

QUARTERLY PROGRESS REPORT

**PACIFIC NORTHWEST
WATER LABORATORY
CORVALLIS, OREGON**

JANUARY 1—MARCH 31, 1970

**FEDERAL WATER POLLUTION
CONTROL ADMINISTRATION
NORTHWEST REGION**



PACIFIC NORTHWEST WATER LABORATORY

QUARTERLY REPORT

January 1 through March 31, 1970

United States Department of the Interior
Federal Water Quality Administration
Northwest Region, Corvallis, Oregon

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OFFICE OF THE LABORATORY DIRECTOR

On February 21 Dr. Bartsch addressed the annual meeting of the Save Lake Superior Association, Duluth, Minnesota, under title of "People and the Ravaged Environment."

Dr. Bartsch was the speaker at the Annual Engineering and Science Week Banquet sponsored by the Idaho Society of Professional Engineers, Idaho Falls, on the topic "Pollution of Lakes--Problems and Future."

The annex structure adjacent to the laboratory was completed and accepted. It will be used for pilot plant activities and for storage.

On February 10 Dr. Seyb spoke to the "30 Staters," an alumni group of Oregon State University on the subject "What's Happening in Water Pollution Control." The same talk was also presented to a group at Westminster House February 15.

Bureau of Mines personnel from the Albany, Oregon station visited the laboratory for a briefing of PNWL activities.

The annual meeting of the Oregon Interagency Pesticide Council in Corvallis was attended by Dr. Seyb March 3, 1970.

Mr. John Perry, PNWL Facilities Manager, resigned in January to accept promotion to a similar position in the Robert A. Taft Water Research Center, Cincinnati. Mr. Clarence Lintz, formerly with the Arctic Health Research Center in College, Alaska replaced Mr. Perry at PNWL.

NATIONAL EUTROPHICATION RESEARCH PROGRAM

910101/1601 and 910102/1601

General

On January 13, 1970, Dr. Bartsch provided technical assistance to the Missouri Basin Region in connection with potential eutrophication aspects of the Platte Valley Dam Project proposed by the Omaha District, Corps of Engineers.

Dr. Bartsch attended a meeting of the Joint Industry/Government Task Force on Eutrophication, held in Washington, D. C. on February 16 and 17.

T. E. Maloney travelled to Stockholm, Sweden to discuss with Swedish experts the impact of non phosphorus detergent builders on environment. This was followed by a briefing of FWQA headquarters personnel of this Sweden trip. T. E. Maloney visited the SE Water Laboratory to review the experimental studies being conducted there on CO₂. He reviewed the algicide research contract with representatives of the Dow Chemical Company in Midland, Michigan. T. E. Maloney attended a meeting at FWQA headquarters to discuss the proposal study on phosphate-free detergents.

On March 2 and 3 A. F. Bartsch, T. E. Maloney, W. E. Miller, A. R. Gahler, K. W. Malueg and C. F. Powers participated in the Lake Restoration Workshop, sponsored by the Department of the Interior, Washington, D. C. During the Public Session on the final afternoon, Dr. Bartsch gave an address entitled "The Preservation and Restoration of Lakes - Prospects and Needs."

Dr. Bartsch participated in a meeting of the Eutrophication Research Institute Review Committee, University of Wisconsin, Madison March 16 and 17 and on the 18th he served as guest lecturer at the Center for Great Lakes Study, University of Wisconsin, Milwaukee; on the 19th he participated in a meeting of the Project Advisory Committee to the Inland Lakes Renewal and Management Project.

Dr. Powers met with the Lake Sallie Weed Control Study Group at Fargo, North Dakota on January 28 to discuss progress on the Lake Sallie project.

Mr. Brice and Dr. Powers attended a meeting in Chicago on March 25 relative to planning the full-scale tertiary plant at Shagawa Lake.

Messrs. Malueg, Powers and Tilstra met March 20 with FWQA Northwest Region and U.S. Forest Service personnel relative to the Waldo Lake studies.

Dr. Malueg met with Mike Sheridan FWQA Missouri Basin Region, to discuss possible cooperation in eutrophication studies of some lakes in Yellowstone National Park.

Waverly, Swan and Timberlinn Lakes in Albany, Oregon were subjected to limnological exploration with a view toward their possibilities as subjects of lake restoration experiments. This action was initiated by a request from the city for our assistance in improving the recreational value of the lakes. A monitoring program has been established to determine whether worthwhile experimental studies might be carried out on any of the four lakes next year.

At Shagawa Lake, Mr. Brice appeared as a panel member on an Ely radio broadcast dealing with the Shagawa Lake program and other aspects of environmental concern; he spoke before a city council meeting and also before the Ely school system Faculty Wives Club on environmental pollution and the Shagawa Lake project. Mr. Brice provided tours of the pilot plant operation for five classes of 9th grade science students and presented talks to the Lincoln School PTA, Senior Citizens Society, and Washington Junior High School students. He met with personnel of the Minnesota State Pollution Control Agency at Duluth, with Bill Pearson, consulting sanitary engineer from Boulder, Colorado, and spent a great deal of time providing coordination, counsel, and other services relative to the full-scale tertiary plant planning, involving the City of Ely, Ruble and Kaple consulting engineers, and AWTRP at Cincinnati.

PHYSIOLOGICAL CONTROL BRANCH

Status of Projects and Significant Accomplishments

Algal Assay Procedures Section

The evaluation of Selenastrum capricornutum as a test organism for the Provisional Algal Assay Procedure was continued. Studies on samples from the Shagawa Lake project continued with emphasis on the addition of both nitrogen and phosphorus spikes to Shagawa Lake water, Burntside River water, and tertiary effluent. Algal assays were conducted on Waverly, Upper and Lower Swan and Timberlinn Lake samples

from Albany, Oregon. Carbon studies using PAAP medium, Shagawa Lake and Burntside River water have been initiated.

The effects of the addition of phosphorus, nitrogen and a combination of both on the productivity of Selenastrum capricornutum in Burntside River water, Shagawa Lake water and tertiary effluent were determined. Algal growth appears to be phosphorus limited in both Burntside River water and tertiary sewage effluent. Addition of both phosphorus and nitrogen stimulates growth in both Shagawa Lake and Burntside River waters.

