

**STATE OF OHIO**  
**WATER RESOURCES RESEARCH INSTITUTE**

**ANNUAL REPORT**  
**Fiscal Year 1964-1965**

**to**

**Director Office of Water Resources Research**  
**The United States Department of Interior**

**Submitted by:**

**Water Resources Center**  
**The Ohio State University**

**Sept. 1, 1965**

**THE OHIO STATE UNIVERSITY**

**ENGINEERING EXPERIMENT STATION**

**WATER RESOURCES CENTER**

**1791 NEIL AVENUE**

**COLUMBUS, OHIO 43210**

**August 24, 1965**

**293-6108**

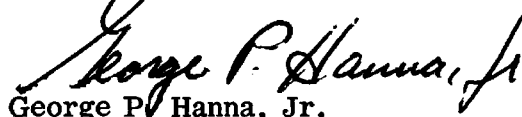
**Dr. Roland R. Renne, Director  
Office of Water Resources Research  
The U.S. Department of Interior  
Washington, D.C. 20240**

**Dear Dr. Renne:**

**The Water Resources Center at The Ohio State University hereby respectfully submits its Annual Report for Fiscal Year 1965 in accordance with Paragraph 506.2 "Rules and Regulations pursuant to Water Resources Research Act of 1964" - Federal Register Volume 29 No. 235, December 2, 1964.**

**The period covered by this report is from February 1, 1965 through June 30, 1965. However, comments in the narrative also refer to additional progress on the projects to date. The report covers the four original projects approved, and the results of the Water Resources Symposium held on June 24-25, 1965.**

**Very truly yours,**



**George P. Hanna, Jr.**

**Director, Water Resources Center**

**GPH/jm**

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**George P. Hanna, Jr., Director  
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**September 1, 1965**



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## INTRODUCTION

The Memorandum of Agreement by and between the Water Resources Center at The Ohio State University and the Director of the Water Resources Research, Department of Interior, for the purpose of conducting water resources research pursuant to the provisions of the Water Resources Research Act of 1964 (PL 88-379), became effective March 9, 1965. The Allotment Agreement for the first year was signed simultaneously and made retroactive to February 1, 1965. The funds provided, (\$75,000), under this Allotment Agreement have primarily been used for administration of the Center, for conducting a Water Resources Symposium involving participation of those involved in Ohio water resource problems, and for initiating the several projects that were approved as a part of the Agreement. In the proposal to the Office of Water Research, the Water Resources Center indicated that the current aims and goals would be in conformance with the overall planning associated with the future of Ohio, and that the major goal of the Center would be to further the optimum utilization of water resources consistent with these developments. In order to achieve this goal steps are being taken to develop a "Center of excellence" of research and training, and an associated task force to which the various groups concerned with water resources can look for information and guidance. Efforts are being expended to establish a means of information exchange with various agencies involved in water resources, and to provide a reservoir of well-trained personnel in the various water specialties to fulfill the various needs of industry and public service.

Consistant with these aims and goals, the Advisory Committee of the Water Resources Center, appointed by the President of the University from the several departments and colleges involved in water resources research, elected to initiate the program by concentrating on particular studies involving the available talent, interest, and background of University personnel, as well as available facilities pertinent to water problems of major concern within the state. Consequently the committee selected for study the two areas of immediate concern, acid mine drainage, and the oil field brine wastes. The four projects proposed under this program consist of three involved in the acid mine drainage area and one in the oil field brine wastes pollution problem. A section of this report is further devoted to the description and the current status of each of these projects.

The provisions of the Water Resources Research Act have been particularly helpful in strengthening the development of a continuous research program, cognizant of current needs, and capable of integrating separate but related studies in a comprehensive program directed toward the overall aims and goals. Aware of the special needs for developing a system of communications and exchange of information between the departments within The Ohio State University, as well as all other universities interested in water resources within the State of Ohio, and the State and Federal agencies working on the myriad of problems in the State, the Water Resources Center organized a Symposium on Water Resources Research, held on June 24th and 25th of this year at The Ohio State University, for the purpose of establishing the roles of the various organizations within the framework of water resources research. This symposium was

