NEWS

WATER RESOURCES RESEARCH INSTITUTE

OF THE UNIVERSITY OF NORTH CAROLINA

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CONTENTS

ADVANCE NOTICE ON RESEARCH PROPOSALS

Advance notice is given to faculty of all senior colleges and universities in North Carolina of the September 1 deadline for receipt of research applications under the OWRR-WRRI Matching Grants Program for FY 1974 (starting July 1, 1973). Notices and instructions will be mailed in the next few weeks to all faculty members whose names appear in the 1971 edition of Institute Report No. 3, "Water Resources Research Interests in the Colleges and Universities of North Carolina." Other interested faculty will be sent this material upon request.

Interested faculty are encouraged to read the Institute assessment of "Water Resource Problems and Research Needs," Report No. 2 (revised January 1, 1972), for background on priority research areas. The Institute Director, David H. Howells, and Associate Director, F. Eugene McJunkin, are available for consultation concerning proposed research. They can be reached at 755-2815 (2816) in Raleigh. Prof. McJunkin can also be reached at 966-2129 in Chapel Hill.

HIGHLIGHTS OF NATIONAL SYMPOSIUM ON COSTS OF WATER POLLUTION CONTROL

The National Symposium on Costs of Pollution Control, held in Raleigh on April 6 and 7, was, by all accounts, an unqualified success. The more than 225 participants included economists, engineers, administrators, and conservationists from as far away as Anchorage, Alaska. Discussion was brisk throughout and interest was sustained from the warm welcome by Chancellor Caldwell to the closing summary by Water Pollution Control Federation Executive Secretary Robert Canham.

In his remarks preceding the opening session, EPA's Deputy Assistant Administrator for Water Programs, Eugene T. Jensen, said, "The National Symposium on Costs of Water Pollution Control is being held at a particularly appropriate time. There is a growing awareness that the Nation will no longer tolerate and can no long afford the continual destruction of land, water, and air resources. There is also a growing awareness that the national cost of correcting two centuries of neglect will be substantially higher than had been predicted only a few years ago. This national concern is clearly reflected in recent Congressional actions on environmental legislation."

"The economist and the environmentalist have taken their separate paths for many years," Jensen said. "The recent action by both the Senate and House of Representatives in passage of extensive water pollution control legislation is a clear indicator that these pathways must now be joined." The correction of environmental insults and preservation of environmental values will require major decisions in public and private investment. "In every case," said Jensen, "a variety of choices becomes available, each with its own dollar and environmental costs, tradeoffs, and characteristics." "I believe," he continued, "that it is in these areas the economist can work closely with the environmentalist in selecting the best possible solution to a given set of problems. We also need to be certain that we have accurately assessed the cost of our various pollution control strategies and that the public is made reasonably aware of these costs in terms of goods and services."

Perspective

In the opening paper, Edward J. Cleary, former Director of the Ohio River Valley Sanitation Commission, traced the evolution of public policy for water pollution control since the turn of the century. "The salient fact emerging from such a review," he said, "is that at different times and under different circumstances society has found reason to attach different values to the condition of its waterways. These preferences have ranged from past acceptance of foulness to currently expressed aspirations for the achievement of pristine purity."

At the beginning of the century, Cleary noted, "social motivation for curbing pollution rested primarily on preventing the transmission of water-borne disease and occasionally to minimize local nuisances." The reluctance of citizens to forego the convenient and costless system of discharging sewage into the nearest watercourse is reflected by early anti-pollution legislation which restrained regulatory action by health authorities until proof of a nuisance condition was produced. Somewhat greater awareness of the public-welfare aspects of water degradation began to manifest itself in the period between the two World Wars. "By then," said Cleary, "entire waterways were being rendered unfit for any use except as sewers. Pollution was an acceptable tradeoff for many things more highly valued than clean waterways." Other characteristics of this period that reflected the prevailing mood of restraining public intervention were: the indulgence accorded to municipalities who resisted or otherwise delayed compliance with pollution control orders; the deference shown to industrial polluters; and a reluctance to resort to the courts for enforcement of remedial measures.

By the 1940's Cleary said, "the name of the pollution control game became establishment of standards for the balancing of equities." This was played in various ways. "One version involved zoning of waterways based on adoption of standards reflecting the status of existing uses." Few of the standards that were being adopted "reflected a rigorous assessment of scientific criteria and economic considerations . . . The extension of the practice of stream standards was ordained by the Congress in the Water Quality Act of 1965."

"Events associated with implementation of the 1965 legislation," Cleary noted, "have projected the nation into its fourth and current endeavor to explicate pollution control goals." This involves the "presumption that the greatest beneficial use of water resources can be realized only if they are maintained at the highest level of quality." Cleary referred to this as the "holy water syndrome," which has culminated in new legislation which would require "zero discharge" of pollutants by 1985. It would also dismiss "consideration of tailoring waste discharges to conform to river quality standards. "Instead," he said, "it involves uniform application of clean-as-technically-possible requirements for all discharges." Critics of this policy argue that it "denies exploitation of an array of alternative means to achieve appropriate water quality goals at significantly lower investment costs." The exploitation of quality-management techniques, Cleary observed, "requires first the establishment of administrative agencies with something more than regulatory authority. There has been little disposition at the national level of government--and only minimal interest on the part of state legislatures--for creating institutions clothed with the requisite powers to design, finance, construct, and operate facilities for the management of water quality."

A state viewpoint

Dwight F. Metzler, Deputy Commissioner for Environmental Quality, New York State Department of Environmental Conservation, presented some preliminary estimates of what various levels of waste treatment would cost the industries and municipalities in New York State. "The order of magnitude of costs imposed by conditions of S. 2770 (zero discharge) must be measured as hundreds of billions of dollars," Metzler said. "New York's experience has indicated the value of setting goals, establishing comprehensive plans, estimating implementation costs and then getting on with pollution abatement. Some costs and guidelines for a national effort can be developed from our experience," he noted. Since 1965, $2.3 billion have been committed to achieve secondary treatment and greatly expanded regional systems. An additional $4.3 billion worth of work remains to be accomplished. Since 1965, construction costs have increased about 50 percent. Metzler estimated that the wastewater treatment and disposal problem for New York is about 10 percent of the national problem. He concluded that the cost can range on a national scale up to three trillion dollars over a twenty-five year period and to several hundred billion dollars in New York State.

In order to avoid falling into the trap of setting very high goals and providing funding for much lesser objectives, Metzler proposed that a national effort be made to develop comprehensive sewage facility plans. "Every effort should be made to complete these plans in a short time frame--say, five years," he said. Such plans would evaluate alternative solutions for secondary, tertiary, and complete treatment. They would provide a mechanism for evaluating the costs and benefits for each alternative. Metzler said, "Our continual shifting of goals is leading to the frustration on the part of the public and, perhaps, to some unwise expenditures insofar as municipalities and industries are concerned." He noted that, "Stream quality standards based upon water use provide a sound basis for determining effluent limitations.' "This theory," he said, "should not be abandoned."

