PROCEEDINGS

Incodel Annual Conference
Pocono Manor, Pennsylvania
October 15-16,1962

THE INTERSTATE COMMISSION ON THE DELAWARE RIVER BASIN

PROCEEDINGS

INCODEL ANNUAL CONFERENCE

POCONO MANOR, PENNSYLVANIA

October 15-16, 1962

C O N T E N T S

FOREWORD

A Delaware River Basin Water Resources Conference was held at Pocono Manor Inn, Pocono Manor, Pennsylvania on October 15-16, 1962. The Conference was jointly sponsored by Incodel, the Delaware River Basin Commission and the Water Resources Association of the Delaware River Basin.

Attending the Conference were about 250 federal, state and local governmental officials and representatives of industrial, business and civic associations.

These Proceedings include a copy of (1) Program for the Conference; (2) each of the reports, either as prepared in advance or recorded, as given in their order at the Conference session; (3) and a Registration List.

PROGRAM

DELAWARE RIVER BASIN WATER RESOURCES CONFERENCE

Pocono Manor Inn, Pocono Manor, Pennsylvania
Monday-Tuesday, October 15-16, 1962
Jointly Sponsored By
Interstate Commission on the Delaware River Basin
Delaware River Basin Commission
Water Resources Association of the Delaware River Basin

MONDAY FORENOON, OCTOBER 15, 1962

10:00 A.M. - WELCOME AND OPENING REMARKS
- Charles R. Bensinger, President, Water Resources Association of the Delaware River Basin

DELAWARE RIVER BASIN WATER POLLUTION CONTROL PROGRAMS
- George A. Elias, Regional Sanitary Engineer Region VII, Pennsylvania Department of Health, presiding

10:15 A.M. - THE INCODEL PROGRAM
- John Boardman, Engineer, Interstate Commission on the Delaware River Basin

10:30 A.M. - LEHIGH UNIVERSITY RESEARCH PROJECTS
- Basil W. Parker, Head, Department of Biology Lehigh University

10:45 A.M. - DELAWARE WATER POLLUTION COMMISSION PROJECTS
- Harold L. Jacobs, Chairman, Delaware Water Pollution Commission

11:00 A.M. - U.S. GEOLOGICAL SURVEY - CITY OF PHILADELPHIA PROJECT
- Norman H. Beamer, District Director, Quality of Water Branch, U.S. Geological Survey

11:15 A.M. - U.S. PUBLIC HEALTH SERVICE TIDAL ESTUARY STUDY
- Earl J. Anderson, Project Director, Delaware Estuary Study, U.S. Public Health Service

11:30 A.M. - ECONOMIC CRITERIA FOR DESIGN OF REGIONAL WASTE DISPOSAL SYSTEMS
- Allen V. Kneese, Research Associate, Resources For The Future

11:50 A.M. - GENERAL DISCUSSION

MONDAY AFTERNOON, OCTOBER 15, 1962

DELAWARE RIVER BASIN COMMISSION'S COMPREHENSIVE PLAN
- James Kerney, Jr., Member of Incodel and formerly Executive Vice President, Water Research Foundation for the Delaware River Basin, presiding.

2:30 P.M. - EVOLUTION OF THE COMPREHENSIVE PLAN
- Herbert A. Howlett, Chief of Planning, Delaware River Basin Commission

3:00 P.M. - STATUS OF MAJOR MULTIPLE PURPOSE PROJECTS
- Col. T. H. Setliffe, Engineer, Philadelphia District, U. S. Army Engineers

3:20 P.M. - WATERSHED PROTECTION AND FLOOD PREVENTION PROJECTS
- Alvin C. Watson, United States Soil Conservation Service

3:30 P.M. - NEW TECHNIQUES FOR RELATING ECONOMIC OBJECTIVES,
- ENGINEERING ANALYSES AND GOVERNMENTAL PLANNING IN
- DESIGN OF WATER RESOURCES SYSTEMS
- Maynard M. Hufschmidt, Director, Harvard Water Program, Graduate School of Public Administration, Harvard University

4:00 P.M. - GENERAL DISCUSSION

MONDAY EVENING, OCTOBER 15, 1962

6:30 P.M. - SOCIAL HOUR

7:30 P.M. - CONFERENCE BANQUET - Sen. Elisha T. Barrett,
- Chairman, N.Y. State Joint Legislative Committee on Interstate Cooperation, Master of Ceremonies.

- THE DELAWARE RIVER BASIN IN THE YEAR 2000
- Hon. Maurice K. Goddard, Alternate Pennsylvania Member, Delaware River Basin Commission and Member of Incodel

TUESDAY MORNING, OCTOBER 16, 1962

REGIONAL AND LOCAL AGENCY WATER RESOURCES PROGRAMS

- James H. Allen, Executive Secretary, Interstate Commission on the Delaware River Basin, presiding

10:00 A.M. - THE BRANDYWINE VALLEY PLAN
- Clayton M. Hoff, Executive Vice President, Brandywine Valley Association

10:15 A.M. - NESHAMINY VALLEY PROGRAM
- John T. Carson, Jr., President, Neshaminy Valley Watershed Association

10:30 A.M. - WISSAHICKON VALLEY PROGRAM
- Paul M. Felton, Executive Director, Wissahickon Valley Watershed Association

10:45 A.M. - BUCKS COUNTY MASTER PLAN FOR WATER AND SEWERAGE FACILITIES
- Franklin C. Wood, Executive Director, Bucks County Planning Commission

11:00 A.M. - MONTGOMERY COUNTY WATER SUPPLY PLAN
- Arthur F. Loeben, Executive Director, Montgomery County Planning Commission

11:15 A.M. - REGIONAL SEWERAGE PROGRAM - PHILADELPHIA METROPOLITAN AREA
- Morton Lustig, Fels Institute of Local and State Government, University of Pennsylvania

11:30 A.M. - GENERAL DISCUSSION

12:30 P.M. - CONFERENCE LUNCHEON
- Charles R. Bensinger, President, Water Resources Association of the Delaware River Basin, presiding.

- INCODEL - A SALUTE TO THE PAST AND PRESENT
- Francis A. Pitkin, Chairman, Interstate Commission on the Delaware River Basin

- ORGANIZATION AND PROGRAMS OF DELAWARE RIVER BASIN COMMISSION
- James F. Wright, Executive Director, Delaware River Basin Commission

2:00 P.M. - CONFERENCE ADJOURNMENT

THE INTERSTATE COMMISSION ON THE DELAWARE RIVER BASIN

THE INCODEL PROGRAM

John Boardman, Engineer
Interstate Commission on the Delaware River Basin

October 15, 1962

THE INCODEL PROGRAM

by

John Boardman, Engineer
Interstate Commission on the Delaware River Basin

It is a pleasure to open this session on the Delaware River Basin Water Pollution Control Programs with a report on The Incodel Plan.

You will note from the schedule for this session that there are now a number of agencies, governmental and private, which are engaged in water pollution control activities. This is a marked contrast to the situation which existed a quarter of a century ago when Incodel came into existence in 1937. At that time stream quality was practically the sole responsibility of the State Health Departments.

One of the primary reasons for the formation of Incodel by the four states' legislatures was to create an agency which could bring together the administrative forces of the four States' Health Departments to formulate and execute a co-ordinated program for abating the pollution of the Interstate Delaware River and its tributaries.

Only a few of Incodel's old timers will remember how five men; Jim Allen, then engineer for Incodel, Charlie Holmquist, Chief Engineer, New York State Department of Health, Uncle Ted Moses, Chief Engineer, Pennsylvania Sanitary Water Board, Harry Croft, Chief Engineer, New Jersey Department of Health and Dick Beckett, Chief Engineer of the Delaware State Department of Health and a member of Incodel met in Philadelphia one or two days a month for two years to develop the Incodel Plan for the control of pollution in the Delaware River and the tributaries at their confluence with the Delaware.

The Incodel program was adopted by the administrative agencies of the four states in 1939 and subsequently was enacted into law as a Reciprocal Agreement by the legislatures of the states.

Briefly, the program divides the Delaware River Basin into four water pollution control zones. Zone 1 extends from the New York - Pennsylvania boundary line to the head of tide at Trenton. Zone 2 is that part of the River from Trenton to the mouth of Pennypack Creek in Philadelphia and a corresponding point in New Jersey. Zone 3 extends from Pennypack Creek to the Pennsylvania - Delaware boundary line and Zone 4 is that section of the River extending from the Pennsylvania-Delaware boundary to the Atlantic Ocean.

The Reciprocal Agreement embodying the Incodel Plan describes each zone and states what the principal uses of their waters are expected to be. The Agreement stipulates that no sewage, industrial waste or other polluting matter shall be discharged into any zone unless it has been so treated as to produce an effluent which will meet the minimum standards for such zone which are specified in the Agreement.

The program is administered in each state by the water pollution control agency of that state. Such agency may require higher standards than the standards which, it should be stressed, apply only to the interstate Delaware River. The states, however, under the terms of the Incodel plan, also agreed to require sewage, industrial waste and other polluting material, which are discharged into the waters of any intrastate tributary, to be treated to such degree as may be necessary to maintain a satisfactory quality of the waters of such tributary.

Although zoning had been used by municipalities for many years previously for controlling land use and buildings the zoning of the Delaware River Basin was probably the first instance in this country of zoning an entire watershed. The minimum standards applicable to each zone have proved to be very effective in controlling many types of pollution and protecting the water quality in the respective zones.

From the time of the adoption of the Incodel program in 1939 until our entrance into the second world war on December 7, 1941 substantial progress

in interstate pollution abatement had been made. But, as a result of the war effort industrial processes changed, materials and manpower scheduled for waste treatment plants were diverted to war production. Many new and untreated waste discharges were added to the already overtaxed Delaware River and its tributaries in the Philadelphia-Camden metropolitan area which resulted in a critical pollution problem in the region.

Just to give you a couple of examples of the situation as it then existed, we at Incodel recall an article which appeared in the Reader's Digest that referred to the Delaware as a "Dying River". We recall too, the column in the press captioned, "And Then, There is The Delaware" in which the author, Bill Wolf, referred to the Delaware between Philadelphia and Camden as "a fetid, malodorous body of sewage in which no life can exist - - - " And, finally, we remember that President Franklin D. Roosevelt, on October 17, 1941, almost exactly 21 years ago, described the situation as "a stench in the nostrils" and ordered an investigation to determine whether the pollution problem in the Delaware River constituted a threat to the nation's defense program.

Since its adoption, the Incodel program has been prosecuted diligently and harmoniously by the respective administrative agencies. As evidence of the success of this method of operation, I am pleased to inform you that the sewage from 95 percent of the population served by public sewerage systems is now processed in treatment plants. Almost all of these plants fully comply with or exceed the requirements of the Incodel basin-wide water pollution control plan. A few require extensions and improvements.

This is a strikingly different situation from the one which existed when Incodel embarked upon its program. At that time about 90 percent of the sewage from sewered communities was discharged in its raw state into the Delaware and its tributaries.

Comparable progress in the execution of the Incodel plan has been made in the handling of industrial wastes.

As the result of these pollution abatement activities the water quality in the river has improved considerably. There are no acutely polluted areas. Shad and other migratory fish have returned to the river in huge numbers and the use of the river for recreational purposes is increasing materially.

It must be said, however, that despite the fact that the State's Health Departments have required a higher degree of treatment of wastes discharged into zone 3 than the Incodel minimum requirements, all the improvement that was originally anticipated has not been accomplished due to the greatly increased amount of treated waste now being introduced into the River. There is still considerable work to be done.

Thus far I have described for you the basic elements of the Incodel plan. When an action program for implementing this plan was clearly underway, Incodel turned its attention to other phases of water pollution control. In this connection it spearheaded the efforts which led to the adoption in 1948 of the U. S. Geological Survey-City of Philadelphia cooperative program for the measurement of the quality of water in the tidal estuary which Norman Beamer will explain. Similarly, Incodel has participated wholeheartedly in the programs of the U. S. Public Health Service since they were first authorized under the terms of the 1948 Federal Water Pollution Control Act. Earl Anderson will discuss their Delaware Estuary Survey later in this program. Incodel has used a part of the federal grant for the extension of its water pollution activities to undertake the research programs being conducted by the Institute of Research of Lehigh University which Dr. Parker will discuss.

Incodel has also worked closely with the Delaware Water Pollution Commission since 1956 in the prosecution of its projects regarding the dispersion and assimilation of polluting material in the tidal estuary. The chairman of the Commission, Harold L. Jacobs, will inform you of these activities.

In the light of the record it is generally agreed that the programs for control of pollution in the waters of the Delaware River Basin have been effectively executed. Admittedly, there is now a need to re-appraise current activities in the light of recent developments, particularly the creation of the Delaware River Basin Commission under the terms of the compact between the Delaware Basin states and the U. S. Government.

We of Incodel are delighted that we have built a solid foundation upon which the new Commission can carry out its functions in the field of water pollution control.

THE INTERSTATE COMMISSION ON THE DELAWARE RIVER BASIN

LEHIGH UNIVERSITY RESEARCH PROJECTS

Basil W. Parker, Head
Department of Biology Lehigh University

October 15, 1962

REPORT TO THE INTERSTATE COMMISSION ON THE DELAWARE RIVER BASIN LEHIGH UNIVERSITY RESEARCH PROJECTS DEPARTMENT OF BIOLOGY THE INSTITUTE OF RESEARCH

B. W. Parker
Lehigh University Institute of Research

Since March, 1957, the Interstate Commission on the Delaware River Basin has sponsored two research projects in The Institute of Research and the Department of Biology at Lehigh University. Our last report at the annual Incodel meeting was presented at Pocono Manor in October, 1960. The continued support by Incodel of these projects has provided financial assistance to nine graduate students in biology in formal academic work and field experience. Four faculty members in biology and two members in chemistry also participated.

I. Neutralization of Acid Waters

There are many bodies of water in the Delaware Basin which are naturally acid and low in dissolved minerals. This is primarily due to the limited release of minerals from rock formations. In addition, the vegetation is in large measure made up of acid tolerant plants as, for example, Rhododendron, Blueberries, Azalea and Laurels. The slow decomposition of these plants aids in the development of a soil-humus complex which maintains an acid reaction. Also, there is bog formation in shallow ponds which progressively reduces the water area. These conditions restrict or prevent the growth of many desirable plants and animals in the aquatic environment. It has long been known that additions of mineral fertilizers will alleviate these undesirable conditions and that there will be an increase in the diversity and numbers of organisms. Except in special circumstances, the use of fertilizers is prohibitively expensive. Our studies were initiated when it was observed that the addition of cement stack dust to a naturally acid lake resulted in

partial neutralization and a substantial increase in over-all biological productivity.

Stack dust is a waste product of the cement industry and more than three thousand tons of this waste is produced daily in the cement manufacturing areas of the Lehigh Valley. In the past five years we have used more than 3000 tons and have paid only for transportation costs. The material contains about 30% of alkaline compounds. Also present are small amounts of several mineral elements derived from the original limestone.

In order to determine the amount of stack dust required, we set up systems containing mud and water from Deep Lake in the Poconos. About 1/150 of a pound of stack dust was needed to neutralize a gallon of the mixture.

A detailed chemical and biological study of Deep Lake was then made. The findings showed clearly that, aside from oxygen concentration that the aquatic environment was very poor. Perch taken from this lake were about four inches in length even when six years old. It should be noted that inadequate minerals in this pond prevented the abundant development of microscopic green plants which serve as food supply for small animals as, for example, insects which are in turn eaten by fish. Thus the development of a "food chain" was restricted at its base.

In late June, 1958, about four tons of stack dust were applied over most of the area of this 8-acre lake. After a few days the water was found to be near neutrality and showed a substantial increase in dissolved minerals. For the next five months the lake was sampled at regular intervals. There was a progressive increase in biological activity. In particular the green microscopic plants and the microscopic animals increased over threefold. Similar additions of stack dust were made during the spring and summer of 1959 through 1961. Sampling showed a sustained favorable condition and the lake was successfully stocked with trout.

Similar findings were made in another 8-acre lake and the results are set forth in our detailed reports to Incodel.

Preliminary work had shown that intermittent feeding of stack dust to a naturally acid brook would yield suitable neutralization and improved mineralization. Our prime objective was to try this on a stream contaminated with acid mine drainage and domestic sewage.

A survey of the anthracite region was made in the summer and fall of 1961. Of several possible sites we chose the Nesquehoning Creek as most suitable. This stream originates in clean upland drainage where a variety of plants and animals abound in the water. The inflow of acid mine drainage results in an almost complete cessation of biological growth. At a downstream point a series of sewage outfalls discharge into the stream. For about three miles the stream carries this double pollution load and then enters the Lehigh River. In the fall of 1961 we started design and assembly of an automatic stack dust feed system which would maintain desirable conditions independent of variable stream flow. The equipment was installed on the Nesquehoning Creek in late summer, 1962, and preliminary trials showed a variety of electronic and mechanical problems. These were slowly resolved and it is only within the last month that we have had a dependable feed system. We can, however, report that over the three miles being neutralized that there is an evident increase in biological activity which we hope will contribute to stabilization of wastes and provide a favorable environment for fish.

II. Water Quality Monitoring

Since the 1960 report at the annual Incodel meeting, considerable progress has been made in instrumental methods of water quality monitoring. In particular, with Incodel's pioneering support in this field, several instrument manufacturers have recognized the market potential and the merits of this approach to appraise water quality. In 1957 there were instruments for three

parameters diagnostic of water quality and these were developed primarily for chemical process control. At present there are instruments for automatic measurement of at least 15 water quality characteristics and there are now three instrument companies which have developed water quality monitoring systems fundamentally similar to the Lehigh-Incodel Monitor System. In each case the objectives are many; namely, to measure water quality characteristics for comparative purposes, to detect abnormal conditions, to collect suitable samples and to alert responsible officials.

The first Incodel Water Quality Monitor Station at Riegelsville, N. J., was put in operation in August, 1958. In early May, 1961, the second station, at Montague, N. J., was started. It should be noted that this station is installed on private property. We hereby acknowledge the excellent cooperation of the property owner Mr. E. R. Burt in permitting the construction and continued operation of this monitor station.

By early June, 1961, another station was in operation at the Martin's Creek steam-electric station of the Pennsylvania Power and Light Co. We are also appreciative of their many courtesies and cooperation in the completion of this station. It should be recorded that Pennsylvania Power and Light also cooperates with the United States Public Health Service in chemical analyses of the Delaware as part of the National Water Quality Network.

Each of these Incodel Monitor Stations records the values of six water quality parameters twice an hour and around the clock. These are Oxygen concentration, temperature, turbidity, specific electrical conductivity, relative acidity or alkalinity and sunlight intensity. Incodel employees maintain and check the instruments on a weekly basis.

It is of interest to report that we have developed two devices which were in the planning stage in 1960. We now have an electronic assembly which detects the start and stop of rainfall. Of greater importance is the Lehigh-

Incodel Oxygen Electrode, now tested and in commercial fabrication. This is one of the three electrodes commercially available in the United States and costs about half of the nearest equivalent electrode.

Our most recent achievement is the development of a portable monitor station, weighing 120 pounds and recording five water quality characteristics on miniature strip chart recorders. The equipment has been tested on the Delaware River at Riegelsville, on the Nesquehoning Creek during trials of the acid mine drainage neutralization mechanism and in oxygen-temperature distribution studies in a water filled slate quarry. Provision has been made so that the station will operate with a gasoline driven generator. Thus we may collect data on streams where electric power lines are not available.

One of these portable monitor stations will be tested by the Pennsylvania Sanitary Water Board and another at the Taft Sanitary Engineering Center of the United States Public Health Service.

In August, 1960, we presented a report on the Incodel Water Quality Monitor System at a technical meeting at the Taft Center in Cincinnati. This was subsequently published as is noted in the publication list of Incodel supported research.

Late in 1960 this meeting was reviewed by Mr. M. M. Cohn, Editor of Water Works Engineering. It is pertinent to quote a part of his editorial. "The day is coming when we will have to manage water quality of whole river basins, much in the same push-button manner that we now transmit and manage electrical power. Certain streams will be fully instrumented. Data will be telemetered. A central computer will turn out the finished data. Our successors will then look back to the good years of the 1960's when things were rather simple."

Publications on Cement Stack Dust Research

1. Trembley, F. J., Mihursky, J.A., and Hertz, E.W., Use of Cement Plant Stack Dust as a Neutralizing Agent in an Acid Water Lake. Transactions, New England Wildlife Conference; Montreal, 1958.

2. Mihursky, J. A., Results of a Field Application of Cement Plant Stack Dust in an Acid Water Lake. Transactions, New England Wildlife Conference, 1959.

3. Trembley, F. J., and Parker, B. W. The Use of Cement Stack Dust in the Reclamation of Mineral Deficient and Acid Waters. Fifteenth International Congress of Limnology, Madison, 1962. (In Press)

Publications on Water Quality Monitoring

1. Parker, B.W., Freeburg, J.A., and Barber, S. B., Automatic System for Monitoring Water Quality. Journal of the Sanitary Engineering Division, American Society of Civil Engineers. Paper No. 2554, SA4, vol. 86, p. 25-40, 1960.

2. Parker, B. W., and Morris, A. R., Automatic Surveillance; An Operating System. Symposium on Water Quality Measurement and Instrumentation, U. S. Public Health Service. Cincinnati, p. 165-174, 1960.

3. Parker, B.W. Automatic Analyses as Applied to Water Quality Determinations and Water Treatment. Annals of the New York Academy of Sciences, vol. 91, Art. 4, p. 909-915, 1961.

4. Parker, B. W., Discussion - - "An Electronic Monitor System for River Quality Research and Surveillance", E. J. Cleary, Ohio River Valley Sanitation Commission. The International Conference on Water Pollution Research, London, England, Sept., 1962. (In Press)

THE INTERSTATE COMMISSION ON THE DELAWARE RIVER BASIN

DELAWARE WATER POLLUTION COMMISSION PROJECTS

Harold L. Jacobs, Chairman
Delaware Water Pollution Commission

October 15, 1962

THE DELAWARE WATER POLLUTION COMMISSION PROGRAM

By
H. L. Jacobs, Chairman
Delaware Water Pollution Commission

Although the Delaware Water Pollution Commission was not created until 1949, the importance of the Delaware River to the welfare of the State of Delaware has long been recognized.

The first study was made as early as 1952. This involved the determination of iron deposition and distribution in the bottom muds of the river below the Delaware-Pennsylvania line. The reason for such a study was a request by an industry to discharge soluble iron salt to the river. A great deal of information was developed during the course of the investigation and much of it has led directly to the present concept of the river behavior.

The first comprehensive work was actually begun in 1956 when a unique method of measuring pollution of a tidal estuary was tried and proven. This method is known as the "same-slack" technique and has been adapted and modified into a successful method of study for the Delaware River by Dr. A. J. Kaplovsky, Director of the Delaware Water Pollution Commission.

The "same-slack" technique depends on samples taken at each station at exactly the same state of the tide. I'm sure all of you are aware of the fact that tidal movement in an estuary moves up and downstream in a regular manner and that the state of the tide is precisely predictable. By assessing the water quality on any given tide cycle at the same relative tidal position at all stations, the analytical results may be plotted and smooth curves will result. These plots eliminate the variable of changing water quality due to backflow and recirculation. The "same-slack" technique has been tested for a sufficient time and throughout enough sampling trips that its validity has been proven.

It became evident early in our program that it would be desirable to include water quality measurements all the way up to Trenton. The work beyond our State boundary has been carried out, therefore, in cooperation with the Water Quality Committee of Incodel. Since the distance travelled from the head of Delaware Bay to Trenton on each sampling trip is about 90 miles, and since the time difference at the extremes is only three to four hours, it is obvious that speed must be attained in excess of 25 miles per hour. In 1957, the Delaware Water Pollution Commission purchased a boat capable of accomplishing the purpose of delivering the sampling crew at each sampling station on time. This boat is 38 feet long by 11 feet in the beam and is driven by two 225 HP Chrysler motors. It is enclosed on three sides to offer adequate protection from the weather. This boat with a crew trained for fast and accurate action is responsible for the success of Dr. Kaplovsky's "same-slack" technique. Since the start of this program, a total of 80 successful series have been completed. Records have been kept of the water quality for 15 different characteristics including dissolved oxygen, BOD, solids, pH, color, turbidity and many others. These results have been made available to Incodel and to the other three states for their individual uses.

In order to obtain a better understanding of diffusion, flow and natural purification characteristics of the lower Delaware River, a series of tests were made on the model of the river constructed and maintained by the U. S. Army Corps of Engineers at Vicksburg, Mississippi. These studies were financed jointly by Incodel, the City of Philadelphia, the states of Pennsylvania, New Jersey and Delaware and by the U. S. Public Health Service. Approximately 10,000 measurements of dye releases at various stations in the model were made and the study extended over a period of nearly two years. Since 1952, over 30,000 measurements have been made on the prototype itself. All of this information has been compiled and reported. The use of an Analog Computer donated

by private industry made compilation of this tremendous mass of data possible in a relatively short space of time. Without such aids, data would outlive its usefulness before it could be catalogued and analyzed. Advantage is being taken of the data by university groups which have computer installations available.

There is no way of assessing the total cost of all of the investigations of Delaware River water quality and other characteristics in the past ten years. The State of Delaware, however, has spent in excess $300,000 in such studies. I think there is no doubt that Dr. Kaplovsky and his staff know more than any other group anywhere about what makes the Delaware River work as it does, at least in the biological sense. The job is not completed by any means and we expect to continue our work indefinitely. In particular, we are now cooperating with the study group of the U. S. Public Health Service in their five year program.

The information which has been collected by the Delaware Water Pollution Commission has been outlined in "Technical Report II, Investigation of Sanitary Water Quality in the Lower Delaware River". The report is divided into four parts covering the following general subjects: study techniques, sanitary quality of the water within the State of Delaware, the pollutional load within the State of Delaware and an extended study aimed at establishing the rate of self-purification for the entire river. Some of this information has already been published and is available on request. Nearly all of the information collected so far has been made available to all interested agencies.

Other phases of our work on water quality have not been neglected. Equipment for radiological measurement has been obtained and extensive use has been made of it in measuring background levels of river, lake and well waters as well as of milk. To date a detailed study of possible radioactivity in Delaware

River water has not been drawn up, but such a program can be carried out at any time. Our technicians have received excellent training in the use of this equipment having attended appropriate schools at the facilities maintained by the U. S. Public Health Service in Cincinnati. While this equipment is primarily for use within the State of Delaware, I am quite sure that its use can be extended, if necessary, to measurements on water samples now collected as far upstream as Trenton.