provided for under the item for Seminars and Conferences in the original proposal for funds and the fiscal information relating to this symposium is included in a later section on fiscal items. The Symposium was attended by 74 participants all of whom are actively involved in water resources planning or studies at the various universities, or with the several Federal and State agencies represented. A copy of the program is included in Appendix 1. Currently the papers presented at this Symposium are being edited for publication in a proceedings which will be ready for distribution early this fall. The symposium was established essentially for the purpose of bringing together the several university and public agency groups involved in water resources research in order to effect a means of communication and coordination of research projects. The program appears to have been very successful and has stimulated consideration of it as an annual event. It is anticipated that the next year's symposium will relate to more specific research problems. Plans are currently being formulated for this symposium.

During the period covered by this report members of the Water Resources Center attended and/or participated in the following regional meetings pertaining to water resources research:

<u>Date</u>	<u>Name</u>	<u>Meeting</u>
3/24/65	C.I. Randles	Second Water Research Symposium, Morgantown, W. Va.
3/28/65	P.R. Dugan	Eighth Conference on Great Lakes Research, University of Michigan, Ann Arbor, Mich.

<u>Date</u>	<u>Name</u>	<u>Meeting</u>
4/8/65	G. P. Hanna, Jr.	Water Resources Research Center Conference, Indiana University, Bloomington, Ind.
4/25/65	C.I. Randles*	American Society of Microbiology, Annual Meeting, Atlantic City, N.J.
5/3/65	G. P. Hanna, Jr.** W.D. Sheets K.S. Shumate*	20th Annual Purdue Industrial Waste Conference, Purdue University
5/20/65	P.R. Dugan C.I. Randles* G. P. Hanna, Jr. E.E. Smith K.S. Shumate	Symposium on Acid Mine Drainage, Mellon Institute, Pittsburg, Pa. (Sponsored by Bureau of Mines)
6/15/65	G. P. Hanna, Jr.	Fourth Rudolfs Research Conference, Rutgers University, New Brunswick, New Jersey
7/6/65	C.A. Dambach	Western Resources Conference, Seminars in Water Resources Research and VCAR Meeting, H. Collins, Colo.
7/7/65	G. P. Hanna, Jr.	Meeting of Regional Data Center Branch, Great Lakes Study Group, Chicago, Ill.
7/26/65	W.D. Sheets K.S. Shumate	National Symposium on Sanitary Engineering Research, Development, and Design, University of Pennsylvania

\*Papers presented

#### ANALYSIS OF LOCAL, STATE, REGIONAL, AND NATIONAL WATER NEEDS PROGRAM OF THE CENTER

The basic problems of the state that are tied in closely to the work of the Center will relate very definitely to the problems of water use and reuse. The entire problem of waste disposal as it relates to water carriage with its associated need for consideration of low flow augmentation and its impact on other competing water uses must be evaluated with respect to possible modifications or even alternative solutions.



More efficient use and reuse of recycled waters for industrial purposes will be a necessary adjunct to the water conservation program. The application of scientific principles and engineering techniques to the overall reduction of organic and inorganic contamination of water resources must be advanced on all fronts.

More insights and research talents in such areas as urban sociology, ecology and demography, resources, geography, economics, community and regional analysis, social organizations and mass communication will be required, and definite research focused on problems of water use and abuse. Mounting population pressures of rural to urban migration and urban to suburban migration multiply these problems of water conservation particularly within our state. Predictable changes in the character of urban populations and economics foreshadow developing problems involving water resources. Economic and social criteria will have to be developed in order to assess optimum values both with respect to individual and multiple use functions. The impounding of waters in suburban areas by metropolitan authorities for use in urban centers generates problems of intercommunity conflicts, regional area planning, mass communication and mass education. These are some of the major problems that have to be dealt with in the ever-growing urban areas in the near future. As our program continues, we anticipate that more effort will be put into this type of study. One of the approved studies for the coming year will involve the economics of the acid mine drainage problem, relating to the analysis of economic means of dealing with acid mine drainage, and the extent to which abatement would be in the economic interests of the region.