Federal viewpoint on pollution control economics

Dr. Ralph Luken, EPA economist, told the Symposium that equal levels of waste treatment are not required in all areas of the Nation. "The marginal cost of treatment accelerates very rapidly as we begin to approach high levels of waste treatment," he noted, "and the total costs at very high levels may exceed any noticeable benefits which we may be able to achieve." Luken said there is general feeling that the standard requiring a level of expenditure equivalent to secondary treatment can be justified in most areas, though they are "hard pressed" to come up with much quantitative evidence.

EPA has estimated the total cost of constructing municipal waste treatment facilities to meet present objectives through FY 1976 to be $18.1 billion. Estimates of costs for industrial waste treatment total $8.1 billion. Chemical manufacturing, primary metal production, pulp and paper, petroleum refining, and food processing account for 27, 18, 17, 12, and 11 percent of the indicated investment. Luken reported that EPA has found very little correlation between needed expenditures for water pollution control and value of industrial output. About 85 percent of capital requirements associated with water pollution abatement comes from only one-third of the value added by manufacturing. In terms of resources required to be invested in water pollution control, the burden is going to fall rather heavily on certain segments of the industrial economy. As much as one percent of value added in some industries will be added by waste treatment costs, Luken said. If such costs were absorbed by the manufacturer, they would reduce the pre-tax profits by 0.9 percent. If additional costs associated with pollution control are passed on to the consumers with full maintenance of margins, prices of manufactured goods may increase by 0.1 percent.

In the industrial area, Luken said, EPA is somewhat limited in trying to achieve least cost solutions. At the present time, the Agency's greatest role can be made by specifying effluent limitations rather than technological goals. Industry, he observed, is moving toward process changes and concentration of pollutants to minimize costs. A recent survey indicates that practically 30 percent of capital expenditures for water pollution control were made by manufacturing changes to reduce pollution. With regard to the concentration of wastes, Federal Reserve Board data for 1959-1968 showed a 59 percent increase in production with only a 29 percent increase in water use.

Assuming the House Bill will prevail, Luken said that EPA has several options available. One of these is a national effluent charge. He reiterated EPA support for this concept, and said that there are strong theoretical arguments on its behalf. One of these is that it would lead to the most efficient allocation of pollution abatement costs among discharges. In view of the uncertainty beyond 1976, EPA will actively study a combination of the effluent charges and enforcement. Luken reaffirmed EPA's commitment to stream quality standards and guidelines to meet water quality objectives. Effluent limitations will be based upon the stream standards.

A conservation viewpoint

Thomas L. Kimball, Executive Director, National Wildlife Federation, and one of the Nation's most effective spokesmen for conservation, told the Symposium that the real question is what is economically feasible. Neither economists, scientists, nor government agencies are going to provide the answer, he said. It will be how much Mr. John Doe, who "heads up a family, who has to rear, clothe, and educate his children, will be willing to pay in order to achieve that degree of cleanliness." That family, Kimball noted, is beset by a government $400 billion in debt--the interest on which would meet the cost of cleaning up the environment--and by a hodgepodge of conflicting national priorities.

Kimball reported that the National Wildlife Federation has found it extremely difficult to collect information on environmental quality and present it in such a way that the average person can understand it. Their recent Environmental Quality Index was developed with this in mind. One of the difficulties, he said, is the conflicting data. "If professionals can't agree, pity the average citizen." The scientist will have to eliminate the "continuing cancer of credibility that crops up on nearly every one of our national issues, if he is to maintain his position in this society."

Attempts have been made to analyze why we haven't made more progress in water pollution control, Kimball said. A Harris survey in 1969 found that four out of five Americans are either concerned or deeply concerned about what's happening to the environment. A repeat survey by the Gallop organization in 1971 disclosed that the proportion of concerned or deeply concerned citizens had increased by two percent. Kimball concluded that public interest is neither transitory nor a "vociferous minority."

Another argument, he said, is that costs for pollution control are too great. "We always talk about costs and not much is said about the benefits," Kimball noted. "These should be cranked in also." The Federation has found very little information on benefits. They have talked with EPA economists who gave some "ball park" figures. But, said Kimball, "even the economists couldn't agree." Using a nationwide annual bill of $28.9 billion for air and water pollution damages, the Federation calculated the annual bill for the average family to be $481. With a "reasonable clean-up" program requiring $10.2 billion annually the average family share would be $170 per year. Despite the fact that most persons covered in the Gallop survey were not informed on pollution control costs, about half indicated they would pay $170 per year to avoid higher costs later. Those who took this position were generally college graduates, younger people, and had above-average incomes.

<u>Economic implications of pollution control policy</u>

Dr. Alan K. McAdams, Senior Staff Economist, Council of Economic Advisors, Executive Office of the President, spoke to this year's economic report and the cost implications of various levels of water pollution control. Using data developed by the Council on Environmental Quality and the Environmental Protection Agency, McAdams developed the following relationships:

to remove the first 87 percent of pollutants would cost about $60 billion between now and 1982,
to remove another 10 percent would cost an additional $60 billion,
to remove the final three percent would cost another $200 billion.

These figures, said McAdams, suggest an exponential curve which shows that it costs about $0.6 billion per percentage point waste reduction for early stage treatment (87 percent). For the next 10 percent, it costs about $6 billion for each percentage point, and for the last three percent about $60 billion per percentage point. "When an economist looks at these figures," McAdams said, "he gets worried, particularly when Congress passed 86 to 0 a law which says let's go for zero discharge."

McAdams observed that he was not saying it would be inappropriate for a nation to make a choice to commit its resources this way--only that when it costs 100 times as much to move from 87 percent treatment to 100 percent, "maybe you ought to stop, look, and analyze before you jump."

As a society and as a nation, we do need to control pollution, said McAdams, but "we should be doing that in a way which does not waste our resources." The complete implementation of present water pollution control legislation would not have enormous impact on the economy, according to McAdams. Growth of the GNP would drop from about 4.8 percent annually to 4.7 percent. With appropriate monetary and fiscal policy, "we can move right back up to full employment so that we have lost nothing," he said. He estimated that the unemployment rate would increase from 4.6 percent to 4.7 percent and that net exports would drop by $700 million over the decade. "We as an economy can afford this." McAdams reported on a "first cut" study of 12,000 plants in 14 industrial groups. In none was the impact of pollution control extreme. About 200-300 of this total would probably be put out of business by additional pollution control costs.

"What we really want to do is to accomplish as much as we can through the private market," he said. "We speak of ourselves as a private enterprise economy and that is a myth. We are, have been, and must be a mixed economy. Where possible, we would like to do things through the private mechanism." The private market works, said McAdams, where an individual decision maker faces all the costs of his decision and all of the benefits. If a person gets all the benefits and somebody else picks up some of the costs, he is being subsidized. In the case of water pollution, he said, "we are attempting to identify those costs not currently faced, get them back into the decision . . . in order for the private decision maker to make intelligent decisions he has to bear the costs. If we continue to subsidize pollution control, we will continue to misallocate resources, which will lead to economic waste."