Results of algal assays performed on waters from Waverly, Timberlinn, Upper Swan and Lower Swan lakes at Albany, Oregon, will support an average productivity (mg dry wt) of Selenastrum capricornutum of 20 mg/l.

Aquatic Plant Control Section

Attempts have continued to isolate viruses and bacteria that either lyse or inhibit the growth of Anabaena flos-aquae and Microcystis aeruginosa. While there has been no success in the isolation of viruses, isolation of algal growth inhibiting bacteria has been most successful. Preliminary results suggest there is a particular ratio necessary between the number of bacteria present and the number of blue-green algal cells present for the bacteria to be inhibitory to the algae.

Various techniques by which the contaminants in water samples can be removed without impairing the recovery of the viral particles are being explored. The techniques include the use of Millipore filtration,

freeze drying, Nucleopore membrane filtration, and chloroform treatment. Use of the latter two resulted in the highest recoveries (over 96 percent).

Grant and Contract Research

Technical reviews of preproposals and proposals for research grants, demonstration grants, and contracts, and of published articles were provided for the following subjects:

1. Provisional Algal Assay Procedure.
2. Organic Nutrient Factors Effecting Algal Growth.
3. A Nonmyopic Approach to the Problems of Excess Algal Growths, by F. A. Ferguson, Stanford Research Institute, Menlo Park, California.
4. Carbon Cycle: Its Role in Regulating the Growth of Mixed Populations of Heterotrophs and Autotrophs in an Aquatic Ecosystem, by Pat C. Kerr, Southeast Water Lab, FWQA, Athens, Georgia.
5. Nutritional Value of Algae for Herbivores.
6. Chemical Control of Mat-Like Algal Growth Along a Recreational Lake Shoreline with an Assessment of the Effect of Decaying Algal Nutrient Release and Chemical Residue Build-Up on Water Quality.
7. Annual Report from the University of Wisconsin on "Role of Phosphorus-Sediment Interactions in Eutrophication," by D. E. Armstrong, University of Wisconsin, Madison, Wisconsin.

Plans for Fourth Quarter, FY 1970

1. Continue PAAP evaluation.
2. Continue study of the effects of nitrogen, phosphorus and carbon on the growth of Selenastrum capricornutum in natural waters.

3. Continue study of algal and bacterial viruses.

ECOLOGICAL CONTROL BRANCH

Status of Projects and Significant Accomplishments

Nutrient Control Section

Rainfall has been monitored continuously at PNWL, and snow samples were collected at Waldo Lake, in an ongoing study of contribution of nutrients to aquatic systems via precipitation. Some algal assay studies have been conducted on rain water.

Comparative studies of the uptake of nutrients through the roots and leaf-stem systems of Elodea are being made using ^{32}P and ^{33}P as tracers. Results to date show uptake through the leaf-stem portion of the plant to greatly exceed uptake through the roots.

Analyses of aquatic plants collected last year from Lake Sallie are being continued. Nutrient budget calculations to determine the quantities of nitrogen and phosphorus removable through weed harvesting are in progress.

General agreement has been reached with the U. S. Forest Service on the nature of the ground water studies to be initiated this spring at Waldo Lake. Test wells will be drilled in one of the campgrounds and ground water movement monitored using dye tracers. The regular lake monitoring program will be resumed this summer.

Sediment-Water Interchange Section

Analyses of sediments from Waverly, Timberlinn and Swan Lakes were made. Nutrient concentrations in Swan Lake sediments were relatively higher than those of the other two lakes.

Laboratory nutrient inactivation experiments using calcium, lanthanum, and zirconium were completed. Lanthanum was very effective in the control of algal growth. In the case of zirconium and calcium, the finely divided particulate matter remaining in suspension appeared to contain sufficient nutrients to support good algal growth.

Analysis of a 48-cm sediment core obtained through the ice at Lake Herman, South Dakota, showed that the total nutrient content (C, N, P) decreased appreciably with depth. Carbon decreased from 6.7% in the upper 12 cm to 2.5% in the lower 19 cm section. Nitrogen decreased from 0.7% to 0.2% and phosphorus from 0.12% to 0.09%. These data from a single core indicate that dredging would be beneficial in Lake Herman.

Analysis of Upper Klamath Lake sediments were continued throughout the winter months. Examination of NERP and Battelle-Northwest data from 1967-70 relating to total phosphorus content in sediments from Upper Klamath Lake indicate rhythmic fluctuations varying by a factor of 2. This may quantitatively indicate the amount of phosphorus interchange between the sediment and water during the year. Further characterization of Shagawa Lake sediments was made on sediments collected in February under the ice.

The literature was reviewed relating to toxicity of aluminum, lanthanum, and zirconium on benthic organisms and other biota. Laboratory tests with Cladoceran in aquaria after nutrient inactivation with Al, Zr, and La showed that these elements were not toxic to this biota. Preliminary contacts were made with the Duluth Water Quality Laboratory for toxicity information.

A paper was submitted for publication to Environmental Science and Technology entitled "Effect of Storage, Freezing, and Ionizing Radiation Upon Lake Sediments," by A. R. Gahler, Julie A. Searcy and R. E. Pacha.

A report of invention, "Lake Restoration by Nutrient Inactivation," was submitted to Headquarters by A. R. Gahler and W. D. Sanville.

Shagawa Lake Project

Regular monitoring of Shagawa Lake and tributaries continued as part of the program to obtain limnological background data pertinent to evaluation of changes following initiation of full-scale phosphorus removal from Ely municipal sewage effluent. In cooperation with Ken Byram at PNWL and Messrs. DiToro and O'Connor of Manhattan College, initial efforts have begun on a mathematical modeling study of the Shagawa Lake complex.

Experiments in laboratory-scale removal of nitrogen from secondary and phosphorus-stripped effluents, using clinoptilolite, were made. The N-stripped products were sent to PNWL for algal assay tests by the Physiological Control Branch. Although ammonia removal was quite high, sufficient nitrate was present in the effluents to support significant algal growth; nitrate is not removed by clinoptilolite.

Experimental work was carried out in the pilot plant to determine the efficiency of hydrated lime as a phosphorus removal agent in the Water Boy stage. A concentration of 312 ppm CaO resulted in 99.1% total P removal from secondary effluent.

