 to the present), and J. C. Ingle, Jr. (1963). 1963 was fifth year of this project. The following reports were completed in 1963: (1) "Foraminiferal Trends, Laguna Beach Outfall Area," Amer. Soc. Limnology and Oceanography, Vol. 9, No. 1 (in press). (2) "Foraminifera, Los Angeles County Outfall Area, California," Amer. Soc. Limnology and Oceanography, Vol. 9, No. 1 (in press). (3) "Facies Trends, San Pedro Bay, California," Geological Society of America, Bull. (in press). All reports by Dr. O. L. Bandy, J. C. Ingle, Jr., and J. M. Resig. Public Health Service funds, \$19,000 for 1962-63.

CALIFORNIA DEPARTMENT OF FISH AND GAME, STOCKTON

- 102 DELTA FISH AND WILDLIFE STUDY. D. W. Kelley, D. Ganssle, C. Blunt, J. Turner, R. Painter, W. Griffith, R. Mall, S. Sasaki, T. Farley, C. Hazel and L. Radtke. Ecological study of the fish and wildlife and their food organisms in the San Joaquin Delta. Study will continue to July, 1966. Supported by California Department of Water Resources, \$250,000 yearly.

SOUTHWEST BRANCH, SOIL AND WATER CONSERVATION MANAGEMENT
DIVISION, U.S.D.A. AGRICULTURAL RESEARCH SERVICE, POMONA

- 103 INFLUENCE OF COLORADO RIVER WATER UPON IRRIGATION AND DRAINAGE OF THE SAN JACINTO BASIN, CALIFORNIA. Sterling Davis and L. B. Grass. Location--Hemet, California. Started July, 1955 and continuing in 1963. Supported by U.S.D.A. funds.
- 104 SALINITY CONTROL PLOT STUDY. Sterling Davis and L. B. Grass. Location--Moreno, California. Started May, 1961 and continuing in 1963. Supported by Federal funds in cooperation with Eastern Municipal Water District.
- 105 ARLINGTON-HIGHLANDS, SALINITY TREND INVESTIGATION. Sterling Davis and L. B. Grass, with U.S.D.A. Soil Conservation Service staff, Riverside, California. Location--8 miles south of Riverside, California. Started in May, 1961, to continue for five years or more. Supported by U.S.D.A. funds.
- 106 EXPLORATORY STUDY ON MANGANESE AND IRON SOLUBILITY IN SUB-SOILS. L. B. Grass. A comparative study of reducing agents reveals presence of large reserve of easily reducible iron and manganese in two Imperial Valley soils. When subjected to leaching under reducing conditions, 1.53 lbs. of iron and 2.61 lbs. of manganese were removed per acre-foot of leachate. Evidence suggests that organic matter and biological activity may stimulate the rate of the reaction which affects the solubility. The problem is increasing in Imperial and Coachella Valleys, with clogging of tile drains constituting a serious expense in irrigation. Project continued in 1963. Supported by U.S.D.A. funds.

U. S. DEPARTMENT OF AGRICULTURE, SALINITY LABORATORY,
RIVERSIDE

- 107 TOLERANCE OF PLANTS TO BORON. J. T. Hatcher, G. Y. Blair and L. V. Wilcox. Location--Laboratory in Riverside, California. Boron is extremely toxic to plants. It occurs in toxic concentration in some irrigation waters and saline soils and is a potential pollutant because of its widespread use. This is an extension of boron-tolerance studies started many years ago. Project active in 1963. Supported by funds from ARS and U. S. Department of Agriculture.

- 108 THE PRECIPITATION OF CALCIUM FOR IRRIGATION WATERS AND SOIL SOLUTIONS. G. W. Akin, L. V. Wilcox and M. G. Keyes. This is a study of the equilibria involved in the precipitation of CaCO_3 on natural waters. Project active in 1963. Supported by funds from ARS and U. S. Department of Agriculture.
- 109 SALT-BALANCE CONDITION OF THE RIO GRANDE PROJECT. L. V. Wilcox and M. G. Keyes. This is a cooperative project between the U. S. Bureau of Reclamation, U. S. Section International Boundary & Water Commission, and U. S. Geological Survey. Salt-balance and salt-burden studies are the principal objectives. A great deal of information has accumulated on the effect of irrigation return flows on the quality of water of the Rio Grande. Project active in 1963 and Technical Bulletin 1290, "Salt Balance and Leaching Requirement in Irrigated Lands," by L. V. Wilcox and W. R. Resch has been completed. Supported by funds from ARS, U. S. Department of Agriculture.

U. S. ARMY DISTRICT ENGINEER, SAN FRANCISCO

- 110 COMPREHENSIVE SURVEY REPORT, EEL RIVER BASIN, CALIFORNIA. San Francisco District, U. S. Fish & Wildlife Service, Federal Power Commission, U. S. Bureau of Reclamation, U. S. Forest Service and U. S. Public Health Service. Draft report March, 1963. Supported by U. S. Army Engineers, Civil, funds \$10,000.
- 111 REVIEW REPORT FOR FLOOD CONTROL AND ALLIED PURPOSES, RUSSIAN RIVER, CALIFORNIA. San Francisco District, U. S. Fish & Wildlife Service, Federal Power Commission, Bureau of Reclamation, U. S. Public Health Service, State of California, and Sonoma and Mendocino Counties. Location--Knights Valley Project, Sonoma County, California. Draft report March, 1963. Supported by General Investigations, U. S. Army Corps of Engineers, Civil, \$12,000.
- 112 COMPREHENSIVE SURVEY REPORT, PAJARO RIVER BASIN, CALIFORNIA. San Francisco District, U. S. Fish & Wildlife Service, Bureau of Reclamation, U. S. Public Health Service and Soil Conservation Service. Location--Santa Cruz, San Benito, Monterey and Santa Clara Counties. Started 1958; to be completed June, 1964. Supported by U. S. Army Engineers, General Investigations, \$12,500.

- 113 COMPREHENSIVE SURVEY REPORT, GUADALUPE RIVER AND ADJACENT STREAMS, CALIFORNIA. San Francisco District, U. S. Fish & Wildlife Service, Bureau of Reclamation, U. S. Public Health Service and Soil Conservation Service. Location --Santa Clara County. Started 1963; to terminate May, 1966. Supported by General Investigations, U. S. Army Corps of Engineers, Civil, \$12,500.
- 114 REPORT FOR FLOOD CONTROL AND ALLIED PURPOSES, SOQUEL CREEK, CALIFORNIA. San Francisco District, U. S. Fish & Wildlife Service, Bureau of Reclamation, U. S. Public Health Service and Soil Conservation Service. Location--Santa Cruz County. Started 1960; to be completed 1964. Supported by General Investigations, U. S. Army Corps of Engineers, Civil, \$2,000.

U. S. GEOLOGICAL SURVEY--BRANCH OF QUALITY OF WATER, MENLO PARK

- 115 SEPARATION, IDENTIFICATION, AND MEASUREMENT OF ORGANIC SUBSTANCES IN WATER AND METHODOLOGY. W. L. Lamar and D. F. Goerlitz. Papers presented: (1) Lamar, W. L. and D. F. Goerlitz, "Characteristics of Carboxylic Acids in Unpolluted Streams by Gas Chromatography," Amer. Water Works Ass'n. Jour., V. 55, pp. 797-802, 1963. (2) Goerlitz, D. F. and W. L. Lamar, "Effluent Collector for Gas Chromatography," Art. 155, U.S.G.S. Prof. Paper 475-D (in press).
- 116 WATERS OF DEEP ORIGIN AND THEIR ALTERATION PRODUCTS. D. E. White and Robert Schoen. Project studies chemical and isotopic composition of waters to distinguish meteoric, connate, metamorphic, and magmatic sources, and studies alteration of rock minerals in hot-spring areas. Started in 1957; continued in 1963. Supported by Federal funds.
- 117 APPLICABILITY OF UNSATURATED FLOW THEORY TO THE PHENOMENA OF INFILTRATION AND DRAINAGE. Jacob Rubin. Started in 1963. Supported by Federal funds.
- 118 CHEMISTRY OF HYDROSOLIC METALS IN WATER. J. D. Hem, W. L. Polzer, C. E. Roberson and D. E. Donaldson. Started in 1956 in Denver, Colorado; moved to Menlo Park in 1963. Has studied effects of Eh, pH, organic and inorganic ion activities, and biochemical processes on solution and deposition of iron and manganese in surface and ground-water. In 1963, studies of aluminum chemistry in dilute

solutions were started and work was continued on studies of the solubility of kaolinite. Supported by Federal funds.

CENTRAL COASTAL REGIONAL WATER POLLUTION CONTROL BOARD

- 119 EVALUATION OF EFFECT OF WASTE DISCHARGES ON GROUNDWATER QUALITY IN THE LOMPOC PLAIN. Department of Water Resources and U. S. Geological Survey. Location--Northern Santa Barbara County. Started 1961. Extended through 1963 for collection of data. Report expected to be published during 1964. Supported by Board funds, \$10,000.
- 120 WATER QUALITY INVESTIGATION OF SAN LUIS OBISPO COUNTY COASTAL PLAIN. California Department of Water Resources. To be completed in 1964. Supported by Board funds, \$3,000.
- 121 GROUNDWATER CONDITIONS NEAR ALLIED FOODS, INC., SANTA CLARA COUNTY. California Department of Water Resources. A study of the effect on groundwater from the disposal of pickling brines. Completed. Report published as "Groundwater Conditions Near Allied Foods, Inc., San Martin, Santa Clara County," California Department of Water Resources, February, 1963. Supported by Board funds, \$800.
- 122 EROSION STUDIES, SAN LORENZO VALLEY, SANTA CRUZ COUNTY, CALIFORNIA. Department of Water Resources. A study of the effect on several streams within the San Lorenzo River resulting from erosion of large open pit and mining operations. Completed. Report published as "Erosion Studies, San Lorenzo Valley, Santa Cruz County," California Department of Water Resources, March, 1963. Supported by Board funds, \$1,200.

LOS ANGELES COUNTY SANITATION DISTRICTS

- 123 OCEANOGRAPHIC STUDY TO ESTABLISH CRITERIA FOR CONTROL OF CHLORINATION OF SEWAGE EFFLUENT FROM OCEAN OUTFALL. J. D. Parkhurst, F. R. Bowerman, M. L. Whitt and F. D. Dryden. Location--White Point, Los Angeles County. Observations of ocean current, magnitude and direction from 0' to 600' depth, temperature, salinity, dissolved oxygen, plankton, turbidity, coliform concentrations, and meteorological conditions at time of observations. Started July, 1960; to continue into 1964 with additional funds. Supported by funds from the Sanitation Districts, \$30,000 per year.