"If we adopt zero discharge," he alleged, "we will be throwing away the yardstick for measurement of benefits from expenditures. Zero discharge says that no matter what the benefits, you will make the expenditures. We have a problem. We should be facing it squarely and should be moving in a direction leading to its resolution. Such requirements as best available treatment do not move in the right direction. There are streams where standards can be met with secondary treatment . . . If water quality standards are currently being met, why push beyond that?" McAdams concluded with the observation that the environment should not be treated in a religious fashion, that it should be dealt with rationally.

Cost effectiveness in setting of goals

Dr. Robert V. Thomann of Manhattan College asked whether we should "admit into our discussions of water pollution control the notion of alternative courses of action which rest to some extent on the economic costs and the expected return of those actions. "Water pollution," he said, "has to compete on a priority scale with all other worthwhile programs in our society." Such competition is keen since water pollution control is not cheap. "Maximum removal or zero discharge is not meaningful," Thomann emphasized, "because it fails to recognize variable response levels of different bodies of water to an identical input of waste and the concept of variable water use patterns." He illustrated this with case studies of New York Harbor, Boston Harbor, and lower Bucks County in the Delaware River System.

The goal of 4 ppm of dissolved oxygen in the East River of New York Harbor can be achieved by a combination of waste removal averaging about 85 percent; anything beyond that brings only relatively small improvements, Thomann said. He attributed this to the relatively large volume of water in the system and the effects of urban runoff. Rather than require additional removal, he suggested that the next phase of clean-up should turn attention to some of the bacterial problems from storm water overflow.

In the case of Boston Harbor, Thomann stated that present water quality standards can be met with only primary treatment. Projections made with verified models under a variety of conditions for 1995 indicated that present standards would not be contravened under present treatment practices with the possible exception of the inner harbor region where the pollution is due primarily to wastes from combined sewer overflows. "In light of these kinds of results," Thomann said, "one begins to wonder about the need to continue a policy requiring additional treatment in such locations. The return is minimal. For a fixed amount of economic input, one should look carefully at zeroing in on problems associated with interferences with water uses. It would be a very serious error to ignore interactions between waste discharges and water quality and to promulgate a program based solely on maximum removal of waste or zero discharge."

Thomann concluded that, "A policy of zero discharge applied solely to point sources of waste is cost inefficient since it can be demonstrated that such a policy may have little or no effect on water quality. One of the reasons for present problems is failure in the past to critically analyze the consequences of our actions." He does not think we should repeat this failure and follow a policy which ignores physical, biological, and economic realities. The goal he advocates is a "kind of reasoned analysis of water quality problems, recognizing anticipated cost effectiveness of policies and costs involved in achieving sought-after goals." "Comprehensive planning, coupled with a rational analysis of system response to proposed control actions, can aid immensely in this reasoned analysis," he said.

Understanding the problem

The importance of "unrecorded pollution sources" was emphasized by a paper by General William Whipple, Jr., Director of the Rutgers University Water Resources Research Institute. Studies of pollution in three New Jersey river basins during 1969 disclosed that this organic pollution in each river was more than twice that which could be accounted for from known sources of waste discharge. "Where there is widespread unrecorded pollution, as is almost sure to be the case in developed areas, the advanced waste treatment of recorded effluents cannot be counted upon to produce really pure rivers," Whipple observed. Even the additional treatment of storm water runoff and combined sewer overflow would leave uncontrolled many other sources of oxygen demand of suspended solids, and of nutrients. "To plan a regional water quality system without a study and projection of the origins of pollution in the basin," he said, "is analogous to planning a flood control system for a major river without knowledge of the river's hydraulic characteristics."

Economic incentives

Dr. A. Myrick Freeman, Chairman, Department of Economics, Bowdoin College, argued that residual or effluent charges were to be preferred to the present strategy of non-market regulation, enforcement, and subsidy. This strategy has not been effective according to Freeman. Citing the recent GAO study of federal construction grants, he alleged that the Nation's rivers were in worse shape at the time of the study than before. The reasons: lack of planning, absence of necessary incentives to cities for effective operation of pollution control facilities, and indirect subsidy to industry--biasing their decisions concerning in-plant changes. The present strategy, he said, is "inherently ineffective on the enforcement side and present efforts toward reform such as new legislation are, at best, patchwork jobs on what is a very leaky sieve."

"It is in the American tradition," said Freeman, "to create regulatory agencies to deal with problems caused by malfunction of the economic system or market. Careful analysis shows that such agencies very rarely deal with problems successfully. Regulation and enforcement are essentially political processes which entail bargaining between parties of unequal power. The real issues are camouflaged in technical jargon, regulators are largely protected from political accountability for their actions, and public interest is very diffuse, poorly organized and represented. The outcome is predictable."

"The basic case for economic incentives," he said, "rests on acceptance of two primary propositions: (1) in a market economy prices play a major and valuable role in allocating resources to their highest value use, and (2) degradable environmental resources are presently outside the scope of the market and are not subject to the guidance of prices in their allocation among alternative uses." When a common property resource like water is being overused, the effect of the private market can be imposed by charging a price or fee to those who use the common property resource.

Under a system of residual charges, "waste dischargers are required to pay the government certain sums for each unit of waste discharged." Dischargers are led to compare the costs of using the environment for waste disposal as reflected by the charge with the cost of handling their waste disposal in some other way. The choice of a means is left to the discharger, and he has a wide range of options which he understands and has the most knowledge about: treatment, recycling, process changes, etc. His only guide is the relative costs of these alternatives, one of which is to discharge untreated wastes into the environment. Waste generators will reduce their discharges as long as the marginal cost of doing so is less than the price or marginal cost of discharging waste to the environment. The higher the residual charge, the higher the incentive to seek alternatives to direct discharge. Charges must be set high enough to induce dischargers to limit their discharges to those levels permitted by water quality standards. Freeman said that, "study of water management programs has shown that a residual charge policy in conjunction with other appropriate public policy can lead to the attainment of water quality objectives at the least possible total cost."

Industrial waste surcharges

Dr. James A. Seagraves, Department of Economics, North Carolina State University, reviewed his research on water and wastewater surcharges as economic incentives for pollution control. This included water use and waste control in the poultry processing industry and the use of surcharges for industrial wastes discharged to municipal sewer systems.