In addition to the foregoing operations, personnel were quite busy with the continuing work of compiling and working up data relating to yearly nutrient budgets and last summer's algal assay studies, and with planning relative to the proposed full-scale phosphorus removal plant.

Grant and Contract Research

Technical reviews of proposals for research and demonstration grants, and contracts were provided for the following subjects:

1. Phosphate Exchange with Sediments.
2. Eutrophic Lake Reclamation by Physical and Chemical Manipulations.
3. Sediment-Water-Bacteria in Eutrophication.
4. Investigation of Primary Production Rates by Plant Life of Lake Erie.
5. Demonstration of Enhancement of Water Quality of Small Lakes in New Mexico by Induced Aeration.
6. Chemistry of Nitrogen in Natural Waters.
7. Movement, Absorption, and Transformation of Various Phosphorus Compounds in Soils and Lake Sediments.
8. Initiation of a Limnological Analysis with a Large Scale Chemical Equilibrium Model.
9. Chemistry of Phosphorus Pollutants in the Missouri Basin Sediments.

Plans for Fourth Quarter, FY 1970

1. Resumption of Limnological studies of Waldo Lake, and initiation of studies on ground water movements in the proximity of the lake.
2. Field studies on nutrient inactivation in lakes, using 20-ft diameter enclosures in Cline's Pond.
3. Field and laboratory studies on the role of NTA in eutrophication.

WASTE TREATMENT RESEARCH & TECHNOLOGY PROGRAM

GENERAL

Mr. Boydston addressed meetings of the Institute of Food Technologists, Intermountain Section at Sun Valley, Idaho, and the Engineering Foundation Research Conference on Wastewater Engineering in the Food Industry at Pacific Grove, California. At the end of the quarter Mr. Boydston was asked to substitute for Mr. Cawley of Headquarters as a member of the U.S.-Japan Natural Resources Panel on Water Pollution Control and attended the 5th meeting of the Panel held in Tokyo in March and April. This assignment involved discussions on United States waste treatment research and construction with Japan's panel members.

PAPER & ALLIED PRODUCTS RESEARCH - 910101/1204

Status of Activities and Significant Accomplishments

Cooperative work between Crown-Zellerbach and FWQA has continued on the Lebanon project with studies on operating parameters of the aerated lagoons. Variations of detention time have been completed and present operations include a reduction of neutralizing chemicals, which compose 30 percent of the operating costs. Comparison of series and parallel unit operation showed a greater efficiency of treatment by using ponds in series.

Quality control on this project is being examined by quadruplicate samples analyzed by CLS, NCASI, State of Oregon Department of Environmental Quality, and Crown-Zellerbach Laboratories. Other samples are

being filtered to determine the reduction of BOD loads that may be affected by secondary settling.

A small, 10 cubic foot, rotating biological contactor (RBC) has been in operation at Lebanon. Successful treatment of the waste has been achieved, but only with daily maintenance. Laboratory respirometer studies are being conducted on both the lagoon and RBC units.

We received delivery on the Beloit-Passavant microsieve during the quarter. The screens were delivered later by Beloit personnel who also provided some instruction on mounting the screening material, and on unit operation. This rotary screen will be used first by Weyerhaeuser Company at Longview.

Grant and Contract Research

Grant review and grant monitoring occupied the majority of the time during the quarter. A new project was authorized this month granting over \$128,000 to Weyerhaeuser Company for "Steam Stripping and Rectification of Kraft Pulp Mill Condensates and Black Liquors for Pollution Control and Byproduct Recovery," 12040 FKS. Installation of these facilities will be added to the Springfield plant under director, Oliver Morgan. Funding is in progress for two additional projects in the 1204 area.

The Logging Effects Study, 13010 EGA, incorporates facilities on Oak Creek and the Alsea Watershed. On April 3 the sediment transport facility at Oak Creek was shown to the public along with some of the data collected during storms this past winter.

A meeting was held with Klamath Plywood; Columbia Plywood; Cornell, Howland, Hayes & Merryfield; and FWQA personnel to consider progress on the grant related to the treatment of glue waste condensates at Klamath Plywood. Recommendations for recovery of the overloaded (sour) aerobic basin were discussed and implemented.

Project review meetings were held with many of the grantees. Basic data were supplied Headquarters concerning a full-scale reverse osmosis facility proposed by Green Bay Packaging at Green Bay.

Plans for Fourth Quarter, FY 1970

1. Continuation of cooperative work with Crown-Zellerbach, Lebanon.
2. Further in-house evaluation of the RBC unit on primary settled and secondary treated effluent from Crown-Zellerbach, Lebanon treatment system.
3. Additional characterization of sludge loads developed in mechanically aerated lagoons treating pulp and paper wastes.
4. Extramural and in-house work with the Beloit-Passavant microsieve unit on pulp and paper waste sources in the Pacific Northwest.
5. Review and monitoring of grant proposals.

FOOD WASTES RESEARCH - 910101/1206Status of Activities and Significant Accomplishments

Processing at the United Flav-R-Pac Cannery in Salem, Oregon, was discontinued at the beginning of the quarter. As a result, the aerated lagoon pilot study was terminated after a brief period of aerobic digestion. A preliminary analysis of the data was conducted and a draft evaluation of the plant's performance was prepared. It was found that only about five weeks of consistent data were obtained during the four months of operation because of the start-up period as well as high silt content in the influent during the latter part of the season. The data during the five week period yielded good kinetic equations and BOD removals were considered good for this type of facility.

Operation of both small scale anaerobic filters was terminated at the end of March. Feed during the previous three months consisted of corn and beet wastes which had been obtained in October and kept frozen until used.

Plans were completed for a three-day symposium on R&D work in food waste treatment which will be held on April 6-8. Sponsors include FWQA, U.S. Department of Agriculture, Agricultural Research Station, Western Regional Research Laboratory, National Canners Association, and the Northwest Food Processors Association.