- 124 EFFECT OF WIND, TIDE AND WEATHER CONDITIONS ON NEARSHORE OCEAN CONDITIONS. J. D. Parkhurst, W. E. Garrison, M. L. Whitt and F. D. Dryden. Location--along the Palos Verdes Coast. Started June, 1961. Continued into 1963 and expanded to specifically bear on the proposed location of a fourth ocean outfall in the vicinity of White Point. To be terminated in 1964. Supported by funds from the Sanitation Districts, \$25,000.
- 125 A STUDY OF THE PARAMETERS OF ACTIVATED SLUDGE PLANT OPERATION. Carl Nagel, J. D. Parkhurst, W. E. Garrison and F. D. Dryden. Location--Whittier Narrows Water Reclamation Plant. A study of the operating variables which affect the quality of reclaimed waste water from 10 mgd water reclamation plant. Constant controlled influent flow rate provides basis for comparison of costs and effluent quality when plant is operated as standard activated sludge, contact stabilization, and step aeration processes. Started August 1, 1962. In July, 1963 it became joint County Sanitation Districts-Public Health Service project. \$13,000 for 1963-64.
- 126 JOINT CSD-PHS RESEARCH PROJECT ON FOAM SEPARATION. F. D. Dryden, John Zoltek, M. L. Whitt, N. Anderson and J. D. Parkhurst. Location--Pomona Water Reclamation Plant. Revised study plan started July, 1963; supersedes study, "Pilot Plant Study of ABS Removal from Secondary Effluent by Foam-Fractionation," shown in previous inventory. The study covers foam separation techniques to evaluate possible benefits for advanced waste treatment in addition to ABS removal, with particular emphasis on simultaneous removal of organics and suspended solids which are not reactive with methylene blue. Supported 50 per cent by County Sanitation Districts, 50 per cent by U. S. Public Health Service, \$42,000.
- 127 JOINT CSD-PHS RESEARCH PROJECT ON RECREATIONAL REUSE OF OXIDATION POND EFFLUENT. J. D. Parkhurst, G. N. McDermott, G. Stern, F. D. Dryden, J. Kremer and R. Tejidor. Location--District 14 Water Pollution Control Plant, Lancaster, California. Started July, 1963; to be continued into 1964. The objective of the study is to remove algae and algae nutrients from oxidation pond effluent to prepare water for use in recreational lakes to be constructed in a water-short desert area. Processes will be evaluated for effectiveness and cost. In 1964, work will be extended to evaluate fish and virus survival in the treated water. Supported by funds in equal amounts from County Sanitation Districts and U. S. Public Health Service, \$57,000.

COUNTY SANITATION DISTRICTS OF ORANGE COUNTY, CALIFORNIA

- 128 STUDIES OF OCEAN TEMPERATURES, NEARSHORE CURRENTS AND BOTTOM SEDIMENTS ADJACENT TO MARINE OUTFALL. T. A. Dunn, P. G. Brown, Dr. R. Zehnpfennig and Fred Monson. Location--Orange County Shores. Continued in 1963. Supported by County Sanitation Districts, \$10,000.

CITY OF SAN DIEGO--UTILITIES DEPARTMENT

- 129 DEVELOPMENT OF LABORATORY APPARATUS FOR DETERMINATION OF "FLOATABLE MATTER" IN CONNECTION WITH OCEAN OUTFALL DISPOSAL OF PRIMARY SEWAGE TREATMENT PLANT EFFLUENT. Project continued in 1963.
- 130 INVESTIGATION OF PROTECTIVE COATINGS IN WATER AND SEWAGE TREATMENT, DISTRIBUTION AND COLLECTION SYSTEMS. Continued in 1963.
- 131 THE USE OF ELECTRONIC FISH SCREENS IN THE CONTROL OF FISH. No work on this project in 1963. Held in abeyance.
- 132 COMPARISON OF COLIFORM COUNTS BY THE MEMBRANE FILTER VS. LACTOSE BROTH. Completed in 1961. Report written in 1962, "A Comparison of Membrane Filter Counts and Most Probable Numbers of Coliforms in San Diego's Sewage and Receiving Waters," published in Journal of Water Pollution Control Federation, January, 1964.
- 133 EFFECTS OF HEAVY METALS ON THE DIGESTION OF PRIMARY SEWAGE TREATMENT PLANT SLUDGE. Continued in 1963.

SAN DIEGO REGIONAL WATER POLLUTION CONTROL BOARD

- 134 INVESTIGATION OF WATER QUALITY IN MISSION BASIN, SAN LUIS REY RIVER, SAN DIEGO COUNTY. California Department of Water Resources. Location--Oceanside, California. Survey to determine effect of groundwater recharge, with sewage of an overdrafted basin. Recharge point less than three miles from ocean. First report before recharging began, May, 1958. Field work completed in 1962. Subsequent report for 1963 published. Supported by funds from the San Diego Regional Water Pollution Control Board, \$2,000.
- 135 FIELD SURVEILLANCE OF CIRCULATION IN SAN DIEGO BAY. Marine Advisors, Inc. Completed, 1963. Report published, but

reference not available. Supported by funds of Board, \$8,900.

- 136 INVESTIGATION OF GROUNDWATERS OF SAN JUAN AND TRABUCO CREEKS, ORANGE COUNTY. California Department of Water Resources. An investigation of basic hydrology, geology and groundwater quality with emphasis on boron and syndet concentration and sources. Field work completed in 1962; report in process. Supported by Board, \$2,000.
- 137 A PHYSICAL AND BIOLOGICAL STUDY OF SAN DIEGO BAY. Marine Advisors, Inc. An investigation of the comparative biological population and the physical condition of the Bay during and immediately after a severe phytoplankton bloom. Completed and published. Supported by Board, \$2,000.
- 138 AN ECOLOGICAL STUDY OF THE KELP BEDS IN THE VICINITY OF CANYON DE LAS ENCINAS. Wheeler North. To provide background data prior to sewage discharge. Published. Supported by Board, \$2,100.
- 139 AN ECOLOGICAL STUDY OF THE MARINE ENVIRONMENT IN THE VICINITY OF SAN ELIJO LAGOON. California Department of Fish & Game, Charles Turner. Location--San Diego County. To provide background data prior to initiation of sewage discharge. To be completed by July 1964. Supported by Board, \$2,500.
- 140 AN ECOLOGICAL STUDY OF THE KELP BED IN THE VICINITY OF SAN ELIJO LAGOON. Wheeler North. Location--San Diego County. To provide background data prior to initiation of sewage discharge. To be completed by July 1964. Supported by Board, \$2,400.
- 141 GROUNDWATER QUALITY RECONNAISSANCE OF THE LOWER REACH OF THE OTAY RIVER. California Department of Water Resources. Location--San Diego County. To determine current conditions in over-drafted basin. Supported by Board, \$2,000.

ENGINEERING-SCIENCE, INC., ARCADIA

- 142 DEVELOPMENT OF IMPROVED BIOLOGICAL INDICATORS FOR ASSESSING EFFECTS OF INDUSTRIAL WASTES ON MARINE RECEIVING WATERS. H. F. Ludwig, R. Wagner and R. Carter. Location--Oakland, California. A continuing project started in 1960; will continued into 1964. Supported by a Public Health Service contract.

- 143 DEVELOPMENT OF CIVIL DEFENSE PREPAREDNESS PROGRAM FOR MUNICIPAL WATER WORKS. H. F. Ludwig and J. A. Harmon. Conducted at Arcadia, California. From 1962 through 1964. Supported by research contract with the Office of Civil Defense, Dept. of Defense.
- 144 STUDY OF GASES PRODUCED IN REFUSE FILLS AND THEIR MOVEMENT THROUGH ADJACENT GROUND. H. F. Ludwig, W. Bishop and R. Carter. Location--San Gabriel Valley. A study which was started in December 1961 and is scheduled to continue through 1964. Supported by the California State Water Pollution Control Board.
- 145 STUDY OF THE NATURE AND SIZE OF VARIOUS PARTICULATES IN WATER SUPPLIES AS RELATED TO TREATMENT PROCESSES. H. F. Ludwig, R. Carter and Wonsuk Kim. Location--Oakland, California. Started in 1961 and continuing in 1963. This project will be supported in 1964 by U. S. Public Health Service.
- 146 DEVELOPMENT OF CIVIL DEFENSE PREPAREDNESS PROGRAM ON COMMUNITY SANITATION. H. F. Ludwig and J. A. Harmon. Location--Arcadia, California. Started in 1963; to continue through 1964. Supported by contract with the Office of Civil Defense, Department of Defense.

MASONITE CORPORATION, UKIAH

- 147 LAND IRRIGATION UTILIZING PULP MILL PROCESS WATER. Masonite Corp. Started, September 1962; continued in 1963. Supported by corporation.

HAWAII

UNIVERSITY OF HAWAII, HONOLULU

Note: Since the following are the first research projects conducted at the University of Hawaii to be reported in this annual inventory, we are including those of previous years for the information of the reader. Projects completed prior to the current year will not be reported in annual inventories which follow.

- 148 GROUNDWATER MOTION AND SEA-WATER INTRUSION IN COASTAL AQUIFERS. Dr. L. S. Lau. Theoretical and experimental studies of sea-water intrusion in relation to groundwater pumpage and con-

servation. Sand Model studies. Started June, 1960; terminated September, 1960. Supported by Honolulu Board of Water Supply, approximately \$5,000.

- 149 GROUNDWATER RESOURCES DEVELOPMENT--KALAUAO ARTESIAN SPRINGS ON OAHU. Dr. L. S. Lau. To determine the desirability of and methods for developing Kalauao Spring water on the basis of hydrologic criteria. Laboratory experiments and sand model. Started June, 1962; terminated September, 1962. Supported by Honolulu Board of Water Supply, approximately \$7,000.
- 150 SOIL-WATER RELATIONS OF HAWAIIAN SOILS. R. E. Green and G. Uehara. Study soil water retention and conducting properties of the important agricultural and watershed soils of Hawaii. Started March, 1963; to terminate February, 1968. Supported by State funds.
- 151 ENGINEERING GEOLOGY OF A PORTION OF THE HONOLULU CAP ROCK. C. Lao and D. C. Cox, University Graduate School & Institute of Geophysics. Determination of the composition, stratigraphy, history and groundwater hydrology of the Manoa Valley portion of Honolulu. Started June, 1963; to terminate February, 1965. Supported by University of Hawaii.
- 152 ENERGY LEVELS OF IRRIGATION WATER AT THE SOIL SURFACE. Bessel Van't Woudt, Department of Agricultural Engineering. To study impact of energies of water from suspended pipe. To be completed in 1965. Supported by State funds.
- 153 HYDRAULICS AND EFFICIENCY OF IRRIGATION APPLICATION. Bessel Van't Woudt, Department of Agricultural Engineering. To study nozzelation on a boom which is suspended a certain distance above the ground surface, is moving in a direction perpendicular to its axis at a speed to be determined, and is rotating at speeds within a range to be determined. Field and model testings. Started in 1960; to terminate in 1964. Supported by Federal funds.
- 154 INFLUENCE OF PARTICLE COATINGS ON THE MOVEMENT OF WATER IN SOIL. G. Uehara and G. D. Sherman, Department of Agronomy & Soil Science. To investigate the nature of the particle coatings of certain slowly-wetted Hawaiian soils. To investigate the influence of ionic environment, pH , and moisture content on the wettability of these soils. Theoretical and laboratory studies. Started in 1960; to terminate in 1964. Supported by Federal funds, \$2,200 annually.