The quantity of available water resources requires a characterization of the overall hydrologic cycle to be considered. This will make it necessary to do more studies on small watersheds in order to more definitely characterize the conditions affecting these watersheds. Predictions of the effects of groundwater development, flood control projects, and other factors affecting a change on the overall hydrologic cycle might then be possible. A considerable amount of progress that has already been accomplished in terms of quantitative inventory of Ohio water resources by the Ohio Division of Water. It is anticipated that the Water Resources Center will cooperate very closely with the Ohio Division of Water in all of the projects involving hydrologic research. Currently the project involving a study of the groundwater brine pollution in the Morrow County oil fields, is being coordinated very closely with this agency.

## PROJECT PROGRESS REPORTS (through June 30, 1965)

WRC-101

DEVELOPMENT OF A "NATURAL" LABORATORY FOR THE STUDY OF  
ACID MINE DRAINAGE

The professional personnel who have participated in this study include Dr. E. E. Smith and Professor W. D. Sheets of the Department of Chemical Engineering and Dr. K. S. Shumate of the Department of Civil Engineering. In addition, Mr. R. G. Brant, Assistant Chief of the Ohio Division of Geological Survey, has given full cooperation in the detailed planning and execution of the site preparation phase of this study, with particular regard to the geological and hydrological description of the site.

In accordance with the research plan outlined in the Request for Initial Allotment to Establish a Water Resources Research Institute for the State of Ohio, the following progress has been made:

A. Geological, Physical, and Hydrologic Description of the McDaniels Test Mine and Surrounding Area.

Field studies conducted in early April indicated that the primary aquifer supplying the McDaniels Mine with ground water is the massive sandstone formation overlying the coal seam in which the mine is situated. The water flowing into the mine under both flooded and unflooded conditions appears to gain entrance through the sandstone roof. On the other hand, the floor and walls of the mine are relatively impermeable to the flow of water. Therefore, when the outlet valve in the mine seal is closed, the water level in the mine will gradually rise until it reaches an outlet at or near atmospheric pressure, which may be supplied by fractures between the coal and overlying sandstone,