Seagraves said that widely different levels of BOD per $1,000 value added in manufacturing among different industries create problems in the use of combined data from cities with different industrial mixes. "Wage rates have been going up more rapidly than investment in water or waste treatment or value added in manufacturing," he noted, "and industry naturally responds to these relative price changes by putting in labor-saving devices, many of which create more wastes or limit by-product recovery." With regard to surcharges, he reported that his findings indicate that for a surcharge of 5¢ per pound of BOD industry would typically send to a city about 21 pounds of BOD per $1,000 value added in manufacturing. "The price charged in most cities for these wastes is zero," he said, "and if we don't charge for a valuable resource--the capacity of a waste treatment plant or stream--it will be overused." Dr. Seagraves said that in general the addition of a surcharge of 5¢ per pound of BOD can roughly cut industrial discharges in half.

A great deal of interest was shown by participants in the packet of information on Surcharges for Industrial Wastes: Suggestions and Guidelines prepared by Dr. Seagraves for cities and counties advocating charges based on the strength of water-carried wastes. The packet is reviewed elsewhere in this issue of the *News*.

Cost effectiveness of investment in pollution control facilities

A paper by Ralph C. Palange, Director of Municipal Waste Water Programs, Office of Water Programs, Environmental Protection Agency (delivered by Charles Sutfin), dealt with the effectiveness of pollution control investment. In his view, there appears to be a tendency for physical plants and volume of capital needs to expand along with increased federal financial assistance. "The more we invest, the more we seem to need to invest," he noted. While the phenomenon is partially explainable by inflation, overhead requirements of a growing capital base, and more stringent waste treatment regulations, Palange said, "it is also possible that much of the capital need flows from institutional inefficiencies at all levels of government, that some of the increase in costs of pollution abatement could be controlled by more efficient utilization of capital, and that more rapid progress in pollution abatement could be achieved by alternative investment arrangements." "We've been able to correct many of our past mistakes," he said, "and we still have many more to correct."

Cost effectiveness in design

Robert C. Marini, Senior Vice President, Camp Dresser & McKee, Inc., told the Symposium that, "only through understanding and use of cost effective design and management practices will we be able to realize social benefits commensurate with the mammoth cost of the Clean Water Program." "Too many decisions," he said, "appear to be made without investigating all available alternatives and actually comparing costs and functional effectiveness. It is too easy to apply well-known 'solutions' without really asking what the problem is."

Marini cited the following principal steps in the development of economically optimum solutions to environmental engineering problems:

1. listing feasible, effective solutions,
2. preliminary assessment of relative economies and discard of impractical solutions,
3. verification of feasibility,
4. economic comparison of remaining alternatives,
5. if selection is not clear-cut, vigorous functional and cost comparison of remaining alternatives,
6. avoidance of unnecessarily high factors of safety and embellishments,
7. selection of optimum capacity, and
8. study of economic and other conditions surrounding proposed project and recommended actions bearing on cost effectiveness.

Marini said that pilot plants, computers and mathematical models; industrial waste surveys; and construction management, are useful in implementing the above steps.

"Extensive use of pilot plants," noted Marini, "has settled questions of tradeoffs between capital and operating costs, as well as questions of plant configurations and treatability of mixtures of municipal and industrial wastes. With the completion of such pilot plant studies, the designer has an early knowledge of the capabilities and possible alternative arrangements of the treatment process."

"Mathematical models and computers for solving problems of engineering selection and design," he said, "have provided another cost-effective practice. Successful use has been made of a program which provides automated economic comparison of alternative regional wastewater collection and treatment schemes. The basis of the program is a meaningful mathematical model which provides a cost-minimizing technique in planning basin-wide water pollution control programs."

The comprehensive industrial waste survey is a necessary cost effective practice, said Marini, "when gathering data for the design of wastewater facilities in highly industrialized areas. Such surveys furnish the information for determining the treatment process and each industry's portion of the construction cost of the system. Also, the survey results often prod the industries into making in-plant adjustments, resulting in reduced loadings at the treatment plant, and subsequently, reduced construction cost."

Concerning the controversy over "turnkey" construction, Marini contended that, "the construction management system provides, among other advantages, a more economic approach to the construction phase of environmental works. Acting as a watchdog over the schedules and costs of a construction project, the construction management team bridges the gap between contractor and client, insuring maintenance of schedules and budgeted costs as well as quality of workmanship."

Cost picture for industry

Thomas P. Quirk, Partner, Quirk, Lawler & Matusky Engineers, told Symposium participants that the arbitrary inclusion of pretreatment at or above primary treatment can have a very significant effect on the economics of industrial participation in a regional wastewater system. The recent tax reform bill contains provision for rapid depreciation of water pollution control facilities for tax purposes. The effect, he noted, can be viewed in terms of "an effective construction grant." By taking the present worth of tax saving, cost of money at 8 percent, and computing a present worth, "one can view accelerated depreciation as effective as a 17 percent grant for capital costs." Quirk said that under conditions of "removal of the EPA grant," it is a foregone conclusion that industry would not find it economically feasible to participate in regional wastewater systems providing more than primary treatment.

Dr. H. B. Pickle of Auburn University reported on a study of industrial response to pollution control covering the textile, steel, and paper industries. The investigators concluded that textile manufacturers plan to absorb all of the increase per unit cost of waste treatment required to meet present standards. Prices to consumers would not, therefore, be affected. If stricter standards are adopted, such as proposed in the Congress, increased costs may drastically alter this picture. Color and removal of remaining BOD and suspended solids will prove extremely expensive with existing technology.

The problem of environmental pollution is greatly intensified in the steel industry, Pickle said. Steel production waste products encompass a wide spectrum of materials, the removal of which is difficult and expensive. Waste volumes are much larger. Pickle said the steel industry is faced with an ever-increasing economic problem "that causes waste treatment to be a serious enigma. The average price of import steel has consistently been from $20 to $50 per ton cheaper than domestic. Despite voluntary import restrictions, "U. S. steel companies find it increasingly difficult to raise prices to absorb added costs. Pickle stated that, "Profits are not sufficient in the steel industry to cover environmental cleanup and equipment updating. The steel industry has no choice; it must clean up its waste. If the industry attempts to pass on the cost of pollution abatement, more of the domestic market will shift to imports. If it attempts to install effluent treatment facilities at the expense of modernization, it will fall even further behind foreign producers and sales will be lost to imports." He concluded that some form of governmental action seems to be the only factor that could change the bleak future of the industry.

Market for pollution control facilities

The largest part of expenditures for waste treatment facilities are for concrete, brick, and mortar and not for equipment, reported Konstantine L. Kollar, Director, Construction, Water Resources and Engineering Service Division, Office of Business Research and Analysis, U. S. Department of Commerce. For each $1 billion, roughly two-thirds goes for collection systems and one-third for waste treatment. Equipment accounts for only 5.4 percent of the total. For sewage treatment plants alone, the potential market for equipment is only 15.4 percent. Kollar cited problems of lack of information and disparate basic data.

The buying power for construction put-in-place has decreased about 10 percent per year, said Kollar. Equipment manufacturers are working at about one-third capacity. Consulting engineers could double their workload under an expanding waste treatment program. Kollar said that his agency's cost figures for pollution abatement were in the same "ball park" as those reported by Luken for the Environmental Protection Agency.