Grant and Contract Research

The following grant proposals and preproposals were received for review:

1. Dry Caustic Peeling of Tree Fruit to Reduce Liquid Waste Volume and Strength.
2. A State-of-the-Art of Waste Treatment in the Beverage Industry.
3. A Demonstration of Pretreatment of High Strength Industrial Waste by a High-Rate Biological Process.
4. Microbial Conversion of Food Wastes to Single Cell Protein and Clear Water.
5. Dry Corn Milling Wastewater Treatment.
6. High Efficiency Land Ecological-Chemical-Biological-Reclamation Management System for Solids, Runoff, and Wastewaters for Large Scale Cattle Feeding & Slaughtering Installation in South Michigan.
7. Membrane Separation Techniques for Water Pollution Control via Reduction or Elimination of Dairy & Food Plant Wastes.
8. Pollution Study of Wet Milling Industry.
9. Collection System & Utilization of Whey.
10. Utilization of Collected Whey for Animal Feed.
11. Occurrence of Filamentous Slime Organisms Below Outfall.
12. To Determine Effective & Efficient Means for Treating Wastewaters from a Grain Processing Industry.
13. Characterization & Disposal of Effluents from Vegetable Processing Operations.
14. Water & Waste Management in Sweet Potato Processing.
15. Removal of Insoluble Pineapple Wastes from Cannery Effluents.

16. Activated Sludge--Bio-Disc Treatment of Distillery Wastes.
17. Characterization, Control & Use of Processing Plant Wastes.
18. Use of Waste Heat for Concentration of Distillery & Wet Milling Wastes.
19. Distillery Waste Disposal.
20. Industrial Pollution Utilization for Cottage Cheese Whey and Refinement of Existing Methods & Resulting Protein Products.
21. Secondary Treatment Pilot Plant.

Current status of grants which have been assigned, and which Food Waste Research has project officer responsibility, is as follows:

1. 12060 EUZ "Winery Wastewater--Characterization and Treatment" Widmer's Wine Cellars, Naples, New York. Construction plans are nearing completion, state approval has been obtained, and advertisement for bids is expected sometime in May.

2. 12060 EKQ "Kent Cheese Company--Waste Treatment Facility" Kent Cheese Company, Melrose Park, Illinois. Construction is essentially completed and the aerated lagoons are presently receiving domestic sewage from the plant. Process wastes are expected to enter the system sometime in May.

3. 12060 EHS "Cannery Waste Treatment by Lagoons and Oxidation Ditch" Melbourne Water Science Institute, Melbourne, Victoria, Australia. Field investigations are nearing completion and preparation of the final report is underway.

4. 12060 EHV "Aerobic Secondary Treatment of Potato Processing Wastes with Mechanical Aeration" The R. T. French Co., Shelley, Idaho. The system continues to be plagued with various operational difficulties

such as aerator failure and PVC lining failure. As a result, the amount of useful operational data which has been obtained, is considerably less than was anticipated by this time.

5. 12060 DSI "State-of-Art, Sugarbeet Processing Waste Treatment" Beet Sugar Development Foundation, Fort Collins, Colorado. Work on the final report is underway.

6. 12060 ECF "Water Pollution Abatement in the United States Seafood Industry: State-of-the-art" Oregon State University, Corvallis, Oregon. Work on the final report is underway.

7. 11060 EZR "Complete Aerobic Treatment of Combined Domestic and Industrial Wastes with Mechanical Aeration" City of Dallas, Oregon. Heavy rains during January caused flows to increase to near the hydraulic capacity of the plant. Influent strength was substantially reduced because of the excessive infiltration. A satisfactory effluent was maintained throughout the period.

8. 12060 EIG "Full-Scale Demonstration and Evaluation of Potato Dry and Wet Caustic Peeling Processes" Western Potato Service, Inc., Grand Forks, North Dakota. Operation of the "dry caustic" peel equipment has begun.

9. WP-01486-01 "Status and Research Needs for Potato Waste Waters" University of Washington, Seattle, Washington. Final report has been reproduced and is available from Headquarters for distribution.

Plans for Fourth Quarter, FY 1970

1. Continue grant monitoring and reviewing.

2. Reproduce and distribute the Food Waste Symposium Proceedings.

3. Begin operation of Flav-R-Pac pilot plant with operation possibly being conducted by OSU personnel through a small grant for this purpose.

REGIONAL RESEARCH STUDIES

Status of Projects and Significant Accomplishments

Waste Treatment at Recreational Areas: The final report is in draft form and is receiving preliminary review.

Log Handling and Storage: All field and laboratory work has been completed and data is being evaluated. Work continues on a draft of the final report.

Animal Feedlot Waste Disposal: Meetings have been held with the various state cattlemen's associations, and all have promised maximum cooperation in connection with this study. State inventories of cattle feedlots have been obtained from the U. S. Department of Agriculture State Statisticians. The project proposal has been prepared and reviewed, and work is continuing.

Other Activities: Responsibility for the evaluation of biological pilot plant treatment of steam vat condensates has now been transferred to the Paper and Allied Products Research area.

Progress on the regional pesticide status report has been reviewed and additional data collection is now being made.

Grant and Contract Research

The final draft report on "Storm and Combined Sewer Contract 14-12-128" was sent to the Contracting Officer for submission to the contractor with a request for publication. Action is being taken to dispose of the property involved.

Areas of Concern

Fund limitations have necessitated reductions of temporary employees and eliminated all but the most critical expenditures for travel and supplies. The recently acquired Laboratory Trailer cannot presently be utilized due to lack of funds for needed equipment and supplies. No publication of reports is contemplated for the remainder of the fiscal year because of the shortage of funds.

Plans for Fourth Quarter, FY 1970

The Northwest Regional Director has announced that all activities and resources of the Regional Research Studies Program will be transferred to the Portland Office by the end of the current fiscal year. This will require that current studies and the past support of Waste Treatment Research by the Regional Research Studies Program will be terminated.

NATIONAL THERMAL POLLUTION RESEARCH PROGRAM

910101/1613

Status of Projects and Significant Accomplishments

Work Plan (ZFL): Consultation and Advisory Services

The level of activity this quarter was considerably higher than the 15-20 percent staff time normally scheduled and budgeted for this activity.

1. Technical backup and assistance was provided the Southeast Region, Office of Enforcement, and Department of Justice in connection with the Enforcement Conference, February 23-25, and Federal court action, March 24-31, relative to thermal pollution abatement from the Turkey Point plant of Florida Power and Light.

2. At the request of the Regional Office, Missouri Basin Region, Dr. Tichenor met with Regional Office representatives and Mr. Charles Carl, Director, Division of Sanitary Engineering, South Dakota State Department of Health, concerning potential environmental problems associated with a proposed coal-fired power plant near Bigstone Lake, South Dakota.