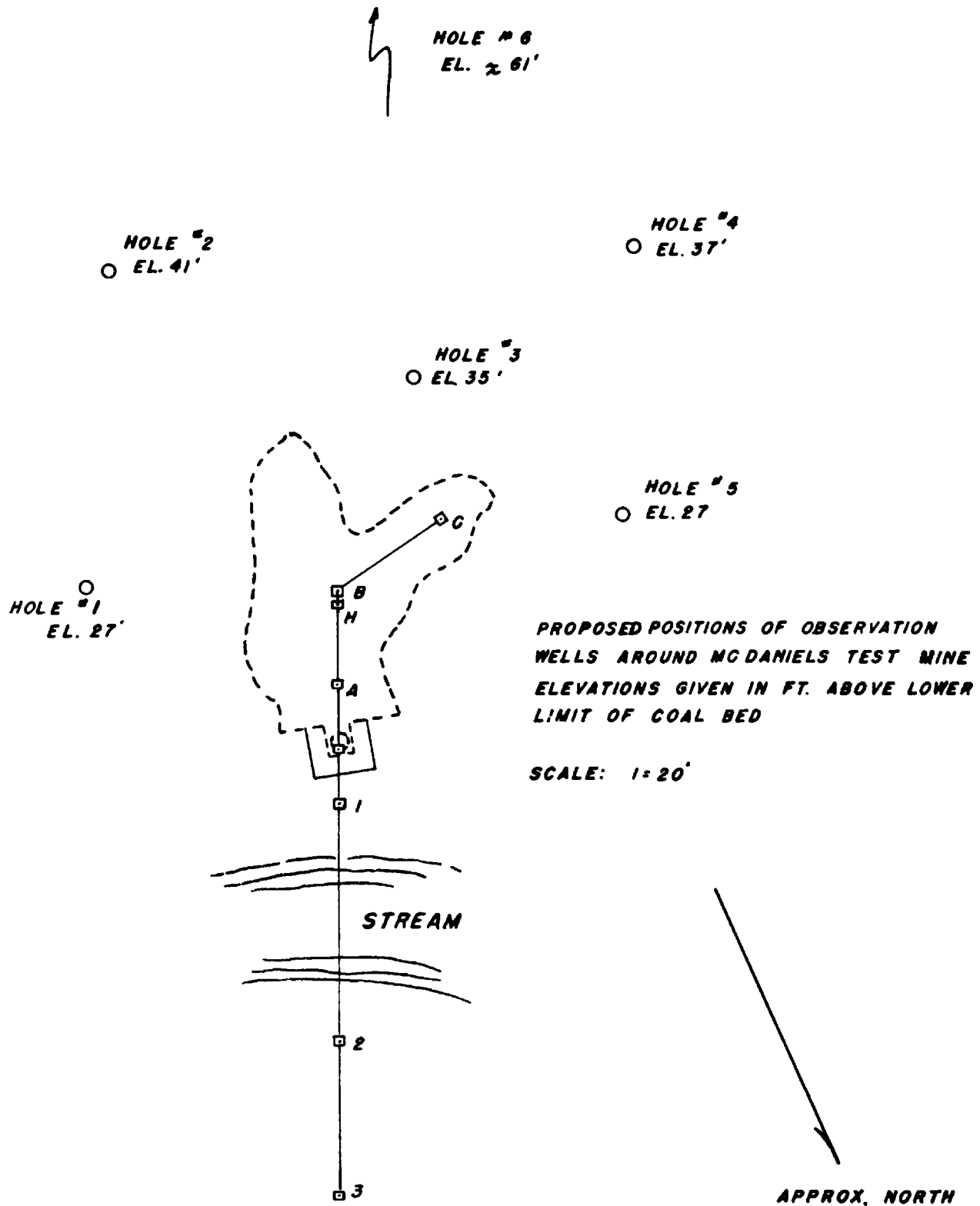












**PLANIMETRIC MAP OF MC DANIELS MINE  
AND OBSERVATION WELLS**

**FIGURE 1**







## WRC-103

## A BIOLOGICAL SURVEY OF ACID MINE WATERS

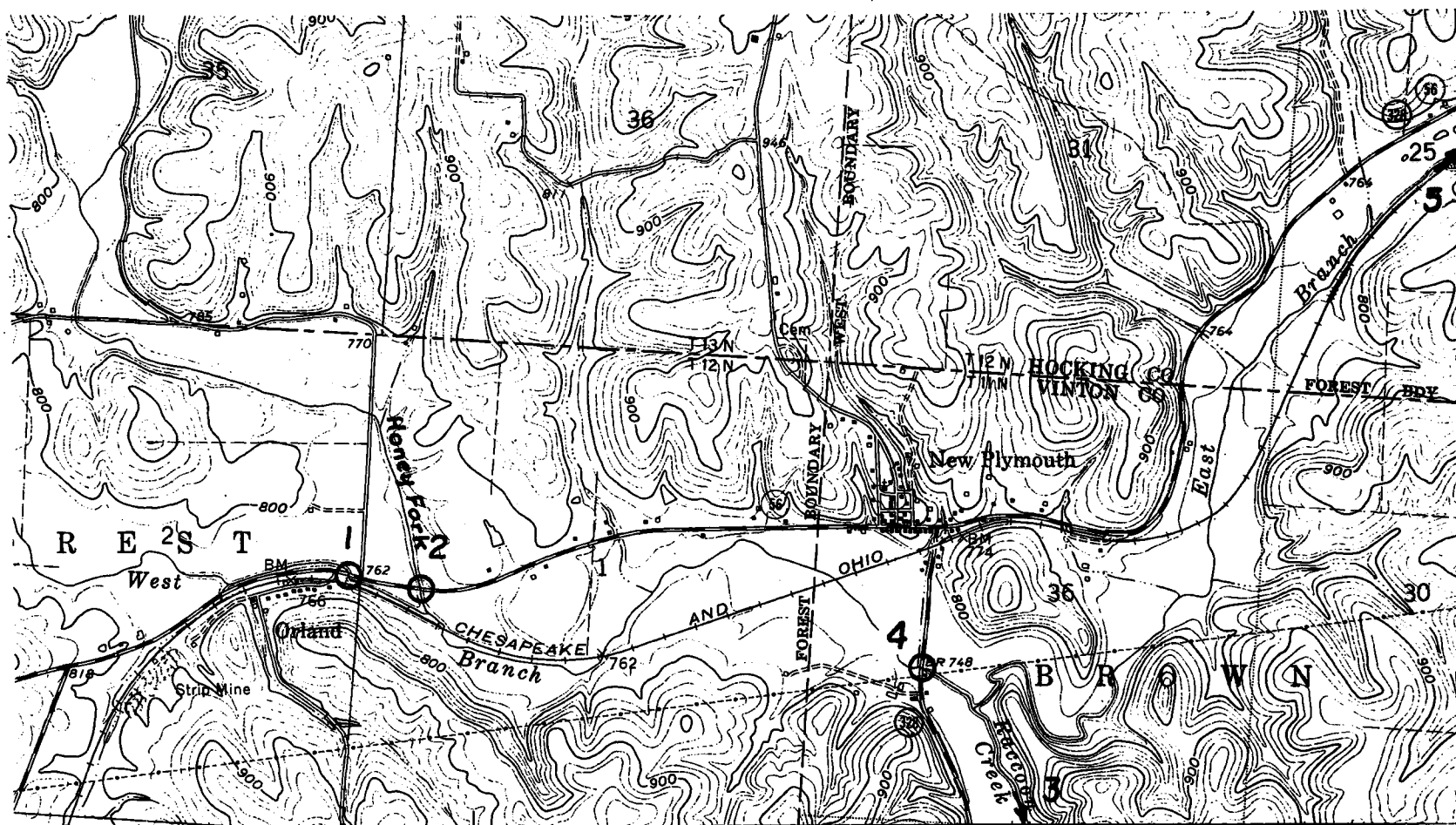
The professional personnel who have participated in this study include Dr. C. A. Dambach, and Dr. C. E. Taft of The Ohio State University, and Dr. John R. Olive of Ashland College.