The Symposium was jointly sponsored by the three Triangle Universities and the Environmental Protection Agency. The Water Resources Research Institute served as secretariat.

NEW INSTITUTE REPORTS

Water Research Application Packet - Surcharges for Industrial Wastes: Suggestions and Guidelines

Prepared by Dr. James A. Seagraves,
Department of Economics, N.C.S.U.,
with assistance from
Mr. James Stewart
Water Resources Research Institute
and published jointly by the
Department of Economics, Water Resources
Research Institute, and Water Quality Division,
State Office of Water and Air Resources, N.C.D.N.E.R.

The packet includes a brochure, "Industrial Wastewater Surcharges," which will be used as a general education piece for wide distribution. Detailed guidelines include the following publications:

I. Suggestions to Municipalities that are Considering Surcharges on Industrial Waste

II. Industrial Surcharges in North Carolina

III. Guidelines for Recovery of Waste Treatment Costs by Units of Government Applying for Federal and State Grants

Appendices:

1. Model ordinance
2. List of Private Laboratories performing monitoring and testing services
3. References

The packet will provide general and detailed information to local government on the use of sewer surcharges for the management of industrial wastes discharged to municipal sewer systems. Copies are being distributed to local officials throughout the State in cooperation with the North Carolina League of Municipalities.

Report No. 60: Contamination of Surface and Ground Water with Pesticides Applied to Cotton

by

Dr. T. J. Sheets, Dr. J. R. Bradley, Jr.,
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Pesticide Residue Research Laboratory and
Department of Entomology, N.C.S.U. at Raleigh

The objectives of this research were (a) to study movement of trifluralin, DDT, toxaphene, and methyl parathion in surface runoff arising from natural rainfall in cotton fields sprayed with the four pesticides, (b) to determine residues of the pesticides in soil at several times after application, (c) to follow the level of contamination of a farm pond with the pesticides applied to cotton fields in a small watershed, and (d) to determine if water in wells (depths of 4, 6, 8, 10, and 12 feet) within fields treated with the pesticides became contaminated. The study was conducted at two locations for two years.

Of the total trifluralin, toxaphene, or methyl parathion applied to cotton plots, less than 1 percent was recovered in surface runoff. When DDT was applied alone, an average of 2.83 percent was present in runoff; whereas only about 1 percent of the DDT from a combination DDT plus toxaphene treatment was found in runoff. Of the DDT, trifluralin, toxaphene, and methyl parathion recovered in runoff, 96, 84, 75, and 12 percent, respectively, was associated with the sediment fractions. Residues of trifluralin, DDT, and toxaphene persisted in soil from one season to the next. On a percent basis, trifluralin appeared to be more persistent than DDT and toxaphene. A much greater percentage of trifluralin, DDT, and toxaphene remained as residues in the soil than was found in runoff. A high percentage of the DDT, toxaphene, and methyl parathion was not recovered from runoff and soil. Residues of DDT in water from a small pond within one experimental watershed ranged from <0.35 ppb before spraying to 13.4 ppb during the spraying season. Toxaphene residues in pond water varied from <1 ppb before spraying to 65 ppb about mid-season. Methyl parathion was detected in pond water for two sampling dates. The highest concentration of trifluralin in pond water (1.61 ppb) occurred during a heavy rain five days after application. None of the pesticides were detected in well water.

Recommendations for the modification of farming practices to minimize the adverse effects of pesticides are included in the report.

Report No. 64: <u>Analog Modeling to Determine the Fresh Water Availability on the Outer Banks of North Carolina</u>

by

Dr. George J. Kriz
Department of Biological and Agricultural Engineering
North Carolina State University at Raleigh

Wise use of the Outer Banks of North Carolina is important to the State and the Nation not only for their recreational value, but also for the protection from the open sea their presence affords the mainland. One important component in the wise use of the Outer Banks is the availability of potable water. Although adequate supplies of potable water have been available in the past, an increasing demand for fresh water supplies caused by increasing numbers of tourists and permanent residents requires that maximum withdrawals of potable water be made without destructive pollution of the aquifer by salt water intrusion.

Because field studies are very difficult and time consuming, laboratory experiments were conducted using a Hele-Shaw model to predict maximum safe pumping rates that could be obtained from a horizontal gallery for various soil and rainfall conditions on long oceanic islands. Particular attention was given to obtaining potable water on the Outer Banks of North Carolina.

The Hele-Shaw model was designed and built to represent a cross section of a long oceanic island. The two fluids that simulated fresh water and salt water were obtained by adding a viscosity-increasing agent to water. The density of one batch was increased by adding salt and sugar. The "fresh water" was added along the top of the fresh water lens in the model at cyclic time intervals. Fluid was pumped from the fresh water lens through one of the three galleries. Two of the galleries were located below mean sea level, and one was located at mean sea level. During a test, pumping from a gallery was initiated at a low rate and was continued at that rate until equilibrium of the interface was obtained. The pumping rate was increased in increments allowing equilibrium to be reached at each increment until the maximum continuous rate was obtained. Pumping stopped when the free surface was pulled to the top of the gallery or when salt water was pumped into the gallery.

The locations of the free surface and interface were recorded for each pumping rate. The maximum safe pumping rate was related to the rainfall and island conditions and characteristics. All the data are presented graphically in dimensionless form to make them applicable to a wide variety of conditions as well as in tabular and graphical form with dimensions to facilitate their use. Several examples are also included.

The laboratory tests showed that the Hele-Shaw model is a very satisfactory analog to predict the location of the fresh water-salt water interface for a variety of conditions. It was determined that increased pumping rates are possible when a horizontal gallery is located below mean sea level, but the risk of salt water intrusion is greatly increased. A maximum safe pumping rate of at least 50 percent of the recharge parameter after subtracting known losses can be expected from a gallery located at mean sea level.

Report No. 65: <u>Phosphorus and Eutrophication in the Pamlic River Estuary, North Carolina, 1966-1969: A Summary</u>

by

Dr. B. J. Copeland and Dr. John E. Hobbie
Department of Zoology, N.C.S.U. at Raleigh

This report summarizes findings of a three-year study initiated to measure the effects of phosphorus on the ecology of the Pamlico River Estuary. Earlier reports for the project were:

No. 33: Phosphorus Concentrations in the Pamlico River Estuary of North Carolina
No. 39: Hydrography of the Pamlico River Estuary
No. 56: Phytoplankton Species and Populations in the Pamlico River Estuary

The Pamlico River Estuary is typically oligo- to mesohaline; tidal influence is minimal and the estuary occasionally stratifies. This stratification is easily destroyed by winds. During summer stratification, anaerobic conditions develop near the bottom muds. The estuary is already rich in phosphorus, and concentrations are increasing via land runoff and mining wastes. Much of the incoming phosphorus is accumulated in the bottom sediments.