Recently the Delaware Water Pollution Commission purchased automated equipment for analytical determinations. This equipment is being evaluated and compared with standard analytical techniques with duplicate equipment installations in the laboratory and on the sampling boats. This is in line with our constant desire to improve analytical techniques and although we have used some semi-automated analytical procedures throughout the years, we have realized that there is always room for improvement. This new equipment can be set up to analyze multiple samples in a fraction of the time required by the usual standard methods and has increased our effectiveness in this regard four to five fold. For instance, the samples from a single sampling run will number from 300 - 400 and will require several weeks for complete analysis and tabulation. The automated equipment can be set up to perform an analysis for a single constituent on these multiple samples and will handle them at a rate of 30 - 40 samples per hour. Not only have we been able to increase separate analyses which can be automated to a total of 32 at this time, but the accuracy has been increased to a point where we now obtain results in parts per billion where formerly we were satisfied with parts per million. It can readily be seen how helpful such equipment can be when thousands of samples must be collected in order to evaluate water quality in a system as large as that of the Delaware River. Before we are through, it is our hope that the sampling

equipment installed on our boats can be used en route so that a great deal of the information will be available immediately following the completion of a run. If we are successful, the entire sampling program will take on new aspects since it should be possible to evaluate the effects of batch discharges and other unusual phenomena. I cite this as an example of what we are doing to keep up with new techniques and to improve the quality and extent of our river studies.

As I said before, there is a great deal of work remaining to be done. From information obtained to date, however, it is possible to make some general statements and to draw certain conclusions.

The Delaware River is a huge biological treatment plant. A tremendous amount of organic contamination is oxidized each day, particularly in the summer time. This accounts for the fact, of course, that the dissolved oxygen content of the river water is reduced below acceptable levels in certain sections of the river. Stated in other terms, this means that the capacity of the river for self-purification is being exceeded in certain areas. In general, water quality within the State of Delaware is nearly always fair to good and in Delaware Bay it is classed as excellent. At times the waters of the river within our State are affected adversely by discharges upstream. This is particularly noticeable at times of sudden flow increase of an intermediate nature. It might be likened to a sudden increase in flow through a biological treatment plant which temporarily results in a discharge of partially treated wastes. We have the distinct feeling in Delaware that the river is being pushed dangerously close to its maximum assimilative capacity during periods of low flow and high temperatures. For these reasons it behooves the State of Delaware to keep a watchful eye on and to encourage efforts to reduce industrial and municipal discharges to the river. It is our intention

to continue our sampling program as long as we are able or as long as it seems necessary. Needless to say, we will cooperate in every way with the newly formed Delaware River Basin Compact Authority.

THE INTERSTATE COMMISSION ON THE DELAWARE RIVER BASIN

U.S. GEOLOGICAL SURVEY - CITY OF PHILADELPHIA PROJECT

Norman H. Beamer, District Director
Quality of Water Branch, U. S. Geological Survey

October 15, 1962

INTRODUCTION

Ladies and gentlemen: It is a pleasure to attend this Water Resources Conference sponsored by Incodel, the Delaware River Basin Commission and the Water Resources Association of the Delaware River Basin. I wish to express my thanks for being asked to talk this morning about the City of Philadelphia and the U. S. Geological Survey's cooperative project.

Because of time limitation I must be brief in my presentation of the history of the program and other details associated with the development of the program in the last 13 years.

The project began in August 1949 as a result of the coordinating efforts of Incodel. After World War II it was apparent to many federal, state and local authorities that a water quality survey of the Delaware estuary, particularly that part from the head of tide at Trenton to Marcus Hook was not only desirable, but very necessary. Recognizing this need, Mr. Sam Baxter, Water Commissioner of the City of Philadelphia, approached Incodel which called several meetings of representatives of the Corps of Engineers, the City of Philadelphia, the Geological Survey, and the Pennsylvania and New Jersey Health Departments and other interested parties. The cooperative water-quality survey between the City of Philadelphia Water Department and the Geological Survey was the outgrowth of these meetings.

From its beginning in August 1949, the basic program has consisted of monthly boat sampling trips which are presently continuing. Top and bottom water samples are collected monthly at five points in the river cross section at eight stations from the Burlington-Bristol Bridge to Marcus Hook (fig. 1). The temperature, dissolved oxygen, biochemical oxygen demand, pH, specific conductance and chloride concentrations are determined on all samples. Other samples collected at the Burlington-Bristol Bridge, Benjamin Franklin Bridge and Marcus Hook receive a comprehensive chemical analysis. In addition to the boat sampling trips, daily water samples are collected for chemical analysis at Trenton on the Delaware River and Belmont Filter Plant on the Schuylkill River.

Since 1958 the program expanded to include the testing, installation and operation of continuous water quality recorders, particularly continuous dissolved-oxygen-temperature recorders. Presently continuous dissolved-oxygen-temperature recorders are operating at Trenton, Bristol, Torresdale, Benjamin Franklin Bridge, and Chester. A sixth recorder is being installed at the Delaware Memorial Bridge and a seventh installation has been proposed for the Philadelphia Navy Yard.

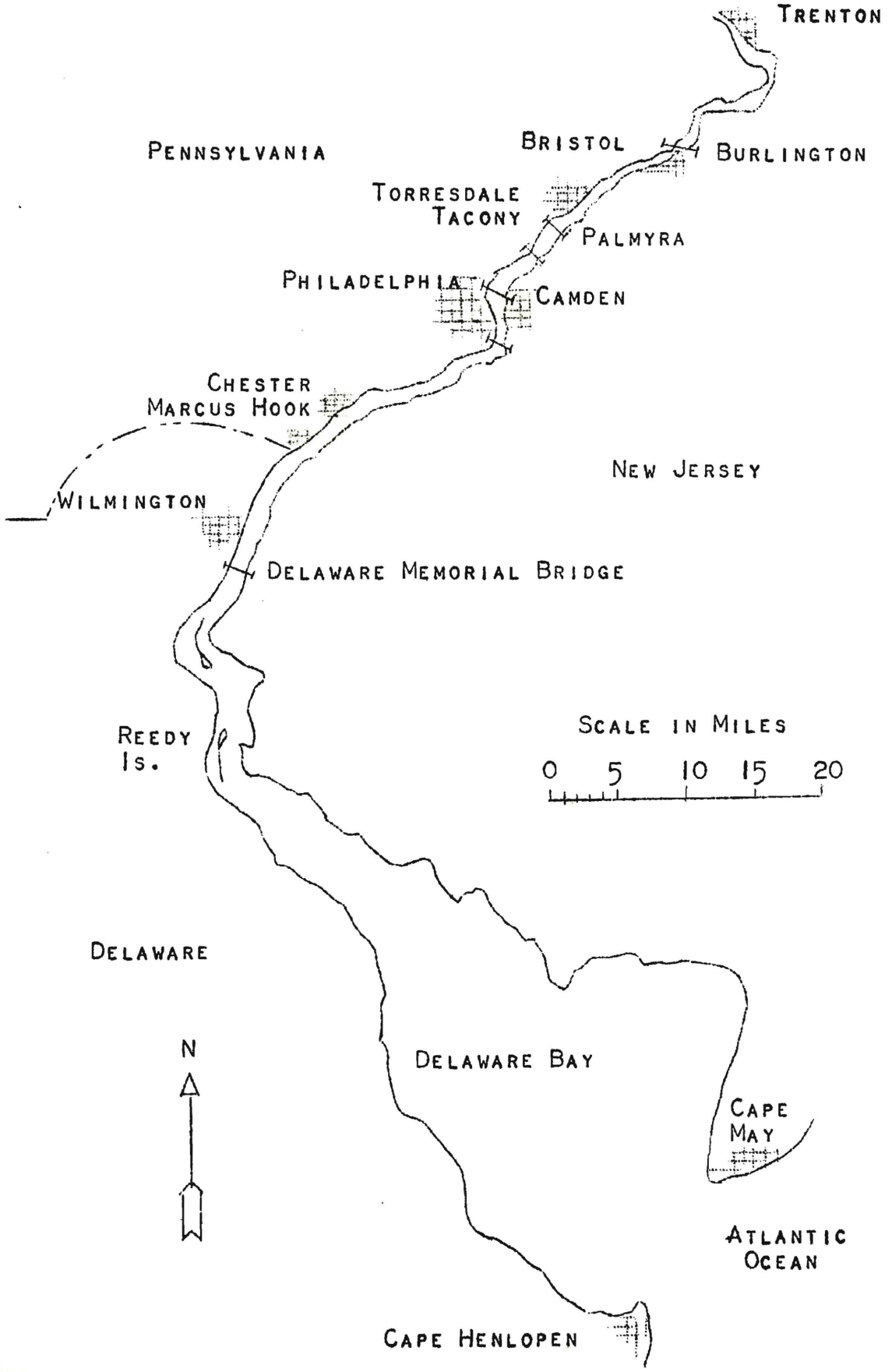


FIGURE 1. THE DELAWARE ESTUARY

Continuous specific conductance or salinity recorders are operating at Torresdale, Benjamin Franklin Bridge, Chester, Delaware Memorial Bridge and Reedy Island Jetty (fig. 1).

The salinity recorders at Delaware Memorial Bridge and Reedy Island Jetty have been in operation since 1955 and 1956. These recorders are operated in cooperation with the Delaware Geological Survey.

Prior to the installations of the salinity recorders the only other continuous and permanently operated recorders in the Delaware River, to our knowledge, were stream gages, tide gages and temperature recorders. The salinity recorders were the forerunners of the present City of Philadelphia - Geological Survey instrumentation program.

Now I would like to discuss significant events that occurred during the low-flow period of the Delaware River within the last 5 months, which were principally documented by continuous water-quality recorders.

DISCHARGE - MAY TO SEPTEMBER 1962

In the 50-year period since 1913, the median discharge of the Delaware River at Trenton for the months of May through September, inclusive, is 8,392 cfs. This year the average discharge for these months was 3,539 cfs, or 42 percent of the median. Not only was the discharge at Trenton deficient for the May to September period, but the average discharge for the 5 months was the lowest on record: May flow was the 2nd lowest; June was the lowest; July was 5th lowest; August was 14th lowest; and September, was 9th lowest on record.

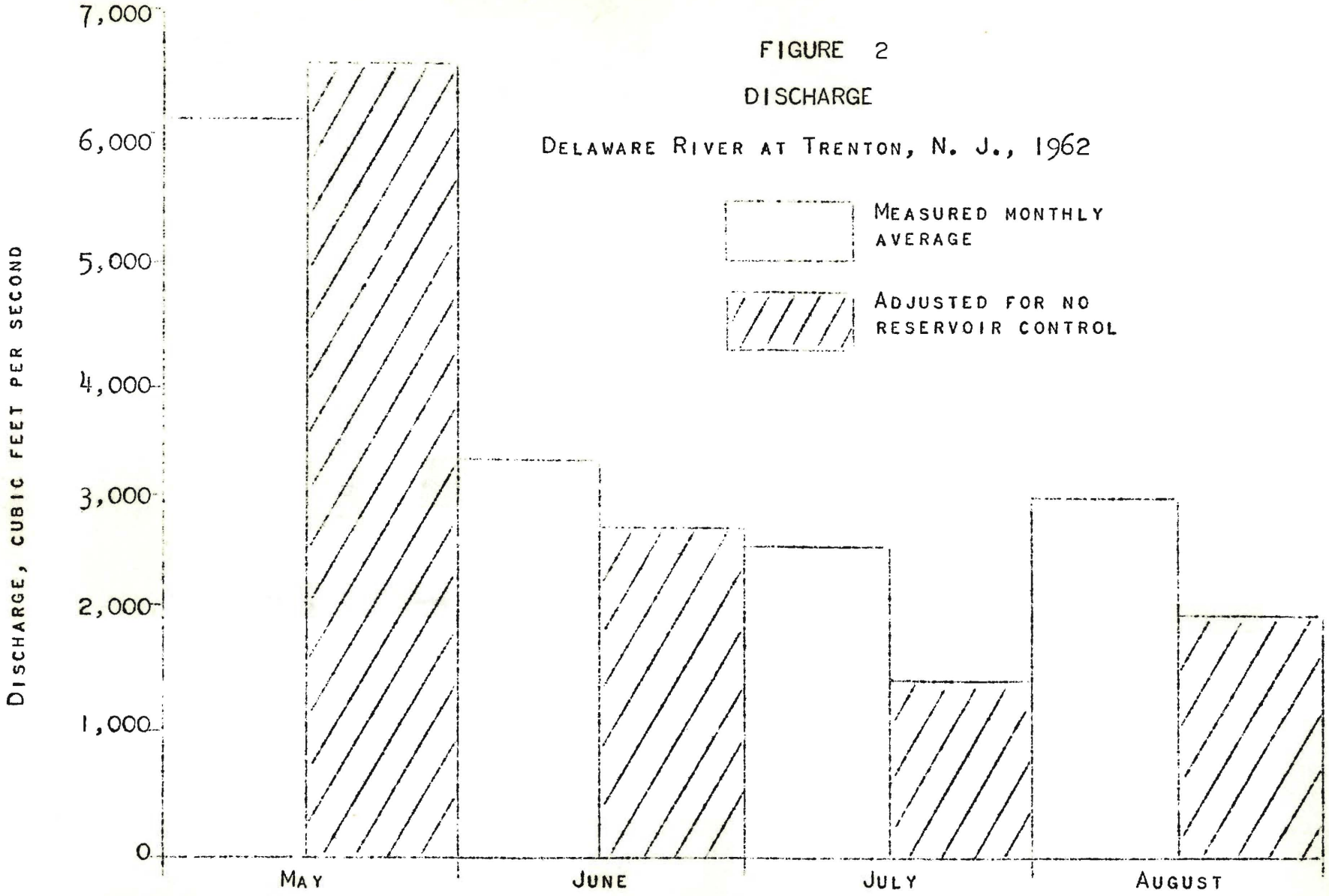
The previous low flow of 3,972 cfs for the May to September period occurred in 1957 during the prolonged drought. A discussion of flow conditions from May through September 1962, however, would be incomplete without considering the role of the reservoirs in the upper basin.

Figure 2 shows the measured monthly discharge and an estimated discharge for the Delaware River at Trenton for May through August 1962. The estimated discharge has been adjusted for storage or release of water by New York City's Pepacton and Neversink water-supply reservoirs and Rio and Wallenpaupack power reservoirs and is the discharge that would have occurred without reservoir control.

FIGURE 2

DISCHARGE

DELAWARE RIVER AT TRENTON, N. J., 1962



As illustrated, a deficiency of 4 percent streamflow occurred in May because of storage of water in reservoirs. The flow was increased, however, 22 percent in June, 65 percent in July, 46 percent in August, and 67 percent in September by reservoir releases of stored water. Expressed as percent of measured flow, the reservoir releases were: 18 percent of June flow; 39 percent of July flow; 31 percent of August flow; and 40 percent of September flow. Low-flow augmentation by these releases from June 1 to September 30 amounted to over 9.5 billion cubic feet, or about 72 billion gallons of water, of which 89 percent was from New York City's reservoirs and 11 percent from the power reservoirs.

There was enough water released to fill the Delaware River to mid-tide capacity from Trenton to below the Schuylkill River, a distance of 40 miles. It is also enough water to supply about 200 gallons of water per day to a population of 1 million for about a year.

Dissolved Solids - May to September 1962

Now that we have set the stage by discussing discharge of the river during the drought this summer, a natural question to ask is "What was the quality of the river water at Trenton this summer?"

From May 1 to September 30, the measured dissolved solids were 19 percent higher than median, even with low-flow augmentation. As the dissolved solids of the river vary inversely with discharge, the above normal dissolved solids this summer were the result of the below normal flows.

The dissolved solids were higher than the 18-year median by: 38 percent in May; 33 percent in June; 14 percent in July; 13 percent in August; and 14 percent in September.

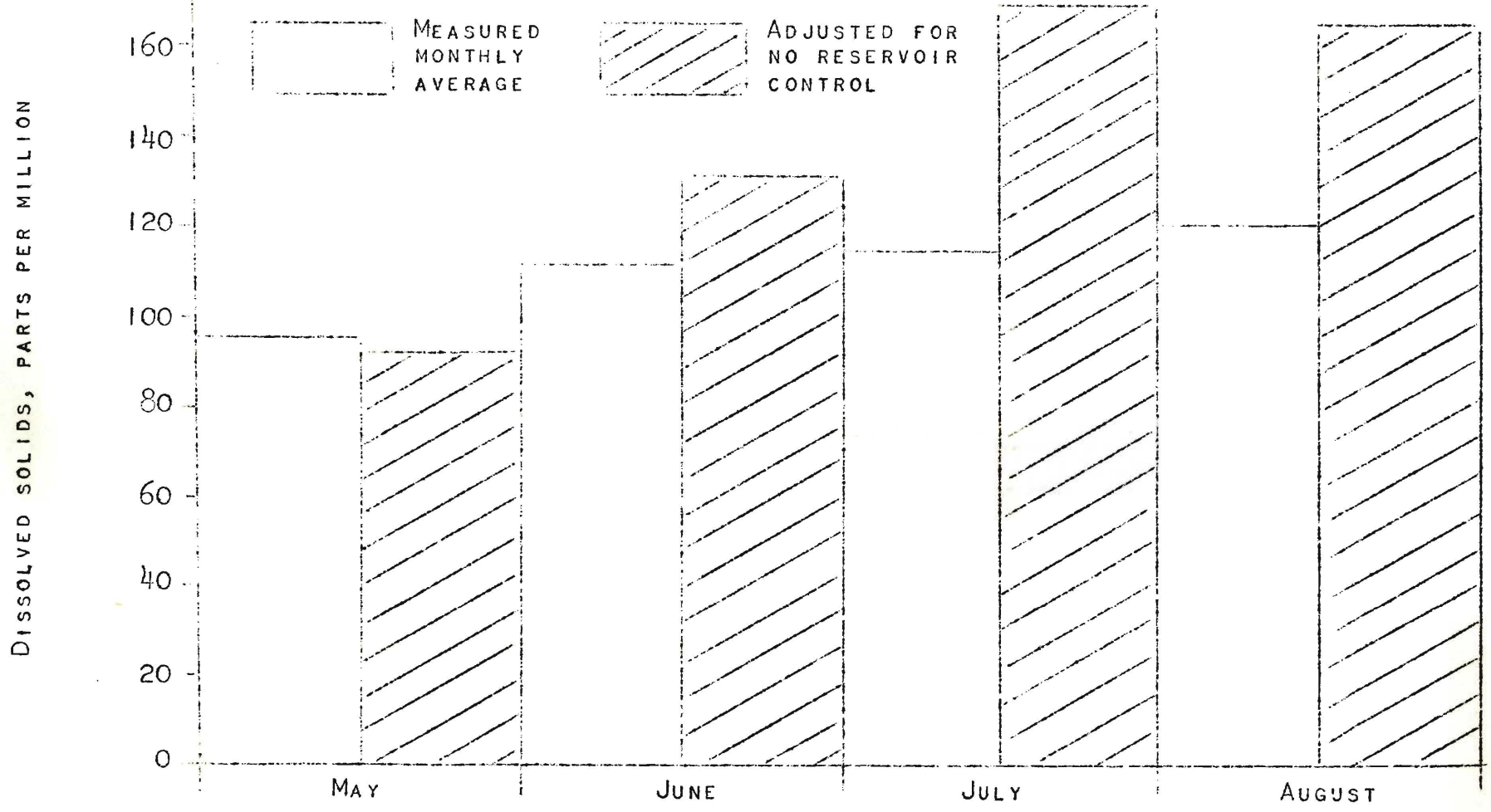
Figure 3 compares the dissolved-solids content of the river that would have occurred under natural flow conditions and the measured dissolved solids of the river at Trenton. As illustrated for May, the dissolved solids of the river were slightly higher because of storage of water in reservoirs. In the upper basin surface waters have a very low dissolved-solids content (25-40 ppm). Because of the low dissolved-solids content, these waters have a high dilution capacity upon release during low-flow periods when the dissolved-solids content of downstream tributaries is high.

On the other hand, by storing this low dissolved-solids water in reservoirs at times of high flows, the natural diluting capacity of the stored water is lost. As a result, at times of storage higher concentrations of dissolved solids occur, as in May.

FIGURE 3

DISSOLVED SOLIDS

DELAWARE RIVER AT TRENTON, N. J.



THE DISSOLVED SOLIDS OF THE RIVER AT TRENTON WERE INCREASED 2 PERCENT IN MAY BY STORAGE OF WATER IN RESERVOIRS, BUT DECREASED 14 PERCENT IN JUNE, 30 PERCENT IN JULY, 27 PERCENT IN AUGUST, AND 33 PERCENT IN SEPTEMBER BY LOW-FLOW AUGMENTATION.

NOW WE MAY ASK "WHAT DO THESE CHANGES IN WATER QUALITY MEAN TO WATER USERS?"

TO BEGIN WITH, LET'S CONSIDER AN INDUSTRY THAT NEEDS 1 MILLION GALLONS OF DEMINERALIZED WATER PER DAY FOR PROCESS WATER IN MANUFACTURING OR FOR BOILER FEED MAKE-UP WATER.

WITHOUT LOW-FLOW AUGMENTATION, FOR EACH 1 MILLION GALLONS OF WATER TREATED, THERE WOULD BE 1,240 POUNDS OF DISSOLVED SOLIDS REMOVED. BECAUSE OF THE DILUTION OF THE DISSOLVED SOLIDS BY RESERVOIR RELEASES THIS SUMMER THERE WAS ONLY 990 POUNDS OF DISSOLVED SOLIDS PER MILLION GALLONS, A REDUCTION OF 250 POUNDS PER MILLION GALLONS OF WATER, OR 20 PERCENT. CONSEQUENTLY, A WATER-USING INDUSTRY HAS BEEN BENEFITTED IN ITS WATER TREATMENT BY LOW-FLOW AUGMENTATION. THERE MAY OR MAY NOT BE A SIGNIFICANT COST BENEFIT TO AN INDUSTRY BY THIS LOW-FLOW AUGMENTATION. HOWEVER, IN THE CASE OF A DEMINERALIZER, THE LIFE OF THE UNIT BEFORE RECHARGE OR REPLACEMENT HAS BEEN INCREASED BY 25 PERCENT BECAUSE OF RESERVOIR RELEASES.

IN THE CASE OF PUBLIC WATER SUPPLY FOR THE CITIES OF EASTON, TRENTON AND PHILADELPHIA, THERE IS NO DOUBT THAT LOW-FLOW AUGMENTATION HAS IMPROVED THE QUALITY OF THE RAW WATER DELIVERED TO THEIR INTAKES.

BESIDES THE OVERALL REDUCTION IN DISSOLVED SOLIDS, THERE IS A CORRESPONDING DECREASE IN THE HARDNESS OF THE WATER.

IN MAY THERE WAS A 3 PERCENT INCREASE IN THE HARDNESS OF THE RIVER WATER AT TRENTON BECAUSE OF RESERVOIR STORAGE, BUT THERE WAS A DECREASE IN HARDNESS OF: 16 PERCENT IN JUNE; 32 PERCENT IN JULY; 29 PERCENT IN AUGUST; AND 32 PERCENT IN SEPTEMBER BECAUSE OF THE DILUTION EFFECTS OF LOW-FLOW AUGMENTATION.

THIS MEANS THAT A SOFTER WATER WAS DELIVERED TO THE CONSUMER. IT MEANS THAT THERE WAS LESS SCALE FORMATION IN PIPES, BOILERS OR TEA KETTLES. IT MEANS LESS SOAP WAS NEEDED TO FORM A LATHER IN BATHING OR LAUNDERING. FURTHERMORE, BECAUSE OF RESERVOIR OPERATIONS A MORE UNIFORM QUALITY OF WATER IS AVAILABLE TO WATER USERS THE YEAR ROUND.

FOR THESE REASONS THE MINIMUM AND MAXIMUM SEASONAL CONCENTRATIONS OF DISSOLVED SOLIDS THAT NATURALLY OCCURRED IN DELAWARE RIVER WATER IN THE PAST WILL NOT LIKELY OCCUR IN THE FUTURE, AS RESERVOIR DEVELOPMENT CONTINUES.

THE LOW MINERAL CONCENTRATION OF THE SPRING MONTHS WILL BE HIGHER, AND THE HIGH CONCENTRATIONS OF THE SUMMER AND EARLY AUTUMN WILL BE LOWER BECAUSE OF RESERVOIR OPERATIONS.

DISSOLVED OXYGEN

NOW LET'S CONSIDER THE DISSOLVED-OXYGEN CONCENTRATIONS IN THE ESTUARY THESE PAST MONTHS WHEN THE FLOW AT TRENTON WAS BELOW NORMAL. IN EARLY MARCH OF THIS YEAR THE MAXIMUM DISSOLVED-OXYGEN CONCENTRATIONS WERE RECORDED IN THE ESTUARY. AFTERWARD, THE GENERAL SEASONAL DECLINE IN DISSOLVED-OXYGEN CONCENTRATIONS BEGAN, EVEN THOUGH THE DISCHARGE OF THE RIVER INCREASED DURING THE FIRST 2 WEEKS IN APRIL. THIS DECLINE WAS THE RESULT OF THE SEASONAL INCREASE IN WATER TEMPERATURES.

AFTER THE HIGH RUNOFF OF EARLY APRIL, HOWEVER, THE DISSOLVED-OXYGEN DECREASED AT AN EXTREMELY RAPID RATE IN THE ESTUARY. AT CHESTER, THE DISSOLVED OXYGEN DECREASED FROM 6 PPM ON APRIL 15 TO LESS THAN 1 PPM ON MAY 5. AT BENJAMIN FRANKLIN BRIDGE THE DISSOLVED OXYGEN DECREASED FROM 9 PPM ON APRIL 15 TO LESS THAN 1 PPM ON MAY 15. AT TORRESDALE, THE DISSOLVED OXYGEN DECREASED FROM 11-12 PPM ON APRIL 15 TO LESS THAN 4 PPM ON MAY 31.