- 155 TRANSITIONAL ZONE BETWEEN FRESH AND SEA WATERS IN COASTAL
AQUIFERS. Dr. L. S. Lau and H. Chock, Department of Civil
Engineering. To establish a relationship between ground-
water motion and the transitional zone. To compare the
zone as created by periodic and non-periodic motions.
Theoretical and experimental studies. A continuing
project started September, 1961; termination date,
indefinite. Financial support being sought.
- 156 FIELD DETERMINATION OF WATER INFILTRATION CAPACITY OF SOME
SOILS ON OAHU. Dr. L. S. Lau and J. P. Willocks, Depart-
ment of Civil Engineering. To measure in site with a
standard infiltrometer, the infiltration capacity of some
ten typical soils in uncultivated areas. Soils measured
had high infiltration capacity ranges from several to
over 20 inches per hour by standard measurements.
Started February, 1961; terminated June, 1961.
- 157 A METHOD FOR DETERMINING PERMEABILITY OF AQUIFER CONTAINING
A FRESH WATER LENS. Dr. L. S. Lau, Department of Civil
Engineering. To devise a practical field method for
determining aquifer permeability in a two-liquid system
such as those in Hawaii. Theoretical and experimental
studies. A continuing project started January, 1963.
Sponsors being sought.
- 158 TRAVEL OF COLIFORM BACTERIA AND SYNTHETIC DETERGENTS WITH
PERCOLATING WATER THROUGH OAHU SOILS. R. H. F. Young and
Dr. L. S. Lau, Department of Civil Engineering and Public
Health. To study the capacity of some Oahu soils to
remove these groundwater contaminants. Laboratory column
and experimental studies. Started September, 1963; to
terminate September, 1964. Departmental funds.
- 159 GROUNDWATER RESOURCES DEVELOPMENT WITH REFERENCE TO SEA-
WATER ENCROACHMENT IN THE HONOLULU REGION--HYDRAULIC MODEL
STUDIES. Dr. L. S. Lau, Engineering Experiment Station.
To determine the quantity and the rate of sea-water
intrusion and to determine the interrelationship between
leakage through caprock and pumpage. Scaled hydraulic
model studies with available field data to predict re-
sponses of the fresh water lens to water resources de-
velopment. Started February, 1963; to terminate June,
1964. Supported by University of Hawaii, Honolulu Board
of Water Supply, approximately \$10,000.
- 160 SANITARY SURVEY OF HONOLULU NEAR-SHORE AREA. W. W.
Tinniswood and D. E. Avery, Experiment Station, College
of Engineering. Started July 15, 1963. Field work and

data completed. Report being completed. Supported by the Department of Health, \$12,000.

- 161 SEA-WATER DISTILLATION. J. B. T. Downs and J. C. S. Chou, Department of Mechanical Engineering. To survey and to further existing basic and applied research work in sea-water distillation as can be adaptable for low-cost production of fresh water in the State of Hawaii and similar climatic regions. Started April, 1963; to terminate July, 1964. Seeking support from Office of Saline Water.
- 162 STUDY OF COASTAL CURRENTS AND MIXING IN RESPECT TO SEWAGE DISPOSAL. Taivo Laevastu, D. C. Cox and D. E. Avery, Hawaii Institute of Geophysics. Location--Hawaiian Islands. Started November, 1962; to terminate May, 1964. Supported by State funds, \$10,000; Federal, \$20,000.

BOARD OF WATER SUPPLY, CITY AND COUNTY OF HONOLULU

- 163 TRANSITION ZONE IN THE GHYBER-HERZBERG LENS. J. F. Mink, C. K. Lum, L. J. Watson, et al. A continuing project which started about 1960. Supported by Board of Water Supply.
- 164 KALAUAO GROUNDWATER POLLUTION STUDY. John Chang, Y. F. Lee and H. M. Kawano. Location--Kalauao, Aiea, Oahu, Hawaii. Supported by Federal funds, \$24,396.

DIVISION OF WATER AND LAND DEVELOPMENT, DEPARTMENT OF LAND AND NATURAL RESOURCES, HONOLULU

- 165 KOKEE IRRIGATION PROJECT FEASIBILITY STUDY. Division of Water & Land Development, Bureau of Reclamation and U. S. Geological Survey. Location--Kokee, Island of Kauai. This is an engineering and economic feasibility study for the development of a multiple-purpose project which will include the development of a complete irrigation system, hydroelectric power development, and wildlife and recreational facilities. To be completed in 1964. Supported by State funds, \$155,000.
- 166 WATER RESOURCE INVESTIGATION, ISLAND OF OAHU. Division of Water & Land Development and U. S. Geological Survey. Location--Island of Oahu. This project is a detailed study of geology, surface flow, and groundwater occur-

rence in the island of Oahu and the relationship existing among all three. The study will provide the basic information concerning the location, best methods of development, and the quality and quantity of water available for development. Started about 1957 and continued through 1963. Supported by Federal-State funds on a fifty-fifty basis.

- 167 KOHALA MOUNTAIN-HAMAKUA WATER STUDY. Division of Water and Land Development and U. S. Geological Survey. Location-- District of Kohala, Island of Hawaii. This project investigated the water resources on the south slopes of the Kohala Mountain. The purpose was to determine the availability, quality, and quantity of surface and groundwater in this area and to recommend the best method of development. Study began in 1963. Supported by State funds, \$60,000.

IDAHO

IDAHO FISH AND GAME DEPARTMENT, BOISE

- 168 WATER QUALITY INVESTIGATIONS. W. E. Webb, T. C. Bjornn and J. C. Simpson. A statewide investigation started October 31, 1958 and continued into 1963. Studies are: (1) Water Quality Studies combined with Limnological Studies on Various Reservoirs; (2) Water Quality and Pollution Surveys on Two Rivers (Boise and Snake); (3) Bioassays on Various Pesticides and Other Chemicals Using Fish and Insects as Test Organisms; (4) Biological Surveys on Spraying Projects. Funds from Dingell-Johnson appropriation, average \$10,000 a year.

POTATO INDUSTRY OF IDAHO

- 169 TREATMENT AND UTILIZATION OF POTATO PROCESSING WASTES. From information supplied by Miles Willard, Chairman for the Engineering Committee of the Industry. The objectives of this study are: (1) Preliminary investigation of anaerobic digestion of potato waste; (2) Attempts to further dewater thickened or filtered potato waste by pressing; (3) A study of various methods of secondary treatment to determine which may be the most applicable to potato wastes. This work has resulted in the installation of full-scale potato waste treatment plants using a number of the processes developed, such as anaerobic, aerobic lagoon systems plus some form of mechanical aeration such as an Inke Grid

System (Dorr-Oliver), Vortain Aerator (Infilco), etc. Supported by Idaho Potato Processors, except for investigations that involved cooperation of Idaho State Board of Health or waste treatment equipment manufacturers.

MONTANA

MONTANA STATE COLLEGE, BOZEMAN

- 170 HYDROBIOLOGY OF MADISON RIVER AND ITS HEADWATERS. J. C. Wright, I. K. Mills, R. J. Graham, R. M. Horrall, T. S. Roeder, J. R. Heaton and D. M. Gillespie. Location-- Yellowstone Park and south central Montana. Study of the effect of various physical and chemical environments on productivity, community structure and composition. The heat budget of the river system as affected by thermal discharge, climatic conditions and impoundments will also be investigated. A three-year project started September 1, 1962. Supported by Public Health Service grant, \$34,436.

MONTANA FISH AND GAME DEPARTMENT, HELENA

- 171 STREAM SEDIMENT INVESTIGATION. D. R. Bianchi. Location-- Southeast Montana. Initiated in 1960; to continue through 1964. Concerned with the sedimentation of streams and the effects on trout egg mortalities and trout production. Supported by Federal Government, 75 per cent; State, 25 per cent -- \$10,000.

OREGON

OREGON STATE UNIVERSITY, CORVALLIS

- 172 OCEAN OUTFALL DIFFUSERS. C. E. Behlke and F. J. Burgess. To investigate the hydraulic and sanitary engineering problems of the diffusion of industrial wastes and sewage in ocean waters of various densities. This study involves the use of models. Completed in 1963. Supported by U. S. Public Health Service grant.
- 173 SUPERCRITICAL FLOW CHANNEL JUNCTIONS. C. E. Behlke and Harold Pritchett. To investigate forces and wave patterns

generated at the confluence of two channel junctions transporting water at supercritical flow rates. Continued in 1963. Financed in the amount of \$12,410 per year by the Bureau of Public Roads.

- 174 RADAR ANALYSIS OF EFFECTS OF TOPOGRAPHY ON STORMS IN WESTERN OREGON. F. W. Decker. Radar observations of precipitation patterns in storms will provide material for mesometeorological analysis of the effects of the Coast Range and Cascade Mountain topography on these storms. Continued in 1963. Supported by a \$30,000-a-year grant from the U. S. Army.
- 175 WATER SURVEY, ALSEA RIVER BASIN. D. W. Chapman. To inventory the water resources of the Alsea River Basin and to provide a base for research in watershed relationships. Continued in 1963. Financed by Oregon State University, \$4,400 per year.
- 176 ELECTRONIC COMPUTER ANALYSIS OF DRAINAGE PROBLEMS. J. W. Wolfe. Programming the ALWAC and/or the IBM 709 computer for the solution of drainage problems and obtaining field measurements to check the theoretical drainage solutions. Continued in 1963. Supported by Oregon State University and Western Soil and Water Research Committee, \$6,000 per year.
- 177 DRAINAGE OF STRATIFIED SOILS, PROJECT 418. Darrell Watts and Dr. Larry Boersma. To determine depth and spacing criteria for tile drainage. Evaluating methods for improving the drainage of the less permeable soils, and improving the methods for measuring hydraulic conductivity. Continued in 1963. Supported by Oregon State University, \$6,000 per year.
- 178 FREQUENCY AND AMOUNT OF IRRIGATION FOR SELECTED CROPS. Dr. L. Boersma and J. W. Wolfe. To determine irrigation regimes necessary for certain agricultural crops. Continued in 1963. Supported by Oregon State University, \$10,500 per year.
- 179 ADAPTATION OF SPRINKLER IRRIGATION TO SOILS OF LOW INTAKE RATE. J. W. Wolfe. To develop methods of sprinkler irrigation useful in soils having a low water intake rate. Continued in 1963. Supported by Oregon State University, \$7,000 per year.