This project was initiated on April 1, 1965 with the employment of Dr. John R. Olive as field supervisor of the project. Dr. Olive immediately proceeded to develop and train field crews for the project and to develop procedures for field work. Equipment for the project was ordered and preliminary field surveys were conducted in the Raccoon Creek, Hocking River, Olentangy River, and Big Walnut Creek watersheds to establish index stations and collecting points. Preliminary collections were made and chemical and biological determinations made at a variety of stations to evaluate procedures and to establish an effective program of collection of samples for biological examination and chemical determination consistent with the range of conditions found and the limits imposed by personnel, funds, and time.

Collecting stations in the Lake Hope and New Plymouth areas where acid mine drainage is a problem were established. These are indicated in the attached maps reproduced from New Plymouth and Mineral quadrangles of U.S.G.S. 7-1/2 minute maps. Chemical determination performed at each station with a Hach portable laboratory are as follows: Phenol Alkalinity, Total Alkalinity, Carbon dioxide, Chloride, Hardness -- Ca, Hardness -- Mg, Hardness -- total, Iron, Manganese, Nitrate, Oxygen, pH, Phosphate (ortho), Phosphate (meta), Silica, Turbidity, and Temperature.







**NEW PLYMOUTH QUADRANGLE**  
**LOCATION OF SAMPLE STATIONS 1-5**

Figure 3

(Scale 1:24,000)

**(Scale 1:24,000)**

## WRC-104

A STUDY OF GROUNDWATER CONTAMINATION DUE TO SALINE WASTE  
WATER DISPOSAL IN THE MORROW COUNTY OIL FIELDS

Dr. Jay H. Lehr, Department of Geology, is supervising this project.

The purpose of the project is to study the effect of pollution of the ground water in Morrow County, Ohio, due to the introduction of saline oil field wastes through evaporation pits. The investigation is directed toward the determination of the source of pollution, its severity, approximate areal extent, and probable future movements.

The initial approach to the problem was to select three hydrologically different areas and monitor the polluted groundwater as it migrated away from the source. This approach was partially altered when it became apparent that the oil operators were either unable or unwilling to furnish adequate quantitative information about the amount of salt water which had been disposed of through evaporation pits.

An alternative procedure was selected as follows: Evaporation pits in the Olentangy River flood plain, Delaware Township, Ohio are being used as a pilot project which should furnish quantitative as well as qualitative data. This location presents the opportunity of studying the direct relationship between a ground water system and a brine water disposal system. The pits drain very fast, indicating a high infiltration rate into the glacial till.