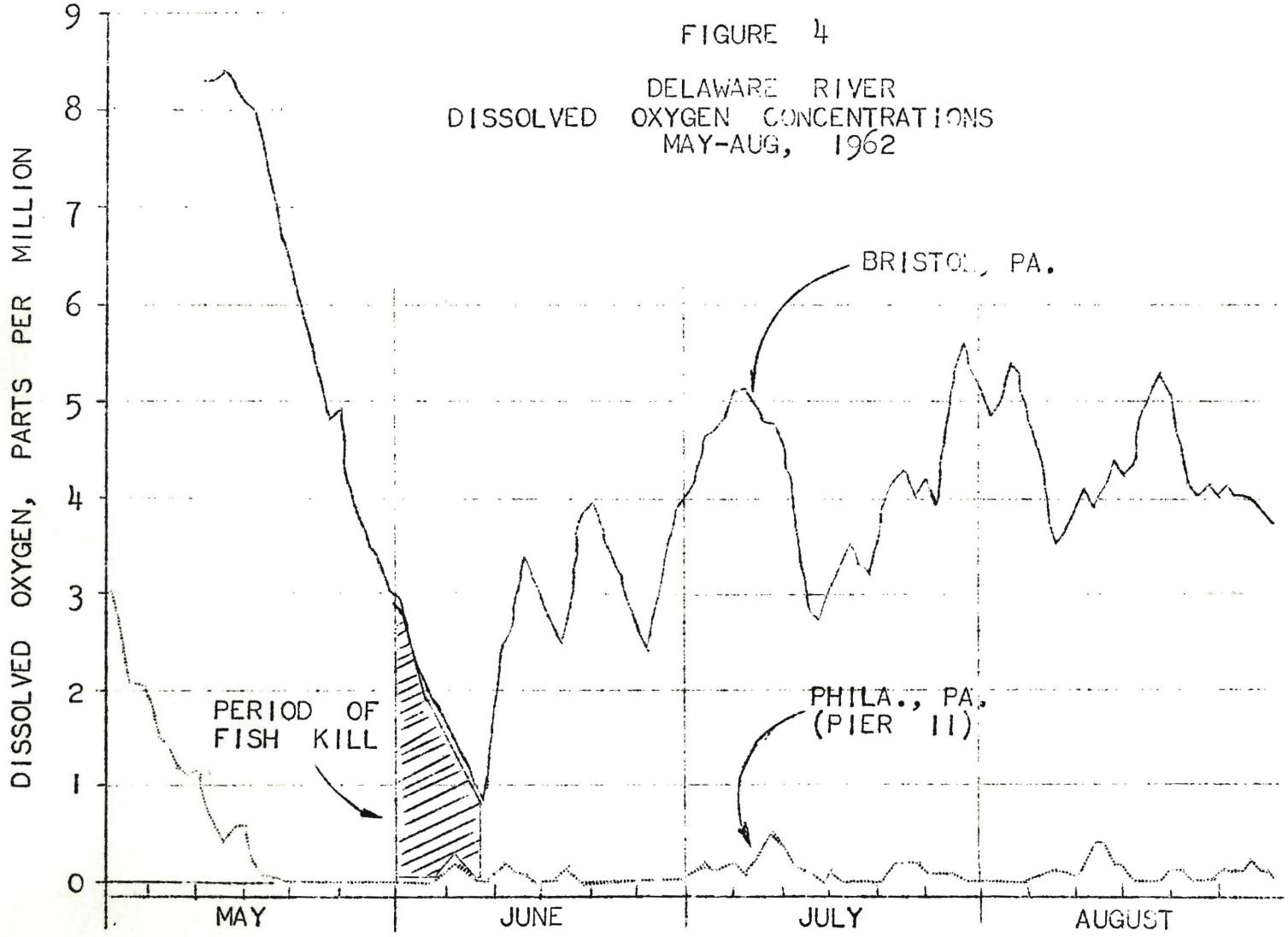
ON FIGURE 4 IS PLOTTED THE AVERAGE DAILY DISSOLVED OXYGEN AT BRISTOL AND BENJAMIN FRANKLIN BRIDGE FOR MAY 1 TO AUGUST 31, 1962. THE DISSOLVED-OXYGEN PATTERN AT TORRESDALE FOR THE PERIOD WAS QUITE SIMILAR TO THE BRISTOL PATTERN, AND THE CHESTER PATTERN WAS QUITE SIMILAR TO THE BENJAMIN FRANKLIN BRIDGE PATTERN. DURING THIS PERIOD THE DAILY DISSOLVED OXYGEN AT TRENTON AVERAGED 9 TO 10 PPM.

THIS SPRING VERY LARGE NUMBERS OF MIGRATORY FISH ASCENDED THE ESTUARY FROM THE OCEAN ON THEIR ANNUAL RUN TO THE SPAWNING GROUNDS IN THE UPPER REACHES OF THE RIVER. THIS SPAWNING RUN IS AN ANNUAL EVENT, TO A GREATER OR LESSER EXTENT. THIS SPRING, HOWEVER, THE NUMBER OF FISH ENTERING THE RIVER WAS DESCRIBED BY SOME AS THE GREATEST SINCE THE TURN OF THE CENTURY. THE FISH NUMBERED IN THE MILLIONS.

THE FISH ASCENDING THE ESTUARY SAFELY REACHED THE UPPER RIVER BECAUSE OF THE RELATIVELY HIGH DISSOLVED-OXYGEN CONCENTRATIONS IN MARCH, APRIL AND EARLY MAY. HOWEVER, FROM JUNE 4TH TO 9TH LARGE NUMBERS OF DEAD FISH OF THE HERRING FAMILY WERE OBSERVED IN THE RIVER AND ON THE BANKS FROM BRISTOL TO NEW CASTLE. THIS WAS A TERRIFIC FISH KILL, AND IT IS LIKELY THAT THE NUMBER OF FISH KILLED WAS IN THE MILLIONS. THE FISH THAT WERE KILLED MOST LIKELY HAD SPAWNED EARLIER AND WERE RETURNING TO SEA. BECAUSE OF THE LOW DISSOLVED OXYGEN IN THE ESTUARY, THE FISH SUFFOCATED AND DIED IN LARGE NUMBERS.

FIGURE 4

DELAWARE RIVER
DISSOLVED OXYGEN CONCENTRATIONS
MAY-AUG, 1962



THE FISH FLOATING IN THE WATER AND SUBSEQUENTLY WASHED UP ON BEACHES AT HIGH TIDE CREATED QUITE A STIR. MOST NEWSPAPERS FROM TRENTON TO WILMINGTON COVERED THE FISH KILL STORY TO SOME EXTENT. BECAUSE OF OUR CONTINUOUS RECORDERS, WE WERE IN A POSITION TO DOCUMENT EVENTS LEADING UP TO THE FISH KILL. WE WERE ABLE TO POINT OUT TO HEALTH AND FISH AND GAME REPRESENTATIVES THE DISSOLVED-OXYGEN LEVELS PRIOR TO, DURING, AND AFTER THE FISH KILL. ALSO, WE WERE ABLE TO DOCUMENT THE TEMPERATURE, FLOW AND OTHER PERTINENT CHARACTERISTICS OF THE RIVER WATER AT THE TIME OF THE KILL. WE WERE ABLE TO POINT OUT THAT THE LOW DISSOLVED-OXYGEN LEVELS THE FIRST WEEK IN JUNE WERE THE LOWEST FOR THIS WEEK IN THE LAST 13 YEARS. WE WERE FURTHER ABLE TO POINT OUT THAT THE WATER TEMPERATURES WERE ABOVE NORMAL. WE WERE IN A POSITION TO DO THIS BECAUSE OF OUR INSTRUMENTATION PROGRAM.

AFTER REACHING A MINIMUM ON JUNE 9, THE DISSOLVED OXYGEN AT BRISTOL RECOVERED SOMEWHAT AND, AS ILLUSTRATED, RANGED FROM 2.5 TO 5.5 PPM FOR THE REMAINDER OF THE SUMMER. THERE WAS NO RECOVERY AT THE BENJAMIN FRANKLIN BRIDGE WHERE THE DISSOLVED OXYGEN AVERAGED LESS THAN 1 PPM FROM THE MIDDLE OF MAY ON.

SALINITY

FOR MANY YEARS, PARTICULARLY SINCE THE DROUGHT YEARS OF THE EARLY 1930'S, THERE HAS BEEN CONSIDERABLE INTEREST IN THE SALINITY OF THE DELAWARE ESTUARY.

MANY INVESTIGATIONS HAVE BEEN UNDERTAKEN TO EVALUATE THE MAGNITUDE, EXTENT AND DURATION OF THE SEASONAL SALINITY INVASIONS. SEVERAL FEDERAL, STATE AND LOCAL AGENCIES HAVE PERIODICALLY RUN LONGITUDINAL BOAT SURVEYS TO DETERMINE THE SALINITY DISTRIBUTION.

MOST INVESTIGATORS AGREE THAT THE PRINCIPAL FACTOR THAT DETERMINES THE SALINITY DISTRIBUTION IN THE RIVER IS THE MAGNITUDE OF THE HEADWATER DISCHARGE INTO THE ESTUARY. AT HIGH FLOW, ESPECIALLY IN THE SPRING OF EACH YEAR, THE SALT FRONT IS PUSHED DOWNSTREAM. AS FLOW DECREASES IN LATE SPRING, THROUGH THE SUMMER, INTO THE EARLY FALL MONTHS, HOWEVER, THE SALT FRONT ADVANCES UPSTREAM. THIS OCCURS TO A GREATER OR LESSER EXTENT EVERY YEAR, DEPENDING UPON THE MAGNITUDE OF THE HEADWATER DISCHARGE AND OTHER FACTORS.

PERHAPS THE GREATEST SALINITY INVASION FOR THE PERIOD OF SALINITY RECORDS SINCE 1907 OCCURRED IN 1957. THE SALT FRONT CONTINUOUSLY ADVANCED UPSTREAM BECAUSE OF THE PROLONGED LOW FLOWS OF THIS DROUGHT PERIOD. THE MAXIMUM PENETRATION OF THE SALT FRONT IN 1957 WAS TO THE VICINITY OF THE TACONY-PALMYRA BRIDGE IN NORTHEAST PHILADELPHIA. SEVERE AS THE SALINITY INVASION WAS IN 1957, IN MAGNITUDE AND EXTENT, THE DURATION WAS NOT AS GREAT AS THAT IN 1930 WHEN THE SALT FRONT REMAINED ABOVE MARCUS HOOK UNTIL EARLY JANUARY 1931.

In 1954 the U. S. Geological Survey, in cooperation with the Delaware Geological Survey, began an investigation of the salinity of the lower Delaware. However, very early in the program it was recognized that periodic boat sampling, while necessary and desirable to delineate the horizontal and vertical distribution of salinity in the river cross section, left a lot to be desired.

It was decided that continuous specific conductance or salinity recorders located at strategic spots along the estuary would, at less cost in both time and money, give a more accurate picture of the salinity movements with time.

Therefore, in 1954 a continuous salinity recorder was installed at the Delaware Memorial Bridge. In 1956 a salinity recorder was installed at Reedy Island Jetty.

These two stations, Reedy Island Jetty and Delaware Memorial Bridge, are considered important because the salt front most of the time ranges between these stations. Every year during low-flow periods the salt front advances above the Delaware Memorial Bridge. During salinity invasions since 1956 additional recorders have been operated on the river above the Delaware Memorial Bridge to determine the extent of the salt front.

Presently we are operating on a continuous and permanent basis 5 specific conductance or salinity recorders from Torresdale in northeast Philadelphia to Reedy Island Jetty. This program is in cooperation with the River Master, the Delaware Geological Survey and the City of Philadelphia.

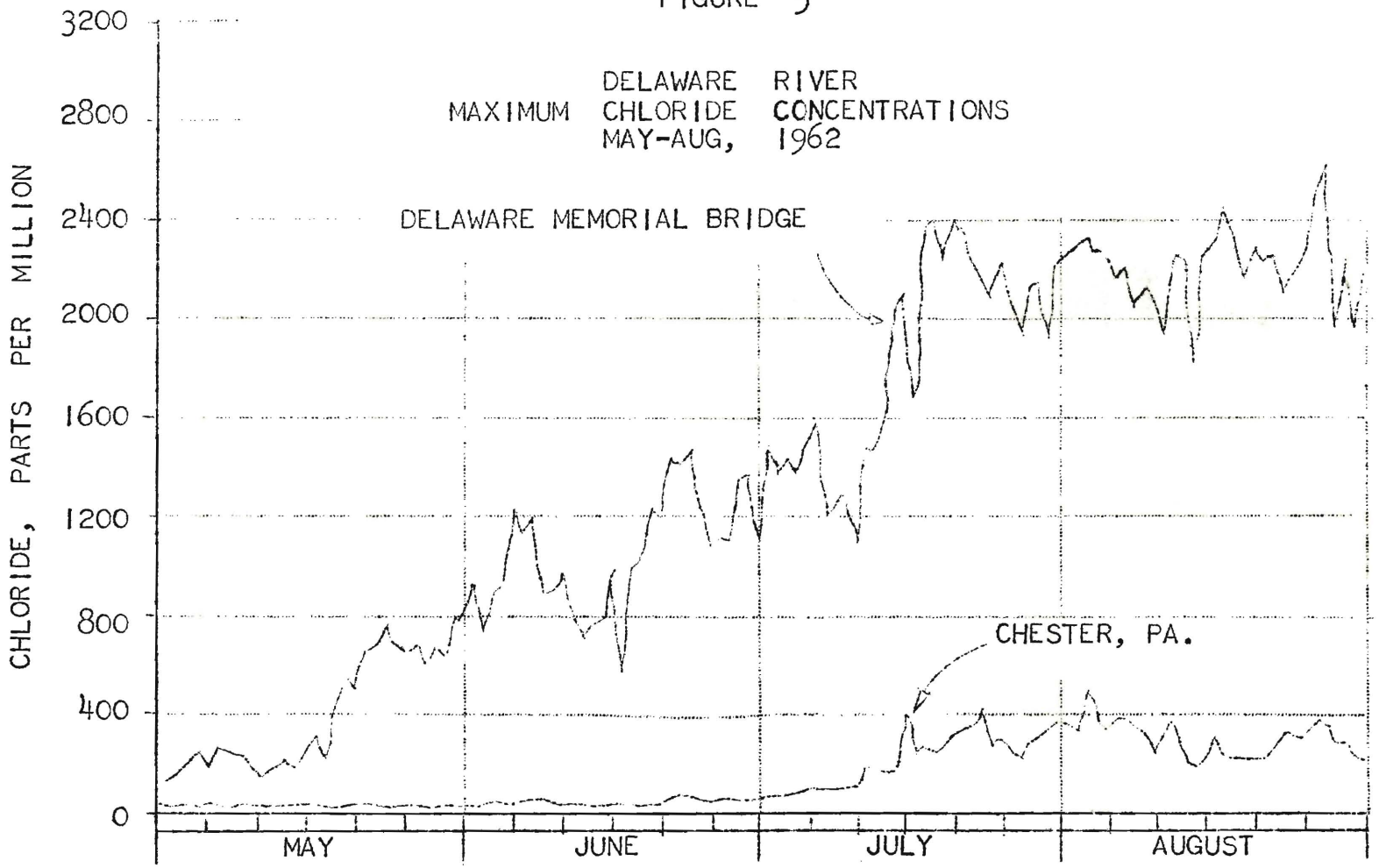
A report on the salinity of the Delaware estuary is published in the Salinity Section of the Annual Report of the River Master of the Delaware River.

SALINITY - MAY TO AUGUST 1962

Now let's see how these continuous salinity recorders documented the salinity of the estuary this year. On figure 5 we can trace the increase in salinity during the low-flow period this summer. These curves represent the highest concentration observed each day, and, therefore, are high-tide or high-water slack chloride. The concentrations also represent the least desirable daily water quality for an industry that requires relatively fresh water.

As illustrated, the salinity generally increased from May 1 to July 20, after which there was a slight increase before leveling off through August.

FIGURE 5


MAXIMUM CHLORIDE CONCENTRATIONS
DELAWARE RIVER
MAY-AUG, 1962
DELAWARE MEMORIAL BRIDGE
CHESTER, PA.
CHLORIDE, PARTS PER MILLION
3200
2800
2400
2000
1600
1200
800
400
0
MAY
JUNE
JULY
AUGUST

THE PEAKS AND TROUGHS IN THE SALINITY PATTERN THAT IS MOST APPARENT FOR THE DELAWARE MEMORIAL BRIDGE ARE THE RESULT OF TIDAL ACTION INFLUENCING TIDAL DISCHARGE. BECAUSE OF THE DROUGHT CONDITION DISCUSSED PREVIOUSLY, THE FLOW INTO THE ESTUARY WAS BELOW NORMAL AND AT A RATHER CONSTANT RATE FROM LATE MAY THROUGH THE END OF JULY. IT WAS NOT UNTIL WE RECEIVED HEAVY RAINFALL IN THE LOWER BASIN IN AUGUST THAT THERE WAS ANY APPRECIABLE INCREASE IN THE FRESH-WATER DISCHARGE TO THE ESTUARY. ALTHOUGH THERE WERE HEAVY RAINS IN THE BASIN BELOW TRENTON IN AUGUST, THE PRECIPITATION ABOVE TRENTON DID NOT CAUSE ANY SIGNIFICANT INCREASE IN DISCHARGE AT TRENTON. THE NET RESULT OF THE HEAVY AUGUST RAINS BELOW TRENTON WAS TO SLIGHTLY ARREST THE SALINITY ADVANCE UPSTREAM BY INCREASING THE FRESH-WATER DISCHARGE TO THE ESTUARY. THE AUGUST DISCHARGE, HOWEVER, WAS NOT SUFFICIENT TO FLUSH THE SALT FRONT SEAWARD TO ANY EXTENT, AND THE SALINITY CONCENTRATIONS AT THE BRIDGE AND CHESTER AGAIN BEGAN TO INCREASE IN SEPTEMBER, WHICH IS NOT SHOWN ON FIGURE 5.

MOST INVESTIGATORS OF THE SALINITY IN THE ESTUARY CONCLUDED THAT HEADWATER DISCHARGE WAS THE PRINCIPAL CONTROLLING FACTOR IN SALINITY MOVEMENTS. WHILE GENERALLY TRUE, THIS IS BY NO MEANS THE COMPLETE STORY. IT IS NOT THE DISCHARGE INTO THE ESTUARY, BUT RATHER THE TIDAL DISCHARGE IN THE ESTUARY THAT IS THE CONTROLLING FACTOR.

LET ME ILLUSTRATE THIS LAST POINT WITH THE CHLORIDES AT DELAWARE MEMORIAL BRIDGE. NOTE THAT AFTER A SIGNIFICANT DECREASE IN CHLORIDE CONCENTRATIONS FOR ONE DAY THAT THE CONCENTRATIONS IN SUBSEQUENT DAYS ARE HIGHER THAN THOSE PREVIOUS TO THE DECREASE. ON THE OTHER HAND, NOTE THAT AFTER A SIGNIFICANT INCREASE IN CHLORIDE FOR A DAY OR A NUMBER OF DAYS, THERE IS GENERALLY A CORRESPONDING DECREASE IN CHLORIDES TO THAT WHICH PREVIOUSLY EXISTED. THESE INCREASES AND DECREASES ARE THE RESULT OF TIDAL ACTION, OR MORE SPECIFICALLY TIDAL DISCHARGE.

IN THE FIRST CASE, TO CAUSE A DECREASE IN CHLORIDE AT ANY LOCATION THERE HAS TO BE AN INCREASE IN THE EBB-TIDE DISCHARGE. THIS IS PRINCIPALLY THE RESULT OF A LOWER THAN NORMAL LOW TIDE OR A LONGER THAN NORMAL EBB TIDE, OR BOTH. BECAUSE OF THE INCREASED EBB-TIDE DISCHARGE MORE FRESH WATER FROM ABOVE THE SALT FRONT IS DISCHARGED DOWNSTREAM INTO THE SALINE WATER BELOW. THIS FRESH WATER IS MIXED WITH THE SALTY WATER DOWNSTREAM. THEREFORE, ON SUBSEQUENT FLOOD TIDES THE SALINITY INCREASES AT A GREATER RATE BECAUSE OF THE LOSS OF FRESH WATER BY THE ASSIMILATION OF FRESH WATER WITH SALINE WATER DOWNSTREAM.

ON THE OTHER HAND, AN ABOVE NORMAL INCREASE IN A FLOOD-TIDE DISCHARGE CAUSES A SURGE OF SALINITY UPSTREAM. FRESH WATER, HOWEVER, IS BACKED UP BECAUSE OF THE HIGHER THAN NORMAL HIGH TIDE, AND ALTHOUGH SOME FRESH WATER IS ASSIMILATED DURING THE RISE, THERE IS GENERALLY NO SIGNIFICANT LOSS OF FRESH WATER. WHEN THE RIVER LEVEL BEGINS TO DROP, THE GREATER HEAD OF THE BACKED-UP FRESH WATER FLUSHES THE SALINITY DOWNSTREAM, AND CONDITIONS REVERT TO THOSE PRIOR TO THE RISE.

RESERACH - TIDAL HYDROLOGY

A RECENT INNOVATION IN THE U. S. GEOLOGICAL SURVEY COOPERATIVE PROGRAM IS THE COLLECTION OF DATA ON THE QUANTITY OF WATER FLOWING PAST PHILADELPHIA AND CAMDEN AT ALL TIMES THROUGHOUT THE EVER-CHANGING CYCLE OF TIDES. ALTHOUGH MANY GAGING STATIONS HAD BEEN MEASURING STREAMFLOW AT SELECTED LOCATIONS IN THE UPPER DELAWARE BASIN SINCE THE EARLY 1900'S, NONE OF THESE WERE LOCATED ON THE TIDAL PORTION OF THE ESTUARY.

THE GAGING STATIONS ON THE DELAWARE RIVER AT TRENTON AND THE SCHUYLKILL RIVER AT PHILADELPHIA, BOTH JUST ABOVE THE HEAD OF TIDE, MEASURE THE FLOW FROM 6,780 SQUARE MILES AND 1,893 SQUARE MILES, RESPECTIVELY, OUT OF THE TOTAL OF 12,757 SQUARE MILES IN THE ENTIRE BASIN. ACCORDINGLY BOTH OF THESE, AND PARTICULARLY THE TRENTON GAGE, HAVE BEEN USED FOR YEARS AS INDICATORS OF FLOW CONDITIONS IN THE TIDAL ESTUARY. SOMETIMES THE INSTANTANEOUS FLOW AT TRENTON, OR PERHAPS THE AVERAGE FLOW AT TRENTON THE PREVIOUS DAY, WAS CORRELATED WITH OTHER FACTORS. OTHER STUDIES ATTEMPTED TO USE THE AVERAGE TRENTON FLOW DURING THE PAST WEEK OR EVEN THE PAST MONTH. SOMETIMES THE SCHUYLKILL FLOWS WERE ADDED TO THE TRENTON FLOWS FOR ADDITIONAL REFINEMENT.

THE FLOW FIGURES REALLY NEEDED MANY TIMES WERE THOSE OF ACTUAL FLOW AT BURLINGTON, PHILADELPHIA, CHESTER, OR OTHER SPECIFIC POINTS ON THE ESTUARY. THESE FIGURES WERE NOT AVAILABLE BECAUSE THE EQUIPMENT AND TECHNIQUES HAD NOT BEEN PERFECTED TO MEASURE FLOWS IN RIVER AFFECTED BY OCEAN TIDES. THIS TECHNOLOGICAL BARRIER HAS NOW BEEN HURDLED BY COUPLING THE LATEST DEVELOPMENTS IN DIGITAL RECORDING, ON PUNCHED PAPER TAPE, WITH THE SPEED AND FLEXIBILITY OF THE MODERN ELECTRONIC COMPUTER. THE FIRST SUCH INSTALLATION IN EASTERN UNITED STATES, AND PROBABLY THE FIRST IN THE WORLD, TO RECORD BOTH UPSTREAM AND DOWNSTREAM FLOW WAS ESTABLISHED THIS PAST SUMMER ON THE DELAWARE RIVER IN THE VICINITY OF THE TACONY-PALMYRA BRIDGE.

THE GEOLOGICAL SURVEY AND THE PHILADELPHIA WATER DEPARTMENT ~~WERE~~ JOINED IN THIS TIDAL GAGING PROJECT BY THE NEW JERSEY DIVISION OF WATER POLICY AND SUPPLY AND THE PHILADELPHIA DISTRICT OF THE CORPS OF ENGINEERS, AS THE FIRST COSTS FOR INSTALLATION AND CALIBRATION WERE ESTIMATED TO RUN 5 TO 10 TIMES THE COST OF A SIMPLE STREAM GAGING STATION. ALSO BECAUSE MUCH RESEARCH AND EXPERIMENTATION ARE STILL NEEDED TO COMPLETELY EXPLOIT THIS BREAKTHROUGH IN HYDROLOGIC SCIENCE, THREE RECORDING GAGES WERE INSTALLED, ALTHOUGH TWO PROBABLY WOULD FURNISH MOST OF THE BASIC DATA NEEDED FOR GENERAL PURPOSES.

THE BASIC UNIT EMPLOYED IS THE "ADR", ANALOG TO DIGITAL RECORDER, DEVELOPED BY THE FISCHER & PORTER CO. AT THEIR HATBORO, PA., PLANT. THIS WAS MODIFIED BY FISCHER & PORTER WITH THE GUIDANCE OF SPECIALISTS FROM THE SURVEY'S INSTRUMENT RESEARCH LABORATORY TO MEET THE SPECIFIC SERVICE REQUIREMENTS AND MAINTENANCE PROBLEMS OF TIDAL GAGING. THE MODIFIED RECORDER IS FLOAT ACTUATED. THE FLOAT IS PROTECTED BY A PIPE STILLING WELL IN WHICH THE FLOAT GOES UP AND DOWN WITH THE TIDE, BUT WIND AND WAVE EFFECTS ARE DAMPENED OUT. THE PAPER TAPE IS PUNCHED WITH A BINARY DECIMAL CODING EVERY 5 MINUTES TO RECORD THE EXACT WATER LEVEL.

THE UPSTREAM GAGE IS INSTALLED IN THE OLD GATE HOUSE OF THE TORRESDALE FILTRATION PLANT. A SECOND TIDE GAGE IS LOCATED AT THE OLD DISSTON SAW PLANT, 2,500 FEET ABOVE THE TACONY-PALMYRA BRIDGE ON THE PENNSYLVANIA SIDE, AND THE DOWNSTREAM GAGE IS LOCATED ON THE END OF A MOORING PIER AT THE PHILADELPHIA ELECTRIC CO. RICHMOND GENERATING STATION.

EVERY 5 MINUTES ALL THREE PUNCH SIMULTANEOUSLY TO RECORD (1) WATER LEVEL AND (2) SLOPE OF THE WATER SURFACE BETWEEN GAGES. THE TAPES CONTAINING THESE TWO VARIABLES ARE LATER FED INTO A DIGITAL COMPUTER, ALONG WITH CERTAIN CONSTANTS SUCH AS DISTANCE BETWEEN GAGES AND CROSS-SECTIONAL AREAS AT ABOUT 10 POINTS IN THE REACH. THE COMPUTER THEN QUICKLY SOLVES A VERY COMPLEX FORMULA FOR UNSTEADY FLOW AND PRINTS OUT THE RIVER DISCHARGE.

AFTER INSTALLATION, THE GAGES HAD TO BE CALIBRATED BY MEASURING THE FLOW CONTINUOUSLY FOR SEVERAL TIDE CYCLES AT THE SAME TIME THAT THE GAGES WERE RECORDING WATER LEVEL AND SLOPE. THIS WAS DONE FROM THE TACONY-PALMYRA BRIDGE NEAR THE MIDDLE OF THE GAGING REACH. STANDARD BATTERY-POWERED STREAM GAGING EQUIPMENT WAS USED FOR THESE MEASUREMENTS WITH FIVE UNITS BEING MANNED CONTINUOUSLY FOR 14 HOURS AND 28 HOURS TO COVER ONE AND TWO-TIDE CYCLES, RESPECTIVELY. MEN AND EQUIPMENT FROM SURVEY OFFICES IN ALL THE BASIN STATES WERE BROUGHT IN TO ASSIST ON THIS PHASE AND VALUABLE ASSISTANCE WAS ALSO FREELY GIVEN BY THE CORPS OF ENGINEERS, PHILADELPHIA DISTRICT.