- 180 WASTE WATER LAGOON CRITERIA FOR MARITIME CLIMATES. F. J. Burgess and Martin Northcraft. To determine the feasibility of using waste water oxidation lagoons in maritime climates as an economic solution to waste treatment problems of cities and industries. Research emphasis has been on establishment of loading criteria, reaeration mechanics, bacterial survival and disinfection requirement. Continued in 1963. Financed by U. S. Public Health Service grant, \$9,000 per year.
- 181 ENGINEERING--CHEMICAL AND BIOLOGICAL ASPECTS OF DEEP TRICKLING FILTERS. F. J. Burgess and C. M. Gilmour. To establish loading criteria, removal efficiencies and biological reaction rates as a function of depth, contact time and surface area in the biological contact processes of a deep filter. Continued in 1963. Supported by U. S. Public Health Service grant of \$14,700 per year.
- 182 ECOLOGICAL STUDIES OF AN EXPERIMENTAL STREAM. F. J. Burgess, C. E. Warren, Jack Lattin, H. K. Phinney, Joseph Wales and Peter Doudoroff. To increase understanding of the factors determining and controlling the production in streams of biological organisms of direct or indirect interest to man. Continued in 1963. Supported by a Public Health Service grant of \$21,070 per year.
- 183 THE INFLUENCE OF DISSOLVED OXYGEN UPON THE SURVIVAL, DEVELOPMENT, GROWTH, AND MOVEMENT OF FRESH-WATER FISH. C. E. Warren, Peter Doudoroff and Dean Shumway. To learn through ecologically-oriented laboratory studies how oxygen may influence the biological activities and functions of freshwater fish. Continued in 1963. Supported by a Public Health Service grant of \$13,618 per year.
- 184 STUDIES OF THE TROPHIC DYNAMICS OF SIMPLIFIED COMMUNITIES IN ARTIFICIAL STREAMS. C. E. Warren and H. K. Phinney. To study in simplified plant and animal communities under different experimental conditions of light and nutrients the pathways, rates and efficiencies of energy exchange. Continued in 1963. Supported by National Science Foundation, \$8,500 per year.
- 185 FUNGITOXIC RESIDUES IN SOIL, WATER AND PLANTS. R. A. Young and M. E. Corden. Started May 1, 1961; continued in 1963. Supported by U. S. Public Health Service, \$11,000 per year.
- 186 BIOCHEMISTRY AND PHYSIOLOGICAL ECOLOGY OF POISONED FISH. V. H. Freed and C. E. Warren. To gain an understanding

of the action of the toxic materials and the influence of them on the ecological condition of fish. Continued in 1963. Supported by a Public Health Service grant of \$24,500 per year.

- 187 AN ECONOMIC EVALUATION OF THE SALMON AND STEELHEAD SPORT FISHERY IN OREGON. W. G. Brown and E. N. Castle. To estimate the quantitative relationships needed for an appraisal of the economic value of the salmon and steelhead sport fishery in Oregon. Continued in 1963. Supported by Oregon State Game Commission, \$24,000.
- 188 AN ECONOMIC EVALUATION OF WATER POLLUTION CONTROL. E. N. Castle and F. J. Burgess. To develop a methodology which will permit evaluation of monetary benefits and costs of water pollution control. Continued in 1963. Supported by Public Health Service grant, \$31,000 per year.
- 189 DRAINAGE OF STRATIFIED SOILS, PROJECT 418. Darrell Watts and Dr. Larry Boersma. To determine depth and spacing criteria for tile drainage. Evaluating methods for improving the drainage of the less permeable soils, and improving the methods for measuring hydraulic conductivity. Financed by Oregon State University, \$6,000 per year.
- 190 INSTRUMENTATION FOR FREQUENCY AND AMOUNT OF IRRIGATION FOR SELECTED CROPS. Dr. Larry Boersma and Dr. J. W. Wolfe. To develop instruments for field determination of when to irrigate and how much to apply. Supported by Oregon State University, \$5,000 per year.
- 191 FREQUENCY AND AMOUNT OF IRRIGATION FOR SELECTED CROPS. Dr. Larry Boersma and Dr. J. W. Wolfe. To determine irrigation schedules for selected crops. Supported by Oregon State University, \$2,000 per year.
- 192 DRAINAGE OF STRATIFIED SOILS. Dr. Larry Boersma and Darrell Watts. To determine design criteria for tile drainage systems. Evaluations are being made of the beneficial effects of tile drainage on the soil physical environment. Supported by Oregon State University, \$5,500 per year.

PORTLAND STATE COLLEGE, PORTLAND

- 193 BENTHIC FAUNAL INDICATORS OF POLLUTION IN COOS BAY (OREGON). J. A. Macnab, D. McKey-Fender, Dale Long, Frances Duryea

and Catherine Dunlop. Location--Oregon Institute of Marine Biology, Charleston, Oregon. Collections of benthic fauna are being made four times per year at 10 stations in Coos Bay. At the same times and places, plankton tows, trawl hauls and water samples are taken from a boat. An anchor dredge is proving very satisfactory for taking 1/10 m³ samples of the bottom from a boat. When low tides are available, 1/10 m³ samples are being collected on beaches. The following hydrographic data are being obtained: (1) Transparency and color of water; (2) Temperature; (3) pH; (4) D.O.; (5) Salinity; (6) Sulphide and sulphite; (7) Nitrate; (8) Phosphorus; (9) Silica and lignin. A beach contaminated by sulphite waste liquor has been thoroughly sampled along transect lines, forming a grid of stations. Some interesting results are beginning to be apparent. Started September 1, 1961; continuing to August 31, 1964. Supported by Public Health Service grant of \$21,554 yearly.

- 194 HEAVY METAL POISONS IN WATERS AND INDUSTRIAL WASTES. C. R. Johnson and research assistants, Chemistry Department. Project started September 1, 1961; to be completed August 31, 1964. Paper scheduled to appear in "Analytical Chemistry" in February, 1964; another paper has been accepted for "Chemist-Analyst." It is expected that three or four more papers will ensue from the data collected. Supported by U. S. Public Health Service grant totaling \$21,050 for three years.

NATIONAL COUNCIL FOR STREAM IMPROVEMENT, CORVALLIS

- 195 PULP AND PAPER MILL WASTE DISPOSAL BY IRRIGATION AND LAND APPLICATION. R. O. Blosser and E. L. Owens. Location--Oregon State University. Field studies in progress at mill sites. Started 1960 and continued in 1963. Supported by Council funds, \$6,000 per year.
- 196 EFFECT OF TIDAL ACTION IN LOWER PORTLAND HARBOR ON NATURAL SELF-PURIFICATION CHARACTERISTICS OF THE LOWER WILLAMETTE RIVER. R. O. Blosser and E. L. Owens. To establish the manner in which observed tidal action affects the dissolved oxygen profile sag during critical low-flow periods in the lower Portland Harbor. Supported by Council funds.
- 197 CHARACTERISTICS OF KRAFT MILL EFFLUENT. R. O. Blosser and E. L. Owens. A study of the sanitary characteristics of kraft mill wastes that may contribute to odors in the vicinity of their discharge. Supported by Council funds.

OREGON FISH COMMISSION, PORTLAND

- 198 OBSERVATIONS ON THE ECOLOGY OF THE OCEAN BEACH IN RELATION TO PAPER MILL EFFLUENTS. C. D. Snow, Waldemar DeBen and N. E. Stewart. Location--Newport, Oregon. A continuing project started in 1958. No work was done on it in 1963, but it will be resumed in 1964 on observations and collections. Supported by State funds.
- 199 OBSERVATIONS ON POLLUTION AND OTHER FACTORS AS THEY AFFECT THE FISHERY OF THE LOWER COLUMBIA RIVER. Columbia River Investigations Staff. Location--Woody Island area of Lower Columbia River. Observations of water temperature, turbidity and pH were taken every other day. General observations of sphaerotilus lodged on gill nets were made. This program is no longer considered a research program on pollution or water quality. Began March 15, 1963--ended April 24, 1963. Supported by Fish Commission.
- 200 MINIMUM FLOW STUDY. R. C. Rulifson, R. E. Sams and L. S. Pearson. A limited amount of work is continuing in the Willamette River Basin to determine salmonid rearing flows. Project completed. Final report being prepared. Supported by State funds.

OREGON GAME COMMISSION--RESEARCH DIVISION--OREGON STATE UNIVERSITY, CORVALLIS

- 201 THE EFFECT OF LOGGING ON AQUATIC RESOURCES. H. J. Campbell and R. W. Phillips. Location--Drift Creek tributaries, Lincoln County, Oregon. Now in fifth year of pre-logging calibration of environmental factors on three virgin streams. Controlled logging may begin in 1964. Embryo survival studies in field and laboratory at various oxygen levels and gravel sizes. Began September, 1959 and continuing in 1963. Supported by license fees for salmon and steelhead trout fishing, \$25,000 annually.

PUBLIC HEALTH SERVICE, DIVISION OF WATER SUPPLY AND POLLUTION CONTROL, PORTLAND

- 202 IMPROVED ANALYTICAL METHODS. W. A. Moore and associates. Project presently involves studies of methods for the determination of sugars, pentachlorophenol and sulfite waste liquor in the minute quantities present in natural waters as a result of the discharge of industrial wastes.

Continued in 1963. Supported by U. S. Public Health Service.

- 203 A STUDY OF THE EFFECTS OF PULP AND PAPER MILL WASTES ON WATER QUALITY AND MARINE RESOURCES OF PUGET SOUND. A. F. Bartsch and staff. Located primarily in the waters adjacent to Everett, Anacortes and Bellingham on Puget Sound and Port Angeles on the straits of Juan de Fuca. A field study involving pulp mill wastes and their various components; the patterns of travel within Sound waters; the effects on aquatic marine life; and other chemical, physical and biological factors attending the disposal of these wastes. Continued in 1963. Supported by U. S. Public Health Service.