3. The probability of adverse weather modification for cooling towers at the Vernon Site is being studied for the Northeast Region, by use of the mathematical model developed under contract with EG&G.

4. The Southeast Regional Office was provided an evaluation of engineering report on prediction of heat dissipation associated with Duke Power Company's Keowee--Jocassee development.

5. Mr. Ed Chaney, Information Director, National Wildlife Federation, requested and was provided technical information concerning

salt drift from cooling towers and other devices circulating brackish water.

6. Dr. Garton completed final manuscript for "Guidelines for collection and statistical analysis of biologic data at potential sites of heat discharges." Publication is scheduled for 4th quarter, FY 70.

7. Advance printings of "Thermal Pollution: Status of the Art," prepared under grant to Vanderbilt University was received and distributed selectively to Headquarters staff and to all Regional offices.

Work Plan ZFC: Heat Transfer and Behavior in the Mixing Zone

1. Reportable Progress:

The effect of thermal discharges at or below the thermocline is being studied by Cornell Aeronautical Laboratory by extending their stratified lake model. The effects of arbitrary density stratification on the behavior of the plume are considered. The solution is sought through the use of the integral forms of the equations of conservation of mass, momentum, and energy. The result of this work will be a model describing the distribution of temperature in the thermal plume, as well as a determination of the effect of the heated discharge on a stratified lake as a whole.

2. Continuing Projects:

a. In-house (cooperative with USGS).

Turbulent diffusion of a heated plume.

b. Grants and Contracts:

(1) "Thermal Plume Dispersion," Oregon State University,

16130 DGM.

(2) "Research on the Physical Aspects of Thermal Pollution," Cornell Aeronautical Laboratory, 14-12-526. (Also a part of Work Plan ZFD).

(3) "Studies on the Effect of Waste Heat Discharged from Nuclear Power Plants into Large Bodies of Receiving Water," Tetra Tech, 16130 DWQ.

(4) "Project for Concentrated Research and Training in the Hydrologic and Hydraulic Aspects of Water Pollution Control," Vanderbilt University, 16130 FDQ, Project 1 - Temperature Distribution Resulting from Cooling Water Discharges.

(5) "Prediction and Control of Thermal Pollution," MIT, 16130 DJU.

3. Completed Projects -- None.

4. New Projects -- None.

5. Papers and Reports:

Chapters VII and VIII of Parker and Krenkel, "Thermal Pollution: Status of the Art," Vanderbilt University, prepared under Grant Number WP-01387-01. (Also see other work plans).

NOTE: There is a large degree of similarity between technology required within this Work Plan (ZFC) and Work Plan (ZFH), "Design Criteria for Heat Discharge Outfalls." Due to this similarity, the reader is urged to consult Work Plan ZFH for additional information on NTPRP activities related to the behavior of heat in the mixing zone.

Work Plan ZFD: Heat Transport and Behavior in Large Hydraulic Systems

1. Reportable Progress:

A new mathematical model and associated computer program has

been developed by Water Resources Engineers, Inc., for predicting temperatures in stratified reservoirs. The new model advances our capability for predicting reservoir temperatures by including three refinements not available on WRE's previous model:

- (a) Has the ability to predict the effect of selective withdrawal.
- (b) Contains an improved method of determining eddy conductivity (i.e., vertical diffusion) coefficients.
- (c) Can handle weakly stratified reservoirs.

The computer program has been "put on" U.S. Timeshare's Washington, D.C., facilities and is thus accessible through FWQA terminals.

A mathematical model for predicting the formulation of stratification in a lake has been developed by Cornell Aeronautical Laboratory. The model's computer program is functioning, although some refinements are still being made. The model uses improved methods for handling the diffusion coefficients, and more rigorous solutions are provided in place of certain simplifying assumptions found in available models.

Fundamental work in predicting the transfer of mass and heat between the water surface and atmosphere is being conducted at Cornell University. Researchers are providing analytical solutions to theoretical equations to remove the present requirement for empirical coefficients. Among other things, they have shown that the horizontal diffusion in the atmosphere has very little effect on the transfer rates.

Developmental work on stochastic models for temperature prediction has emphasized the determination of the statistical characteristics of the energy budget terms. Using a revision of Pisano and Young's stream-flow simulator, cross correlations and lag correlations between the

terms have been calculated for hourly data inputs.

2. Continuing Projects

a. Intramural

- (1) Stochastic model development (cooperative with FWQA's Systems Analysis and Economics Branch, Headquarters).
- (2) Refinement of techniques for predicting stream evaporation.

b. Grants and Contracts

"Heat and Water Vapor Exchange Between the Water Surface and Atmosphere," Cornell University, 16130 DIP.

3. Completed Projects

- a. "Formulation of a General Mathematical Model for the Prediction of Thermal Energy Changes in Impoundments," Water Resources Engineers, Inc., 14-12-422.
- b. "Thermal Stratification and Reservoir Water Quality," MIT, 16130 DJH.

4. New Projects - None

5. Papers and Reports

- a. "Mathematical Models for the Prediction of Thermal Energy Changes in Impoundments," Water Resources Engineers, Final Report, Contract No. 14-12-422.
- b. "Sundaran, T. R. and R. G. Rehm, "Formation and Maintenance of Thermoclines in Stratified Lakes Including the Effects of Power-Plant Thermal Discharges," paper presented at the American Institute of Aeronautics and Astronautics, 8th

- Aerospace Sciences Meeting, New York, January 19-21, 1970. (Paper on work supported by Contract 14-12-526.
- c. Four papers prepared under Grant No. 16130 DIP. They have been submitted for publication in professional journals.
- (1) Yeh, Gour-Tsyh and W. Brutsaert, "Numerical Solution of the Turbulent Transfer Equation."
 - (2) Brutsaert and Yeh, "Implications of a Type of Empirical Evaporation Formula for Lakes and Pans."
 - (3) Yeh and Brutsaert, "Perturbation Solution of the Equation of Atmospheric Turbulent Diffusion."
 - (4) Yeh and Brutsaert, "A Solution for Simultaneous Turbulent Heat and Vapor Transfer Between a Water Surface and the Atmosphere."
- d. Chapters VI and IX of Parker and Krenkel, "Thermal Pollution: Status of the Art," Vanderbilt University, prepared under Grant No. WP-01387-01. (Also see other work plans)

Work Plan ZFF: Engineering and Cost Aspects of Heat Dissipation

1. Reportable Progress

Preliminary calculations by Dynatech Corporation show that FROTH CONTACT heat exchangers could be used as cooling towers for electric power plants. The economic aspects of this mode of cooling is under investigation. A substantial reduction in size over the conventional cooling tower would result with this method.