WHILE THE BASIC OBSERVATION OF RIVER DEPTH AND VELOCITY WERE BEING TAKEN, ADDITIONAL DATA FOR RESEARCH WERE GATHERED. VERTICAL VELOCITY OBSERVATIONS WERE MADE TO DETERMINE THE VARIATIONS IN VALOCITY FROM RIVER BOTTOM TO WATER SURFACE ON INCOMING, OUTGOING AND CHANGING TIDES. THE DIRECTION OF UNDERWATER CURRENTS WAS INVESTIGATED AT MANY POINTS ACROSS THE CHANNEL, AT VARIOUS DEPTHS AND FOR DIFFERENT TIDE CONDITIONS. THE EXTENT OF SURGE OR VARIATION IN INSTANTANEOUS VELOCITIES AT VARIOUS TIMES AND PLACES WERE MEASURED. THESE LATTER MEASUREMENTS WERE ACCOMPLISHED BY THE USE OF NEWLY DEVELOPED EQUIPMENT WHICH IS NOT YET GENERALLY AVAILABLE.

Naturally the Geological Survey and other agencies took advantage of this opportunity to tie in chemical quality, sediment concentration and other subsidiary data with velocity and discharge data for this reach. Temperature, specific electrical conductance and dissolved-oxygen observations and sampling for various mineral constituents in the water were accomplished using portable equipment from boats. Special data for photosynthesis studies were collected in cooperation with Johns Hopkins University. It had been hoped to conduct dye-tracer studies concurrently, but the newly developed fluorometer dye detection equipment of the Geological Survey was in use below the Oak Ridge Atomic Energy installation in Tennessee and the Public Health Service equipment was tied up for sanitary surveys in Raritan Bay. Some data were gathered using conventional surface floats and depth-integrated floats, but it is hoped to test dispersion and travel of water particles with the dye equipment soon.

The discharge figures for several locations in the Delaware estuary may be of interest. Figure 3 shows the maximum instantaneous flow measured at the Delaware Memorial Bridge, the Tacony-Palmyra Bridge and the Burlington-Bristol Bridge. For comparison the approximate flow at the gaging station at Trenton at the same times is shown. It can be seen that the rate of flow, as well as the volume of flow, increases very sharply as one goes from head-of-tide toward the ocean. In fact, the flow on a normal tide cycle at the Delaware Memorial Bridge is almost twice as great as the maximum flood flow of record at Trenton.

It was found that a particle of water may move as far as 12 miles during one tide cycle if it stays in the main current all the time. Of course, this would also be true of any pollution or slug of impurities.

More than anything, it was found that the tidal flow is an ever-changing quantity and that the quality of the water changes almost as rapidly. The only way to completely describe this part of the river is with recording instruments to document those variables of special interest.

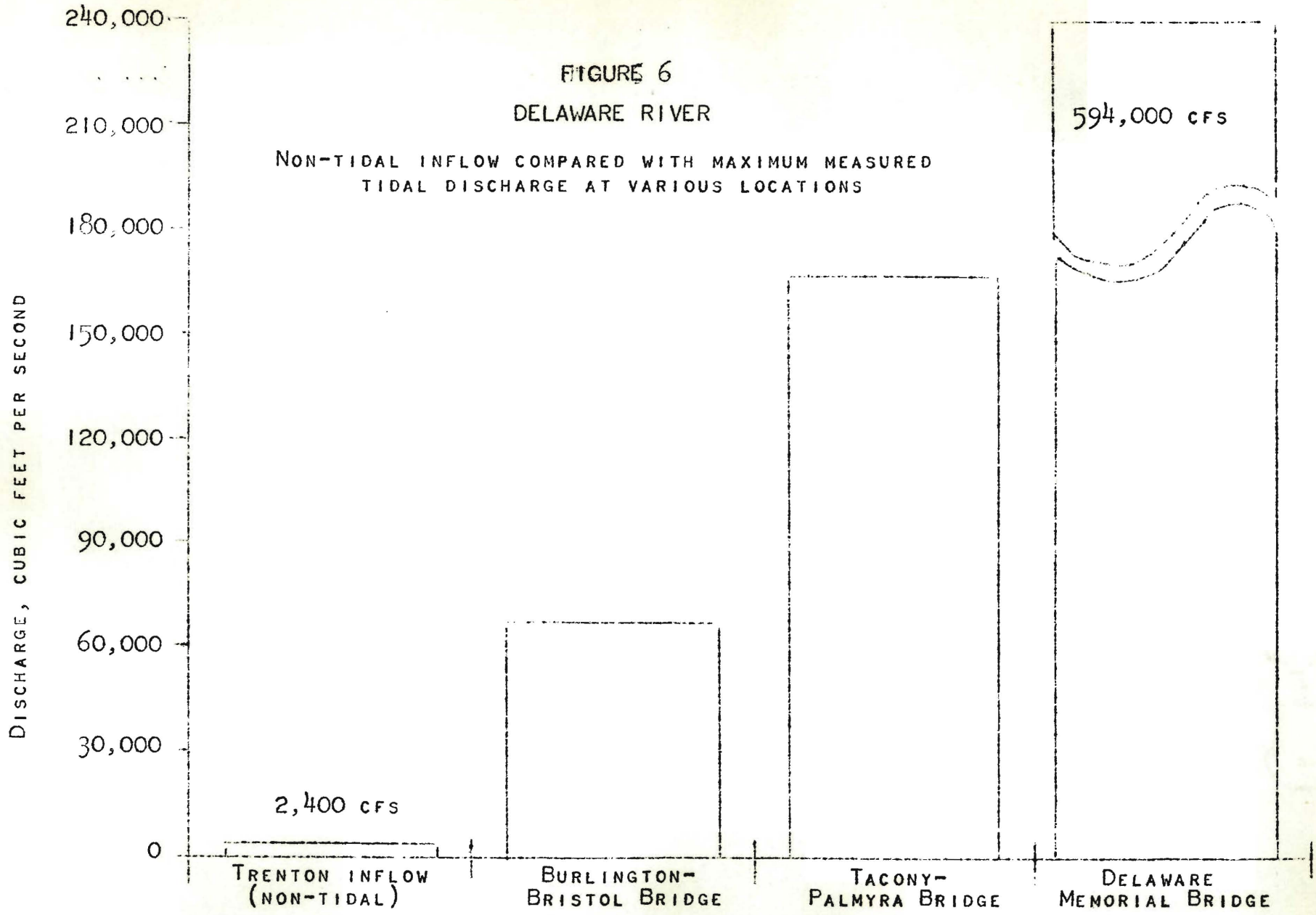


FIGURE 6
DELAWARE RIVER
NON-TIDAL INFLOW COMPARED WITH MAXIMUM MEASURED TIDAL DISCHARGE AT VARIOUS LOCATIONS
DISCHARGE, CUBIC FEET PER SECOND
240,000
210,000
180,000
150,000
120,000
90,000
60,000
30,000
0
2,400 CFS
594,000 CFS
TRENTON INFLOW (NON-TIDAL)
BURLINGTON-BRISTOL BRIDGE
TACONY-PALMYRA BRIDGE
DELAWARE MEMORIAL BRIDGE

THE INTERSTATE COMMISSION ON THE DELAWARE RIVER BASIN

U.S. PUBLIC HEALTH SERVICE TIDAL ESTUARY STUDY

Earl J. Anderson, Project Director
Delaware Estuary Study, U. S. Public Health Service

October 15, 1962

COMPREHENSIVE WATER QUALITY STUDY OF THE DELAWARE ESTUARY

By

Earl J. Anderson
United States Public Health Service, Region II

From a 1957-58 Public Health Service study in the Delaware River Basin it was evident that the quality of the water in the Estuary, particularly the stretch from Philadelphia to Marcus Hook was poor, especially so during the summer months. There was increasing concern about the capacity of the Estuary to assimilate wastes. As a result the Public Health Service was asked, under authorization of the Federal Water Pollution Control Act, to undertake a cooperative study to develop a comprehensive program for water pollution control there. We have started such a study in cooperation with Incodel, the Delaware Water Pollution Commission, the New Jersey Department of Health, the Pennsylvania Department of Health and the City of Philadelphia, Department of Sewers and Water. Other Federal agencies will also cooperate.

The scientific investigation of the quality of the water of the Delaware Estuary from Trenton to Delaware Bay has a threefold purpose:

1. To obtain a better knowledge of the natural and man-made contributions to the present condition of the Estuary, as well as all waste treatment systems there.
2. To develop methods of forecasting the variation of the water quality.
3. To develop methods of optimum management to control the quality of water in the Estuary.

The first step of the study entails the processing of large amounts of data, obtained from continuously recording water quality monitoring stations. These are operated jointly by the City of Philadelphia and the U. S. Geological Survey. The City is supplying an average 4,000 items per week on the quality

of the Estuary. This includes such information as water temperature, oxygen content (important for a balanced fish population) and salt content. These data are being supplemented by additional weather information such as precipitation, wind and sunlight from the U. S. Weather Bureau and the Philadelphia Electric Company. Operating data are also being received from municipal sewage treatment plants. Altogether some 20,000 items per week on all aspects of water quality will be processed. These data will be analyzed on a computer to determine the effects on water quality from a variety of causes, both natural and man-made.

In addition, a continuous year-long program of weekly river sampling has been undertaken. Fourteen river stations between Marcus Hook and Trenton are visited each week by boat. Analyses of the water samples for dissolved oxygen, temperature, and pH are made on board the vessel. The remaining portions of the water samples are taken to the Public Health Service laboratory located at the Raritan Arsenal, Metuchen, New Jersey. Here the samples are further analyzed to determine amounts of chlorides, sulphates, turbidity, and microscopic organisms.

On these weekly runs the Pennsylvania Health Department is cooperating by collecting and plating bacteriological samples for incubating and counting in their laboratory at Philadelphia. New Jersey will alternate with Pennsylvania on the bacteriological sampling program. Biological studies on bottom samples will be made by the Public Health Service.

The Estuary field sampling program is designed to fill the gaps in present information. In addition, data on industrial waste discharges are being obtained for us by the States through an inventory of industries which discharge to the Delaware tidal system. Sampling and analysis of some of the industrial wastes will be required in order to complete the picture.

Included in the analysis of industrial waste samples will be an ultimate oxygen demand test. This is necessary to determine how much organic material is being stabilized in the Estuary at any one time. At the present time wastes are evaluated on the basis of a five-day bio-chemical oxygen demand test, but due to length of time required for complete stabilization and for passage from Trenton to Delaware Bay, it is necessary to have more complete information on the amounts of these wastes remaining.

Work has also started on step two of our program - - the development of methods of forecasting the variations in water quality. Water quality predictions can be made now based on experience and judgement. However, computers can be used to predict water quality for a particular stretch of the river, on a more scientific and accurate basis.

What can be gained by attempting to forecast water quality? First, it will enable us to predict more accurately the quantity of water available for future use. If it is possible to forecast water quality much the same as our weather is forecasted, some problems can be avoided or at least alleviated. For example, a good quality forecast may indicate that the stream will not be able to support an impending fish run downstream. It then might be possible to raise the aeration of the stream, increasing the DO, or to increase the flow in certain areas, triggering fish movements at a more opportune time.

Also, knowledge of future water quality variations at municipal and industrial water intakes can be of significant economic value in savings in cost of chemicals.

One of the basic problems in controlling our weather today is the tremendous scale of the atmospheric phenomena and the nebulous boundaries involved. In contrast, any body of water under consideration has definite boundaries such as the river bed and banks and the air above - - so that we may consider a segment of this mass and the effect that the many variables

may have on it. Variables to be predicted will be selected after consultation with the interested agencies and industry. At the present time, dissolved oxygen appears to be one of the more likely variables, and all factors playing a part or having an effect on the amount of dissolved oxygen in the water will be programmed for computer analysis. Some of these include flow data, waste discharges, sunlight, precipitation, turbidity, etc. This analysis should predict the future conditions of the Estuary. Should the predicted conditions be unsatisfactory, remedial steps can be taken to avoid them. Water quality forecasting has long term as well as short term possibilities. The short term prediction would involve considerations in the immediate future, and includes planning for short term operational procedures that might have an effect on any unsatisfactory forecast for a section of the Estuary.

When procedures have been developed to some degree of reliability, we can then develop satisfactory methods of water quality management on both a short term and long term basis. Thus it is expected that this study by the Public Health Service will assist the State Water Pollution Control agencies and the Delaware Water Pollution Commission in developing a sound comprehensive program of management, to preserve or improve the water quality of the Delaware Estuary.

The inventory of water conditions in the Estuary and the ability to forecast changes in the system will be the basis of an over all water quality management program. Through a cooperative program involving the State authorities, the Commission, and the Public Health Service, this broad control program can preserve and improve the water quality of the Delaware Estuary.

THE INTERSTATE COMMISSION ON THE DELAWARE RIVER BASIN

ECONOMIC CRITERIA FOR DESIGN OF REGIONAL WASTE DISPOSAL SYSTEMS

Allen V. Kneese,
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Resources For The Future

October 15, 1962

Economic Criteria for Design of Regional Waste Disposal Systems

Allen V. Kneese*

Before the Delaware River Basin Commission and Water
Resources Association of the Delaware River Basin
Joint Conference on Water Resources
Pocono Manor, Pennsylvania, October 16, 1962

The recent report on the research findings of the Senate Select Committee on National Water Resources has given a new perspective to water resources problems in the U.S. 1/ It replaces the prevalent image of future quantitative shortage on a nationwide scale with the conclusion that in most regions, especially in the East, water supply is much more than adequate to meet projected evaporation and transpiration which will result from the various uses which man makes of concentrated water supplies (lakes, streams, underground aquifers). But it also concludes that presently dependable supplies are in general far from adequate to provide dilution of future municipal and industrial waste discharge. This result emerged even when high levels of waste treatment were assumed. The conclusion was based on the assumption that current relationships of wastes produced to population and economic activity would continue, that a rate of 4 PPM of dissolved oxygen and non-toxic conditions for fish life were to be maintained in all streams.

It was further assumed that standard biological treatment and augmentation of low streamflow (by releases from reservoir storage) would be the only devices used to deal with pollution loadings. Given these assumptions, the report

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*Resources for the Future, Inc. The views expressed are those of the author and not necessarily of his organization.

1/ U.S. Senate Select Committee on Water Resources, Water Resources Activities in the U.S., Water Supply and Demand, Committee Print 32 (Washington: USGPO, 1960), and Water Requirements for Pollution Abatement, Committee Print No. 29 (Washington: USGPO, 1960).

concluded that large-scale extension of the degree of waste treatment and reservoir space to augment low flows would be needed. It was calculated that a minimum cost combination of these facilities would require a national investment of perhaps $100 billion (1954 prices) by the year 2000.

This is indeed a huge sum. By contrast, the cost of completing the Bureau of Reclamation program of multipurpose development is estimated at a mere $4 billion after 1954, and the aggregate of federal appropriations for water resources development from 1824 to 1954 was reported to have been only $14 billion. This includes all the impressive dams, power plants, irrigation, and diversion works which all of us have seen at one time or another.

The preliminary estimates of the Senate Select Committee study cannot be viewed as more than broad indicators of the potential magnitude of various aspects of water supply problems. They do suggest, however, that achieving fairly clean streams throughout the U.S., in view of expected future economic-demographic development, will involve public investment far higher than in any other field of resources development or conservation. This conclusion has special force in the Eastern U.S. where the actual depletion of water supply is hardly a problem but where immense industrial and household waste loads are put into streams. Moreover, while parts of the West will undoubtedly continue to show very high percentage rates of growth, by far the greatest absolute future growth will be in the already comparatively heavily populated and industrialized East.

The magnitude of the task of managing water quality and the great need for the most efficient quality management has called forth organizations a major or primary purpose of which is to plan socially optimal regional waste disposal systems. Among these is of course the Delaware Commission, whose work in water resources management will be observed with great interest in the coming years by everyone concerned with water resources.

I will begin my presentation on economic criteria for the design of regional waste disposal systems by indicating briefly how pollution gives rise to social costs which are not reflected in private calculations and by pointing in a general way to the implication this has for the best allocation of society's resources. Then I will describe how the matter of designing a regional waste disposal system arises as a problem separate from that of rectifying the distribution of social costs. In my view these are the two basic issues which a regional authority such as the Delaware River Basin Commission will face with respect to the pollution problem.

Let me indicate them once more. (1) Approximating an optimal system for the disposal of the region's wastes, and (2) Distributing the costs inevitably associated with waste disposal in a socially optimal way.

A major point of my presentation this morning is that these two problems, while distinguishable, are strongly interrelated.

In the U.S. we generally depend upon the market place to guide production in such a way that consumer demand is satisfied as well as possible, given the limited amount of resources at the disposal of society. I think it is the concensus of most economists and other economically informed persons that this process works quite well for most goods and services. However, it is possible to identify instances in which the individual decision making units of our decentralized society fail to make decisions in the public interest. This is because under some conditions they have no incentive to include the full ramifications of their decisions in their calculations or perhaps even to find out what the full results are.

One of the basic conditions for satisfactory social results from the decisions made in the marketplace is that the technical conditions of production and consumption be such that the costs and benefits of performing a given act fall upon and accrue to the economic unit which performs it. This condition is often not fulfilled in private water resources development and its lack of fulfillment, in regard to waste disposal, is the essence of the pollution problem.

If some costs can be shifted to other economic units, the private costs incurred by a particular economic unit do not correspond to the full cost to society. Consequently, resource allocation is distorted even though markets function in an otherwise satisfactory fashion. Let me illustrate with an example not connected with water resources. If the employment of a mother results in the delinquency of her children, private costs of the employer (i.e., the wages) do not equal social costs. The latter may include such things as property damages, extra police, etc. Economists often call indirect effects of this kind "spillover" or "external" effects.

Water pollution, together with smoke nuisances and damages, are the economist's classic examples of such "spillover" effects. Where "spillover" damages due to water pollution are significantly large, the general type of distortions which occur can be readily foreseen.

1. The costs of some economic units are understated (due to apparently costless waste disposal into water courses) and some are overstated (imposed damages and treatment costs). This tends to induce over-production and consumption of some items and underproduction and consumption of others. For example, the upstream paper mill which dumps its wastes into water without bearing any of the downstream costs produces paper which is artificially "cheap." In effect, it pays nothing for the use of a valuable resource, i.e., the waste, dilution,

degradation, and carriage capacity of the water course. From a social point of view the value of this resource is measured by the alternate uses of the water. Failure of the polluter to consider the reduced value of water in other uses which are made more expensive or foreclosed entirely by his pollution is a, perhaps the, basic element of the pollution problem.

2. Because the polluter does not consider the social cost of his actions, he is induced to produce too much waste. Because he may dispose of "waste" material at a cost to others, not to himself, he makes a lesser effort (i.e., spends less money) to design and operate industrial processes in such a way as to conserve materials, than if the full social costs of waste disposal were met. The efficacy of process engineering and materials recovery processes in reducing waste loads has been richly demonstrated in West Germany by the Genossenschaften (regional water resources authorities in the main industrial area of West Germany), and by various instances in this country. Moreover, studies of waste loads generated per unit of physical output by plants producing identical goods but with different productive processes suggest the degree to which wastes can be engineered away. This emphasizes the importance of regional water resources authorities providing the appropriate incentives for such procedures. A society which neglects the off-site costs of waste disposal or under-values them will waste too much. Moreover, in such a situation there will be no treatment of waste water effluents even when such treatment is less costly than water supply treatment or the value of water use opportunities foregone downstream.

These points having been made, it appears that the way to deal with the pollution problem is to redistribute costs. As a matter of fact, under some conditions this can be considered the answer. If all the downstream opportunity costs of pollution could be identified, expressed as monetary values, and levied

upon polluters, private incentives could be relied upon to approximate proper levels of treatment, optimal process and product adjustments by manufacturers, and appropriate industrial location decisions. All these decisions would have reflected in them the real costs of waste disposal as they do the wages of labor, outlays for materials, and other costs.

Industrial plants would then tend to take steps to reduce waste loads by all relevant means (treatment, and process and product changes) until the costs of all these measures were equated at the margin with the reduction in damages which they produce. In other words, until the manufacturer could no longer profitably "trade off" an additional dollar spent to reduce wastes discharged into the water for more than additional dollar in reduced effluent levies or charges.

In effect, a situation would prevail in which attempts to minimize private costs (i.e. to produce output efficiently) would also produce a minimization of costs to society. This would, of course, not be the result of the laudable private motivation to minimize costs if waste disposal costs are neglected in private decisions. Similarly a system of assessing downstream costs on communities would give them an incentive to treat their wastes to the point at which the damages avoided downstream (i.e. the effluent charge avoided) is just equal to the cost of producing a further increment of treatment. These adjustments would mean that the sum of the costs associated with waste disposal (including pollution damages) would be minimized. 1/

1/ It is notable that this result does not require the payment of compensation to injured parties -- indeed, if compensation is to be paid on equity grounds, the manner of payment must be carefully framed to avoid introducing inefficiencies.

In principle this objective can be approached by imposing effluent standards and by directly controlling industrial location instead of imposing effluent charges, and these procedures are frequently proposed and used. However, it should be understood that to use these devices in an approximately ideal manner a pollution control authority would need at least as much and in many cases more information than if charges representing downstream damages were laid upon the effluent. This is particularly true in light of the streamflow variation which strongly influences the level of social costs associated with pollution over time. This is a point I wish to return to later.

However, I wish to briefly follow up the point about information requirements, without at present considering the complexities introduced by streamflow variation. To use such devices as effluent standards and zoning in an ideal fashion, the authority would have to know the locational advantages and disadvantages of a particular site (not only the effects of location there on costs associated with waste disposal). It would have to know the opportunities for process and product adjustments, and for treatment of industrial wastes, and it would have to know the costs of all of these alternatives in order to arrive at optimal effluent standards at each location. To the degree that the authority does not itself find it desirable to operate a waste disposal system merely imposing the downstream costs of polluters upon them, would accomplish desired results without such extensive knowledge of results. In effect, many of the most difficult decisions would be imposed on individual decision makers who are more likely to possess the requisite information.

It may, of course, be argued that downstream damages (such as reduced aesthetic or recreational amenity) defy evaluation and cannot therefore be accurately mirrored in effluent charges. Two points can be made in this regard --

(1) Considerable steps have been made toward providing a basis for assigning at least minimum values to water resource related goods commonly termed intangible, and (2) A moment's reflection will show that whatever regulations are adopted (say, effluent standards), imply an evaluation of downstream costs. For example, if we impose an effluent standard on a community or an industry which it will cost $1 million to meet, we are in effect saying that at least $1 million worth of damages are avoided downstream. In my view, the possibility of using effluent charges as a flexible and effective administrative tool merits serious attention.

It may be noted that recent developments in the computer simulation of the effects of wastes in streams hold great promise for more rational methods of quality control and point toward a very useful tool in the assessment of pollution costs.

To return to the main theme, however, in general it may be said that procedures such as effluent charges, effluent standards, and zoning may be viewed as efforts to produce more socially meaningful distributions of costs.

Does this mean then that the function of regional water resources authorities with respect to water pollution is simply to administer better distributions of costs? The answer is no in all instances where some of the most economical methods of controlling water quality are not available to individual decision units in the planning area. When this is the case the problem of system design presents itself.

System design arises as a separate problem when economies of large scale exist in waste treatment, or when measures such as augmentation of low streamflows by reservoir releases or artificial rearation of streams are efficient alternatives to treatment over certain ranges. In other words, when economical abatement measures which cannot be undertaken by individual polluters exist.

In virtually all highly developed regions efficient alternatives will be available the use, or the "best" use, of which cannot be induced by levying the net social costs of their pollution on polluters. In these cases a social cost minimizing solution will demand planning of the system by an organization which can comprehend the significant large-scale alternatives. Such an organization (presumably a public agency in the U.S.) is thus confronted with the dual problem of designing the system and allocating system costs in such a way as to induce efficient resource use. 1/ Moreover, the planning authority must anticipate the, perhaps very substantial, impact of its allocation of system costs upon the amount of wastes generated in the basin.

Ideally the public authority should plan and implement a system which equates the costs of all relevant waste disposal alternatives at the margin of their use. As already indicated, costs of waste disposal include all manner of waste treatment and water supply treatment, methods of flow regulation, methods of conforming waste discharge to streamflow, changes in industrial processes, and pollution damages.

Under U.S. conditions, low flow augmentation of streams by means of releases from reservoir storage would ordinarily be an element in an optimum system. Relationships of complementarity and substitution exist between flow augmentation and other aspects of multipurpose development such as navigation, irrigation, flood control, and hydroelectric power generation, and these relationships must be considered in computing the opportunity costs of utilizing flow augmentation for pollution abatement. Thus the problem of planning efficient waste disposal-water supply systems is an integral element of the over-all water resources planning problem.

1/ For a more detailed discussion of the problems of waste disposal system design, see Allen V. Kneese, Water Pollution-Economic Aspects and Research Needs, Resources for the Future, Inc., 1962.

In sum, the results of all relevant alternative water resources system designs and operating procedures would have to be considered and a solution derived which simultaneously indicated the optimum combination of system elements and their operating procedures. In industrial areas such a solution would necessarily entail a system of charges or other measures such as effluent standards and zoning in order to generate the optimum amounts and locations of waste discharge. If this were successfully done, the solution would be "efficient," maximum benefit would be obtained from the available water resources, and, as the latter implies, the real cost associated with the disposal of an optimum amount of wastes would be minimized.

To recapitulate the ideas I have stated rather cryptically in the past few minutes, let me indicate again the general economic characteristics of a regional system of waste disposal which would minimize all costs associated with waste disposal. In such a system it would be impossible to reduce costs by "trading off" between alternatives. This is what is meant by saying that the marginal or incremental costs of all relevant alternatives would be equalized. In such a system costs could not be lowered by doing a little less sewage treatment and permitting a little more pollution damage, or by doing a little more augmentation of low flows and a little less treatment of sewage, or by doing a little more engineering away of wastes and a little less water supply treatment, and so on for each set of alternatives. If the augmentation of low flows is one of the alternatives, then its cost is lowered (and it "trades off" better) against other alternatives, like waste treatment, if it simultaneously serves other purposes like maintaining the stream high enough to maintain navigation. Conversely, if the stored water can be put to other uses, like generating power, flow augmentation "trades off" less well against other alternatives.

A regional authority with the power to plan, construct, and operate, and finance abatement works could well utilize such economic criteria as guidelines since minimizing the costs associated with waste disposal in the sense that I have used the term is not only consistent with but required by the widely accepted objective of obtaining the largest net benefit from water resources.