The dinoflagellate, <u>Peridinium triquetrum</u>, dominates a large phytoplankton bloom that develops during the winter, apparently in response to nitrogen buildups. The annual cycle of phytoplankton numbers and biomass in the Pamlico River Estuary is similar to that found in other similar east-coast estuaries.

Experimentation revealed that mud would remove significant amounts of dissolved reactive phosphorus from the water column. There was a release of phosphorus from the mud under low oxygen conditions. High concentrations of phosphorus in clay-silt sediments increased the unfavorableness of the substrate for growth and survival of Rangia clams. The clams utilized organic matter and phosphorus from the sediments.

Limiting nutrient experiments revealed that phosphorus additions did not cause increased carbon uptake; whereas, nitrogen additions resulted in significant increases. Nitrogen, therefore, is the limiting major nutrient in the Pamlico River Estuary. Although no direct effects of slime pond wastes on the estuary could be detected, luxury uptake of phosphorus by phytoplankton and changes in phytoplankton speciation (increased blue-green algae) were experimentally observed.

ACTIONS OF ADVISORY COMMITTEE

The Institute Advisory Committee held its annual meeting in Raleigh on March 21, 1972. Following review and discussion of the present and proposed programs, the Committee unanimously adopted the following resolutions concerning research application and communication between university researchers and research users:

RESOLUTION ON RESEARCH APPLICATION

WHEREAS the application of research findings will have a direct influence upon the ability of state and federal agencies and others to meet their overall objectives in water resource areas; and

WHEREAS the speed and the effectiveness with which new research is used and research needs are identified are important to the total water resource programs in the State; and

WHEREAS one of the purposes of the Institute's program is to seek application of research findings found to be relevant to problems in North Carolina; and

NOW, THEREFORE BE IT RESOLVED that the Advisory Committee reaffirms its support of the Institute in its program for encouraging research application and its efforts to seek resources toward that end.

RESOLUTION ON COMMUNICATION BETWEEN INVESTIGATORS AND STATE AGENCIES

WHEREAS the research program of the Water Resources Research Institute is directed toward the water resource problems of North Carolina; and

WHEREAS communication between research users and investigators is essential to the definition of problems, research needs, and utilization of research findings; and

WHEREAS closer communication between investigators and user-group personnel can enrich the data and informational base available to research, facilitate the application of research findings, and contribute to an upgrading of skills utilized in the planning and management of North Carolina's water resources; and

NOW, THEREFORE BE IT RESOLVED that the Institute and State agencies receive additional encouragement to maintain viable communication with regard to water resource problems and related research of mutual interest; and

BE IT FURTHER RESOLVED that provision be made for periodic reviews of research in progress with applicable State agency and other user-group personnel. Such reviews should be scheduled at times appropriate for reporting on major stages of work completed. In general, however, the frequency of such periodic reviews should be no less than once every year and at completion of research projects.

Dr. Arthur W. Cooper, Assistant Secretary, North Carolina Department of Natural and Economic Resources, addressed the committee luncheon on the topic, "Significance of Environmental Impact Legislation to North Carolina."

"The requirement for writing an environmental impact statement," said Cooper, "can force an agency into a clearer articulation of its reasons for proposing an action and the goals it has set for a project. The statements, he said, can "provide an organized method for public disclosure of many of the relevant facts surrounding proposed agency actions. The failure of full public disclosure is . . . one of the major problems that has spurred the environmental activism of the past few years." "If there is one clear inference that we can draw from the litigation and agitation of the recent past, it is that the traditional interagency review and consultation is utterly inadequate as a tool for providing input from the various groups with interests in proposed environmental actions."

Cooper said that the weakest single feature of the impact statements prepared to date is their failure to adequately deal with the assessment of alternatives to proposed actions.

NEW WATER COMMISSION REPORTS

The National Water Commission has announced the availability of the following reports:

"Authorization of Federal Water Projects" (PB 206 096 @ $6.75)
"Forecasting Water Demands" (PB 206 491 @ $6)
"The Choice of Institutional Arrangements for Water Resource Development" (PB 207 314 @ $9)

The first report was prepared as a part of the Commission's legal study program under a contract with Northcutt Ely, an attorney in private practice in Washington, D. C. Its purpose is to provide background information for consideration of possible improvements in the procedures for authorization of Federal water projects. The report identifies the major Federal agencies involved in construction of water resource projects and examines the process by which projects come into being from the point of initial conception, through planning and review, to construction, including the role of the Office of Management and Budget and procedures used by Congress in authorizing water resource projects. It discusses review procedures of the Fish and Wildlife Service and Bureau of Outdoor Recreation. It also examines the procedures of the primary agencies administering grant and loan programs for water resource development. Among the report's recommendations is one for a proceeding to be developed to provide a "day in court" early in the authorization process for potential opponents of a project.

The purpose of the second report is to show the effects of changes in policy and technology on the demands for water. In ordering preparation of the report, the Commission rejected the premise that there are "requirements" for more than minimal amounts of water needed for human survival, and called for consideration of water as a commodity, the supply of and demand for which will be influenced in the future by economic factors. The Report describes economic models which enable forecasts to be made of demands for water for agriculture, steam-electric power generation, petroleum refining, and residential use. Through use of a model developed by Wollman Bonem, alternative forecasts of relative levels of withdrawals and losses of water in agriculture, mining, manufacturing, power plant cooling, and municipal purposes, as well as use of water for waste disposal, are presented for the years 1980, 2000, and 2020. Emphasis is on rationale and methodology of forecasting demands for water and on the directions of possible trends, rather than on absolute numerical values. The report was prepared by the Forecasting Unit of the Commission's staff.

The purpose of the third report is to examine and clarify the institutions which have developed to support the American water industry. This includes the elements that have entered into the development of the American water industry, with special reference to the California water industry. A variety of public and private enterprises engaged in water resource development and the rendering of water services are analyzed and evaluated in terms of the theory of organization used by public administration and administrative analysts, and the concepts of political economists. The level of productivity of the American water industry is examined as a consequence of opportunities for public entrepreneurship afforded by a system of overlapping jurisdictions and fragmentation of authority. The report sets forth problems in the assessment of organizational arrangements, examines the terms and conditions of political choice, and reviews the choice of institutional arrangements in the development of California water industry. An assessment is presented of alternative approaches to policy problems in water resource development. The report was prepared by Dr. Vincent Ostrom of Indiana University.

All three reports may be ordered from the National Technical Information Service, 5285 Port Royal Road, Springfield, Virginia 22151.

NEW WATER POLLUTION FILMS

The Environmental Protection Agency has announced the availability of the following two new color films on advanced waste treatment:

"Somebody Round Here is Doing Something Good" - 20 min.
(Richardson, Texas story)

"Fresh Water from Wastewater" - 15 min.
(Lake Tahoe Story)

Both films can be borrowed from EPA's Technology Transfer Program, 1421 Peachtree Street, NE, Atlanta, Georgia 30309.