In a study by Christianson and Tichenor on the effect of operating temperature on cooling pond sizing, it was found that higher cooling pond inlet temperatures (condenser discharge) reduce both the area requires as well as the water lost by evaporation.

2. Continuing Projects

- a. Dynatech Corporation, "Survey and Economic Aspects of Alternate Cooling Methods for Cooling Condenser Discharge Water in Thermal Power Plants."
- b. R. W. Beck and Associates, "Non-Evaporative Cooling Towers."
- c. Littleton Research Corporation, "An Economic Engineering Study of Cooling Ponds."

3. Projects Completed - None

4. New Studies Initiated

- a. Purdue University, "Turbulent Bed Cooling Towers."
- b. Travelers Research Corporation, "Study of Costs of Reducing Heat Disposal to Aquatic Environment by Steam Electric Power Plant."

5. Papers

Alden Christianson and Bruce Tichenor, "Effect of Operating Temperature on Cooling Pond Sizing and Water Loss," abstract submitted for presentation at the 43rd Annual Meeting Conference of the Water Pollution Control Federation.

Work Plan ZFJ: Beneficial Use of Waste Heat

1. Reportable Progress

Work in this area has so far been concentrated on grant reviews and on literature survey to determine feasibility of various uses of

waste heat. Most emphasis to date has been upon agriculture and aquaculture and both of these hold promise. Limited application of waste heat is being made in both areas but, with a very few exceptions in aquaculture, no large-scale projects are underway on a commercial basis.

2. Continuing Projects - In-house feasibility studies

3. Projects Completed - none

4. New Studies Initiated - none

5. Papers

a. The document, "Thermal Pollution: Status of the Art," received from Vanderbilt University, contains a chapter on beneficial effects of heat additions which summarizes some of the ways waste heat is being used.

b. Dr. Garton and Mr. Christianson have prepared a paper entitled, "Review and Prospective for Beneficial Uses of Waste Heat," to be presented by Headquarters personnel at the Working Conference on Beneficial Uses of Waste Heat at Oak Ridge, Tennessee, on April 20-21, 1970.

Work Plan ZFI: Advanced Technology for Power Generation and Utilization

1. Reportable Progress

A review of current and advanced aircraft and industrial gas turbine programs has led to a tentative projection and documentation of advanced blade materials and cooling techniques that will be available for the use in the next two decades. It is shown that top thermal efficiencies of 32 percent are obtainable with advanced materials in

open cycle gas turbines operating under high inlet temperature and pressure.

The feasibility of operating thermoelectric generators that are powered by the waste heat from thermal-electric power plants was assessed by Dr. Shirazi. It was found that production cost is at least ten times greater than conventional methods.

2. Continuing Projects - None

3. Projects Completed - Feasibility of thermoelectric generation

4. New Studies Initiated

- a. United Aircraft Corporation, "Feasibility of Nonthermal Power Generation Systems."

5. Papers

M. A. Shirazi "Thermoelectric Generators Powered by Thermal Waste from Electric Power Plants," IECEC, 1970.

Work Plan ZFH: Design Criteria for Heated Discharge Outfalls

1. Reportable Progress

The problem of multiple buoyant jets in an arbitrary density stratification that includes the effect of jet interference was analyzed by Tetra Tech Corporation. It is found that significant reduction of excess temperature at the free surface can be achieved by employing multiple port diffusers that are optimally spaced instead of discharging at the end of the pipe.

The horizontal spreading of a heated effluent in a quiescent water was analyzed both for the steady state and time dependent situations. A significant finding in this study is the analytical prediction

of the onset of an internal hydraulic jump. An attempt is made to check the model against available experimental data.

The mathematical model for the passive turbulent dispersion in a current is formulated and programmed. A few example cases have been run on the computer. The model includes the effects of current variation with depth and diffusion variation with depths as well as laterally.

2. Continuing Projects

- a. Tetra Tech Corporation, "Outfall Design."
- b. MIT, "Prediction and Control of Thermal Pollution."

3. Projects Completed - None

4. New Studies Initiated - None

5. Reports and Papers - None

Work Plan XAL: Local Meteorologic Effects of Cooling Towers

In our opinion, the research needs associated with this work plan have been satisfied by reports by Decker on "Cooling Towers and Weather," and E. Bollay and Associates on "Theoretical Evaluation and Development of Criteria to Determine Inadvertent Weather Modification in the Vicinity of Cooling Towers."

The latter report will be distributed within FWQA and the associated math model placed in the Headquarters computer library for use by operations of FWQA, State regulatory agencies, and interested Federal agencies.

Unless statements of other needs develop, this Work Plan will be terminated in the 4th Quarter, FY 1970.

Work Plan ZFA: Measurement of Temperature and Heat Budget Parameters

Inactive

Work Plan ZFB: Sources of Heat Input to Waters1. Reportable Progress

The quarterly progress report of the project listed below as continuing contains information on relation of logging practices to small stream temperatures:

- a. Stream temperature can be controlled by a relatively narrow strip of shade, although not so effectively as by large uncut sections. A strip two trees wide (50-75 feet) on Little Rock Creek, Oregon, significantly reduced net radiation and consequent warming of the stream. The benefit was achieved at a cost of roughly 0.1 percent of the sale volume of the 55 acre logged tract.
- b. Water which was heated in unshaded stretches did not cool again in the shaded areas but continued to pick up heat, although at a slower rate.

2. Continuing Projects

One grant is now outstanding on this subject: "Studies on the effect of watershed practices on streams (sub-project "Effects of Logging and Temperature Prediction on Small Mountain Streams"), Oregon State University, completion date, June 30, 1970.

3. Projects Completed - None
4. New Studies Initiated - None
5. Papers - None

No Work Plan

Pending transfer of program responsibility to the National Water Quality Laboratory, two intramural projects of the Biological Effects Laboratory are partially supported by NTPRP funds and personnel. These are:

1. Thermal effects to tissue enzymes of Pacific Salmon.
2. Columbia River Thermal Effects Study -- simulation of adult Pacific Salmon migration through elevated temperatures and effects on reproduction and survival.