All the parameters in this area can be determined. The size of the reservoir is known, as is the depth to the water table, and therefore the amount of water

in the reservoir. The amount of salt water that has been produced by the oil wells, can, and will, be determined. Consequently this area will lend itself to rather precise quantitative measurements and results.

A regional survey over a portion of Morrow County will compliment the Delaware area study. This regional study will facilitate the mapping of chloride enclaves in the ground water reservoir, produced by a large number of disposal pits. The bedrock surface can be mapped, and the height of the water table will be determined. This will give the amount of water present in the near surface reservoir. By mapping the areal extent of the chloride enclaves, an estimate of the amount of chloride that has been introduced into the ground water can be made. The rate of movement of these enclaves will allow an estimation to be made of the length of time necessary for the reservoir to flush the salt. These investigations are now underway.

**Delaware Area:** The Delaware area has had saline wastes introduced into the ground water system through two evaporation pits that have been in operation approximately eighteen months. One pit is still being used to dispose of salt water, but the operator of the second pit has abandoned pit disposal and is injecting the water back into the petroleum reservoir through a dry hole drilled near his production.

The Delaware area lies in the flood plain of the Olentangy River. Glacial till, composed primarily of coarse sands and gravels, varies in thickness from 10 to 25 feet. This till is an excellent near surface water source but is somewhat limited in areal extent, being confined to a strip along the river channel approximately one-half mile wide.

A system of fourteen observation wells have been drilled around the pits to define the limits of the chloride enclave. The wells are spaced at varying distances from the pits, allowing calculation of the rate of movement to be made. The wells range in depth from eleven feet to twenty-two feet. Observation wells have been drilled on three sides of the pollution source which are free of excessive chlorides. The Olentangy River borders the fourth side and all wells drilled on the river side of the pits show high chloride contents.

Two series of chemical analyses on water taken from the observation wells have been made to date. These analyses have used the standard Mohr Method Titration for chloride concentration. The chloride concentration in parts per million for the two analyses are as follows:

Analysis #1      July 1, 1965		
Well #	Specific Conductance micromhos/cm	Chloride Concentration PPM
1	8000	33,000
2	8000	29,500
3	8000	10,500
4	8000	17,000
5	8000	2,600
6	8000	18,250
7	480	14.5
8	8000	13,000





The movement of these enclaves will be mapped on a monthly basis by contour isochlor maps based on the results of the sampling program. The ground water movement, and to a limited extent the near surface water resources of the area will be defined by this survey.

The geology of the area presents no great problem. In general there is a layer of glacial till at the surface varying in thickness from approximately 20 feet to as much as 200 feet thick in old buried stream channels. This till is laid down on a glacially eroded shale surface. Most of the domestic wells in the area do not penetrate the shale, therefore, they give an accurate measure of the chlorides that have been introduced through the numerous disposal pits in the area.

Four hundred and twenty-nine domestic water wells have been selected for sampling purposes. Two samples have already been taken from each well and the chloride concentrations determined. From these results, isochlor maps are being made which show the chloride enclaves in the survey area. Attached is a topographic map of the area surveyed, and the initial isochlor of the same area. (pp. 27 and 28)

In most instances the enclaves can be traced to disposal pits that lie within the limits of the chloride build-up. Additional observation wells are being drilled in each area where pollution occurs to substantiate the isochlor interpretation and to better define the limits of pollution. (Note: The normal chloride concentration for the ground water in the area ranges from 10 to 15 parts per million. A figure of 25 parts per million has been taken as the lower limit of pollution for mapping purposes.)

The magnitude of the sampling program makes it a very time consuming operation, therefore an attempt is being made to get individuals to sample their wells each month and leave the sample at a centrally located collection station. The Morrow County Health Department and the Morrow County Extension Agent are cooperating in this effort.

A number of oil operators in the area have discontinued the use of unlined disposal pits in compliance with recently enacted legislation dealing with disposal of saline water by evaporation pits. Others still continue to use pits for disposal purposes, but the amount of ground water pollution by oil field wastes has been curtailed in the last ninety days.