Since some of the more important decisions affecting the amount and character of wastes entering the system, and governing the methods used to adjust waste loads in industrialized basins, might best be left in the hands of private decision makers (i.e., waste recovery, process and product changes, industrial location, pre-treatment of wastes), the regional authority would have to plan carefully to provide incentives for the optimum use of these measures. I have already suggested that effluent charges might play an important role in this regard.

Furthermore, when scale economies in treatment, opportunities for flow regulation, rearation of streams, etc., present the regional authority with a separate problem of system design, the use of a method of distribution costs of the system by means other than tying them to the construction of specific abatement works becomes essential.

For example, economies of scale in treatment may mean that wastes from factory A are given far reaching treatment because it has a large effluent volume and costs per unit of waste removed are comparatively low. Say plant B has only a very small effluent volume and treatment would be very expensive. Desirable (cost minimizing) stream conditions may be attainable by treating only factory A's wastes at low cost and not treating B's at all. If an appropriate method of assessing costs exists, part of the cost will be paid by B and both A and B can benefit because total costs are lower than they would have been if the same result had been achieved by two smaller plants. The German Genossenschaften, the associations

which manage water resources in the Ruhr area of West Germany, and which I have mentioned earlier, provide a precedent by having worked out rather sophisticated procedures along these lines.

I have certainly greatly oversimplified the problems of planning a system. For one thing, adequate evaluation of some types of pollution damages, for example, to aesthetic amenities, to recreation, and in some instances to public health, has a long way to go. Yet as I have previously indicated in a different context, progress has been made. Moreover, there are ways of incorporating certain politically or administratively determined physical goals with data on economic values into a system which minimizes measurable costs while meeting the goals which have been set. Such a goal might be that, in the interest of aesthetic amenity, there are to be no floating materials on the water or, in the interest of sport fishing, dissolved oxygen is not to drop below 4 PPM more than once in 10 years. When such goals actually constrain a system that would minimize measurable costs, i.e., abatement measures are carried further than they would have been in the interest of controlling measurable pollution damages, then such a goal can be assigned an implied cost. This cost is the difference between what the system would have cost without the goal and what it costs with it. This can provide a basis for reconsideration of the goal by competent authority in light of its costs and a possible resetting of the level of the goal or its exclusion altogether.

I will not speak further of the problems of handling goals not readily measurable in dollars and cents except to reiterate that there are ways of handling them and they need not frustrate the planning of systems which are efficient with respect to measurable economic values. Moreover, the appropriate economic design criteria and criteria for the distribution of system costs are in principle very little different from those applicable to a simple system in which all values are measurable, although of course the system itself may be very different.

I would, however, like to refer briefly to one other complication in the economics of regional waste disposal systems. This is the problem of streamflow variation. As all of you know, the concentration of most pollutants in stream waters is not steady over time even when the amounts discharged are. Rather it is inversely related to the rate of streamflow. Thus pollution damage tends to be heavily concentrated in low flow periods. This presents problems not only for system design but also for devising means of providing waste dischargers with the incentive to vary waste discharge with streamflow to the extent that this is more economical than alternative abatement measures or permitting pollution damage.

I won't speak much about the system design problems resulting from hydrologic variation. I just wish to make two points: (1) streamflow variation means that the costs of pollution damages and abatement measures become matters of mathematical probability rather than being determinate and fully predictable through time, and (2) the fact that we are dealing with events which reach high intensity only on comparatively rare occasions means that in the interest of minimizing costs over time, careful attention should be given to alternatives which may involve high operating costs but which require relatively little capital investment. For example, the use of high rates of aeration in activated sludge plants, addition of chemicals at the primary stage of effluent treatment, occasional barging of wastes to the sea, etc. These alternatives involve high operating costs but since they need be used only rarely and for comparatively short periods of time, they may often be found to "trade off" positively against additional investment in reservoir capacity for flow augmentation or increased size of treatment plants.

I do wish to spend a few more minutes on the matter of providing appropriate incentives to vary wastes discharged into the system over time.

The point has already been made that the costs associated with pollution vary strongly over time. This is certainly true of damages. Since the concentration of pollutants rises during low flows, fish kills, increased water treatment, costs, effects associated with salinity, and hardness, and, in waters extremely heavily loaded with organic pollutants, anaerobic conditions are more likely during low stream stages. The costs of operating a quality control system in an optimal fashion also rise during such periods. During these times chemicals would be added to aid precipitation, aeration rates would be stepped up, power turbines and other devices might be used to increase rearation of the stream, and low flows might well be augmented by reservoir releases. In regard to the latter, while there might be little out of pocket operating costs, opportunity costs arise if there are substitute uses for the water. The costs may be foregone peak power which could have been generated or lost recreation opportunities due to drawdown of the reservoir.

Thus it is clear that the social costs of pollution (including the cost of damages and the cost of abatement measures) rise strongly during periods of low flow. Consequently a rationale exists for levying charges on effluents on a variable basis in much the same manner that electrical utilities levy higher rates for "peak loads."

If it were clearly uneconomical to change the amount and/or quality of waste discharge over short periods of time, it might not be a matter of great concern whether or not costs levied upon polluters varied correspondingly over time. However, it appears probable that measures to change the pattern of discharge would enter economically into a quality control system designed to minimize costs.

For example, depending upon the location of a manufacturing concern and upon attendant land values, it may be less expensive for the company to withold its waste discharge temporarily in a lagoon rather than bear its share of the costs of storing and, at long intervals, releasing a much larger volume of river water. In addition, if retention time is significantly long, such retention ponds will provide a degree of organic waste stabilization. In some instances, especially where the product is storable, it may be more economical to reduce or halt production during low flow periods rather than to provide additional treatment or dilution capacity for an unchanged effluent. In other instances it may pay the manufacturer to provide temporary treatment (like chemical neutralization of acids) rather than meet the full costs of putting his effluents into the receiving water during low flow periods. In light of such possibilities, incentives should be provided to use them to an optimal degree.

The work of the German Genossenschaften indicates that reasonably satisfactory methods of distributing costs among polluters can be worked out and the German methods can certainly be improved upon. However, the Genossenschaften levy charges only on an annual basis which permits them to get by with a relatively few effluent samples a year. These they use to establish the parameters of effluent quality in their cost distribution formula. They depend upon reports from the manufacturers to indicate the quantity of effluents discharged.

Application of peak load pricing would, however, require more or less continuous monitoring of effluent quantity and quality. My understanding is that recent technological developments in automatic monitoring devices hold promise that comparatively simple and inexpensive devices may be used to continuously measure a variety of quality parameters. It is probably not visionary

to foresee a time when regional authorities will be in a position to continuously and economically record relevant indicators of pollution for every major outfall in an entire basin.

Certainly few organizations have ever been created which are in as good a position to respond constructively to the challenges which face them as in the Delaware Commission. The authority provided under the Compact permits the application of imaginative approaches in order to achieve the highest benefits of unified water resources management and planning for the people and industries of the Delaware Basin. I hope this talk has provided a few stimulating thoughts concerning such approaches.

THE INTERSTATE COMMISSION ON THE DELAWARE RIVER BASIN

EVOLUTION OF THE COMPREHENSIVE PLAN

Herbert A. Howlett, Chief of Planning
Delaware River Basin Commission

October 15, 1962

EVOLUTION OF THE COMPREHENSIVE PLAN

by

Herbert A. Howlett, Chief of Planning
Delaware River Basin Commission

If statistics can be trusted, early this morning a child was born in Mercer County Hospital, in Trenton. This and other similar events are significant to us, because according to information published by the Pennsylvania Department of Public Health, each person in the United States at the present time requires an average of 1,685 gallons of water per day. This, of course, includes the water necessary to bath the child, to raise the crops to feed him, to cook the food, to manufacture the steel necessary to build the bed, etc., etc., etc. While I am not here to debate whether this child may have been a part of a planned family, it is reasonable to assume that any planning that may have been done did not give any consideration to where the 1,685 gallons of water is to come from each day to support this child throughout its life. This is indicative of the reliance the public places on its governmental agencies assuming that at all times water will be available by simply turning on the faucet and complaining about the price of the bill at the end of the month.

The public may be wrong in taking such a callous position, but, whether it is or not, it does assume that governmental agencies will watch out for its welfare insofar as water is concerned. This leads us then to the position we now find ourselves in of having a Delaware River Basin Compact, which was ratified by the representatives of the people of Delaware, New Jersey, New York, Pennsylvania (as well as those of the other 46 states), and signed by the President, and by the governors of the signatory states. We find at the moment, we also have elements of a Comprehensive Plan the major physical features of which were taken from a one-time survey conducted by the U. S. Army Engineer District, Philadelphia. However, there is more to a comprehensive plan than physical works. It must also cover such items as goals, policies, relationships

and approaches to solutions. Therefore, there is much more to say in regard to the "Evolution of The Comprehensive Plan" for the Delaware River Basin.

The most basic elements of sound planning are that the planner must have a long ranged goal and an immediate objective. The planner may, with the passage of time, find that his goal has changed. However, he should be intelligent enough to recognize that people change, that conditions change and, therefore, that goals may change. Not withstanding these possibilities, and indeed probabilities, there should be a stated goal before him so that he will be constantly reminded of the direction in which he is traveling. You will find some who are extremely reluctant to state their goal in simple terms. They will hedge when asked, or qualify their statements to a point where they become meaningless. My position is that a governmental agency should be able to define the utopian situation it is seeking for its constituents. I also feel that a good goal statement should be one that can be contained in a single sentence. Our planning goal is "to guide the development of the water resources of the Delaware River Basin so that present and future generations may enjoy freedom from devastating floods and the maximum benefits from the river system, including those from its recreation resources".

In order for us to accomplish this goal, it will first be necessary for us to determine what information is available where; who is doing what where in the Basin in the field of water resources planning and/or development; what are the possible uses of the water resources of the Basin and are they compatible, desirable or even wanted by the people. We have laid out nine Planning Programs which we will be conducting during the remainder of the 1962-63 fiscal year and during the 1963-64 fiscal year. Our Executive Director, Mr. James F. Wright, will discuss these programs in greater detail tomorrow. They are designed to acquire sufficient data on the many factors related to water supply and water use so that our staff can, (1) prepare annually a meaningful Basin-wide water

resources program - - a statement of supply vs demand and a list of the works proposed for construction during the coming 6 years, (2) review projects proposed by any agency which might affect the resources of the Basin for which the Commission has management responsibilities and (3) continually update or evolve a comprehensive plan. While this may appear to be a very limited objective, I feel that it is wiser for us to carefully select staff and develop a sound foundation for our longer ranged programs rather than to proceed without this foundation and without the benefit of well thought through basic policies and procedures. Therefore, as part of our immediate objective, we will be selecting competent staff, compiling and/or locating information which will be essential to us, analyzing these data from the viewpoint of our ultimate goal, and developing and recommending fundamental policy for adoption by the Commission for inclusion in the Comprehensive Plan.

A major function of the Delaware River Basin Commission during the "Evolution of The Comprehensive Plan" for management of the Basin will be to act as coordinator among many existing governmental and private agencies interested in the water resources of the Basin - - to develop a recognized spirit of teamwork. It has never been conceived that the Commission would be the constructor, or operator, of all of the various physical features of the Comprehensive Plan. Indeed, the existing works, as well as works to be constructed by existing and future agencies of all level of government will be part of the evolved Comprehensive Plan. However, these existing agencies cannot do the whole job and are not in a position to and I quote the Compact, "to apply the principal of equal and uniform treatment to all water users who are similarly situated and to all users of related facilities, without regard to established political boundaries". It will be necessary for the Commission to see that all projects are compatible. We may very well find that the Commission is the agency suited best to construct and operate certain projects having broad areal

benefits. So, we will be working toward the development of a team of our own organization, as well as forwarding the idea of teamwork among the signatory parties to the Compact. We will be taking the Basin-wide point of view in the evolution of a Comprehensive Plan.

Let's turn now to some of the factors which must be considered in the evolution of a Comprehensive Plan. First of all, such a plan must be workable, i. e., it must be physically feasible of construction with the resources available, including the financial resources available. Next, the plan must be subject to an orderly sequence of development. Here I refer to a plan which is capable of being staged over a long period of time and, yet, each stage being compatible with other features. And, next, the plan must be realistic. By this I mean it must recognize the desires of the people in the Basin and must accommodate these desires. And, finally, it must be a coordinated plan that takes recognition of the many separate uses to which the Delaware River Basin and the water resources of the Basin might be utilized. For example, as a previous speaker pointed out, a given reach of the river might be used for navigation, for water supply, for sewerage disposal, for recreation, and for fishing. Other sections of the river might not include all of these potential uses but might include others such as the generation of hydro-electric power. Harking back to the broad goal that I have stated earlier, the potential uses of the water resources of the Basin should be so amalgamated that they will result in a Comprehensive Plan which recognizes the desires of the people and the full potential of the water of the Delaware River Basin.

So, at the present time we find ourselves with portions of a Comprehensive Plan, and also with a recognition that a Comprehensive Plan is a dynamic object which must be continually monitored and modified. To continually modify and/or evolve a Comprehensive Plan, we must have a

Goal - objective

we must develop

Teamwork - an Overview

The plan must be

workable, orderly, realistic, coordinated.

With the evolution of such a Comprehensive Plan, in so far as this Basin is concerned, future parents will need not worry about a water supply to satisfy the demands of their children.

And so what do we do now? The answer can be taken directly from these keywords - we TO TO WORC - and just as we have imperfection here, we will have imprefections in our Plan which we will continually strive to improve upon, reaching toward one ultimate goal.

THE INTERSTATE COMMISSION ON THE DELAWARE RIVER BASIN

STATUS OF MAJOR MULTIPLE PURPOSE PROJECTS

Colonel T. H. Setliffe,
Philadelphia District Engineer
U. S. Army Engineers

October 15, 1962

Presentation by Colonel T. H. Setliffe
at Delaware River Basin Water Resources Conference
at Pocono Manor Inn, Pocono Manor, Pa.
15 October 1962

Gentlemen.....

Jim Allen requested that I talk to you about.....

LIGHTS OUT

VU GRAPH ON

.....the status of the multiple purpose projects in our comprehensive plan. As you know....both the Senate and House sub-committees last week approved authorization of the eight multiple-purpose projects recommended in our report. These are .....

FLIP

HIDDEN VOICE

.....Tocks Island....Beltzville ....Aquashicola....Trexler....Maiden Creek....Blue Marsh....Bear Creek..... and Prompton.....the last two being revisions to existing projects.

VG OFF

We regret we have no money to report for Tocks Island.....so I can't derive any real pleasure out of describing the wonderful features of this fine project. In any event....each of you is familiar with the Tocks Island project....certainly the major features of the project are not unknown to you.

We have an artist's conception of Tocks Island Dam on display at the rear of this assembly hall. You'll also find two pamphlets.....

VG ON

.....dealing with Tocks Island on a table near the painting. The one prepared by my people.....

SHOW PAMPHLET

.....contains a description of the project and some discussion on the features and economics of the project. I believe you'll find the project map useful. The other brochure.....printed by the Water Resources Association....Frank Dressler ....goes into considerable detail on the dam and reservoir and especially on the real estate phase of the project.

VG OFF

Now then.....there is no sense in being sad over things that are not to be....at least for this year....so let's look at the bright side of recent events. We expected $100,000 for Beltzville. We have an artist's concept of Beltzville at the rear of the room. You'll also find a supply of these pamphlets.....

SHOW PAMPHLET

....which have the same type information as was developed for Tocks Island.

Beltzville blocks Pohopoco Creek.....about one-third of a mile from its

juncture with Sawmill Run....and some four miles east of Lehighton. (PAUSE)

The $13.8 million Beltzville Dam will look something like this.....

VG ON

.....4500 feet across the Pohopoco Valley.....and 160 feet above the river bed. It will be an earth filled structure with stone rip-rap facing. A gate....(POINT)....controlled outlet works will discharge through a conduit in the southern end of the dam. The spillway....with a channel in bedrock....will be on the northern end. (PAUSE)

VG OFF

It is a multiple-purpose project.....for.....water supply....flood control....and recreation. There's no electric power. (PAUSE)

The long-term storage provided by the Beltzville project.....some 40,000 acre feet....will provide a net yield of 80 cubic feet per second. this flow.....

VG ON

.....augmentation will help satisfy the water needs of Palmerton....Bethlehem....and Trenton-Philadelphia areas during the next 50 years. Beltzville helps in.....

FLIP

....reduction of flood damage in the heavily industrialized Allentown....Bethlehem....Easton areas....and at other locations along the Lehigh.

The Beltzville Reservoir will be able to....

FLIP

.....satisfy the recreational needs of some 500,000 people annually. The 13 mile-long shore line will be publicly owned space with five recreational sites. A total of 2,413 acres of land will be necessary for the Beltzville Project.....1,030 acres for construction of the project itself.....1,383 acres for recreation. The lake will cover 870 acres.....36% of the total. Facilities will be provided both for camping and one-day outings.....and hunting will be permitted in season.

VG OFF

At spillway crest level....elevation 641....the reservoir pool will extend some seven miles upstream....

VG ON

....or about a half-mile above the community of Trauchsville. No communities or railroad needs relocation; however, nearly five miles of county road will be relocated or improved.... and sections of two oil pipelines will also have to be moved....(PAUSE)....

VG OFF

NOW....as I mentioned earlier....we think Congress has appropriated $100,000 for Beltzville. What will this money be used for.....

Upon receipt of this money, we will immediately.....

VG ON

.....start surveys by both aerial....

submitted, or in the following spring, to determine the best site for the

and on-side methods. This work will continue throughout the year.....to include topography of the dam and reservoir areas, and start of surveys for real estate acquisition.....

FLIP

....Weather permitting....we will start subsurface explorations in the fall of the first year money is submitted, or in the following spring, to determine the best site for the dam and to provide a basis for preliminary design.

During the same period office work will.....

FLIP

.....update and expand hydrologic data and will initiate hydraulic design of the gates, conduit and spillway. The design and economic studies to establish the final site for the dam will be essentially completed by the end of the second fiscal year.

FLIP

....Coordination with the Delaware River Basin Commission and local, State and Federal agencies will continue throughout the year on such subjects as recreational development, relocations, water supply, pollution abatement, low flow augmentation and fish and wildlife.

VG OFF

Additional planning work, probably by contract, would be initiated for highway relocations and for real estate appraisals leading to land acquisition. A Board of Consultants for the Project will be constituted and functioning during the latter part of the second year.

Now....what about construction? About 21 months after we get planning money, we can get under way with construction.....

VG ON

....The first major contract will be for construction of the outlet works....intake channel....conduit....and outfall.

VG OFF

Relocations will begin about the same time. The next major contract will be for....

VG ON

....construction of the embankment ....spillway....and phase two of the outlet works....(PAUSE) Work on the recreational facilities will get under way about a year after the work on the second major contract begins. And, of course, this all hinges on the orderly receipt of necessary funds. If everything works out all right, we should finish Beltzville in about six years. It is interesting to note that we got our first money for engineering and design for Bear Creek in 1954 and we dedicated this dam 10 June 1961, although it actually provided flood control in the spring of 1961.

VG OFF

LIGHTS ON

As you can see....we are ready to move on Beltzville as soon as we get funds. We are also ready to move on Tocks Island when funds are appropriated.

Thank you.

THE INTERSTATE COMMISSION ON THE DELAWARE RIVER BASIN

WATERSHED PROTECTION AND FLOOD PREVENTION PROJECTS

Alvin C. Watson
River Basin Representative
United States Department of Agriculture
United States Soil Conservation Service

October 15, 1962

WATERSHED PROTECTION AND FLOOD PREVENTION PROJECTS IN THE DELAWARE RIVER BASIN

Mr. Chairman; Members of Incodel, the Delaware River Basin Commission, and the Water Resources Association of the Delaware River Basin; Ladies and Gentlemen:

It is a pleasure to be here and to give you a brief report on the watershed protection and flood prevention projects in the Delaware River Basin Commission's comprehensive plan and those in the various stages of planning. There are a total of 19 watershed protection and flood prevention projects at some stage of planning or development in the basin. At the outset, may I say that the land use and treatment work, so basic to all structural work, is moving ahead in good shape and, in general, is on schedule. The status of the structural work on the projects is as follows:

Three in New Jersey have been completed. Nine projects, three in New Jersey and six in Pennsylvania, are under construction or authorized for operations. Seven projects, three in New Jersey and four in Pennsylvania, are in various stages of planning.

The Pequest River project in New Jersey, a channel improvement job to prevent the flooding of agricultural muckland, was completed prior to the passage of the compact. The Town Bank, New Jersey, project, involving channel work and diking for flood prevention, was also completed. The Silver Lake-Locust Island, Pine Mount-Mill Creek, and Maurice River Cove projects, all in New Jersey and all involving primarily channel or diking work, as well as the Paulins Kill project involving channel work and three dams, have been included in the first phase of the Delaware River Basin Commission's comprehensive plan.

Presented by Alvin C. Watson, River Basin Representative, USDA, Upper Darby, Pa., at the Delaware River Basin Water Resources Conference, Pocono Manor Inn, Pocono Manor, Pa., Monday, October 15, 1962.

New projects in New Jersey in the planning stage are the Assunpink project, involving five multi-purpose reservoirs and six flood prevention structures; Repaupo Creek project, involving 12 miles of channel improvement; and the Salem River project, for flood prevention of agricultural land and water supply.

On the Pennsylvania side of the Delaware, there are 10 projects in various states of planning or construction. Five of these -- the Brandywine, Little Schuylkill, Lackawaxen tributaries, Brodhead, and Greene Dreher -- have been included in Phase I of the Commission's comprehensive plan. All of these projects have some dams with multi-purpose features with the exception of the Lackawaxen, which is for flood prevention only.

In the Pennsylvania portion of the Delaware River Basin there are 86 dams planned, 10 of which have been built. Nine dams are scheduled for construction in 1963. By projects, these breakdowns are as follows:

The Pocono project is in the early planning stage, and it appears that 16 flood prevention structures will be needed.

The Neshaminy is also in the early planning stage. Here, too, it appears that 16 structures will be needed. The U. S. Department of Agriculture will cooperate with the state government in a comprehensive study of the Neshaminy watershed. The study will include water needs and water supply for the next 50 years. It will encompass a state park; fish and wildlife development; and water supply for municipal, industrial, and agricultural uses. Tomorrow, you will hear from others, the details concerning the Brandywine, the Wissahickon, and the Neshaminy Watersheds.

The Wissahickon is in the planning stage, and a local grant of $30,000 was just made to assist in the development of a comprehensive

watershed plan for this project. It is expected the plan will include nine dams.

Mauch Chunk is likewise in the planning stage, and the plan calls for one dam to be developed in a unique way for maximum fish and wildlife, recreation, and water supply use. It is hoped to develop the full watershed area for recreation, and the project is attracting a great deal of attention.

Three structures are planned for the Kaercher Creek watershed (the work plan for this project was approved by Congress a few days ago), one of which will include, in addition to flood prevention, fish and wildlife development in cooperation with the Pennsylvania Fish and Game Commissions.

Four structures are planned in the Brodhead Creek area for flood prevention, and one is scheduled to be built in 1963. You may recall that during hurricane Diane 100 people were killed on the Brodhead. One flood prevention structure on the Brodhead will include a 10 acre recreation pool.

The plan for the Brandywine Creek watershed, involving a total cost of approximately $14 million, is for flood prevention, fish and wildlife and recreational development, and water supply. Ten structures are planned here, with one being scheduled for construction in 1963. Two of the sites will come under the ownership of the Pennsylvania Fish Commission and another will be owned by the Pennsylvania Department of Forests and Waters to be developed as a state park.

A total of four dams are planned for the Little Schuylkill area. Two have been completed, one is under construction, and one is scheduled for construction in 1963. Construction on the Locust Creek Branch of the Little Schuylkill is being carried out in cooperation with the Pennsylvania

Department of Forests and Waters and the Pennsylvania Fish Commission. Maximum development of this site has resulted in the county and state governments purchasing several hundred acres of land for a state park. This is a multiple purpose flood prevention and fish and wildlife reservoir. It will provide for a 75-acre lake in the state-owned and operated park. The dam on Little Schuylkill proper, which is scheduled to be built next year, will be the largest dam constructed in the Northeast under Public Law 566.

In the Greene-Dreher watershed 16 dams are planned, three of which have been completed and three of which are scheduled for construction in 1963. One site is planned for flood prevention with a 25-acre recreation pool. It is expected that others will have multiple purpose features before they are designed.

A total of seven dams are planned for the Lackawaxen tributaries; five have been completed and one is scheduled for construction in 1963.

In summary, three watershed projects have been completed at a cost of $1-1/2 million; nine projects at an estimated cost of $23 million have been approved for operations; seven projects are in various stages of planning. The small reservoir program in the watershed protection and flood prevention projects in the Delaware River Basin, planned or being planned, includes an estimated total of 100 dams. Forty-seven dams, including 3 in the Kaercher Creek project, have been approved for construction, 12 have been built, and 10 are scheduled for construction in 1963.

THE INTERSTATE COMMISSION ON THE DELAWARE RIVER BASIN

NEW TECHNIQUES FOR RELATING ECONOMIC OBJECTIVES, - ENGINEERING ANALYSES AND GOVERNMENTAL PLANNING IN - DESIGN OF WATER RESOURCES SYSTEMS

Maynard M. Hufschmidt, Director,
Harvard Water Program,
Graduate School of Public Administration
Harvard University

October 15, 1962

NEW TECHNIQUES FOR RELATING ECONOMIC OBJECTIVES, ENGINEERING ANALYSIS AND GOVERNMENTAL PLANNING IN DESIGN OF WATER RESOURCE SYSTEMS

by

Maynard M. Hufschmidt, Director
Harvard Water Program, Harvard University

In contrast to the presentations of Colonel Setliffe and Messrs. Howlett and Watson on the evolution of the Delaware basin plan and the status of individual projects, my talk will be on a more theoretical or abstract level; although I hope to show the close relationship between theory and completed plan.

Since 1956 I have had the good fortune to be associated with an outstanding group of scholars at Harvard University on a research enterprise dealing with techniques of planning complex water resource systems. On the engineering side this group included Professor Gordon M. Fair - who is well known by reputation to many of you - and Professor Harold A. Thomas, Jr. From economics we had Professors Robert Dorfman and, for a time, Professor Otto Eckstein. And from political science, . . . Professor Arthur Maass, who was primarily responsible for starting the enterprise and who has served continuously from the start as leader of the group. My role has been as full-time research associate to the group, whose members necessarily could give only a part of their time to the work.

Why did this group decide in 1956 to undertake this research project focussing on water system planning, or, as we call it, water system design? To answer this question we need to go back a bit into history.