See report of Biological Effects Laboratory for progress on these projects.

NATIONAL COASTAL POLLUTION RESEARCH PROGRAM
910101/1607

Status of Projects and Significant Accomplishments

Ocean Outfalls

Work continues on Part II of the State-of-the-Art Report which will cover design and performance evaluation guidelines. Work has begun on the construction of a hydraulics laboratory for modeling of coastal discharge problems.

Tracing Kraft mill plume. The procedure previously developed for tracing Kraft mill plume by fluorescence was applied in a combined boat--airborne sensor operation. The boat data were obtained to provide ground truth during an attempt to demonstrate the use of the natural fluorescence rather than the use of an added tracer such as rhodamine in providing calibration data for the air-photo interpretation. The data from the airborne part of the experiment are still in the computer stage.

Barge Disposal Systems

The state-of-the-art report on barge waste disposal systems is complete and is now being typed for technical review.

A detailed plan for study of the fate of domestic sewage sludge was forwarded to Taktite II for possible inclusion in a Virgin Islands study this summer.

Estuarine Modeling

a. Columbia River estuary temperature model. Part I of the final report was completed and sent to the printer. Part II, a

discussion of input-output and model verification, is 90 percent complete. A revised version of the model was sent to the Northeast Region for their work in modeling Boston Harbor.

b. Consultation. Mr. Callaway met with representatives of the Middle Atlantic Region staff and public agencies in Columbia, South Carolina, to discuss mathematical modeling in the vicinity of the proposed BASF plant near Beaufort. The area was modeled and results presented at the meeting. Mr. Callaway visited U. S. Navy Fleet Numerical Weather Central and Postgraduate School in Monterey, California, to discuss possible cooperation on two-dimensional ocean modeling.

Reaeration

No runs were scheduled in this quarter, and work on the in situ detector was discontinued because of financial limitations.

Equipment and Instrumentation

Bidder qualification statements for development and demonstration of equipment and methodology for tracing solids discharged to the marine environment are still awaiting action in Headquarters.

A Geodyne current-temperature-salinity-depth system was received.

Grant and Contract Research

Waste Management in the Coastal Zone

The draft state-of-the-art report on waste management in the coastal environment, prepared by NAS-NAE under contract 16070 DUF,

was reviewed and suggestions, corrections, and comments submitted for consideration in the final report.

Grant and Contract Applications

The following subject matter in research proposals were reviewed by the Coastal Research staff:

1. Studies on Wind Driven Circulations off the Coast of California.
2. Coastal Water Circulation.
3. Sediment Composition: Detection of the Effects and Fate of Wastes and Discharges Disposed of in Offshore and Other Waters.
4. The Significance and Control of Wastewater Floatables in Coastal Waters.
5. Distribution of Physical, Chemical, Geological, and Biological Variables Relative to Waste Discharge into Tampa Bay, Florida.
6. Fate of Pollutants in Rivers and Estuaries under Conditions of Unsteady Flow.
7. Dispersion of Pollutants in Tidal Estuaries.
8. Ecological Demonstration Model.
9. Public Policy and Political Institutions for Water-Quality Management on Lake Erie.
10. The Water Circulation of Mobile Bay, Alabama.
11. Chemical Water Quality and Sediment-Water Reactions in Louisiana and Mississippi Estuaries.
12. Effects of Pollutants on Submarine Plant Synecology.

Reports and Papers

1. "Salinity, Runoff and Wind Measurements - Yaquina Estuary, Oregon," by R. J. Callaway, G. R. Ditsworth, and D. L. Cutchin.(In press)
2. "Mathematical Model of the Columbia River from the Pacific Ocean to Bonneville Dam - Part I: Theory, Program Notes and Programs," R. J. Callaway, K. V. Byram, and G. R. Ditsworth.
3. "Ocean Outfall Design - Part I - Literature Review and Theoretical Development," D. J. Baumgartner and D. S. Trent.
(In press.)
4. "Design and Construction of a Saltwater Environment Simulator," W. A. DeBen. (In press.)
5. "Tracing of Kraft Mill Effluent from an Ocean Outfall by Means of Natural Fluorescence," D. J. Baumgartner, M. H. Feldman, and Carl L. Gibbons (draft).
6. "Trace Materials in Wastes Disposed to Coastal Waters," M. H. Feldman (draft).

Plans for Fourth Quarter, FY 70

Prepare report for technical journal on plume analysis from ocean outfalls. Continue work on guidelines and hydraulics lab.

The state-of-the-art report will be forwarded for review, revised, and published as a laboratory report. Continue participation in Tektite II.

The second conference on estuary modeling will take place in early May, in or near Newport, Oregon. Part II of the report on mathematical modeling of the Columbia River will be completed.

Work on reaeration in Yaquina Estuary will resume in this quarter to a limited extent.

Work will continue on review of trace materials in domestic sewage and sludge and possible mechanisms and fates in coastal waters.

An elaborate pulse height analysis system suitable for trace element work has been bid on by several vendors, and this procurement is to be carried out. The next step - coordination with the Oregon State University Computer Center - will be initiated via conferences and decisions as to feasible actions preparatory to a program of barge/pipeline sludge disposal studies.

BIOLOGICAL EFFECTS RESEARCH PROGRAM

Status of Projects and Significant Accomplishments

Thermal Pollution Studies

1. Tissue Enzyme Studies:

Optimum conditions were determined for assaying salmon lactate dehydrogenase (LDH), and these differ considerably from the classical temperature and pH used for mammalian LDH. Subsequently these optima were used to determine the effects of temperature adaptation and heat death on steelhead trout smolts. The results indicate no dramatic temperature effects on LDH, either in terms of temperature-activity relations in vitro or LDH activity per unit of tissue in vitro. For these reasons, the enzyme studies will not be pursued beyond the current effort.

2. Simulation of Adult Coho Salmon Migration Through Elevated Temperatures:

Eggs from coho that were held at various temperatures were incubated and hatched in Tanner Creek water. Fertilization was at typical levels, except possibly among the two females that survived 20C (68F) for 14 days. In the latter case, infertility and malformed embryos were common and indicate a latent effect of high temperature. The resulting fry from selected pairs are being reared as a check on other latent but adverse effects. A rough draft report was prepared to cover all phases of this research.