- 204 DEVELOPMENT OF TECHNIQUES FOR ECONOMIC BASE ANALYSIS. J. H. Davidson, E. F. Snyder and R. L. Coughlin. Studies to develop a better understanding of the relationships between types of industries and population as a predictive tool for forecasting the future economic base. Techniques will have an application in water resource comprehensive planning. Continued in 1963. Supported by U. S. Public Health Service.

PACIFIC NORTHWEST FOREST AND RANGE EXPERIMENT STATION, U. S.
FOREST SERVICE, U. S. DEPARTMENT OF AGRICULTURE, PORTLAND

- 205 PHYSICAL SOIL PROPERTIES RELATED TO EROSION. D. D. Wooldridge (Forest Hydrology Laboratory, Wenatchee). Objective: To determine for the major soil types in forests and related ranges of the Pacific Northwest the physical properties which are related to their inherent stability and susceptibility to erosion. Continued in 1963. Supported by Department of Agriculture funds.
- 206 RELATION OF SOIL PROPERTIES TO CLIMATIC FACTORS. A. N. Balci and D. D. Wooldridge (Forest Hydrology Laboratory, Wenatchee). Presently doing physical and chemical analysis of soils from eastern and western Washington. Continued in 1963. Supported by U. S. Department of Agriculture funds.
- 207 EFFECT OF LOGGING AND ROAD BUILDING ON WATER YIELD AND SEDIMENTATION. N. H. Miner. Location--Bull Run Watershed. Watersheds gaged since 1957; continued in 1963. Logging treatments to begin in 1964. Supported by the U. S. Department of Agriculture and Portland Bureau of Waterworks.
- 208 EFFECTS OF SKYLINE, HIGH LEAD AND TRACTOR LOGGING ON SOIL SURFACE CONDITIONS AND SURFACE BULK DENSITY. C. T. Dyrness,

Forest Sciences Laboratory, Corvallis. Location--H. J. Andrews Experimental Forest, Blue River, Oregon. Logging done in 1962 and 1963. Supported by U. S. Department of Agriculture.

- 209 EFFECT OF LOGGING AND SLASH BURNING ON CHEMICAL PROPERTIES OF STREAMFLOW. R. L. Fredriksen. Project located in H. J. Andrews Experimental Forest, Blue River, Oregon. Watersheds gaged since 1952. Watersheds logged 1962 and 1963. Supported by U. S. Department of Agriculture.
- 210 HYDROLOGY AND SEDIMENT PRODUCTION--SUGAR PINE--DOUGLAS-FIR FORESTS. Jack Rothacher, Forestry Sciences Laboratory, Corvallis. Location--South Umpqua Experimental Forest near Tiller, Oregon. Two watersheds gaged since 1960. Stream gages installed in two additional watersheds in 1963. Supported by U. S. Department of Agriculture.
- 211 HYDROLOGY AND SEDIMENT PRODUCTION IN MIXED CONIFER FOREST. H. G. Herring, Forest Hydrology Laboratory, Wenatchee. Location--Entiat River Basin, Washington. Watersheds gaged since 1959; continued in 1963. Supported by U. S. Department of Agriculture.
- 212 METHODS OF REVEGETATING GAME RANGES FOR WATERSHED STABILIZATION. D. D. Wooldridge, Forest Hydrology Laboratory, Wenatchee. Location--eastern Washington and Oregon. Continued in 1963. Supported by U. S. Department of Agriculture.
- 213 SEDIMENT PRODUCTION FROM SWAUK SANDSTONE SOILS IN CENTRAL WASHINGTON. D. D. Wooldridge, Forest Hydrology Laboratory, Wenatchee. Sediment measured from three small drainages in Mission Creek watershed. Project continued in 1963. Supported by U. S. Department of Agriculture.
- 214 EFFECT OF ROAD BUILDING ON STREAM SEDIMENTATION IN OLD-GROWTH DOUGLAS-FIR WATERSHEDS. R. L. Fredriksen and J. S. Rothacher. Location--H. J. Andrews Experimental Forest, Blue River, Oregon. Measurements of sediment production under way. Continued in 1963. Supported by Department of Agriculture funds.
- 215 EFFECT OF HARVESTING OLD-GROWTH DOUGLAS-FIR ON SEDIMENTATION. J. S. Rothacher. Location--H. J. Andrews Experimental Forest, Blue River, Oregon. Continued in 1963. Supported by Department of Agriculture funds.

- 216 STUDY OF SOIL EROSION USING RADIOISOTOPES. D. D. Wooldridge.
Location--Forest Hydrology Lab., Wenatchee, Washington.
Radioactive iron used as a tracer. Applied to bare soil
on an exposed slope in Mission Creek watershed. Approved
by U.S.D.A. Radiological Safety Committee and A.E.C. Began
in 1963. Supported by U. S. Department of Agriculture.
- 217 CHANGES IN STREAM CHARACTERISTICS AFTER SHELTERWOOD CUTTING
OF 120-YEAR-OLD DOUGLAS-FIR ON A SOUTH SLOPE. Jack Rothacher.
Location--H. J. Andrews Experimental Forest, Blue River,
Oregon. Three watersheds, 37, 42, and 86 acres in area,
gaged with type H flumes. Calibration period started in
1963. Shelterwood cuttings to be applied after termination
of calibration, approximately 1967. Results to be assessed
in terms of changes in water yield and sediment content of
the streams. Supported by U. S. Department of Agriculture.

U. S. GEOLOGICAL SURVEY, GROUNDWATER BRANCH, PORTLAND

- 218 ARTIFICIAL RECHARGE THROUGH A PUBLIC-SUPPLY WELL AT SALEM
HEIGHTS, OREGON. B. L. Foxworthy and Don Price. Started
October, 1961. On the basis of favorable preliminary
results, the water district successfully recharged through
the experimental well during Fall and Winter, 1962, and is
presently recharging (Winter 1963-64). Final report in
preparation. Supported by U. S. Geological Survey and
Salem Heights Water District, \$8,000.
- 219 ARTIFICIAL RECHARGE OF BASALT AQUIFERS AT THE DALLES, OREGON.
B. L. Foxworthy, C. T. Bryant and E. R. Hampton. Started
October, 1960. Final report completed and in review.
Supported by U. S. Geological Survey and Dalles City,
\$8,000.
- 220 HYDROLOGY OF THE COLUMBIA RIVER BASALT (Research into all
phases of geohydrology of this volcanic terrane.) R. C.
Newcomb. Indirect relation to pollution and water quality
--expected to yield new information on modes of ground-
water recharge to and movement in basalt aquifers. Papers
published on two sub-projects and on two allied observa-
tions of type hydrologic situations. Started in 1959;
continued in 1963. Supported by U. S. Geological Survey,
\$19,000.

U. S. SOIL CONSERVATION SERVICE, PORTLAND

- 221 WATER TEMPERATURES. L. D. Marriage and Service field and office staff. Location--Middle Fork Hood River, Pine Valley and Napa River. The collection of existing water temperatures in various watersheds on which reservoirs are proposed in an attempt to make the best use of reservoirs for fisheries and to predict the effect on fishery habitat. Thermographs installed for continuous recording. Continued in 1963. Supported by Service funds, \$1,000.

WASHINGTON

UNIVERSITY OF WASHINGTON, SEATTLE

- 222 QUALITY OF IMPOUNDED WATER AS INFLUENCED BY SITE PREPARATION. R. O. Sylvester, R. W. Seabloom, Tacoma Water Division, Corps of Engineers, Soil Conservation Service. Location--Howard Hanson impoundment, Green River, Washington. Project started May, 1962; continued in 1963. Supported by U. S. Public Health Service demonstration grant, \$14,500 per year.
- 223 EFFECT OF REFUSE DISPOSAL ON WATER QUALITY. R. W. Seabloom and W. L. Dunn, Civil Engineering Department. Location--Union Bay, Lake Washington, Seattle. (Seattle refuse is dumped along margin at Union Bay in a semi-sanitary fill operation.) Started in 1958; continued in 1963. Funds from the University, \$550.
- 224 AMINO ACID UTILIZATION IN ACTIVATED SLUDGE. D. A. Carlson. Started September 1, 1961 and continued in 1963. Supported by grant from the Public Health Service, \$12,857.
- 225 A WATER QUALITY STUDY OF WHISTLE LAKE, ANACORTES, WASHINGTON. R. O. Sylvester, D. A. Carlson and R. T. Oglesby. Location--Anacortes, Washington. A physical, chemical and biological study of Whistle Lake to determine its suitability as a future water supply reservoir in consideration of the increased impoundment by dam construction and the introduction of off-peak city water, together with recommendations for water quality control, if found necessary. One-year project beginning May, 1963 and ending June, 1964. Supported by City of Anacortes, \$3,935.

- 226 AN ENGINEERING AND ECOLOGICAL STUDY FOR THE REHABILITATION OF MOSES LAKE, WASHINGTON. R. O. Sylvester and R. T. Oglesby. Location--Moses Lake, Washington. To obtain data on the lake's chemical, biological and physical characteristics; to relate them to the drainage basin (effect and cause); and to prepare, if possible, recommendations for lake rehabilitation. Started March, 1963. Supported by funds of the Moses Lake Irrigation and Rehabilitation District, \$4,691.
- 227 THE EFFECT OF MOLECULAR SUBSTITUTION ON BIO-OXIDATION. R. H. Bogan and J. A. Servizi, Civil Engineering Department. Starting date, January 1, 1962; continued into 1963. Funds from U. S. Public Health Service and the University.
- 228 DEVELOPMENT, DESIGN AND STUDY OF WASTE TREATMENT FACILITIES FOR HANDLING CLOSE CYCLE WORKS. R. H. Bogan, Civil Engineering Department. A preliminary study of waste disposal in a space environment. Continued in 1963. Supported by research contract with Boeing Airplane Co., Aero-Space Division.
- 229 THE NATURE OF ORGANIC COLOR IN WATER. R. F. Christman, Sanitary Engineering Division, Department of Civil Engineering. To determine the chemical nature of the organic compounds responsible for color in water, and to study the mechanism of the coagulation of this colloidal dispersion with salts of Al(III) and Fe(III). Started October 1, 1963; to continue through September 30, 1965. Supported by U. S. Public Health Service grant, \$27,676.
- 230 OCEANOGRAPHIC MODEL STUDIES OF PUGET SOUND. M. Rattray, Jr., and H. G. Farmer, Department of Oceanography. Source of funds: Office of Naval Research.
- 231 THEORETICAL STUDIES ON THE DYNAMICS OF ESTUARINE CIRCULATION. M. Rattray, Jr., and D. V. Hansen, Department of Oceanography. From April 1, 1963 to April 1, 1964. Supported by National Science Foundation.
- 232 OCEANOGRAPHIC STUDIES IN PUGET SOUND AND NORTHEAST PACIFIC. R. H. Fleming and staff, Department of Oceanography. Work in Puget Sound and coastal waters basic to understanding of water quality and water pollution. Water movement and diffusion, chemical and biological characteristics, nature and distribution of sediments, and

oxygen utilization rates studied. A continuing project. Supported by Office of Naval Research.