The basic notions of comprehensive river basin development - one river - one plan and the multiple purpose approach - were stated in remarkably complete form as early as 1907 by President Theodore Roosevelt's Inland Waterways Commission. But many years were to pass before it was possible to put these notions to the test. In fact, the first tests were made not by the Federal

Government, but by local agencies. The planning studies of the Pittsburgh Flood Commission in 1912 and the Miami Conservancy District from 1913 to 1920 were pioneer applications of principles of comprehensive planning. In fact, the Miami Conservancy District flood control development was probably the first integrated system of reservoirs for a major river basin - although it was limited to a single purpose - flood control.

Of course, the Federal Government followed later with the "308" reports of the Army Corps of Engineers, the TVA development and the major basin wide programs on the Western rivers - the Columbia, the Missouri and others.

As river development projects became larger, more numerous and more complex, the planning agencies were faced with more and more difficult problems of formulating the best system plan. It was no longer possible merely to set certain physical objectives - such as an assured supply of a million gallons of water per day - and then devise the least-cost means of meeting the objectives. It was necessary to choose among various conflicting purposes, at least to some degree. And, in a complex system, these choices were far from obvious.

As the planning agencies struggled with these formulation problems, largely on a case by case basis, there developed in Federal water planning circles the principles and techniques of benefit-cost analysis. As many of the products and services of river basin developments were non-marketable - the standard financial pay-out tests were not applicable; there was need for "benefit" measuring rods to supplement and replace the financial measuring rods.

Furthermore, the Flood Control Act of 1936 established the criterion that the worthwhileness of flood control projects should be tested by determining if "the benefits, to whomsoever they may accrue, exceed the costs". Soon after, this test was adopted by all Federal water planning agencies as a gauge of project worth.

During the 1940's there arose an intensive effort by the water planning agencies to achieve consistency in benefit-cost analysis. In 1950, a sub-committee of the Federal Inter-Agency River Basin Committee produced the famous "Green Book" - Proposed Practices for Economic Analysis of River Basin Projects. This was followed in late 1952 by Budget Circular A-47 prescribing uniform economic and financial standards and criteria.

These principles, standards and criteria were primarily to serve as guides for the field level planner, and indeed they were very useful to him. But they were far from adequate guides. Planners were advised to plan projects to the scale where net benefits are maximuzed, but no specific guidance was given on how to select the best combination of project units, purposes and scales of development from among the many possible combinations. This remained as an art for the planner to practice as best as he could.

This, then, was the situation in 1955. River basin planning and development was a major activity in the United States and it was rapidly expanding in the developing countries, largely through United States help and stimulation. General principles and standards of economic analysis were developed and there was general agreement on the desirability of applying them in a consistent manner in river system planning. But, with all the emphasis on the general, there was no significant research under way on the application of the principles and standards to actual field level planning. It was in this largely untouched field of research that our research group decided to concentrate.

As the major function of the Graduate School of Public Administration is advance training of public servants, it was logical to combine our proposed research with a training program. Under this program, mature and experienced water resource planners from Federal and State agencies came to Harvard for an academic year to work with us in the Water Resources Seminar and to take other courses for advance training. We gained from the knowledge and experience

of these experts - in fact, our research would have been sterile without their participation.

The research and training Seminar operated for three years - 1956-57 through 1958-59. An additional year was used by the Faculty Group and supporting staff to write the results of the research. These were published in book form by the Harvard University Press in February, 1962 under the title "Design of Water Resource Systems".

This first phase of our research was supported by grants from the Rockefeller Foundation. But our research would not have been possible without the wholehearted and consistent support of the major U.S. water resource planning agencies - the Corps of Engineers, Bureau of Reclamation Soil Conservation Service - and also the California Department of Water Resources. This support included sending excellent staff members to the School as trainees, providing staff assistance, supplying information, and, most important, participation of top agency officials in periodic reviews and evaluations of research progress. (I recall a session in February, 1957 in which Colonel John Lee, Jr. and Mr. Russell Morgan of the Philadelphia District, Corps of Engineers participated.)

Our approach was to assume at the start that there were no legal, organizational or institutional road blocks to achieving the best design - the design that maximized net benefits - however this might be defined. Under this approach, no designs are ruled out in advance of analysis. Of course, this makes the planning problem much more difficult than if constraints are assumed at the start. At first, for testing planning techniques we hoped to use data from actual cases - in fact we had hoped to use the Delaware Basin case - but we found it expedient to develop a synthetic case - in which we used synthetic, but realistic, cost and benefit data. For our "simplified river basin system" we used the stream configuration and hydrology of the Clearwater Basin in Idaho.

We assumed a four-reservoir system, with associated power plants and irrigation works, and three purposes - flood control, irrigation and electric power generation.

The research results are presented fully in the book and I will only summarize them here. They are stated in the context of what we call the four steps of the planning process:

1. Definition of the planning objectives - a task for the legislative and chief executive - Congress and the President or the Legislature and the Governor.
2. Development of planning or design criteria, that flow from the objectives, to guide field level planners. This is a task for the central office - in Washington or at the State Capitol.
3. Formulating the optimal or "best" plan on the basis of these criteria. This is the job of the field level planners.
4. Reviewing planning objectives and criteria in the light of results obtained from completed field level plans - a task for the legislature, Chief Executive and central office staffs.

A considerable part of the research deals with Steps 1, 2 and 4 - questions of objectives and planning criteria - what they should be, how they can be formulated so as to provide useful guidance to field level planners and how the organization and administration of government can be adapted to this end. I will not discuss this part but will take up Step 3 - questions of field level planning.

We tested two types of techniques for examining a complex river system. (1), called simulation, which consists of reproducing the behavior of a given system design on a high speed, digital computer over an extended period of time (say 50 or 100 years) and observing its response in terms of physical

outputs which are translated into benefits. Alternative designs, that is, combinations of structures and levels and purposes of development, can thus be tested systematically until the best combination - the one that maximizes net benefits - can be found. Simulating a system in this way is akin to the standard technique of running an operating study - only we use high speed computers and simulate for longer periods.

(2), the second technique - a mathematical model approach - adapts the design problem so that it can be solved by mathematical methods which proceed automatically to the best solution. Thus far, this works only for very simple water resource systems, although in other fields - such as oil refinery design - linear programming mathematical models produce optimal designs for large and complex plants.

Turning to simulation, we programmed the simplified river basin system for operation on the IBM 704 computer, and made over 200 runs, each of a different design. Each run was for 50 years - the period of economic analysis that we selected. The system was operated on a monthly basis except that in flood months, a six hour time period was used. A typical 50 year run was accomplished in one and a half to two minutes of machine time.

Simulation as I have described it has three important limitations. First, there are a tremendous number of possible designs to be tested. Even our simplified system with only 12 design variables and with 10 to 15 values for each would produce an astronomical number.

Second, the results of a single 50 year simulation report performance only for the particular trace of the hydrology - the actual record, for example. Yet, many other quite different configurations of hydrology - some with higher peaks and with greater droughts - are theoretically possible.

Third, our results are valid only for the specific operating procedure that was used. This must be selected arbitrarily. There is no way of knowing that

it is the best procedure, although experience and judgment can help here in devising a reasonably good procedure.

We have struggled with these limitations and have achieved some success in overcoming them.

First, we adapted and devised sampling metho for examining the many different design combinations. By a combination of random and systematic sampling it was possible to approximate the best design for the system in only about 200 trials. This design was significantly superior to that selected by so called conventional methods of analysis - those commonly in use by planning agencies - $811 million in net benefits as compared to $724 million.

The second limitation - a single trace of hydrology - was dealt with by developing a method of spinning out synthetic hydrology based on the statistical characteristics of the hydrologic record. Thus, we were able to turn out on the computer synthetic monthly flows for a 500 year period - we could have spun out 1,000 or more years of data, had we wished. When the synthetic record was compared statistically with the actual record - comparison of means, standard deviations, and total distribution - the correspondence was close. Yet the 500 years of synthetic record gave many more configurations of hydrology than did the actual record. Flood flows were also synthesized in a similar manner, but the model used was only a first experiment, although good results were obtained for our case.

The third limitation - the arbitrary nature of operating procedures - remains largely unresolved. Some experiments were conducted on operating rules, and a space rule was devised to govern choice of releases from reservoirs in parallel - that is, reservoirs on separate tributaries. But the problem will not be fully solved until an optimal operating procedure is devised. This is an extremely difficult task that remains to be done.

As for the mathematical model approach, two very simple models were developed. One model, that takes into account the fact that only the probability distribution of stream flow is known, gives an optimal design and operating procedure for a single reservoir. The other, which makes the simplifying assumption that stream flows are known, gives optimal results on design and operating procedure for a multi-reservoir, multi-purpose system providing the number of variables and constraints is not too large. The power of these models has great potential. Both models, however, are severely limited in terms of practical application today. In contrast, the simulation technique - which, after all, is but an extension of existing practice - has immediate practical application.

Our hope was to construct a system planning strategy in which both mathematical models and simulation would have important, complementary roles. We were not able to do this although our research indicates that mathematical models would find their best use in preliminary screening of system units while simulation would be used for detailed system analysis of the screened projects.

Following the conclusion of this first phase of research, the Group decided to press forward on further basic research and to test the application of the techniques to more realistic cases. Again we found the Federal water resource agencies to be interested and cooperative. Research contracts with the Corps of Engineers and the Public Health Service, along with a grant for basic research from Resources for the Future, Inc., are financing this continuing work, which is now entering its second year.

I know that you will be interested to learn that we are using the data gathered under the recently completed comprehensive survey of the Delaware Basin to test our techniques. We are profiting by the large amount of detailed information that was assembled and analyzed by the many local, State and Federal agencies involved in the study.

We are testing the simulation technique, including the generation of synthetic hydrology, on the Delaware situation. We have begun to put the Delaware system on the computer - in this case the IBM 7090, which is much faster than the 704 computer - starting with the Lehigh basin. In a year or so we hope to have the river running on the computer and to begin the further investigation of sampling methods.

Our current research covers much more than testing the simulation technique. We are attempting to develop an overall strategy for planning a river basin system from collection of basic physical, economic and social data to final plan selection. One part of this will be a strategy for preliminary screening of possible dam and reservoir sites, using a newly developed simple method for obtaining storage yield relationships. Work is also being done on problems of estimating demands for and benefits of domestic and industrial water supply. Of particular interest to the Public Health Service is the major effort being made to bring water quality aspects into the system design process. And, finally, further work is being done on problems of dealing with the objectives of development and of translating them into standards and criteria that the field level planner can use effectively.

Our current research has not yet progressed to the point where we can point to definite findings and conclusions. We believe, however, that some of the techniques - such as simulation analysis - that looked promising in the first phase of our research will prove to have immediate practical application.

THE INTERSTATE COMMISSION ON THE DELAWARE RIVER BASIN

THE DELAWARE RIVER BASIN IN THE YEAR 2000

Hon. Maurice K. Goddard,
Alternate Pennsylvania Member,
Delaware River Basin Commission and Member of Incodel

October 15, 1962

ADDRESS BY
HONORABLE MAURICE K. GODDARD
SECRETARY, DEPARTMENT OF FORESTS AND WATERS
COMMONWEALTH OF PENNSYLVANIA
at the
DELAWARE RIVER BASIN
WATER RESOURCES CONFERENCE
POCONO MANOR, PENNSYLVANIA
OCTOBER 15, 1962

"THE DELAWARE BASIN IN THE YEAR 2000"

I brought a picture with me which you will see standing over to my left. I hope that you will come up and inspect it more closely after the dinner.

It was taken from an altitude of 32,000 feet. In the lower right hand corner is Chester, Pennsylvania. In the middle, you see Philadelphia. A little bit to the North and left is Trenton. Toward the top you can make out New York City, Long Island Sound, and a piece of Connecticut.

That thick black band running around the right hand side is the Atlantic Ocean and the Jersey Coast.

This is the heart of Megalopolis.

This is the heart of an urbanized strip, which stretches for 600 miles from Boston to Washington, D.C.

This is the heart and the brains of the American Nation.

This is where more people earn more money and produce more goods than anywhere else on the face of this globe.

The region in this picture represents the physical culmination so far in the history of Western Man.

Its largest city is more than the world capital. It is the focal point of finance and the arts in the Atlantic Community.

And from Wilmington north through Philadelphia and Trenton to New York is the great American Ruhr, the Nation's workshop.

With less than one half of one per cent of the land in the continental United States, it produces 17 per cent of the national personal income.

The French geographer, Jean Gottman, who has published a brilliant book on our region states that "on the average", Megalopolis shelters the richest, the best educated, the best housed, the best serviced group of people of similar size in the world".

And he finds this massive urban civilization we have reared on the Atlantic Coast truly unique - - the forerunner of other communities in other parts of the world which will grow and develop in the same manner during the next half century.

"This region serves as a laboratory", he says, "in which we may study the new evolution reshaping both the meaning of our traditional vocabulary and the whole material structure of our way of life. So great are the consequences of the general evolution heralded by the present rise and complexity of Megalopolis that an analysis of this region's problems often gives one the feeling of looking at the dawn in a new stage in human civilization. Indeed, this area may be considered a new order in the organization of inhabited space."

He is right. And when a speaker is asked to peer into the future and predict what form and substance this new order of civilization is going to take in the next 50 years, he can not help but pause. There are so many questions still to be answered about our region - - political questions, social questions, economic questions. Upon the solutions we find to them hangs the future. And until we do answer them, the years ahead are impossible to predict.

But one thing is certain. Our fate hangs on a very few tenuous threads. This urban civilization is a fragile thing easily violated. And the most delicate thread of all is the Delaware River, for it provides the most basic of all ingredients for survival and growth: water.

Until we have solved the water problem, the rest of the future stands undetermined. This has been true ever since the human animal first got into the habit of building cities. And the question gets more profound the bigger the city grows.

This group gathered in this room tonight can claim to have done more to find some of the answers to the water problem of Megalopolis than any other in the past, or which may come in the future.

The results of your efforts will shape the Megalopolis of 2000 A.D. It will make possible a population in the region of between 50 and 60 million people in that year.

They make possible a greater concentration of industry and commerce in this area than we have yet known. In fact, by the year 2000, it is highly probable that the waters of the Delaware will sustain the greatest agglomeration of heavy industry to be found anywhere on the earth.

Personal incomes will grow with this increase in industry from a total of some $60,000,000,000 today to $220,000,000,000 in 2000.

And just as New York City will continue as the hub of national finance, so Philadelphia will blossom into the industrial capital of the country.

The ports up and down the Delaware will lead the nation in the bulk tonnages received and shipped and most of this cargo will be imported as raw material, processed into new goods, and shipped back out to the harbors of world commerce.

But more than water is needed if we are to keep the urban animal alive. It must be fed, too. Its arteries must be kept open. We must keep them clear of the clots which an antiquated circulation system is sure to make possible.

New modes of transport will dominate the scene in 2000. The automobile will have congested itself into limited utility. Some of those wrestling with these problems anticipate a rail or transit system which can travel at speeds of up to 200 miles an hour.

Think of it! Less than 30 minutes from Philadelphia to New York.

And if good sense prevails over the god-like powers of the New York Port Authority, I would hope to see an International Jetport which is so located that it can serve both New York and Philadelphia. Instead of a limousine, passengers would travel from the jetport to central city in one of these high speed transit systems.

With the ease of transport will come a still greater spreading out of the metropolitan population. Greater New York today covers 2,541 square miles. I would not even hazard a guess at its area in 2000. In fact the sprawl may prove impossible to measure, because by that time Wilmington, Philadelphia, Trenton, and New York will have blended together into one massive metropolitan tissue. Even Allentown and Bethlehem, now separated from New York by a little open space and only feeling the first gingerly and flirtatious touches of Greater Philadelphia, will be caught up in the sprawl.

Lord knows what this stew will look like. The Army predicts we will lose approximately 2,000,000 acres of open land to urban growth. I think the estimate is conservative. But I'm optimistic, if for no other reason that New York, New Jersey, and Pennsylvania are all aware of what can happen if we allow the indiscriminate sprawl of the suburbs to continue without attempting to channel it in some way.

New York is buying up open space with its $75,000,000 bond issue and is going back for more money. New Jersey has "Green Acres". And Pennsylvania has PROJECT 70.

Here in the Quaker Commonwealth, the reservoirs about to be built on the Delaware will play the key role in our open space plans, for each of them on the urban periphery will serve as the heart of a giant regional park. In effect they will ring each of our metropolitan areas.

Then - - in the Greater Philadelphia area, for example - - the wooded ridges which run like concentric circles around the area and the stream valley which serve as the spokes of the wheel will be preserved, so that the suburban resident of 2000 will live in a checkerboard of open and green areas. Urban development will proceed within this grid, channeling sprawl, enhancing livability, bringing beauty to suburban surroundings.

I visualize this plan as consummated far before 2000. Indeed, if we wait even ten years, we will be too late. But the residents of this region will be the beneficiaries of today's wisdom.

If I seem to lay stress on the de-centralization of our central cities, I do not mean to. For the city's heart is going to regain some of the role which it seems to have lost in the last few decades.

I think it lost the functions it once exercised because the cancerous blight which had been eating away for decades had gone untreated, congestion ruled out land for the kind of manufacturing and residential construction which modern home owners and businessmen demanded. We are finding solutions to these problems.

Some of the most exciting reading in America today is the Master Plan for the City of Philadelphia with its provisions for great open parks, waterfront promenades, malls, hidden greenways, new cleared industrial sites, convenient shopping areas with excellent transportation and rejuvenated residential areas. Before we are half way to 2000, Philadelphia's Master Plan will become reality in stone, concrete, and a thriving, vibrant city.

And the same holds true for every major community in the basin. Many of the higher income suburban residents of today will be back in the city as homeowners and those who are fighting their way up the social ladder will have finally won out and may live far from the tenements.

All this will be possible only if we recognize the strange new society now being born.

It will be a society in which much of the back-breaking labor of building and manufacturing will have been taken over by machines. As productivity goes up, so will wages. And as wages go up, so will the amount of income each family will have to spend on other than the essentials of life. Fortune Magazine estimates that by 1970 alone, more than half of the personal income in the United States will be discretionary.

This will work profound changes on the way our time is spent, the kinds of goods we purchase, the tastes we follow in selecting a home or a job.

Under such conditions the prime requirement which every community will be compelled to supply is "livability". Without it, a municipality will fail to attract the wage earners and without the wage earners there will be no industry.

That is why the amenity states - - California, Arizona and Florida - - already rank as the fastest growing in the Nation.

That is why we must lay such heavy emphasis upon livability in the city, livability in the suburbs - - in total livability in the basin.

Great new play and vacation areas in the Poconos and the Catskills are essential if we are to provide the broad based year round recreational activity we need to make the region attractive to this new breed of American.

And the giant National Recreation Area at Tock's Island must be the corner stone in this development. I do not visualize a Coney Island. I visualize a giant recreational facility serving a broad range of tastes from those who come searching for cultural recreation to those who simply want to splash and sun.

But then back in the wooded mountain ranges away from the National Recreation Area we must provide still more of the recreational services required in the coming years.

In the world of 2000, man will have here in this Basin, for the first time in the history of mankind, the means, the time, and the opportunity to realize the full measure of his talents and of his humanity.

But will he?

Are we in danger of breeding a nation of spectators, content to stare, hypnotized, into a television set breathing in other men's ideas, thinking other men's thoughts?

Are we foredoomed to a massive unemployment problem simply because there is nothing for many men to do since machines have been found as more efficient substitutes?

Are we prepared to make the enormous investments in people - - in education - - rather than "things" which this new world will require?

We have, in attacking the problems of the Delaware, comeup with some of the physical answers for the world of tomorrow. And other technicians are working on still others.

But who is working on the human challenge? Should there be a commission of politicians, social scientists, and artists working out the answers to the problems of the human mind and the human heart? For it is on these answers that the shape of tomorrow must ultimately depend.

The wise John Dewey once said that a "culture which permits science to destroy its traditional values, but which distrusts its power to create new ones is a culture destroying itself".

I suggest that finding the values to govern us in the year 2000 is the next order of business.

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THE INTERSTATE COMMISSION ON THE DELAWARE RIVER BASIN

THE BRANDYWINE VALLEY PLAN

Clayton M. Hoff, Executive Vice President,
Brandywine Valley Association

October 16, 1962

THE BRANDYWINE WATER SUPPLY AND FLOOD CONTROL PROJECT

by

Clayton M. Hoff

INCODEL CONFERENCE
Pocono Manor Inn
Pocono, Pennsylvania

October 16, 1962

The Brandywine Water Supply and Flood Control Project was not one of the projects of the Brandywine Valley Association when it was incorporated in October, 1945. Its purposes as listed at that time were to restore, conserve, and improve the natural assets of the Brandywine Valley, an area of 330 square miles, occupied by some 220,000 people.

Its projects dealt with soil, forests, water, wildlife, fish, game and facilities for recreation.

Its methods were primarily educational, promotional and urging and helping people to get appropriate assistance from local, state and federal agencies on their natural resource problems.

The people of the Valley can point with pride to many noteworthy achievements. Some of their accomplishments are as follows: a Soil Conservation District for Chester County, Pennsylvania; a Water Pollution Commission for the State of Delaware; a Conservation Workshop for Teachers at the University of Delaware and West Chester State College; and support of the Laboratory at Penn State University.

Working through the two Soil Conservation Districts, complete conservation plans have been established on over 65% of the farms in the Brandywine Valley and conservation practices on many more. About 96% of the sewage and industrial waste of the Valley are now being treated and silt or mud carried by the stream has been decreased by some 60%.

Several 100 farm ponds have been constructed, providing water supply, fire protection, recreation, wildlife and waterfowl habitat.

With these and many other accomplishments, the people of the Valley were feeling quite happy about the progress they were making, when new problems suddenly presented themselves.

They started with the severe drought in 1954, when pastures were so parched that they provided little or no food for cattle; many of the forests were tinder dry and were damaged or destroyed by fire. Desperate farmers were installing supplemental irrigation to salvage their withering crops, and dairymen, with their wells drying up, were forced to haul water for household purposes and for watering their stock.

Many industries were forced to curtail their production and municipal water departments were hard-pressed to meet the bare needs of their communities. Flushing streets, sprinkling lawns, and washing automobiles was prohibited, and in Wilmington, Delaware the flow of the Brandywine, of 38 million gallons per day, was insufficient to meet the domestic water needs of over 30 million gallons per day and that of industry too. Therefore, industry in the vicinity of Wilmington voluntarily reduced its water consumption by curtailing its production in order that the City of Wilmington would have sufficient water for domestic needs.

Following the severe drought in the summer of 1954, the Brandywine Valley Association called together representatives of the major water users in the Brandywine watershed. More than 50 persons were present, representing the area from Wilmington, Delaware to Honey Brook, Penna. Several cases of rather severe water shortages were reported.

The group created the Brandywine Water Resources Committee, with Peter J. Short, Jr., of Lukens Steel Company, as chairman. The committee engaged the Brandywine Valley Association to survey the entire water needs of the area for the next 25 years.

It became evident that the natural flow of the Brandywine was not currently able to meet these requirements, and would be even less able in the future, with the increasing demands by industry, community and agriculture for greater quantities of cool and potable water.

In the summer of 1955 a second and more serious drought occurred. The water survey showed a need for at least 50% more water in the next 25 years. Preliminary survey of reservoir sites by Henry Rowan, engineer for the Interstate Commission on the Delaware River Basin, indicated that adequate water supplies for the future could be obtained by impoundments on the Brandywine and its tributaries, and also that the terrain of the Brandywine was such that these impoundments would be both feasible and economical.

In August 1955, the scene changed rapidly from too little water to too much water. Two hurricane floods, a week apart, caused severe flood damage in several places in the Valley, and were so intensive and extensive that they precipitated a re-survey of the entire Delaware River Basin by the Engineers' Corps of the U. S. Army.

Through the Soil Conservation Districts in both states, the committee turned to the U. S. Soil Conservation Service for a flood protection plan. Under Public Law 566, the Soil Conservation Service, with the help of local people, checked the amount of flood damage in 1955. It came to $673,779. Flood damages were high enough to justify small dams. Sites were studied.

After a year of study, it was evident that these dams would not be large enough to include sufficient water for water supply as well as flood storage.

After the third dry year, in the summer of 1957, the Brandywine Water Resources Committee concluded that larger reservoirs for water supply would also be needed. There were several requests for more water soon. Wilmington

had to restrict water use. So did West Chester. Lukens Steel had permission to siphon water from Icedale Lake if the stream-flow in the West Branch got too low. Farmers were using more water for irrigation.

The committee then turned to the Pennsylvania Department of Forests and Waters at Harrisburg. It asked Secretary Maurice K. Goddard to be a partner in the project and to help construct larger reservoirs. He agreed to help if:

1. The local people would acquire the land to be covered by water and move roads and buildings -
2. The State could develop parks and recreation areas around certain dams.

The Brandywine Water Resources Committee agreed. Governor Boggs of Delaware appointed the Delaware Water Resources Liaison Committee to work with Pennsylvania officials. Dr. George Worrilow, of the University of Delaware, was selected as chairman.

Secretary Goddard hires Bourquard, Geil & Associates to study:

1. Water needs for the next 50 years.
2. Best reservoir sites.
3. Costs of development.

Now the Local, State and Federal studies became a coordinated effort. The final plan was to include water supply, flood protection and recreation.

To provide official status and to comply with certain regulations, a local sponsoring committee was formed, consisting of the Chester County Commissioners, the New Castle County Levy Court, the Chester County Soil Conservation District, the New Castle Soil Conservation District, the Delaware County Planning Commission, the Delaware State Soil Conservation Committee, and the Brandywine Valley Association.

Formal application was then made to the Soil Conservation Service, U. S. Department of Agriculture, under P. L. 566, for assistance on the flood control project and also to the Department of Forests and Waters, Commonwealth of Pennsylvania, for its assistance on the water supply project.

Cooperation was promptly effected between the Soil Conservation Service and the Department of Forests and Waters, as well as excellent coordination on the part of the engineers of these two organizations in their field work.

After two years of work in the field and thousands of hours on the drawing board, a comprehensive plan was evolved which was formally presented jointly by Ivan McKeever, Soil Conservationist, Soil Conservation Service and Secretary Maurice K. Goddard, Department of Forests and Waters on January 12, 1959 at Downingtown, Pennsylvania.

This plan, known henceforth as the Brandywine Water Supply and Flood Control Project was presented to over 100 representatives of interested agencies, committees, and organizations and unanimously approved by them.

The plan involves the construction of 12 dams and reservoirs over the next 25 years. They would all be in Pennsylvania, all above Coatesville and Downingtown. High up in the watershed, they would catch the water before it gets out of control. Water would be made to work all the way to Wilmington. The reservoirs would store up water in winter, or when there is too much. It would be released downstream in the summer, or when there is too little.

Five of these reservoirs would be used primarily for water supply, seven primarily for flood control, but all to be operated as multipurpose reservoirs, providing water supply, flood control, and recreation. They would vary in size from 20 acres to 1,000 acres of water.