The adult holding facility was dismantled at Bonneville and moved to Corvallis. Site cleanup was completed and the next task will

be to re-establish this facility on the Willamette Site.

3. Temperature Effects to Toxicity:

Guideline levels of ten toxicants in Columbia River Water Quality Standards were tested using static bioassays and death as a criterion. Replicate studies strongly indicate that these guidelines need revision, as may be the case in other areas.

Waste Treatment Studies

Coho eggs that were fertilized in various wastes continue to incubate. Hatching has been delayed by using extremely cold water. As yet the results are unknown.

Areas of Concern

The redevelopment of the adult salmon testing facility is proceeding slowly due to limitations of money, time, and manpower. This may preclude adult testing until late fall or perhaps later, depending on our progress.

Meetings and Manuscripts

Dr. Bouck met with various agencies in Montana to discuss research problems and their possible solution regarding (acid) metal mining pollution in the Clark Fork River. A tentative research proposal was submitted to the Northwest Regional Office via the Laboratory Director.

The following manuscript was written and is in the process of receiving a technical review:

Bouck, G. R. 1970. Observations on gas bubble disease among adult sockeye salmon (Oncorhynchus nerka) in the Columbia River.

Grants and Contracts

Management of two Section V grants is continuing.

CONSOLIDATED LABORATORY SERVICES PROGRAM

Status of Projects and Significant Accomplishments

The backlog of analyses is starting to increase due to an increase of activities in Research and Technical Assistance Programs. The analysis of phosphate in detergent formulations and analysis of dissolved nitrogen in water required special attention during this quarter.

Analysis of the phosphorus content of algae and detritus entrapped on 3-micron filters was made. Due to the variation in filter weights and the variation in the amount of phosphate which is filtered out, the answers were not very precise. The Kjeldahl nitrogen analysis of these filters with and without algae and detritus was so erratic that the analytical exercise was futile.

Oil pollution problems in Alaska required considerable attention of the staff at the Portland Laboratory.

There was participation in a Workshop on dissolved nitrogen analysis at the Bureau of Commercial Fisheries Research Laboratory in Seattle where some decisions on methods of analysis were made.

Automated Analytical Systems

The Technicon Kjeldahl digester problems have not been solved. Pressure of other activities has limited further attempts to solve the digestion of organics by automated systems. Kjeldahl determinations continue to be run with the semi-micro Aminco technique.

Specialized Analysis

The gas chromatographic techniques, paper chromatography,

infrared scans, total sulfur, and a variety of other organic and oil-related techniques were used in differentiating oil samples. Oil samples were the priority item at the Portland Laboratory.

Atomic Absorption Spectrophotometry

CLS has resorted to adding 25 ml of concentrated nitric acid per liter of sample to all water samples collected for trace metal analysis. Instructions for such preservation will be changed as a result of problems experienced with the use of less acid.

Biology

The first draft of the Log Handling and Storage Project report is being typed.

Reports and Papers

A talk on taste and odors in surface waters was presented to water treatment plant operators. CLS continued to aid the training programs in January for the course "Sewage Treatment Facilities for Federal Installations" and in March for the course "Chemical Analysis for Water Quality." Four papers are in preparation for submittal for publication.

Equipment

The Radiometer automated titration system has been received and has been used in the analysis of phosphates in detergents. Bids are being prepared for modification of the carbonaceous analyzer. Discussions are in progress for the choice of suitable equipment to

analyze for dissolved gases in water. The Fisher-Hamilton Gas Partitioner was damaged in a fall and is being repaired. A gas chromatograph on campus in Dr. Frank Schaumberg's laboratory was used to analyze for dissolved gases in water.

Plans for Fourth Quarter, FY 70

The papers in preparation will be completed. Repairs will be completed for the Fisher-Hamilton Gas Partitioner and modifications will be made on the clinical model gas partitioner for the analysis of gases. The automated titration system will be set up for routine analysis. Efforts will be continued in reducing the backlog of analyses.

TRAINING AND MANPOWER DEVELOPMENT

910205/001

Status of Projects and Significant Accomplishments

Direct Training

The training course, "Sewage Treatment Facilities for Federal Installations," was presented twice during the month of January to 49 students.

"Chemical Analyses for Water Quality" training course was presented in March to 29 students.

An Applied Biology Seminar was held in Portland, Oregon in March for 94 students. The seminar was presented as part of the annual education meeting of the Oregon Sanitarians Association.

A staff member participated as an instructor in a sewage treatment plant operator short course sponsored by the Idaho State Board of Health in Boise, Idaho in January. In addition, laboratory assistance and facilities were provided for an Oregon State University-Oregon State Board of Health sewage treatment plant operator short course.

CAMPS (Cooperative Area Manpower Planning System)

Staff support was provided for the Linn-Benton Community College sewage treatment plant operator training course until the course ended with graduation exercises on March 7. H. M. Freeman, Acting Director, Division of Manpower & Training, Washington, D. C., was the principal speaker at the ceremony for the 22 graduating operators. A new class of 28 students began on March 23, 8 students from the State of Idaho. This class will complete training in December 1970.

Washington State University has requested on-job-training funds to train 75 operators in the State of Washington. Green River Community College, Auburn, Washington, has requested Manpower Development Training Act funds for training of sewage treatment plant operators.

Public Relations

Tours of the Laboratory and orientation on the water pollution control program were provided for 320 people. In addition, staff members were guest speakers at local schools with audiences of 140 students. Films on water pollution were loaned for viewing by approximately 2,340 viewers. Over 4,500 pieces of literature were distributed.

A slide-tape show, "This Land is Your Land," has been prepared by the training staff for use at the Earth-day Teach-in to be held at Oregon State University the week of April 20. This show is being made available for use in other Regions.

Plans for the Fourth Quarter, FY 70

"Survey of Chemical Analyses for Water Quality" -- Fairbanks 4/13-17/70
"Survey of Current Practices in Water Microbiology" --	
Fairbanks.....	4/20-24/70
"Biological Treatment Technology".....	5/11-22/70
"Marine Biology & Pollution Ecology".....	6/15-26/70