Additional work will include the drilling of additional observation wells to better define the areas of pollution and the drilling of six 4 1/2 inch wells for the installation of continuous water level recording devices. These water level recorders will determine the annual variation of the water table and when correlated with water level readings in the domestic wells will give a very reliable indication of the water table configuration of the area throughout each year.

A continuing program of well sampling, and analysis for chloride concentrations will be maintained throughout the course of the project. Isochlor maps will be made on the basis of these samples and the development and travel of the chloride enclaves will be mapped.

Dispersion of the brine wastes into the ground water will be studied by means of chemical investigations into the ionic exchange between constituent

compounds in the reservoir, and by sorption of the contaminating chemicals by the rock material of the reservoir.

The project currently employs one doctoral candidate, two masters candidates, and one undergraduate, all from the Department of Geology. At least one doctoral thesis is contemplated from this work.

R 16 E R 17 E

R 21 W R 20 W

OHIO STATE UNIVERSITY  
HYDROLOGY SURVEY

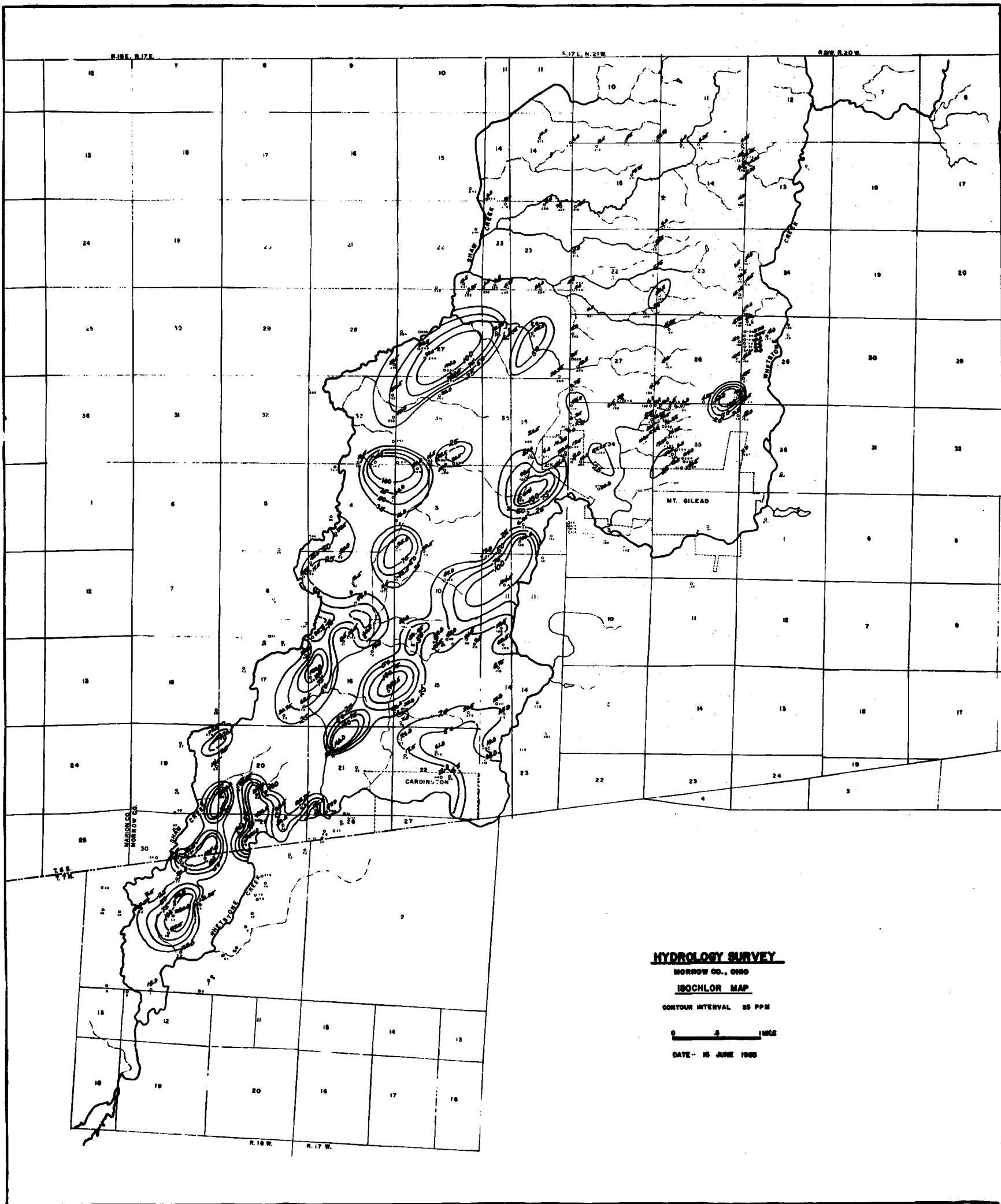
MORROW CO., OHIO

BASE MAP

CONTOUR INTERVAL 20 FTM.  
HORIZONTAL SCALE 1:24000

1 MILE

DATE.....







**"Strontium Isotope Composition and Trace Element Concentration in Lake Huron and Its Principal Tributaries".**

This project will involve the measurement of  $\text{Sr}^{87}/\text{Sr}^{86}$  as a reflection of mixing phenomena in the Great Lakes based upon both isotope composition and its concentration. The proposed work constitutes basic research in physical and chemical limnology, and as such, relates to the overall aims and goals of the Water Resources Center, specifically in its approach to the problems of the Great Lakes.

**"Strip-Mining and Water Quality".**

A study to observe the effects of strip mining in a controlled watershed on the aspects of the watershed's hydrology. This will be a field study extending the results of lysimeter studies in an effort to demonstrate the magnitude of salt production in weathering coal spoils.

Both of these projects are being initiated.

## FORM A

ANNUAL REPORT - TRAINING AND EDUCATION ASPECTS OF THE  
WATER RESOURCES RESEARCH PROGRAM UNDER P. L. 88-379

1(a) New Courses Added Relating to Water Resources

A new course "Measurement Techniques" has been instituted during the last year in Civil Engineering to acquaint the student with sophisticated analytical techniques relating to water quality, such as column and gas chromatography, spectrophotometry, respirometry, etc.