- 233 COLUMBIA RIVER EFFECTS IN THE NORTHEAST PACIFIC. C. A. Barnes, G. C. Anderson, K. Banse, L. K. Coachman, J. S. Creager, M. G. Gross, D. H. McManus, U. Stefanson, T. F. Budinger, and others, Department of Oceanography. To identify and trace Columbia River water as it moves and disperses at sea. Biological, geological, chemical and physical aspects are studied throughout year. A continuing project. Supported by Atomic Energy Commission.
- 234 LAKE WASHINGTON STUDY. W. T. Edmondson, Department of Biology. A three-year study of the ecology of the lake as affected by nutrients from waste effluents. A special emphasis on algal production. Supported originally by National Science Foundation funds of \$42,300 for three years; continued for an additional three years by a National Science Foundation grant of \$118,000.
- 235 MOVEMENT OF WATER AND ASSOCIATED CHEMICAL ELEMENTS IN A FOREST ENVIRONMENT. S. P. Gessel and Dale Cole, College of Forestry. Location--Cedar River Watershed. Started in 1960. Expanded and continued for three years. Electronic monitoring of systems now being installed. Contrasting alder and Douglas-fir systems and also clear-cutting and addition of certain elements. Supported by funds from the National Science Foundation, \$20,000.
- 236 THE EFFECTS OF LOGGING ON YIELD AND QUALITY OF WATER FROM SOME MUNICIPAL WATERSHEDS. S. P. Gessel and Leo Teller, Department of Forestry. Location--Northwest (Oregon, Washington and British Columbia). Started in September, 1961; completed June, 1963. Thesis complete; paper in process. Supported by Resources for the Future, \$3,000.
- 237 HYDROLOGIC PROPERTIES OF FOREST HUMUS TYPES. S. P. Gessel and Nihat Balci, Department of Forestry. Location--western Washington. Started August, 1961; completed September, 1963. Reports now being written. Thesis completed. Supported by Public Health Service grant, \$6,500.
- 238 ECOLOGY OF PARALYTIC SHELLFISH TOXICITY IN WASHINGTON. Dr. A. K. Sparks, Dr. K. K. Chew, John DuPuy and Benny Hsu. Location--coastal waters of Washington. A College of Fisheries project. To continue through September 30, 1966. Supported by Public Health Service funds, \$32,136.

- 239 ECOLOGY OF PARALYTIC SHELLFISH TOXICITY IN SOUTHEASTERN ALASKA. Dr. A. K. Sparks, Dr. K. K. Chew and Richard Neal. Location--Ketchikan area of southeastern Alaska. A College of Fisheries project. Started in February, 1963 and continuing. Supported by U. S. Public Health Service grant, \$18,760.
- 240 STUDIES IN OYSTER PATHOLOGY. Dr. A. K. Sparks and G. B. Pauley. Location--College laboratories and field. A continuing College of Fisheries project. Renewal for five years pending. Supported by Bureau of Commercial Fisheries, \$11,525.
- 241 INCIDENCE AND PATHOLOGY OF MYTILICOLA IN OYSTERS. Dr. A. K. Sparks, Dr. K. K. Chew and S. C. Katkansky. Location--Washington, Oregon and California. A continuing College of Fisheries project; renewal for three years pending. Supported by Public Health Service funds, \$28,085.
- 242 SIMULATION OF NATURAL POPULATIONS AND COMMUNITIES. Dr. G. J. Paulik and Joseph Greenough, Jr., College of Fisheries. Location--Seattle. Supported by State of Washington Initiative 171, \$2,700.
- 243 BOISE CREEK RESEARCH. Dr. D. E. Bevan, W. F. Royce and Denny Miller, Fisheries Research Institute. Location--Enumclaw, Washington. A study of the ecology of a small western Washington stream under altered conditions from industrial, agricultural and domestic uses. Supported by Weyerhaeuser Timber Co., \$8,366.
- 244 IMPROVING THE SIMULATION CAPABILITIES OF THE RESEARCH COMPUTER LABORATORY. Dr. G. J. Paulik and Dr. D. E. Bevan, Fisheries Research Institute. Location--University of Washington. The aim of the project is to extend the present monitor system of the University's IBM 709 digital computer by adding two or more simulation compiler programs to the system. This will greatly extend the usefulness of the computer by making powerful digital simulation available to persons without extensive coding or programming experience. Simulation techniques can be used to model ecological systems where the phenomena are so complex they cannot be reduced to a tractable mathematical formulation. Started June, 1963. Supported by National Science Foundation, \$2,000.

- 245 EVERETT BAY RESEARCH. Dr. D. E. Bevan, W. F. Royce and Richard Tyler, Fisheries Research Institute. Location--Everett, Washington. A study to determine the distribution of young salmonid fishes in the Everett Bay area. Supported by Weyerhaeuser Timber Co., Scott Paper Co. and Simpson-Lee Paper Co., \$14,000.
- 246 BELLINGHAM BAY RESEARCH. Dr. D. E. Bevan, W. F. Royce and Richard Tyler, Fisheries Research Institute. Location--Bellingham, Washington. A study is being made to understand the distribution of young salmon and other fishes in the Bellingham area. Supported by Puget Sound Division, Georgia Pacific Corporation, \$12,803.
- 247 EFFECTS OF LOGGING ON SALMON STREAMS IN SOUTHEASTERN ALASKA. Dr. D. E. Bevan, W. F. Royce and Philip Shapley, Fisheries Research Institute. Location--Hollis, Alaska. A cooperative study with the Northern Forestry Experiment Station, U. S. Forest Service, Juneau. The major objective of the project is to determine how the quality of the spawning bed environment as it pertains to growth, development, and mortality of salmon eggs and larvae is affected by logging. Supported by funds from the Saltonstall-Kennedy Act, Bureau of Commercial Fisheries, \$37,900.
- 248 DETERMINING CHANGES IN SIZE COMPOSITION OF STREAMBED MATERIAL IN LOGGED WATERSHEDS. Dr. D. E. Bevan, Prof. M. C. Bell and R. D. McIrvin, Fisheries Research Institute. Location--Seattle. The research in hydraulics is aimed at understanding the conditions under which fine particles are added to or removed from salmon spawning beds. Supported by Institute of Forest Products, \$3,000.
- 249 DISTRIBUTION OF RADIONUCLIDES IN MARINE ORGANISMS AND WATER NEAR THE MOUTH OF THE COLUMBIA RIVER. A. H. Seymour, G. B. Lewis, Jan Naidu and G. Jonnson, Laboratory of Radiation Biology. Three years of monitoring, beginning January, 1961, were completed with report now in preparation. Special studies on stable zinc and zinc 65 in oysters also included. Part of this work included in Master's Degree thesis by Jan Naidu, "Stable and Radioactive Zinc in Willapa Bay" that was completed August, 1963. In 1964 development of techniques for measurement of phosphorous -32 in sea water to be completed, after which measurement of p32 in water and organisms will be made. Supported by Atomic Energy Commission, Division of Biology and Medicine.

WASHINGTON STATE UNIVERSITY, PULLMAN

- 250 BIOLOGY AND CHEMISTRY OF SPHAEROTILUS. J. L. Stokes, A. Johnson and Mrs. Margaret Powers, Department of Bacteriology. Started June, 1961. Studies reported in paper entitled "Morphology, Nutrition and Physiology of Sphaerotilus discophorus," by M. A. Rouf and J. L. Stokes, submitted to the Journal of Bacteriology. Application has been made to U. S. Public Health Service for a three-year renewal, approximately \$60,000.
- 251 LIMNOLOGICAL STUDY OF ANAEROBIC-AEROBIC SEWAGE PONDS. G. H. Dunstan, R. H. Green and G. H. Bowen, Division of Industrial Research. This study is a continuation of a state-supported project previously entitled "An Investigation of Stabilization Pond Loadings in the Purification of Sewage." The purpose of the study is to determine the biological organisms which contribute to stabilization in anaerobic-aerobic lagoon systems at high loadings, and to relate them to the physical and chemical changes which occur in the stabilization process. Primary emphasis is being placed on algae species, but other predominating organisms also will be evaluated under environmental conditions associated with high pond loadings. Concluded in 1963; continuation included in "Lagoons for Dairy Farms" (No. 252). Supported by funds from the U. S. Public Health Service, \$15,272.
- 252 LAGOONS FOR DAIRY FARMS. D. E. Proctor, R. H. Green, G. H. Dunstan and J. B. Stahl, Division of Industrial Research. Dairy Science Department is cooperating. Location--Knott Dairy Farm, near Pullman (WSU-owned). This study is a continuation of "Limnological Study of Anaerobic-Aerobic Sewage Ponds" (No. 251). Four lagoons have been constructed. Washings from feed lot and milking parlors are flushed into these. Two are designed for anaerobic operation; the other two being operated aerobically. In conjunction with this project, studies at the ponds at the Pullman Sewage Treatment Plant are being continued. Started May 1, 1963. Supported by State Division of Industrial Research, \$15,000.
- 253 EFFECT OF IRRIGATION USE ON QUALITY OF RETURN WATERS. G. H. Dunstan, C. A. Rambo and P. Bennett. This study was conducted in the Columbia Basin irrigation project with supplemental studies on the effect of soils on return flow quality conducted at the University in cooperation with the agricultural department. Work concluded. Final report

in preparation: Paper, "Changes in Water Quality Due to Irrigation," by G. H. Dunstan, D. E. Proctor and Ervin Hindin--Proceedings of the 11th Pacific Northwest Industrial Waste Conference, 1963; p. 74, Circular #29, Engineering Experiment Station, Oregon State University, Corvallis, Oregon.