The total project would be a cooperative enterprise, with Local, State and Federal agencies participating in the cost of developing the program. The towns, industries and local governments in the Brandywine Valley would be responsible for acquiring the land and all easements and rights-of-way in preparation for the dams and reservoirs. The Pennsylvania Department of Forests and Waters would pay for the cost of building reservoirs designed for water supply, recreation and flood prevention.

The Soil Conservation Service of the U. S. Department of Agriculture would pay the cost of construction of the smaller flood detention dams and that portion of the larger dams used for flood control. Suggested distribution of costs:

Federal	(Soil Conservation Service)	$2,556,600
State	(Pa. Dept. of Forests & Waters)	7,368,000
Local	(The Brandywine Valley)	4,218,900
		$14,143,500

When fully completed the Project would provide -

Flood Protection amounting to $150,000 annually, or a reduction of 77% in flood damages;

Water Supply for the next 50 years, adequate for community, industry, agriculture and recreation;

Recreation facilities in the form of several lakes for fishing, boating, swimming and augmented low flow downstream.

Because these reservoirs are multi-purpose; because of local, state and federal sharing of the costs; because towns and industries are willing to go together on the project; and because it is possible to use the water over and over again, there would be a savings of several million dollars compared to separate reservoirs for each town or industry, this project can be reckoned as one of the most economical water supply projects on record.

After seven years of planning, and several thousand hours of work by committees and individuals, the long-range Brandywine Water Supply and Flood Control Project reaches the action stage.

The Chester County Commissioners, on September 7, 1961, created the Chester County Water Resources Authority. This agency officially represents the local interests in the Brandywine Valley to develop the water project and has the responsibility for acquiring the necessary land for the reservoirs, and for local finances.

The Delaware River Basin Commission, at a regular meeting on March 29, 1962, adopted the first phase of the comprehensive plan. This plan includes the Brandywine Water Resources and Flood Control Project.

The Public Works Committee of the House of Representatives, on October 2nd, approved the Watershed Work Plan on the Brandywine, under Public Law 566, as submitted by the Soil Conservation Service of the U. S. Department of Agriculture, thus making available funds to design the flood protection dams.

Marsh Creek Reservoir has been selected as the first of the series to be built, and engineers employed by the General State Authority are progressing rapidly with the design of this reservoir. First borings for fill material are currently being made.

The Chester County Water Resources Authority is in the process of concluding an agreement with the Commonwealth of Pennsylvania for the joint development of the Brandywine Water Supply and Flood Control Project.

The Pennsylvania Department of Forests and Waters is studying the possible recreation areas in conjunction with the reservoir and information concerning this is expected to be available late in October.

The Authority is in the process of selecting appraisers and negotiators in preparation for the purchase of properties in the Marsh Creek area, the site of the first impoundment to be constructed. It is probable that purchases will be made during the latter part of this year.

Local municipalities are having feasibility studies made to determine the most suitable and economic water distribution plans.

While the Brandywine Water Supply and Flood Control Project appears to be moving ahead quite satisfactorily, it will probably be at least two years before the first reservoir is completed, and twenty-five years before the last one is finished. It is hoped that severe droughts and floods will not prevail in the meantime and that the rate of construction can keep abreast

of the increasing demands for water by a rapidly growing population and industrial development.

May I point out also that in this Brandywine Water Supply and Flood Control Project we have endeavored to apply some of the basic tenets of this Association, i.e.

It should be the responsibility of the local people of a watershed to initiate the study of their problems and to implement the solution thereof.

Watershed organizations should not duplicate existing agencies, but should cooperate with them and secure maximum assistance from local, state and/or federal agencies.

The program should be directed toward producing the maximum long-range benefits for all interests in the watershed.

All interests in the watershed should participate in the planning and in the program and in sharing the costs as near as possible in proportion to the benefits received.

It should be noted too, that while the Brandywine Valley Association considers this as its most important project, it not only pursues its original objectives but is attempting to accelerate the adoption or application of Soil Conservation practices on the drainage areas of each of the reservoirs in order that the water in them will be of the highest quality and so the reservoirs themselves will have a long and useful life.

THE INTERSTATE COMMISSION ON THE DELAWARE RIVER BASIN

NESHAMINY VALLEY PROGRAM

John T. Carson, Jr., President,
Neshaminy Valley Watershed Association

October 16, 1962

NESHAMINY VALLEY PROGRAM

By

John T. Carson, Jr., President
Neshaminy Valley Watershed Association

Clayton Hoff, the father of the watershed movement in the East, has just wrapped up the entire story of watershed projects, programs,principles and hopes in his talk. If you were to simply move the Brandywine Valley north and east of Philadelphia, place it down in a slightly smaller watershed with the same soil types and same topography, increase the population and decrease the industry, then I would say you have already heard the story of the Neshaminy Valley. However, each watershed is unique and there are no two exactly alike.

Thanks to the vision, leadership and efforts of Incodel, the Neshaminy Valley Watershed Association was born on June 13, 1956. The role of the Association was quickly outlined and it was seen that there were three points that should be established. One: We should educate the approximately one hundred thousand people in the watershed regarding natural resources problems and their possible solutions. Two: It was our role to bring together federal, state and local agencies and the local people. Third: We should foster specific projects, either in pilot studies or to fill the gap where no agency existed for the job.

If I attempted to outline our progress over the past six years, I would emphasize the fact that a very small group of people can accomplish a lot if they have vision, determination and the cooperation of public agencies. The latter, incidentally, has been outstanding at every level in my experience.

I would like to pay particular tribute today to people like Maurice Goddard, Frank Pitkin and Jim Allen who have done more than anybody could possibly expect anyone to do to assist a small association like ours to get started. Let me illustrate this specifically. In 1956, to help us get started,

Incodel assigned its conservationist to work a large share of his time with our Association. They went further than that. They actually carried out, at Incodel's expense, a field survey and engineering study on the profile of flood heights and stream profiles for the lower portions of the Neshaminy.

The Association was able to pick up this initial work, to persuade local municipalities to underwrite the cost of completing the engineering study. The Bucks County Planning Commission and Park Board supplied base maps and a lot of technical help. The result was that we completed a rather thorough flood plain study of the lower 16 mile reach of the stream which resulted in the publication of flood risk maps. Incidentally, one of these is used in the Corps of Engineers comprehensive report on the basin as an illustration of what can be done in this field.

This, to me, illustrates real cooperation and real foresight on the part of people of vision.

Today, I want to talk very briefly about what has been officially named The Neshaminy Water Resources Development Plan. This plan seems to have blossomed overnight. If I list the developments chronologically I think you will agree with me. On September 18, 1961, the Bucks County Soil Conservation District Directors held their first meeting. In April, 1962, an application for assistance under Public Law 566 was made by Bucks and Montgomery Counties. In May, 1962, the watershed work party of the Soil Conservation Service made their preliminary survey. On June 13, 1962, the Soil Conservation Service presented the results of this preliminary survey to the sponsors of the program. On August 27, Dr. Maurice Goddard announced that the Department of Forests and Waters of the Commonwealth of Pennsylvania would carry out a comprehensive water supply and recreation study in the Neshaminy. On September 18, 1962, the Bucks County Commissioners gave the required assurance to the Soil Conservation Service and they were quickly seconded by the Montgomery County Commissioners,

indicating that everyone "meant business" and we could go ahead with the work plan.

In October, 1962, the Pennsylvania State Health Department was requested to carry out a pollution control study in conjunction with these other studies. On October 4, 1962, there was a meeting of all agencies and sponsors involved in the program to explain the study program and to divide the work.

I am now projecting into the near future. On October 30, 1962, the Neshaminy Watershed Association will hold a public meeting at which time Ivan McKeever of the Soil Conservation Service, Jim Wright of the Delaware Basin Commission, Dr. Wilbar of the State Health Department and Maurice Goddard of the Pennsylvania Department of Forests & Waters will explain to the people of the area just what this program envisions. If this seems like fast action, believe me, it is. It seems to me as though in the last three months we have covered about five years of work. However, behind a program like this is an awful lot of background and detail. There are a lot of missing pieces that don't show in the chronology.

In essence, the water resources development plan provides for 95% reduction of flood damages on a total of about 75 stream miles by a combination of sixteen reservoirs and improved land treatment. The benefit-cost ratio worked out by the Soil Conservation Service is approximately 2.5 to 1, a very high ratio. Some of these reservoirs will be increased in size later to provide for future water supply and recreation development. Other reservoirs may be added to the system. A study will be made to determine how best to provide low flow augmentation to reduce the pollution load.

I would like to emphasize that last point since we have eight municipal sewage disposal plants either under construction or in the planning stage in this stream today. This phase of the study is a <u>must</u>.

The present status of the program is that the Bucks and Montgomery County

Commissioners and their two Soil Conservation Districts, as primary sponsors, have been joined so far by eleven municipalities as co-sponsors of the program. Studies are now underway and should be completed within about a year, providing a comprehensive plan of water resource development.

The Neshaminy Watershed Association, having been appointed by the commissioners of both Counties to carry out the education, information, transfer and liaison in the program, has met with the officials of the twenty-two affected municipalities in the past two months. The Association has worked out a formula for sharing local costs and has obtained agreements from five townships to carry their share of the costs. You may wonder what we mean when we say we worked out a cost sharing formula to underwrite the local cost of this entire program. What we did was to go around and talk to the different groups of municipal officials and ask if they believed in home rule. Their answers were affirmative. We stated that if they believed in home rule, they must believe in paying for it. With this point established, we asked how they felt costs could be met and shared. As they put their ideas together, this, in essence, is how the formula evolved. We have about 150 stream bank miles which will be flood protected. The first step was to figure out how much each township has of flood protected stream banks; ascertain what percentage this is of the total. But this was not fair. Some stream banks are very steep while others are very low and subject to wide flooding. The next suggestion was to add a factor for the area of flood plain involved in each township in order to modify the basic stream length factor. Fine, but is this fair? No, because different townships have different degrees of present development. I'll illustrate this with an example of a supervisor in one of our rural townships in the head waters who told me quite bluntly, "We have no flood problem". I knew the water was twelve feet deep over his field in 1955. He admitted that after the storm he could see debris hanging in the tree branches up above where

he was plowing, but he insisted that he didn't have any flood problem. Then I got the point. This was an area of undeveloped land, no homes, no industries and with no businesses located there. To the local people, this means no problem. So we have to understand what they mean. Floods? Yes. Only they call them freshets. Problems? Well, no, not in the same sense that we think of floods as a problem.

I will illustrate the cost sharing formula with two specific examples. If township A has 8.2 miles of stream bank protected under the program, that would be about 5⅓% of the total. If they have eleven hundred acres of flood plain, it would give them a factor of 1.4, related to the mean flood plain average. This is a township lower down in the Neshaminy on the main stream with wide flood plains. The development is high and they get a factor of 1.3. If we multiply all of these factors together and apply them to the total cost we have a cost for that township roughly estimated at $156,000.

Township B, in the head waters, with the same stream bank length but with only 500 acres of flood plain and practically no present degree of development would get a factor of 0.2 to multiply. Their flood plain acreage is 0.7. We come out then with a figure in the neighborhood of $12,000. Consequently, you get a very wide range of adjustment based on the benefits. This has seemed to be acceptable to the township people.

Two years ago when I spoke to the Annual Conference at Incodel on the subject of liaison in watershed work, I made four points. Number One: Most people are overwhelmed with the magnitude of the problems facing the entire Delaware Basin. They can only understand when the problems are locally related to their own particular area. Number Two: Local people should feel the primary responsibility for solving their own problems with help from state and federal governments only if needed. Number Three: The answer to the resource problem lies in planning to meet local needs with, and I emphasize with, coordination

and overall integration with the entire basin. Finally, all natural resource problems are ecologically interlocking. Planning for flood control structures without also developing water supply is short sighted. Paying for flood control structures without at the same time controlling flood plain development is self-defeating. Forgetting to preserve open land for recreation, insoaks and aesthetics is inviting suburbicide.

The experience that we have had with the Neshaminy Water Resource Development Plan so far emphasizes very strongly that these four points are just as valid in the small watershed sub-unit as they are in the large basin. The people who live in Newtown have no concern whatever with Chalfonte until it is pointed out to them that what Chalfonte does in solving its problems affects Newtown, or, conversely, what Chalfonte doesn't do, affects Newtown.

As John Donne said some three hundred years ago, "No man is an island sufficient unto himself", and this applies in watershed work as well as in poetry.

The major job of a watershed association then, is one of establishing contact with and understanding people. If you can do this and if you can convince the people that you are sincere in what you are doing, and I emphasize that you should not become the tool of somebody else, they are with you.

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THE INTERSTATE COMMISSION ON THE DELAWARE RIVER BASIN

WISSAHICKON VALLEY PROGRAM

Paul M. Felton, Executive Director,
Wissahickon Valley Watershed Association

October 16, 1962

THE WISSAHICKON VALLEY PROGRAM

By

Paul M. Felton, Executive Director
Wissahickon Valley Watershed Association

October 16, 1962

For the past three years the Wissahickon Valley Watershed Association, through the support of its 500 members, has been developing a broad resource conservation program for the 64 square mile Wissahickon drainage area. This program, although not so ambitious as the much larger Brandywine and Neshaminy watersheds, nonetheless will continue to have "heavy going" because of exceedingly rapid urbanization of the area.

The main emphasis of the Association has been to inform the residents of their resource problems and to initiate solutions for these problems. After this it is a matter of providing continued pressure on each project until results are attained.

From a list of 26 projects which we had on our Work Plan for 1962 we have completed some work on about one-half. The lack of time weeds out all but the most important.

A few of our major projects are:

Item 1. - FLOOD CONTROL. The Association has taken the lead in pressing for the Flood Control Project under Public Law 566. With the recent $30,000 grant from the Montgomery County Commissioners the Work Plan for nine flood retarding structures will be completed by fall 1963. Although there is much foot-dragging by local people and government to make the most of multiple use possibilities connected to the nine structures, the Association will continue to drive for the maximum use of these sites especially in the direction of low flow augmenting water. The Wissahickon Creek was about 61% effluent from the 9 sewage plants in the watershed this summer.

Item 2. - FLOOD PLAIN REGULATION - At the urging of the Watershed Association, Montgomery County requested the U.S. Army Corps of Engineers to make a Flood Plain Study of the Wissahickon. This action was authorized by Washington and a set of 12 flood plain maps covering 24 miles of creek are scheduled for completion by mid-1963. In cooperation with the County Planning Commission we intend to help the seven local municipalities in formulating flood plain regulation policy.

Item 3. - CONSERVATION TREATMENT OF THE LAND - This will continue to be a most important part of the Association's program. We started with the farmers but find ourselves more and more involved with the suburban homeowner, the township and industry. If the whole Delaware Valley develops the way the Wissahickon Watershed has been we're all going to be applying conservation practices to cities. We now have six industrial sites in the Wissahickon which have installed grassed waterways and terraces, planted watershed and wildlife plantations and one has even built a flood retarding structure to catch roof and parking lot runoff -- Urban Conservation indeed.

Item 4. - POLLUTION ABATEMENT - The last seven miles of the Wissahickon flow through the World famous Fairmount Park where by actual count hundreds of thousands of Philadelphians seek recreation in a magnificent natural setting. Yet, the fishermen can't see their lines sometimes because of the detergent foam from our nine waste treatment plants. The Association has for the past few years been underwriting a biological survey of the creek waters and recently has begun a study of the detergent proglem which by the way, has turned up a number of cases of ground water contamination. We will continue to cooperate with Public Health officials at all levels to fight pollution.

The Wissahickon Valley Watershed Association's aim is to continue to spearhead a well-balanced conservation program at the grass roots level to meet head-on, problems of natural resources in a land going through the painful transition from country to city.

THE INTERSTATE COMMISSION ON THE DELAWARE RIVER BASIN

BUCKS COUNTY MASTER PLAN FOR WATER AND SEWERAGE FACILITIES

Franklin C. Wood, Executive Director,
Bucks County Planning Commission

October 16, 1962

County Wide Water Supply and Sewage Disposal Plan For Bucks County

By

Franklin C. Wood, Executive Director
Bucks County Planning Commission

The planning and construction of water supply and sewage facilities in Bucks County has lagged far behind the rapid rates of residential, industrial, commercial, and school construction. During the past ten years, 50,000 lots received final review by the Bucks County Planning Commission. Almost half of these were planned for on-lot sewage disposal, and almost one fourth for on-lot water supply. About 50% of the total population of Bucks County presently obtains water from private wells, and 60% of the population uses on-lot sewage disposal. Many of these on-site facilities are inadequate. Septic tank overflow has become a serious problem in many areas, and many wells have insufficient capacity especially during periods of drought. Correction of these conditions through the provision of adequate on-site facilities is of primary importance.

The Bucks County Planning Commission has constantly worked to minimize those problems through the powers granted us under the State enabling legislation. Since 1952, when our county subdivision regulations were adopted, minimum lot sizes have been based on the availability of public water or sewerage facilities. After the Bucks County Health Department was organized, the regulations were amended to require its approval of subdivisions to be served by on-lot sewage systems, prior to approval by the County planning commission. Subdivision regulations, however, cannot take into consideration where and when public facilities should be installed. New housing developments meeting all subdivision requirements have been built with on-site facilities, only to be tied in a few years later to public systems.

The introduction of water and sewer lines after a community has been established presents numerous problems. Because lot size requirements are generally higher where utilities are absent, lot frontages are usually long, increasing sewer assessments to individual property owners. Street patterns and distribution of structures may present service problems. Tying into a new system often requires the tearing up of streets, walks, lawns and shrubs, increasing the cost and inconvenience. There is, too, the additional cost of providing on-site facilities initially, and abandoning them later.

Until very recently, there had been no large area planning for these utilities in Bucks County, and all existing water and sewerage systems have been planned and built by local municipalities or by private companies. The increasing magnitude of the problem made evident that such planning should extend beyond local boundaries since the most economical water and sewerage systems are those whose limits are defined by natural topography and not by political boundaries.

In recognition of this need, the County Commissioners in 1959 approved a recommendation by the Bucks County Planning Commission and the Bucks County Health Department that an engineering firm be retained to survey the existing facilities and develop a long range plan for extension of water and sewerage services at three time horizons: 1965, 1980, and 2010. After evaluating proposals by several engineering firms, Albright & Friel, Inc. of Philadelphia was retained in February 1959.

The primary consideration of the study was to develop a program to meet the future requirements of the entire county in a manner which would be the most economical from a long range standpoint. It departs from the usual practice of taking care only of immediately urgent local problems. This practice results in projects of limited scope involving minimal initial capital outlay, but in many cases increase long range costs. The adoption of a county wide long range plan, as we have learned, can effect major long term economies.

During the conduct of the study, a technical advisory committee composed of leaders in the fields of public health, sanitary engineering, public administration and conservation in our area guided the overall policy and approach to the problem. Near the conclusion, this group recommended to the County Commissioners that a county wide agency be established to implement the plan.

In December 1960 the county commissions appointed the Bucks County Water and Sewer Commission. After a series of meetings to consider the various ways in which the plan could be implemented the commission recommended that the county itself participate in the construction and operation of water and sewer facilities. The commission was of the opinion that the larger facilities such as filtration plants, disposal plants, transmission lines and intercepter lines could be financed more easily and at lower cost by the county than by municipal authorities, or private developers. The commission, thereupon, recommended that it be replaced by a county water and sewer authority, capable of direct implementation.

In January 1962 the county commissioners followed this recommendation and established the Bucks County Water and Sewer Authority, the first and, only such agency in the commonwealth.

The function of the Bucks County Water and Sewer Authority is to implement, modify and coordinate the general recommendations resulting from the findings of the water supply and sewage facilities Master Plan. The Authority proposes to operate regional services facilities in the water and sewage field in order to reduce costs, improve standards and increase efficiency in these fields. Its policy is to provide sewage disposal plants, water filtration plants, interceptor lines and Transmission mains to individual municipal systems and generally to leave the internal systems to the jurisdiction of the participating municipalities.

The Authority also acts as the filing agency for Advanced Planning Grants from the Federal Government, and assists communities in their negotiations to participate in the Public Works Legislation, so that the County may receive its share of tax dollars for the creation of needed sewer and water projects.

THE INTERSTATE COMMISSION ON THE DELAWARE RIVER BASIN

MONTGOMERY COUNTY WATER SUPPLY PLAN

Arthur F. Loeben, Executive Director,
Montgomery County Planning Commission

October 16, 1962

MONTGOMERY COUNTY WATER SUPPLY PLAN

By

Arthur F. Loeben
Executive Director
Montgomery County Planning Commission

About two years ago the Board of Commissioners of Montgomery County, Pennsylvania, directed its Planning Commission to make a survey of the water supply requirements of the County. As the first step, the Commission undertook a detailed study of the water problem in a section of the County where serious shortages have occurred repeatedly in recent years during periods of dry weather. This section is known as the North Penn area and centers around the Borough of Lansdale. In 1957, and again this year, the Lansdale area has been forced to invoke water use restrictions.

As the result of the Commission's study, a plan has been evolved which, if implemented as proposed, will bring Delaware River water into Montgomery County through Bucks County. We initially plan to take about 28 million gallons a day. It is estimated that this will be a sufficient amount to meet the needs of the North Penn area as well as other adjacent parts of the County for many years in the future. The plan also provides for the release of water into Perkiomen Creek for use as a supplementary source of supply by the Philadelphia Suburban Water Company which presently serves a large part of Montgomery County.

The project, in addition, is to be utilized for recreational purpose and will add another unit to our County park system.

The general features of this water supply plan call for the construction of a reservoir on the northeast branch of the Perkiomen Creek. This stream rises in Bucks County, about 7½ miles from the Delaware River, near Point Pleasant. The reservoir is to be about four miles long and very narrow. It will cover about 400 acres of land area with water. The water would be lifted from the Delaware River at Point Pleasant, pumped for a distance of about eight

miles over a ridge, and then released into the northeast branch of the Perkiomen Creek and allowed to flow downstream into Montgomery County to be impounded in the reservoir. A filter plant would be built near the dam. The program calls for the County going, in effect, in the wholesale water business.

A County park will completely surround the reservoir. It will be a rather long, thin park with many miles of shore line. We propose to call this park the Lederach Park, after the name of a little settlement nearby.

The background on the development of this plan is rather interesting. It represents a response to a local water need on the part of county and local governments. As already stated the needs had been felt in Lansdale for quite some time. Industries, community leaders, and other people in the Lansdale-North Wales-Telford-Souderton area - the North Penn area - developed an organization called the North Penn Water Resources Association. The purpose of the Association was to promote the development of a plan that would eliminate the recurrent water shortages.

This is a very rapidly developing area with a lot of industry. Many people have moved into it. Within the area are pharmaceutical plants, transistor plants ceramic plants and metal fabricators. It is very attractive to industry, primarily, I think, because of the labor supply. The area lies about 25 miles outside the City of Philadelphia. Its industries and people now depend almost entirely upon ground water and, as mentioned earlier, this source is inadequate during periods of drought.

The North Penn Water Resources Association petitioned the Montgomery County Planning Commission and the Board of County Commissioners to find out what could be done to alleviate this situation. The County Planning Commission recommended to the Board of County Commissioners that a study be instigated. The Board of County Commissioners approved the recommendation, the organization of Albright & Friel was engaged as consultant, and the study was started. An advisory

committee was formed which included people like Jim Allen, George Elias, members of the Wissahickon Watershed Association and of the North Penn Water Resources Association, local government leaders, and Alan Sommerville from the State Department of Forests & Waters. The Advisory Committee met frequently to consider the reports and recommendations of the consultant and to make decisions.

The background of this plan may be summarized by saying that it represents a response to a local need on the part of County Government and the County Planning Commission, financed through the use of general funds from the County treasury.

Presently, we are in the most critical state of our program development, at least from my view. We are negotiating with the key individuals, the people who are going to make the decisions, to say "go, or no go". We will take the plan to the public in November. We are negotiating with the water supply agencies who are going to have to finance the plan and with the various county officials.

The North Penn Water Resources Association is preparing a summary of the engineering report which the general public can easily understand.

I have just received ten pre-prints of our comprehensive engineering report from the bindery. Initially, we are printing 1000 copies for distribution. We will probably print more later.

We are now trying to negotiate an agreement among the participating agencies for the implementation of the plan, beginning promptly with the acquisition of land and with construction of the dam in 1968.

We have had good press coverage on this plan thus far. At one point recently, The Philadelphia Inquirer apparently thought there might be the makings of a controversy about our plan. Homeowners in the area of the proposed reservoir were interviewed, as were community leaders and many others, but no controversy was uncovered. When a story finally appeared in a Sunday edition,

the headline read "Local People Accept Plan". Even those who will have to move have generally come to accept the project. Fortunately, in the beautiful valley of the park and reservoir, there will only be about 55 homes taken. This is actually a very small number.

The major obstacle to the implementation of our plan now is the significant increase in water rates which will be necessary to invoke in order to carry it out. In some cases the rates must be tripled and, in others, increased even more. We are in the delicate stage of trying to negotiate this problem at the present time.

One of the speakers yesterday brought up four points that apply to the development of our water supply plan in Montgomery County very well. The first of these was the establishment of goals and objectives. The goals and objectives in Montgomery County were clearly set by the Board of County Commissioners and by the County Planning Commission as to the area to be served and the problem to be solved. The multi-purpose aspects were also considered since our plan calls for the inclusion of a new county park. Our goals and objectives were spelled out and transmitted to our consultant. We did not have the consultant establish our goals and objectives for us.

The planning criteria, the second point, were developed in a very fine way. The population projections and growth rates were developed by the staff of the County Planning Commission. The land use pattern was also projected by the Planning Commission staff. The water needs were developed by Albright & Friel and the ground water potential by that firm and its consultant. The financing plan has been a joint effort of the water supply agencies, the consultant and the County Planning Commission.

The third point brought up was to develop the optional or best plan. Our group studied seven alternative plans for solving the water supply problem of the North Penn Area. Of those seven, one was selected. Of the one selected,

three variations were analyzed. Of the three variations, one was finally chosen.

The fourth point called for a review of the results. I assure you that our plan is getting plenty of review at this moment. We already have people wanting to change and modify it. Some people don't believe we are going to need so much water by 1987. Others wonder how in the world we can find enough money to finance the plan.

In summary, I will point out two of the most significant aspects of the Montgomery County Water Supply Plan. First, water from the main stem of the Delaware River will be brought into Montgomery County to meet the immediate and long term needs of the area. Second, in addition to the creation of a new reservoir, for water supply storage, our plan will provide for an important addition to our county park system. The implementation of the plan will represent a great step forward for Montgomery County.

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THE INTERSTATE COMMISSION ON THE DELAWARE RIVER BASIN

REGIONAL SEWERAGE PROGRAM - PHILADELPHIA METROPOLITAN AREA

Morton Lustig,
Fels Institute of Local and State Government,
University of Pennsylvania

October 16, 1962

REGIONAL SEWERAGE PROGRAM - PHILADELPHIA METROPOLITAN AREA

By

Morton Lustig
Fels Institute of Local & State Government
University of Pennsylvania

I feel a little like a maverick after the preceding speakers because they are all concerned with real water and real pollution and I am a paper dreamer compared with them. But sometimes it helps to back away from a problem and take a new look at it and forget for a moment some of the things you have to worry about if you are living with a particular situation and with the political circumstances that surround it.