Two new courses in Geology have been developed during the past year with respect to water resources. The first of these "Geology of Water Resources", is a study of the geology and hydrology of surface and sub-surface waters with applications to conservation programs. The second of these courses "Hydrogeology", deals with the geologic and hydrologic factors controlling the occurrence and behavior of groundwater and surface water. The first course is for undergraduates only. The second course is open to undergraduates in the geology program and to graduate students from other departments.

A special problems course in the Department of Economics relating to water resources analysis has also been started presenting an approach to systems analysis relating to water resources and tying in the problems of water resources with other types of utilities.

A program will be initiated this fall involving a short school presentation of "Basic fundamentals in Groundwater Hydrology". This will be conducted

























## FORM C (Supplement)

**FISCAL YEAR 1965 - ANNUAL ALLOTMENT FISCAL REPORT ESTIMATE  
OF NON-FEDERAL CONTRIBUTION TO PROGRAM**

Estimate of Non-Federal contribution (funds for salaries, etc., and estimated value of "in kind" contributions of laboratory space, equipment, etc.) used in conjunction with the Federal Section 100 Allotment program from period of April 1, through June 30, 1965:

1. Professional and staff salaries contributed by the University	\$ 1,575
2. Retirement contributions by the University for all salaried personnel	1,092
3. The following estimated contributions are based on negotiated overhead rates established with Federal Agencies:	
Administration and general (accounting services, purchasing services, etc.)	4,003
Workmen's Compensation	304
Operation and maintenance	3,715
Library	528
Use allowance-buildings	1,505
Use allowance-equipment	1,296
Indirect expenses(heat, light, other utilities, etc.)	4,659
	<hr/>
Total estimated non-Federal contributions	\$18,677

Cover photograph: A laboratory of the Water Resources Center, Ohio State University.

This two-day symposium on water resources research is sponsored by the Water Resources Center of Ohio State University.

# **Symposium On Water Resources Research**

**June 24-25  
Room 101, Law Building  
1659 North High St.  
Columbus, Ohio**

## **Symposium On Water Resources Research**

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Ohio State University

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**June 24-25  
Room 101, Law Building  
1659 North High St.  
Columbus, Ohio**