- 254 WATER RECLAMATION FROM SEWAGE BY SOLVENT EXTRACTION. E. Hindin, G. H. Dunstan and Donald May. Studies of use of permeable membranes. Started October 1, 1961; completed October 1, 1963. Progress report completed. Continued under "Water Reclamation by Reverse Osmosis," to be started January 1, 1964. Supported by U. S. Public Health Service, \$14,637.
- 255 SPHAEROTILUS CONTROL FOR IRRIGATION WATER. B. A. Nakata, D. S. May and G. H. Dunstan. To study nitrogen and phosphorus requirements of sphaerotilus, the availability of various inorganic and organic nitrogen and phosphorus compounds and the relative amounts required per unit of carbon source. Started April, 1961. Continued in 1963; to be concluded April 1, 1964. Supported by U. S. Public Health Service, \$12,325, first year of a three-year period.
- 256 ANALYSIS OF ORGANIC PESTICIDES BY GAS CHROMATOGRAPHY. E. Hindin, G. H. Dunstan and D. S. May. This study is to develop gas chromatographic methods for the analysis of specific organic pesticides in water. Field studies will be used to evaluate the methods. Report, "Analysis of Synthetic Organic Pesticides in Water," Journal AWWA, January, 1962. Concluded October 1, 1963. Final progress report submitted. Supported by funds from the National Institutes of Health, \$15,479, third year. A proposal has been submitted to U. S. Public Health Service for additional support.
- 257 TREATMENT OF POULTRY WASTES. R. H. Green and D. E. Proctor, in cooperation with Poultry Science Department. Started September, 1962 in the poultry building on Washington State University Campus. Continued throughout 1963 and into 1964. Current studies involve anaerobic digestion of poultry manure collected by water carriage, aerobic treatment of supernatant and recycling of aerobic effluent for carriage water. Supported by the University, \$3,500.

- 258 PEA WASTE NUTRITION BALANCE. D. E. Proctor, D. S. May, Ervin Hindin and G. H. Dunstan, Division of Industrial Research. Location--Sloan Hall, Sanitary Engineering Labs. Warburg studies will be followed by laboratory trickling filter studies, including pre-aeration. Canned blancher waste will be used to simulate actual industrial waste from pea processing. Various supplements, such as nitrogen and phosphorus, will be studied in an effort to determine whether such supplements and pre-aeration are desirable in treatment plant operation. Authorized in December, 1963; to terminate June, 1964. Supported by funds from City of Walla Walla, \$2,000.
- 259 MOVEMENT OF GROUNDWATER IN CRYSTALLINE ROCKS. J. W. Crosby III, Dr. R. M. Chatters and D. Masson, Division of Industrial Research. Conducted in cooperation with Seattle City Power & Light and Pend Oreille Mines & Metals Co. Location --Pullman, Washington and Metalline Falls, Washington. Started October, 1963. Supported by State of Washington, \$32,000 for three-year period.
- 260 STUDIES ON THE APPLICATION OF RADIOISOTOPE TECHNIQUES IN STREAM POLLUTION PROBLEMS IN THE PULP AND PAPER INDUSTRY. Dr. R. M. Chatters, Division of Industrial Research. In cooperation with Potlatch Industries, Lewiston, Idaho and U. S. Atomic Energy Commission. Location--Washington State University. Started in 1963. Supported by Washington State University and U. S. Atomic Energy Commission, approximately \$17,000.
- 261 RADIOCARBON DATING OF WATER AND GLACIAL ICE. Dr. D. M. Chatters, Division of Industrial Research. In cooperation with Albrook Hydraulic Laboratory and the Institute of Polar Studies, Ohio State University. Continued in 1963. Plans are under way to collect glacial water at Greenland and at Antarctica during 1964-65. Supported by State of Washington, \$2,000.
- 262 NUTRIENT INPUT TO WASHINGTON SOILS FROM ATMOSPHERIC SOURCES. C. D. Moodie, Department of Agronomy. Project conducted at Pullman and at eight other experiment stations. This project is intended to provide data on the quantity of nutrients contributed to soils and crops by rainfall and irrigation waters. Rainfall is being collected at eight locations around the state of Washington and analyzed for its nutrient content. Continued in 1963 and will continue in 1964. Supported by Washington Agricultural Experiment Station, \$3,000.

- 263 SOIL TESTING. A. R. Halvorson and C. D. Moodie, Department of Agronomy. This project is concerned with the routine analysis of soil and water samples. The data are used to make fertilizer recommendations. The analyses of irrigation water taken from wells, streams and return flow are interpreted in terms of hazards associated with their continued use on land. Research is conducted relative to the levels of soil tests to crop response to fertilization. The objective is to further the proper use of fertilizers and to conserve the soil and fertilizer resources. Continued in 1963 and will be continued through 1964. Supported by State funds, \$30,000.

BUREAU OF COMMERCIAL FISHERIES, U. S. DEPARTMENT OF INTERIOR,
SEATTLE

- 264 LIMNOLOGICAL STUDIES OF A LARGE IMPOUNDMENT. R. F. Raleigh, Wesley Ebel and C. Koski. Started in 1962 at Brownlee Reservoir, Snake River, Weiser, Idaho; continued in 1963. Part of a program to examine the behavior of salmon migrants in a large impoundment in relation to environment. Supported by Department of Interior.

SHELLFISH SANITATION LABORATORY, U. S. PUBLIC HEALTH SERVICE,
GIG HARBOR

- 265 BACTERIAL CHANGES IN COMMERCIALY HANDLED SHELLFISH. W. J. Beck and staff. Continued in 1963. Research expanded to include shellstock of Pacific oysters and clams. Supported by Public Health Service.
- 266 RELATIVE BACTERIAL CONTENT OF SHELLFISH IN OVERLYING WATERS. W. J. Beck and staff. Continued in 1963. Studies expanded to include Native Littleneck and Manila clams. Supported by Public Health Service.
- 267 SANITARY SIGNIFICANCE OF FECAL COLIFORMS IN SHELLFISH GROWING AREAS. W. J. Beck and staff. Continued in 1963. Supported by Public Health Service.
- 268 VIRUSES IN SHELLFISH. J. C. Hoff. Initiated laboratory studies on the accumulation and retention of bacteriophage by shellfish in 1963. Supported by Public Health Service.

- 269 OCEANOGRAPHIC METHODS. P. S. Kelley. Initiated studies on the development and evaluation of oceanographic methods for small estuaries in 1963. Supported by Public Health Service.

WASHINGTON DEPARTMENT OF FISHERIES

- 270 THE EFFECT OF SULFITE WASTE LIQUOR ON OYSTERS AND WATER. Biological portion: C. E. Woelke, A. M. Andersen and D. R. Well. Water Quality portion: R. E. Westley and M. A. Tarr. Analysis of data was completed and report has been started. Hope to have in manuscript form in 1964.
- 271 CLAM AND OYSTER LARVAE AS SPECIMENS FOR BIOASSAY. C. E. Woelke and D. T. Walsh. Present bioassay methods using adult shellfish require long time periods. Larval bioassay will shorten period of test. Finite statistical analysis of the techniques involved has been completed. Water from various bays and estuaries has been assayed using 48-hour larval development of the Pacific oyster. Control parameters have been studied using water from areas not suspect of pollution. Studies conducted in 1963 included water from known polluted areas. Work continuing and anticipate a report on biometric analysis of the technique during 1964.
- 272 RELATIVE TOXICITY OF SULFITE WASTE LIQUOR. C. E. Woelke, D. T. Walsh and M. A. Tarr. Dilutions of SWL ranging from 2-32 ppm were made up from digester liquor and the effect on 48-hour development of Pacific oyster larvae was determined. Digester waste from five different mills, including all principal types of processes, was evaluated. A total of 25-30 different samples of waste have been evaluated and work on this phase is complete. Studies on liquor components are being held in abeyance pending availability of components for testing. Hope to do assays from various "in-plant" waste streams in cooperation with U. S. Public Health Service in 1964. Also assaying other materials such as phosphamidon, pentachlorophenolates, etc. Report in preparation.
- 273 FIELD WATER BIOASSAYS. C. E. Woelke and D. T. Walsh. Location--Point Whitney. Control parameters have been evaluated using water from unpolluted areas. Water from various bays and estuaries is being evaluated using 48-hour development of Pacific oyster larvae. Expanded in cooperation with U. S. Public Health Service in 1963--to continue in 1964. One or two reports expected in 1964 or early 1965.

- 274 BOTTOM SEDIMENT IN RELATION TO OYSTER GROWTH AND CONDITION. C. E. Woelke, M. A. Tarr and D. T. Walsh. Samples of bottom sediment are analyzed for physical size composition, organic carbon, total ash and inorganic salts, and this information related to the fatness, growth and mortality of oysters. Work to date indicates a relationship between organic and oyster population. Continuing on a limited scale. Results from several facets of this study to be reported in 1964.
- 275 MARINE ALGAE BIOASSAYS. C. E. Woelke and Eugene Sanborn. Location--Point Whitney. Probing studies have been initiated to ascertain the feasibility of using several bacteria-free strains of unicellular marine algae as bioassay organisms. It is hoped that, in the future, wastes, insecticides, etc., would be bioassayed with both bivalve larvae and marine plants to assess their potential impact on marine estuarian waters. Started, autumn 1963. Supported by State funds.
- 276 LIMNOLOGY OF THREE MEDIUM-SIZED RESERVOIRS AS RELATED TO JUVENILE FISH MIGRATION. R. E. Westley, D. Stuckey and W. Hoffman. Dr. George Anderson, Consultant. Location --Lakes Merwin, Baker and Shannon. Study based on distribution of temperature, oxygen, and conductivity. Started March, 1962; continued through 1963. Supported by funds of the Fish & Wildlife Service, \$30,000.
- 277 OYSTER BED PRODUCTIVITY PROJECT. R. Westley and M. Tarr. Location--South Puget Sound and Hood Canal. A project designed to determine hydrographic, chemical, and biological differences between areas which produce oysters of good and poor fatness. Emphasis on primary productivity of water. Started in 1961 and continued through 1963. Supported by Department of Fisheries.
- 278 WILLAPA BAY HYDROGRAPHIC PRODUCTIVITY PROJECT. R. E. Westley, M. Tarr and C. Sayce. Location--Willapa Bay. Project designed to determine relationship between the well-being of oyster population and hydrographic features with emphasis on primary productivity of water. Started in 1961 and continued through 1963. Supported by Department of Fisheries.