The study about which I am going to tell you was sponsored by the Study Commission for the Philadelphia-Metropolitan Area. This is a group appointed by the Governor of Pennsylvania for the purpose of studying metropolitan problems. The study was sponsored and paid for in part by the Pennsylvania Department of Commerce. Our assignment at the Institute was to take a look at the sewerage problem in the five county, Southeastern Pennsylvania area; make some judgments about what the problem would probably be like in 20 years; and see if we could suggest ways in which the problem could be handled most effectively. We have attempted to do these things.

I will give you a few of the background figures in very rough form. There were, in 1960, about 1,800,000 people in the four counties surrounding Philadelphia. Philadelphia, for all practical purposes, is served by a comprehensive sewage collection and treatment project. In the suburban counties, however, about 700,000 of the 1,800,000 people have no public sewerage facilities, at least they did not in 1960. About 20 years from now we expect to add a million more people in the four suburban counties. Thus, we now face the problem of what to do about the 700,000 persons who presently have no public sewerage facilities and the million more who will be coming into the area in the next twenty years.

In planning for sewerage facilities for the future there was one essential conclusion which we reached from our study. We are of the opinion that sewerage facilities should be provided in advance of development. I think Franklin Wood told you a little bit about what happens when sewerage comes after development and he gave it to you in a very moderate way. It seems to us that the cost of not providing sewerage facilities in advance of development is extremely high. We estimate, for example, that it costs almost a thousand dollars per lot more to provide sewerage works after development than to provide them in advance of development. If you also take into account the capital cost of water supply and electricity, the capital cost goes up another thousand dollars if you find, as we have in this area, that where there are no sewerage facilities, this fact establishes the main reason for using large lot zoning.

After studying the zoning for the undeveloped land in the suburban counties in the Philadelphia area, we judged that of the million people we expect in the twenty years between 1960 and 1980, only about half could be accommodated on land which is now zoned for lots of a quarter acre or smaller. About a quarter of them would have to go on lots a half acre in size and another quarter would have to go on lots that are now zoned an acre or more in size. To us, this seems pretty ridiculous. We believe that the size of lot is not related to what people need and what they want. It is related primarily to other objectives, such as restricting the size of population in individual municipalities for other reasons. But these reasons usually add up to a tremendous cost to all of the people in the community and to the metropolitan area as a whole.

So, for our purposes, in studying sewerage programming, we assumed that the existing zoning program was sometimes irrational and that this zoning pattern would not necessarily hold. We assumed that if sewerage facilities were provided in advance in the areas where population growth seemed most logical that zoning could be adjusted to make some kind of reasonable response to the

existence of these facilities and that a reasonable development pattern for the whole area could be established. If you make that assumption, as we did, and if you study the difference in the efficiency of large disposal plant systems versus small disposal plant systems, the indications are that we should try to handle our wastes in fewer and larger sewerage plants than we are now doing. In 1960 there were about 55 operating sewerage plants in the area. Perhaps a half dozen have been added since that time. We found that if the systems were all tied together in a reasonable way, nine large plants distributed throughout the area could do a pretty good job of taking care of about 1,300,000 people in the area. We would also need a few of the existing sewerage plants to take care of isolated situations that couldn't be reached with the trunk lines of the coordinated system on a reasonable cost basis.

These nine large plants would be located as follows: two in Bucks County, one near Morrisville, one at the Neshaminy; the three in Philadelphia which are now existing; two in Delaware County, one of the existing joint plants and the reconstruction of the Chester plant. For the Brandywine Valley, most of the sewage could be handled at the Wilmington plant with an enlargement. Finally, the ninth plant to take care of large sections of both Montgomery and Chester Counties would be located at the juncture of the Perkiomen and the Schuylkill.

Now this is all speculation about physical arrangement. It obviously is something you could not do immediately. It would have to be done in pieces. We don't think there would be a terrible amount of waste in eliminating and displacing a lot of the individual small plants.

In addition, we looked at this physical plan and other physical arrangements that could be made for the same area. We are not suggesting this is the only one, nor necessarily the best one, but it is one that seems to us to be practical and far more effective and far more efficient than the arrangement we have now.

If we got large area systems, we would probably have to have large area governmental units to run those systems. We suggested in our report that there are four criteria for judging what kind of governmental unit ought to be available for operating the sewerage plant. First, the unit ought to be capable of handling the total sewerage job. Most municipalities either aren't or can't put out the kind of money necessary to do a good planning job. Secondly, the unit ought to be one that will accept responsibility for providing sewerage for all the area on a drainage basin that should be included in one system. As it is now, we get individual communities or groups of communities that plan for themselves and may or may not care about upstream areas that logically ought to be joined to theirs. Third, the jurisdiction should be one which is big enough to finance construction of a decent system and which can finance a certain amount of excess capacity in order to tie in new developments as they occur.

There were a number of possibilities for meeting these criteria. Two, however, seemed to be most logical for this area. One was some kind of an overall metropolitan unit. It could be a governmental unit or a limited authority of some kind. We suggest that if, for other reasons, there is to be a regional governmental unit in the area, such unit should have responsibility for the sewerage job. However, in looking at the physical arrangements which we suggested, we think it is not essential that there be a single area-wide government to take care of sewerage. The way the plant and trunk lines worked out, we think that the problem could be handled well if there was county responsibility for sewerage. Almost all of these plants serve either one county or, at most, two counties. Each of the sewerage systems, therefore, it would seem, could be worked out by one county or by agreements between pairs of counties. We think the number of units involved is small enough and the number of arrangements involved is small enough so that the plan could be carried out

effectively. For this reason, we were very pleased to see Bucks County establish a County Water and Sewerage Authority. We are beginning to build more and more on the structure of our county. We think this is a logical and wholesome trend.

In Delaware County incineration facilities are provided by the County. Three plants serve the entire area. All of the counties, too, have planning commissions. Most of them are reviewing subdivision applications. We also have associations for watershed development. Yet, it seems to us, that sewerage, which is more expensive and more difficult to operate, is not yet handled on a watershed basis or on any large scale basis. This is now being left largely to individual minicipalities.

We made some very broad brush estimates of what it might cost to provide sewerage facilities of the kind we are talking about. The nine sewage treatment plants that we have suggested, plus the major trunk lines, would cost about $67,000,000. For the 1,300,000 people who are served by these plants, this amounts to an annual debt service cost of about $12 per family per year. We don't think this is excessive. We did not include, however, the cost of service within the municipality. Our figures are only for major trunk lines and major plants. There would obviously be a good deal of cost in addition to that.

It seems to us, and it has seemed to the Metropolitan Study Committee which approved our report, that the approach we recommend would be in the long run a much more efficient and effective way of handling sewerage problems. With such systems, it seems to us, we would probably get a much more logical development of our total pattern of land use in the Philadelphia Metropolitan area. We believe we can afford it and that we can probably develop the governmental structure we need to carry it out.

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THE INTERSTATE COMMISSION ON THE DELAWARE RIVER BASIN

INCODEL - A SALUTE TO THE PAST AND PRESENT

Francis A. Pitkin,
Chairman, Incodel

October 16, 1962

INCODEL - A SALUTE TO THE PAST AND PRESENT

By Francis A. Pitkin, Chairman

Interstate Commission on the Delaware River Basin

Delaware River Basin Water Resources Conference

Pocono Manor, Penna. October 16, 1962

This is the second time within the past 18 hours that I come before you with strong and mixed emotions.

At the banquet last night, as most of you know, I was presented with an award for distinguished service to Incodel. I told you then, and I repeat now, that the pleasure of being given this recognition before so many associates and friends, both new and old, is tempered only by the fact that honesty requires that I divide this honor with a great many others. We all regret that such stalwart pioneers as Incodel's first real chairman, Ellwood Turner of Pennsylvania, and others such as General Thompson of New York, and Dick Beckett of Delaware are no longer with us here on earth to share in these festivities.

And now, at this concluding session of the Conference, I am about to make what will undoubtedly be the last formal report on the activities of Incodel. After this Conference adjourns, the members of Incodel will meet in executive session to determine what actions must be taken to transfer its assets to the new Delaware River Basin Commission by the end of this calendar year and also to effect its official dissolution by legislative actions of the Delaware Basin states early in 1963. There will be no Incodel, as it is presently constituted, at this time next year! You might expect that after an association of 26 years with Incodel, I would regret to see these impending changes. Actually, of course, we have been hoping for these changes for a decade or more. In our efforts of 1950 to 1953 to secure passage of compact legislation to create what we then called "the Delaware

River Basin Water Commission" we recognized that Incodel with its limited powers should ultimately be replaced by a compact-created agency with power not only to plan but also to finance, build and operate.

Any feelings of sorrow or nostalgic regrets for "the good old days" are compensated for many, many times over by the joy of knowing that Incodel's program is not actually being terminated. Rather it is being passed on to the new Delaware River Basin Commission, an agency designed to execute the things we of Incodel have been working toward for so many years. It is a source of great satisfaction and pleasure to know that the new Commission will inherit from Incodel, in addition to its experienced and knowledgeable personnel and its valuable physical assets, a drainage basin of natural resources far superior to those with which Incodel started business a quarter of a century ago.

Let me examine this statement with you for a few minutes.

Water Pollution Control

We hear a lot of talk today about water pollution control. Almost everyone is in favor of it. The new Commission is fortunate indeed to start out with a functioning basin-wide program for coping with pollution backed by a public consciousness of the need and value of clean water. What a contrast this is, compared to the conditions and attitudes which confronted Incodel when it was first established! At that time the Delaware River and many of its tributaries - - particularly the Schuylkill and Lehigh Rivers - - were rapidly being ruined by pollution. Sections of these streams were then characterized as the most grossly polluted in the world and a national disgrace. These charges, believe me, were not exaggerated. I vividly recall a boat ride in the Philadelphia-Camden section of the River in 1939 which was arranged in order that the members of Incodel could find out for themselves how bad the River really was. We were scheduled to have a box-lunch on board at noon.

But the sight of and stench from the River at our position at that hour were so sickening that we had to abandon the plan, cut the trip short, and head for shore.

This is but one incident. There were many, many more. For example, I remember well the hydrogen sulphide fumes, smelling like rotten eggs, which bubbled from the River in the vicinity of the Philadelphia Naval Base. The gases were so potent and so prevalent that overnight they would blacken the paint on the hulls of ships anchored at the Base as well as on homes in the neighborhood on both sides of the River.

Despite these situations, no agency except Incodel at that time seemed to be greatly disturbed about the disgraceful quality of the Basin's waterways. Actually, we were even accused by representatives of industry and of trade associations of being idealists for urging an end to water pollution. Ellwood Turner used to refer to these critics as "little men in big business".

The new Commission, too, as the result of Incodel's activities, inherits a Schuylkill River, the Delaware's largest tributary, which no longer, as in the early 1940's,is on the verge of being completely choked by the accumulation of coal silt and culm from the operation of the anthracite coal mines in its headwater regions. This disgraceful situation was corrected by the completion of the Incodel-sponsored $35,000,000 U. S. Government - Commonwealth of Pennsylvania Schuylkill River Restoration project which was authorized in 1945.

Flood Damage Abatement

Similarly, the Delaware River Basin Commission is the beneficiary of the products of many other activities in which Incodel actively participated over the years.

Consider, for example, the problem of flood control. When Incodel came into existence in 1936, the Philadelphia District Office of the Army Engineers had completed only a few years earlier its so called "308" reports on the

Delaware, Lehigh and Schuylkill Rivers and other tributaries of the Delaware River Basin. These reports covered the results of surveys authorized by the Congress in 1927 of flood control, navigation and related problems of the major rivers of the country. None of the Army Engineers "308" reports on the Delaware River or its tributaries pointed to flood hazards as a serious problem.

And yet, since then, the need for the construction of physical structures, and for the institution and enforcement of regulatory measures to reduce the cost of damages caused by floods in the Delaware Basin has attained ever increasing importance. It is a source of gratification to Incodel that it actively participated with many citizens' groups and state agencies in the several programs which have culminated (1) in the construction of the Lehigh River and the Lackawaxen River flood control projects, (2) in the utilization of the U. S. Department of Agriculture's Public Law 566 Watershed Protection and Flood Prevention Program in several sections of the Basin, (3) in the preparation of a report on basic data necessary for the formulation of regulations for the control of the use of land and structures within the flood plains of the Neshaminy Creek and (4) in the recommendations contained in the Army Engineers report on the Delaware River Basin calling for the construction by the year 1980 of seven multiple purpose projects with flood control storage.

Each of these projects constitutes an essential element of the new Commission's comprehensive plan for the control and utilization of the water resources of the Delaware River Basin.

Municipal And Industrial Water Supply

It should also be helpful to the new Commission that Incodel, since its inception, has been continuously aware that the waters of the Delaware River Valley constitute an attractive source of future municipal and industrial water supply for many communities and metropolitan areas in each of the states in which the basin is located.

From the very beginning Incodel has taken the position that the use of waters of the Delaware Basin for water supply is superior to its use for all other purposes; and that the Delaware can provide a supply of good water sufficient to meet forseeable requirements for all purposes in all areas of each of the Basin states that may be logically served by the River and its tributaries, provided that their waters are properly developed and conserved.

This is why, as soon after the general acceptance of its basin-wide pollution abatement plan as was practicable, Incodel turned its attention to Delaware River Basin water supply situations.

This is why, in 1949, even before the severe drought which resulted in drastic restrictions in the use of water in New York City and northeastern New Jersey, Incodel urged the Delaware Basin states to provide funds for an intensive survey of the future water supply requirements which could be best served by the Delaware. The result of this survey(made for us by Malcolm Pirnie and Francis Friel) was, as you all know, the Incodel recommendation in 1950-51 that the States enact a compact creating a Delaware River Basin commission to construct and operate a water conservation program consisting of a series of reservoirs in the upper Basin.

The comprehensive plan for meeting future water supply needs in the Delaware River Basin service area, recently completed by the Army Engineers, is essentially an expansion of the plan which Incodel recommended a decade ago.

Conservation Of Soil And Forest Resources

Now let me say a few words about the soil and forest resources of the Basin. When Incodel came into existence they, like the water resources, were in some areas being ruthlessly exploited. The policy which Incodel adopted to protect and properly develop these natural resources was to prevail upon the agencies of federal, state and local governments to tackle the problem on a cooperative, rather than on a competitive, basis. It urged that the

common objective should be to consolidate their efforts in encouraging farmers, land owners and other interests to stop prevailing malpractices.

As a result of the pursuance of such a program, the scars of clear-cutting and burning of woodlands and of improper utilization of agricultural lands have largely disappeared from the landscape of the Delaware River Valley.

Obviously, the new Commission, in contrast to the situation that confronted Incodel at its inception, now has a sound and solid foundation upon which to build a plan for the further enrichment of the soils and forests of the Delaware Basin.

Watershed Associations

These are several other activities that Incodel has spearheaded of which the new Commission will be a substantial beneficiary. Foremost among them is our program to stimulate the local people in the numerous tributary watersheds which comprise the Delaware River Basin to form watershed associations, patterned after the Brandywine Valley Association, to formulate policies and plans at the grass-roots for the development and conservation of the natural resources of their respective drainage basins.

By latest count, there are now at least 15 such associations in the Delaware Valley. Two of them, the Neshaminy and Wissahickon Valley Associations, are growing in strength and stature day by day. These organizations promise to rival the accomplishments of the Brandywine Valley group in the future. Many of the other watershed groups are becoming increasingly effective. All of them have a common goal - the proper development of their natural resources.

These watershed associations, together with regional and county planning agencies, will undoubtedly be a tremendous source of support and aid to the new Commission in the advancement of its programs.

Summary

I have tried during the past few minutes to recount briefly some of the activities in which Incodel has been engaged in the past. And I have attempted at the same time to show that the products of our efforts have resulted in accomplishments constituting essential components of the comprehensive plan for the control, development and utilization of the water resources which the new Delaware River Basin Commission has been directed by interstate-federal compact to adopt and execute.

In compliance with this directive, the compact Commission has now embarked upon a new era of water and related natural resources development in the Delaware River Basin. Last night, Secretary Goddard painted a picture for you of how he believes the Basin will look in the year 2,000. Immediately following my report the executive director of the new Commission, James F. Wright, will conclude this Conference by giving you a preview of the kind of organization and programs the Commission will utilize in order to give life to the picture the Secretary envisions.

For myself, in closing, I am delighted to state I am confident that the era which the new Commission has opened will be one of good will and effective cooperation among agencies of government - federal, state and local - and between government and the people. I expect that all interests concerned will contribute constructively toward the moulding and prosecution of a fully comprehensive plan for the wise control and utilization of the resources of our great Delaware River Valley. I join Secretary Goddard in believing that by the turn of this century most of the projects comprising such a plan will have been completed and placed in operation.

Obviously, I will not be around then to see whether our dreams come true. However, one of my life's greatest satisfactions will be experienced if I am present when ground is broken for the Tocks Island project. This event, it

seems, is now only two or three years away. It will mark a most important mile-post in the Delaware River Basin plan. I am looking forward to the pleasure of being on hand to celebrate the occasion.

* * *

THE INTERSTATE COMMISSION ON THE DELAWARE RIVER BASIN

ORGANIZATION AND PROGRAMS OF DELAWARE RIVER BASIN COMMISSION

James F. Wright,
Executive Director,
Delaware River Basin Commission

October 16, 1962

ORGANIZATION AND PROGRAMS OF DELAWARE RIVER BASIN COMMISSION

James F. Wright
Executive Director
Delaware River Basin Commission

You have heard many fine speeches in the last two days. You have heard some clear and expository, some involved and technical, some proud and optimistic, some frightening in their potential, and now mine which will not be very technical, won't be the most interesting, won't be the most pessimistic, but will be the most welcome because it is the last one.

The Delaware River Basin Commission at the moment is a fledgling agency which has no difficulty in seeing, especially at this traditional Conference, that its work got under way a long time before it arrived on the scene during the past year.

Thanks to the work of our forerunner organization, Incodel, and the many state and federal agencies, our Commission will have plenty to build on as it embarks upon the assigned mission of coordinating a massive program for developing the resources of the beautiful Delaware and its tributaries.

The Commission is mindful, also, that it is the agent of the Basin's millions of residents. This new Commission is not unlike the one Incodel had proposed for the Delaware River Basin nearly a decade ago. But for the lack of approval of one legislative branch in 1953, the compact agency inspired by Incodel might long since have been on the job and Herb Howlett and I would still be in California.

Incodel has done much to bring into focus the Basin's needs that our Commission will be trying to fulfill. We have already profited by our association with Incodel. We hope that our plans to absorb it into our organization serve as ample evidence that we do not intend to turn our backs on the achievements of our predecessor interstate organization. We have a foundation which we appreciate. I am also authorized by the Commission to say that

we want to continue the relationship with the legislative committees of Incodel in an advisory capacity which have proven so valuable to the staff of Incodel in the past and toward this end we shall be working during the next few months.

This is a good opportunity to elaborate on the subject of the Commission's relation with others. Those attending this Conference largely represent organizations or agencies whose purposes make them allies of the Commission and whose functions may appear to overlap with ours at times. Some concern has been evidenced that the Commission might be trying to undertake work now properly regarded as the province of existing state agencies. To this I can only say that you don't know my commissioners very well.

The framers of the compact were acutely aware of the situation and were forthright in establishing a policy that we must follow in our relations with public agencies with whom we have an identity of interest. Any apprehension that the Commission will be doing any jurisdictional poaching should be allayed by this statement in the compact: "It is the purpose of the signatory parties to preserve and utilize the functions, powers and duties of existing offices and agencies of Government to the extent not inconsistent with the compact and the Commission is authorized and directed to utilize and employ such offices and agencies for the purposes of this compact to the fullest extent it finds feasible and advantageous". This is a clear and direct order and there is no intent to depart from it.

I might indicate that we have already dealt with a situation which I think evidences our full faith and confidence in this particular. I refer to the Tri-State Fisheries Resource Study which was launched in 1959 by Pennsylvania, New Jersey, New York and the United States Fish and Wildlife Service. In four years, this program has produced a mass of information on the upper Basin's fish species, including inventory, fluctuating population, age, growth rate and spawning areas, as well as river chemistry, flow and temperature. But not until this information is analyzed and evaluated can decisions be made on how

river development installations can best be designed and located to protect and propogate fish crops and promote more fishing activity.

We might have undertaken this project ourselves, but after careful consideration, our Commission, last month, adopted a resolution recommending that the Federal Fish & Wildlife Service do the job and be given the wherewithall by Congress and the Bureau of the budget with the full cooperation pledged by the interested states and by the Commission in the work leading up to the final analysis.

Under the unique features of the compact which make the Federal Government a partner in our border crossing agency, we especially welcome the opportunity to work in harmony with agencies of the Federal Government. We also recognize our obligations to help agencies of the participating jurisdictions, as well as to respect their boundaries of interest.

We know that we have a common interest with many non-governmental groups, watershed organizations and other important organizations, whose work involves the Basin's natural resources. Our Commission can be expected to maintain its close association and cooperative efforts with these groups just as it is doing and will continue to do with the Water Resources Association.

I have been asked to outline briefly to you how we are going to be organized and what programs we will carry on. We are organized into an Executive Division, which will be the policy division of the Commission, and will concern itself with the "ivory tower" thinking, with the "imagineering", if we may use the term, of the problems ahead, with the relationships between the Commission and the various state and federal agencies and with the direction and coordination of the technical work. This will be supported by an administrative division of more or less standard functions which I will not elaborate upon.

There will be an Engineering - Planning Division, at this time composed of three branches. One will be the Project Planning Branch, one will be the Project Review Branch and one will be the Water Quality Branch. The focus of the work of these three branches will be in the Chief Planning Engineer, Mr. Howlett, whom you heard talk yesterday.

I would really like to discuss in some detail with you the specific programs that we have planned to undertake for the remainder of this fiscal year and for the next fiscal year.

We have identified at this time nine programs.

Program No. one (1) is our continuing inventory of water supply. From data collected from numerous agencies which is not now completely combined in a form suitable to inventory of water supply from the viewpoint of the Commission, we hope to put together a summary of significant water supply information. To the maximum extent possible we expect to use established agencies for raw material. Our function will not be original collection, but rather compilation and analysis.

Our second program (2) will be concerned with analysis of population and requirements for land and water use. As in the case of program one (1) we will not be duplicating the work of the agencies already carrying out this function, but will be putting together from many sources the significant facts about water requirements that relate to our basin needs.

Program No. three (3) will be devoted to annual requirements for recreation fish and wildlife within the basin. We need to develop here a central awareness of the many programs being maintained by each of the states and by at least a half-dozen federal agencies -- to cast them into perspective and to evaluate the sum of these programs in relation to other water resource projects being concurrently developed within the framework of the master plan.

Planning program No. four (4) involves an analysis of the hydroelectric power potential and the market demands for power within the basin. We wish to insure, in conformance with our objective to maximize each purpose of our multi-purpose projects, that full consideration will be given to the power that can be generated within the basin harmoniously with other purposes of the master plan.

Program No. five (5) encompasses the investigation of the projects proposed or undertaken by agencies other than the commission and which are not now specifically embodied within the present phase of the comprehensive plan. We must develop principles and policies concerning the classes of projects that need to be submitted to the Commission for its review. We must develop the rules, procedures, and forms necessary to carry out this review expeditiously. This program will envisage frequent and almost constant liaison with public and private agencies working on water-related matters of the basin and will require review of projects which must be submitted to the Commission to determine compatibility to the comprehensive plan.

Program No. six (6) contemplates a continuation of the basic purposes of Incodel, expanded as may be necessary to meet the major legal requirements assigned to the Commission under the compact. It will encompass familiarization with work carried out by state health departments and federal agencies in the field of stream classification and quality standards because of the necessity of updating and modernization. It will, of course, require that close liaison with all federal agencies, particularly Public Health Service and Geological Survey, be maintained to insure full interchange of information on quality conditions. It will require the ordering of all such information into a comprehensive pattern for each of the appropriate reaches or sections of the basin. It will necessitate the integration of water quality and waste disposal plans with other programs for use of water resources within the basin.

Program No. seven (7) deals with flood loss reduction planning. We visualize the necessity for complementing the work of the Corps of Engineers, Soil Conservation Service and other agencies in providing flood control structures for correlary programs of a non-structural nature to promote maximum reduction of flood loss. Our efforts here will be largely concerned with study and analysis of methods which can be used by local jurisdiction for their own protection. In all programs we will, of course, carefully investigate the nature and extent of similar activities being carried out by state, federal and other agencies also working on this problem, and cooperate with them to determine the most effective way in which Commission efforts can be directed towards better developing those local protections that will reduce flood dangers and losses.

Our eighth (8) program has to do with basin operation planning. Consistent with many of the ideas that have been outlined in the discussion of the studies currently under way at Harvard, we feel that we should begin to consider -- well ahead of the time when these planned projects will become a reality -- the methods to be used to insure integrated operation of all the projects within the basin as contemplated by the comprehensive plan. As in all other programs, we hope to familiarize ourselves with the operational aspects of the projects being planned or constructed by each of the states and the federal agencies involved, and, from all of this, find cooperative schemes for basin operation that will produce the greatest yields and best uses of water resources. Such a program in today's society will require increased use of electronic data processing and electronic computing equipment.

Our ninth (9) and last program is concerned with the development, maintenance and custody of the comprehensive plan and the water resources program. Within this program we will provide direction to the various studies envisaged in the other component programs previously described. We will initiate studies of alternate economic and fiscal analysis to determine the basic allocation of

costs and priorities to evaluate compatible and incompatible uses of the river system. We will develop and recommend an annual water resource program--a statement of supply user demands and a listing of works proposed for construction by any agency during the ensuing six years -- and recommend amendments to the comprehensive plan. Within this program we hope to tie together the related but separate activities encompassed in the programs previously described.

When I consider the task before us, with all that has been done so far, with so much knowledge to be assimilated and correlated, with so many different agencies, with so much more to learn, and with so little control of great natural forces, I think we seem sometimes like prisoners communicating by shouts and by knocking from cell to cell, under the strange illusion that we are thereby operating the penitentiary ourselves. But when I consider how much has been done, not only in physical works, but in the free and full exchange of plans and knowledge and purpose in the concessions of sovereignty and in the joint protection of mutual rights and interests, I know that we shall succeed, and go forward together.

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THE INTERSTATE COMMISSION ON THE DELAWARE RIVER BASIN

REGISTRATION LIST

THE INTERSTATE COMMISSION ON THE DELAWARE RIVER BASIN

REGISTRATION LIST

Incodel Annual Meeting
Pocono Manor, Pennsylvania
October 15-16, 1962

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