STATUS OF STREAMS AND GROUND WATER IN NORTH CAROLINA - MARCH

Streamflow was near normal in the western Piedmont and below normal in the remainder of the State.

Ground water levels rose in the mountains and eastern Piedmont, fell in the western Piedmont and Coastal Plain, and generally remained above average.

——— U.S. Geological Survey

WATER RESOURCES LEGISLATION IN THE CONGRESS

New Public Laws:

Senate

S. 3122 — Authorizing funds for the extension of activities under the Federal Water Pollution Control Act through June 30, 1972. Signed March 1, 1972 (PL 92-240).

Bills Passed:

House

H.R. 11896 — To amend the Federal Water Pollution Control Act, with amendments.

Bills Introduced:

Senate

S. 3274
H.R. 13523 — To authorize the Secretary of Interior to engage in feasibility investigations of certain water resource development proposals.

S. 3330 — To establish a national policy for the management, conservation, use, and development of the Nation's natural resources, to provide for the establishment of a Board on Natural Resources Planning and Policy.

S. 3449 — To authorize and direct the Water Resources Council to coordinate a national program to insure the safety of dams and other water storage and control structures, to provide technical support to State programs for the licensing and inspection of such structures, to encourage adequate State safety laws and methods of implementation thereof; and for other purposes.

House

H.R. 13568 To assure protection of environmental values while facilitating construction of needed electric power supply facilities.

H.R. 13768 To establish policy and principles for planning the use of the water and related land resources of the U.S.

H.R. 13884 To establish a commission to investigate and study the practice of clear cutting of timber resources of the U.S. on Federal lands.

H.R. 14106 To amend the Water Resources Planning Act to authorize increased appropriations.

H.R. 14205 To provide for the establishment of the Great Dismal Swamp National Monument in the States of Virginia and North Carolina.

NEW PUBLICATIONS RECEIVED BY THE INSTITUTE

(Residents of North Carolina may borrow these from the Institute for a two-week period. Where individual copies are desired, readers are encouraged to request copies from the organizations issuing the publication. The addresses are provided by the News for this purpose.)

Water Resources Planning

"East Canyon Dam--Technical Record of Design and Construction," by USDI, Bur. of Reclam. USGPO, Wash., DC 20402, Price $4.10, Dec. 1971.

"A Computer Simulation Model for Flood Plain Development - Part 1: Land Use Planning and Benefit Evaluation," (IWR Rpt. 72-1) by Intasa for U.S. Army Engineer Inst. for Water Res., avail. from NTIS, Springfield, Va. 22151.

"Chippewa Flowage Investigation," (Prog. Rpt.) by Inland Lakes Demonstration Project, Univ. of Wisc. & Wisc. Dept. Nat'l. Res., 215 N. Brooks St., Madison, Wi. 53706, Feb. 1972.

"Local Water Agencies, Communication Patterns, and the Planning Process," (Rpt. 27) by D. W. Hill, et al, Env. Res. Center, CSU, Fort Collins, Co. 80521, Sept. 1971.

"Identification of Urban Watershed Units Using Remote Multispectral Sensing," (Rpt. 29) by R. R. Root, et al, Env. Res. Center, CSU, Fort Collins, Co. 80521, June 1971.

"Charles River: An Urban River in its Changing Social Contexts," (Pub. No. 23), J. W. Sinton, WRRC, U. of Mass., Amherst, Mass. 01002.

"Proceedings, Water Resources Planning Conference," R. I. WRC, U. of R. I., Kingston, R. I. 02881, Nov. 4-5, 1969.

"A Case Study in the Formulation of Water Resources Management Plan," by M. Gardner, III, et al, WRRI, Miss. St. U., State College, Miss. 39762, 1972.

"The Relationship Between Housing and Water Resources Planning and Management," (Final Rpt.) for OWRR by Urban Sys. Res. & Engr., Inc., 1218 Mass. Ave., Cambridge, Ma. 02138, Mar. 1972.

"Water Resources Planning and Social Goals: Conceptualization Toward a New Methodology," (Pub. PRWG-94-1) Utah St. Univ., Logan, Ut. 84321, Sept. 1971.

Water Quality Management

"Neutradesulfating Treatment Process for Acid Mine Drainage," (WPC Res. Ser. ORD 14010 DYH) by Catalytic, Inc., for EPA, USGPO, Wash., DC 20402, Price $1, Dec. 1971.

"Electrochemical Treatment of Acid Mine Waters," (WPC Res. Ser. 14010 FNQ), by Tyco Lab, Inc., for EPA, USGPO, Wash., DC 20402, Price $1, Feb. 1972.

"Induced Aeration of Small Mountain Lakes," (WPC Res. Ser. 16080) by R. S. Kerr Water Res. Center for EPA, USGPO, Wash., DC 20402, Price 65¢, Nov. 1970.

"Supplementary Aeration of Lagoons in Rigorous Climate Areas," WPC Res. Ser. 17050 DVO), by R. L. Champlin for EPA, USGPO, Wash., DC 20402, Price 75¢, Oct. 1971.

"Biological Survey of Stream of Coles County, Illinois, 1967-1970," (WPC Res. Ser. 18050 DZZ), by Eastern Ill. Univ. for EPA, USGPO, Wash., DC 20402, Price $1.25, June 1971.

"Brass Wire Mill Process Changes and Waste Abatement, Recovery and Reuse," (WPC Res. Ser. 12010 DPT) by Volco Brass & Copper Co. for EPA, USGPO, Wash., DC 20402, Price 55¢, Nov. 1971.

"Improving Granular Carbon Treatment," (WPC Res. Ser. 17020 GDN) by FMC Corp. for EPA, USGPO, Wash., DC 20402, Price $1, July 1971.

"Color Removal from Kraft Pulping Effluent by Lime Addition," (WPC Res. Ser. 12040 ENC) by Inter-State Paper Corp. for EPA, USGPO, Wash., DC 20402, Price $1.25, Dec. 1971.

"Combined Cooling and Bio-Treatment of Beet-Sugar Factory Condenser Water Effluent," by G.O.G. Löf, et al, Env. Res. Center, CSU, Fort Collins, Co. 80521, June 1971.

Corps of Engineers Regional Wastewater Management Studies

"Regional Wastewater Management Systems for the Chicago Metropolitan Area," (Summary Rpt.) by Off. of Chief of Eng., Dept. of Army, USGPO, Wash., DC 20402, Mar. 1972.

"Alternatives for Managing Wastewater in Chicago-South End Lake Michigan Area., (Summary Rpt. & Appendices), U.S. Army Corps of Engrs., 219 South Dearborn St., Chicago, Il. 60604, July 1971.

"Alternatives for Managing Wastewater for Southeastern Michigan," (Summary Rpt. & Appendices), U.S. Army Corps of Engrs., Detroit, Mich. 48233, July 1971.