CROWN ZELLERBACH CORPORATION, CAMAS

- 279 DETERMINATION OF VARIABLES SUPPORTING SPHAEROTILUS GROWTH IN THE COLUMBIA RIVER. H. R. Amberg, J. F. Cormack and L. F. Lucas. Continued in 1963. Publication, "Slime Growth Control by Intermittent Discharge of Spent Sulfite Liquor," TAPPI, Vol. 45 (Oct. 1962). Supported by Crown Zellerbach Corporation funds, \$26,000.
- 280 COLUMBIA RIVER SURVEY. H. R. Amberg, J. F. Cormack and L. F. Lucas. A phase of a million-dollar research study aimed at developing products from waste material. Present emphasis is placed on spent sulfite liquor. Projects not detailed here because of confidential nature of some of the research. A continuing study supported by Crown Zellerbach Corporation funds, \$27,650.
- 281 DETERMINATION OF VARIABLES SUPPORTING SPHAEROTILUS GROWTH IN THE COLUMBIA RIVER. H. R. Amberg, J. F. Cormack and L. F. Lucas. Location--Camas, Washington. A continuing project. Publication, "Columbia River Study--A Progress Report, 1958-1963." Crown Zellerbach Corporation, Camas Mill Division, (Nov. 1963). Supported by Crown Zellerbach Corporation funds, \$30,000.

GENERAL ELECTRIC COMPANY, HANFORD LABORATORIES, RICHLAND

- 282 EVALUATION OF RADIOLOGICAL CONDITIONS IN THE COLUMBIA RIVER. R. F. Foster, R. B. Hall, R. W. Meisinger and R. H. Wilson, Radiation Protection Operation. This is part of the comprehensive environmental surveillance program. Some features provide information on the fate of radioactive materials. A continuing project supported by the U. S. Atomic Energy Commission, \$250,000.
- 283 CHONDROCOCCUS COLUMNARIS AS A DISEASE ORGANISM IN FISH. M. P. Fujihara and P. A. Olson, Biological Laboratory. Includes studies on the nature of the columnaris organism, its nutrition, distribution in nature, response to radiation, and environmental conditions which lead to infection of fish. Continued in 1963. Supported by the Atomic Energy Commission, \$30,000.
- 284 EFFECTS OF HANFORD PROCESS EFFLUENTS ON AQUATIC ORGANISMS. P. A. Olson, R. E. Nakatani and D. H. W. Liu, Biology Laboratory. Major effort is expended on a continuous biological assay of reactor effluent water for practical

- demonstration of the effect of various effluent concentrations on the economically important salmonids. In addition, information is developed to fix upper limits of quantities of toxic substances used on occasions which can be added to the river with safety for fish populations. Continued in 1963. Supported by the Atomic Energy Commission, \$60,000.
- 285 SHORT AND LONG-RANGE ANALYSIS OF RELATIONSHIP AMONG WEATHER, IMPOUNDMENTS AND DIVERSIONS AFFECTING COLUMBIA RIVER TEMPERATURES. R. T. Jaske, Irradiation Processing Department. Obtained original data on reservoir thermal mapping. Correlating numerical values to develop a mathematical model to forecast river temperatures. A continuing project supported by the Atomic Energy Commission.
- 286 METABOLISM AND TOXICITY OF RADIONUCLIDES IN AQUATIC ORGANISMS. R. E. Nakatani, P. A. Olson and J. M. Dean, Biology Laboratory. The studies center on investigating the pathological manifestation of radiation injury by internal emitters in fish. Supporting work includes studies on the uptake, distribution and retention of internal emitters by fish from water and food. Also under study is the ability of fish with non-lethal body burden of certain internal emitters to tolerate various environmental stress. Continued in 1963. Supported by the Atomic Energy Commission, \$100,000.
- 287 GROUNDWATER INVESTIGATIONS (DISPOSAL OF RADIOACTIVE WASTES TO GROUND). G. J. Alkire, W. A. Haney, et al., Chemical Effluents Technology Laboratory. Started in 1947 and continued in 1963. Supported by Atomic Energy Commission.
- 288 CHEMISTRY AND KINETICS OF RADIOISOTOPE DISPOSAL IN THE COLUMBIA RIVER. R. W. Perkins, J. L. Nelson and J. M. Nielsen, Radiological Chemistry. Continued in 1963. Supported by Atomic Energy Commission, Division of Biology and Medicine.
- 289 GEOLOGICAL STUDIES AND SOIL PHYSICS (AS RELATED TO THE GROUND DISPOSAL OF RADIOACTIVE WASTES. W. A. Haney, D. J. Brown, R. E. Brown, L. G. King, R. W. Nelson, J. R. Raymond, A. E. Reisenauer, et al., Chemical Effluents Technology. Started in 1947 and continued in 1963. Supported by Atomic Energy Commission, Division of Biology and Medicine.
- 290 COLUMBIA RIVER ECOLOGICAL STUDIES. C. E. Cushing, W. C. Hanson and D. G. Watson. Continued in 1963.

- 291 EFFECT OF REACTOR EFFLUENT ON THE QUALITY OF COLUMBIA RIVER WATER. J. P. Corley. A study of chemical and heat changes occurring in the reach of the river near Hanford. A continuing study begun in 1962. Supported by the Atomic Energy Commission, \$50,000.
- 292 MECHANISMS OF ENVIRONMENTAL EXPOSURE. E. C. Watson, R. F. Foster, J. K. Soldat and R. B. Hall. Determination of parameters relating amounts of radionuclides released, abundance in environmental media and radioactivity in local residents. A continuing study begun in 1962. Supported by the Atomic Energy Commission, \$50,000.

MUNICIPALITY OF METROPOLITAN SEATTLE

- 293 STUDIES OF LAKE WASHINGTON TRIBUTARIES. G. D. Farris and C. V. Gibbs. A study designed to complement the work being performed by W. T. Edmondson on the ecology of the lake. Data obtained will allow determination of the nutrient inflow, outflow and reservoir. The Surface Water Branch of the U. S. Geological Survey is cooperating in the study. The program started in 1963 and will continue indefinitely. Supported predominantly by Metro funds.
- 294 A STUDY OF THE WATER QUALITY, ECOLOGY AND HYDROLOGY OF THE GREEN-DUWAMISH ESTUARY. G. W. Isaac, G. D. Farris and C. V. Gibbs. To determine changes in water quality and ecology following a major pollution abatement program. This program includes study of water quality variables with automatic monitoring equipment of the type pioneered by ORSANCO; of changes in productivity of the estuary with changes in nutrient loading; of the ecology of sewage outfall areas; and other studies related to Metro's waste disposal program. Started in 1961--will continue indefinitely. Supported jointly by Metro and the U. S. Geological Survey, Quality of Water Branch.
- 295 THE EFFECTS OF RUNOFF FROM SPRINKLER IRRIGATION OF TREATED DOMESTIC WASTES ON THE CHEMISTRY AND ECOLOGY OF A SMALL STREAM. G. W. Isaac and G. D. Farris. A study designed to provide information concerning the effects of coliform bacteria and increased nutrients on the algal and benthic production in streams. The increased use of spray field disposal as a temporary treatment method for domestic wastes has not previously taken into account the influence that runoff may have on receiving waters. Began in 1963; to be completed in 1964. Supported by Metro funds.

- 296 A STUDY OF THE EFFECTS OF WASTE DISPOSAL IN THE WATERS OF PUGET SOUND ADJACENT TO METROPOLITAN SEATTLE AREA. G. D. Farris, G. W. Isaac and C. V. Gibbs. To determine the effects of discharging large quantities of treated waste into the waters of Puget Sound. Current studies, bacteriological and chemical analysis and bottom sampling in the area of a proposed outfall to determine pre and post discharge conditions are planned. Includes bacteriological sampling of existing marine outfall areas. Preliminary work began in 1962; to continue indefinitely. Supported jointly by Metro and the U. S. Geological Survey, Quality of Water Branch.

WYOMING

UNIVERSITY OF WYOMING, WYOMING AGRICULTURAL EXPERIMENT STATION, LARAMIE

- 297 EVAPOTRANSPIRATION AND IRRIGATION EFFICIENCY STUDIES. R. D. Burman, O. F. Barnes and Bureau of Reclamation. Location--Eden Farson area. Studies will be concluded in 1966. Supported by State and special grants, \$13,009.
- 298 SOIL TESTING. Dr. Hugh Hough, L. I. Painter, Paul Singleton and Jay Partridge. Location--Laramie, Powell, Riverton and Torrington. Testing of soil and water for agricultural purposes. Work in progress for past eight years. Supported by State funds, \$16,305.

U. S. DEPARTMENT OF AGRICULTURE, ROCKY MOUNTAIN FOREST AND RANGE EXPERIMENT STATION, UNIVERSITY OF WYOMING, LARAMIE

- 299 A STUDY OF THE EFFECTS OF SAGEBRUSH REMOVAL ON CERTAIN WATERSHED CHARACTERISTICS AND ON MANAGEMENT OF SAGEBRUSH RANGES FOLLOWING SPRAYING. H. W. Berndt, R. D. Tabler and D. L. Sturges. Location--Laramie. To determine the influence of sagebrush eradication by spraying on snow accumulation, runoff from snowmelt and other watershed characteristics including sedimentation. Continued during 1963. Supported by Federal funds.

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ADDENDUM

The following projects were reported after the inventory was completed and sent to the printer.

UNIVERSITY OF CALIFORNIA--INSTITUTE OF MARINE RESOURCES-- LA JOLLA, CALIFORNIA

- 300 STUDY OF BEHAVIOR AND SIGNIFICANCE OF TRACES OF CERTAIN RADIOACTIVE SUBSTANCES FOUND IN THE HYPERION TREATMENT PLANT, CITY OF LOS ANGELES. T. R. Folsom, A. T. Rossano, J. E. McKee and G. J. Mohanrao. A study of radioactivity to plant from city, and comparison with other cities. Continuing since October 1, 1959. Supported by Atomic Energy Commission, \$83,420 yearly.
- 301 DETERMINATION OF ANOMALOUS LEVELS OF RADIOACTIVITY IN COASTAL MARINE ENVIRONMENT OF SOUTHERN CALIFORNIA WITH EMPHASIS ON THE AREA NEAR POINT ARGUELLO. T. R. Folsom, R. A. Fredell, L. E. Finnin and B. A. Edwards. Started October 1, 1963; to terminate September 30, 1964. Supported by U. S. Atomic Energy Commission, \$55,000.
- 302 KELP HABITAT IMPROVEMENT PROJECT. W. J. North, D. L. Leighton and L. G. Jones. Location--University of California, San Diego. Development of methods for improving the biology of kelp areas near sewer outfalls after the characteristic flora and fauna have disappeared. Started October, 1962; terminated November, 1963. Supported by Kelco Company, \$14,108.

UNIVERSITY OF WASHINGTON, SEATTLE

- 303 UNIQUE DETERMINATION OF LIGNIN SULFONATES IN WATER. J. L. McCarthy and B. F. Hrutfiord, Department of Chemical Engineering. A continuation of work conducted by Dr. McCarthy and Mr. Felicetta, using a vanillin method. To continue until December 31, 1966. Supported by U. S. Public Health Service, \$47,000.