"Alternatives for Managing Wastewater in the San Francisco Bay and Sacramento-San Joaquin Delta Area," (Summary Rpt. & Appendices), U.S. Army Corps of Engrs., San Francisco, Ca. 94101, July 1971.

"Alternatives for Managing Wastewater for Cleveland-Akron Metropolitan and Three Rivers Watershed Areas," (Appendices I, II, III and Summary Rpt.) U.S. Army Corps of Engrs., Buffalo District, Buffalo, Ohio 43722, July 1971.

"The Merrimack: Designs for a Clean River," (Publications as listed below) U.S. Army Corps of Engrs., New England Div.

"Alternatives for Managing Wastewater in the Merrimack River Basin," Sept. 1971
"Consultant's Land and Water Disposal Assessments," (Annex A), Aug. 1971
"Consultant's Impact Assessment," (Annex B), Aug. 1971
"Introduction, Study Area Today and Study Area Tomorrow (To 2020)," (Appendix I & II), Aug. 1971
"Development of Alternatives (Plan Formulation)," (Appendix III), Aug. 1971
"Assessment of Impacts of Selected Alternatives," (Appendix IV & V), Aug. 1971

"Further Studies of Optimum Operation of Desalting Plants as a Supplemental Source of Firm Yield," (PRWG 82-1), by C. G. Clyde, et al, Utah Water Res. Lab., Utah St. Univ., Logan, Ut. 84321, May 1971.

"Control of Erosion and Sediment Deposition from Construction of Highways and Land Development," by EPA, Off. of Water Prog., USGPO, Wash., DC 20402, Price 60¢, Sept. 1971.

"Eutrophication of Surface Waters - Lake Tahoe," (WPC Res. Ser. 16010 DSW) by Lake Tahoe Area Council for EPA, USGPO, Wash., DC 20402, Price $1.25, May 1971.

"Growth and Movement of Fishes and Distribution of Invertebrates Related to Heated Discharge into White River at Petersburg, Indiana," (Inv. Rpt. 5) by M. A. Profitt, et al, Indiana Univ., WRRC, Bloomington, In. 47401, Dec. 1971.

"Joint Treatment of Municipal Sewage and Pulp Mill Effluents," (WPC Res. Ser. 12130 EDX) by Green Bay Metropolitan Sewerage Dist. for EPA, USGPO, Wash., DC 20402, Price $6, July 1970.

"Deep Tunnels in Hard Rock," (WPC Res. Ser) by Univ. of Wisc. for EPA, USGPO, Wash., DC 20402, Price $1.75, Nov. 1970. (Land Runoff)

"Studies on Effects of Watershed Practices on Streams," (WPC Res. Ser. 13010 EGA) by Oregon St. Univ., Sch. of For. for EPA, Pub. Branch (Water), Res. Inf. Div., R&M, EPA, Wash., DC 20460, Feb. 1971. (Land Runoff)

"Mine Spoil Potentials for Water Quality and Controlled Erosion," (WPC Res. Ser. 14010 EJE) by W. Va. Univ. Div. of Plant Sci. for EPA, Pub. Branch (Water), Res. Infor. Div., R&M, EPA, Wash., DC 20460, Dec. 1971.

"Interaction of Nitrilotriacetic Acid With Suspended and Bottom Material," (WPC Res. Ser. 16020 GFR) by Nat'l. Bur. of Standards for EPA, USGPO, Wash., DC 20402, Price 45¢, July 1971.

"Fluid Product Pipeline Leak Detection from Airborne Platforms," (WPC Res. Ser. 16020 FQT) by Res. Tech. Corp. for EPA, USGPO, Wash., DC 20402, Price $1, Dec. 1970.

"Soluble Phosphorus in the Activated Sludge Process: Part I - Chemical-Biological Process Performance (WPC Res. Ser. 17010 EIP) by the Soap & Detergent Assoc. for EPA, USGPO, Wash., DC 20402, Price $1.25, May 1971.

"Slime Growth Evaluation of Treated Pulp Mill Waste," (WPC Res. Ser. 12040 DLQ), by Oregon St. Univ., Dept. of Microbiology for EPA, USGPO, Wash., DC 20402, Price 60¢, Aug. 1971.

"Alternatives to Secondary Sewage Treatment Offer Greater Improvements in Missouri River Water Quality," EPA Report to Congress by Compt. Gen. of the US, Wash., DC 20548, Jan. 1972.

"Design Guides for Biological Wastewater Treatment Processes," (WPC Res. Ser. 11010 ESQ), by City of Austin, Texas, & Center for Res. in Water Res. for EPA, USGPO, Wash, DC 20402, Price $1.75, Aug. 1971.

"Feasibility Study of Regenerative Fibers for Water Pollution Control," (WPC Res. Ser. 17040 DFC), Pub. Branch (Water), Res. Infor. Div., R&M, EPA, Wash., DC 20460, Oct. 1971.

"Analysis of Water Reuse Alternatives in an Integrated Urban and Agricultural Area," by A. B. Bishop, et al, Utah Water Res. Lab., Utah St. Univ., Logan, Ut. 84321, Sept. 1971.

"Use of Air-Water Relationships for Predicting Water Temperature," by V. Kothandaraman, et al, (Inv. Rpt. 69), Il. St. Dept. of Registration & Educ., Il. St. Water Survey, Urbana, Il. 61801, 1972.

Water Quantity Management

"Global Atlas of Relative Cloud Cover 1967-70," by USAF & U.S. Dept. of Comm., Wash., DC 20013, Sept. 1971.

"A Review of the Stochastic Approach to Flow Through Porous Media," by L. Torelli, et al, U. of Il. at Urbana-Champaign, Urbana, Il. 61801, May 31-June 2, 1971.

"Hydrologic Inventory of the Great Salt Lake Desert Area," (PRWG 40-7), by G. L. Foote, et al, Utah Water Res. Lab., Utah St. Univ., Logan, Ut. 84321, Nov. 1971.

"Contour Trenching Effects on Streamflow from a Utah Watershed," (Res. Paper INT-95), by R. D. Doty, Intermountain Forest & Range Exper. Sta., Forest Ser., USDA, Ogden, Ut. 84401, May 1971.

Miscellaneous

"Annual Report," WRRI, State of N. Y., Cornell Univ. Water Res. & Marine Sci. Cntr., Ithaca, N. Y. 14850, July 1971.

"Annual Report 1971," Resources for the Future, Inc., 1755 Mass. Ave., NW, Wash., DC 20036, Sept. 1971.

"Publications of the Utah Water Research Laboratory," Utah Water Res. Lab., Utah St. Univ., Logan, Ut. 84321, Nov. 1971.

"The Public Service Function of Institutions of Higher Education in the Georgia-Carolinas Region," by E. W. Jones, Univ. Ext., NCSU, Raleigh, NC 27607, Feb. 1971.

"The Role and Relevance of University Water Research," Universities Council on Water Resources, Proc. of Conf. held Aug. 2-4, 1971, Corvallis, Or. 97330.

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