RUTGERS

THE STATE UNIVERSITY OF NEW JERSEY

SOLIDS + SEDIMENTS = A CAREER IN THE MUD MAY 2022

Christopher George Uchrin, Ph.D., P.E., F.ASCE

Professor, Department of Environmental Sciences

Director, Graduate Program in Bioenvironmental Engineering

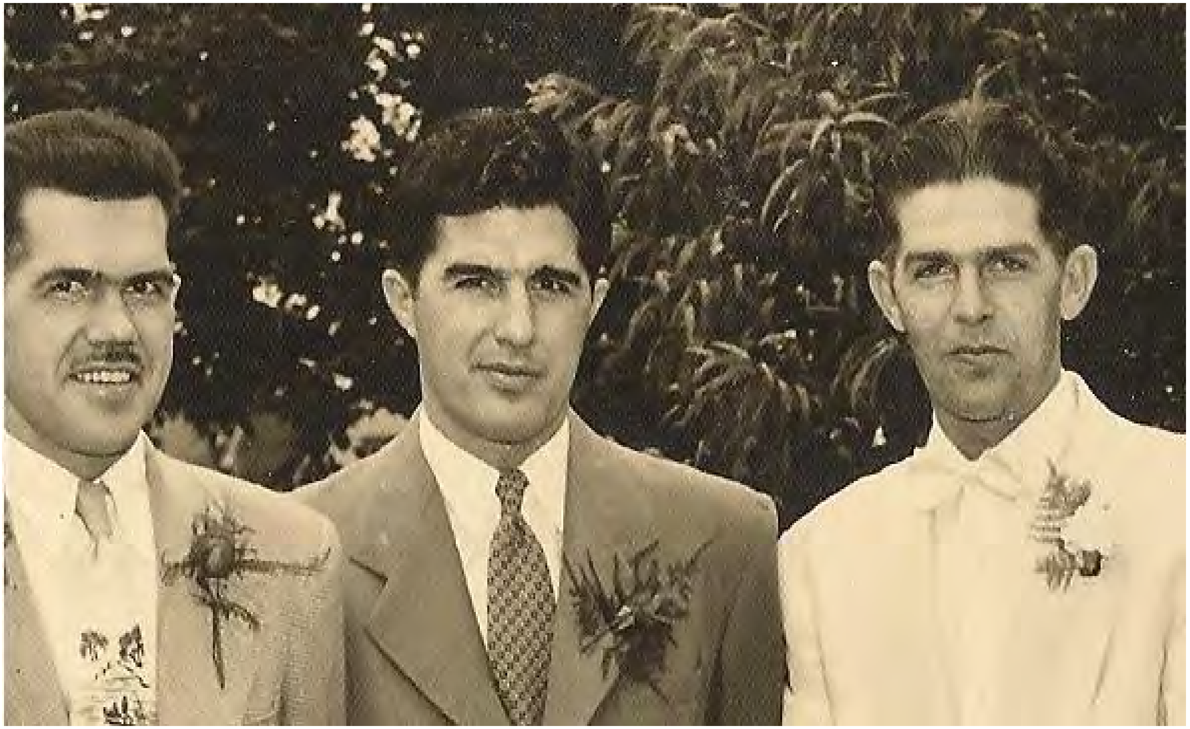
“. . .*YOU KNOW THAT YOU DID NOT GET HERE BY YOURSELF*. . .“

- Barrack Obama - Apr 4, 2009

PROLOGUE

DECEMBER 7, 1941

A BAND OF BROTHERS



JOHN GEORGE STEVE

Rutgers, The State University of New Jersey

On recommendation of the faculty of the

School of Engineering

The Board of Governors confers upon

George Christopher Uchrin

the degree of

Bachelor of Science

in the curriculum in Electrical Engineering

with all the rights, responsibilities, privileges, and immunities appertaining thereunto.

Granted under the seal of the university on the

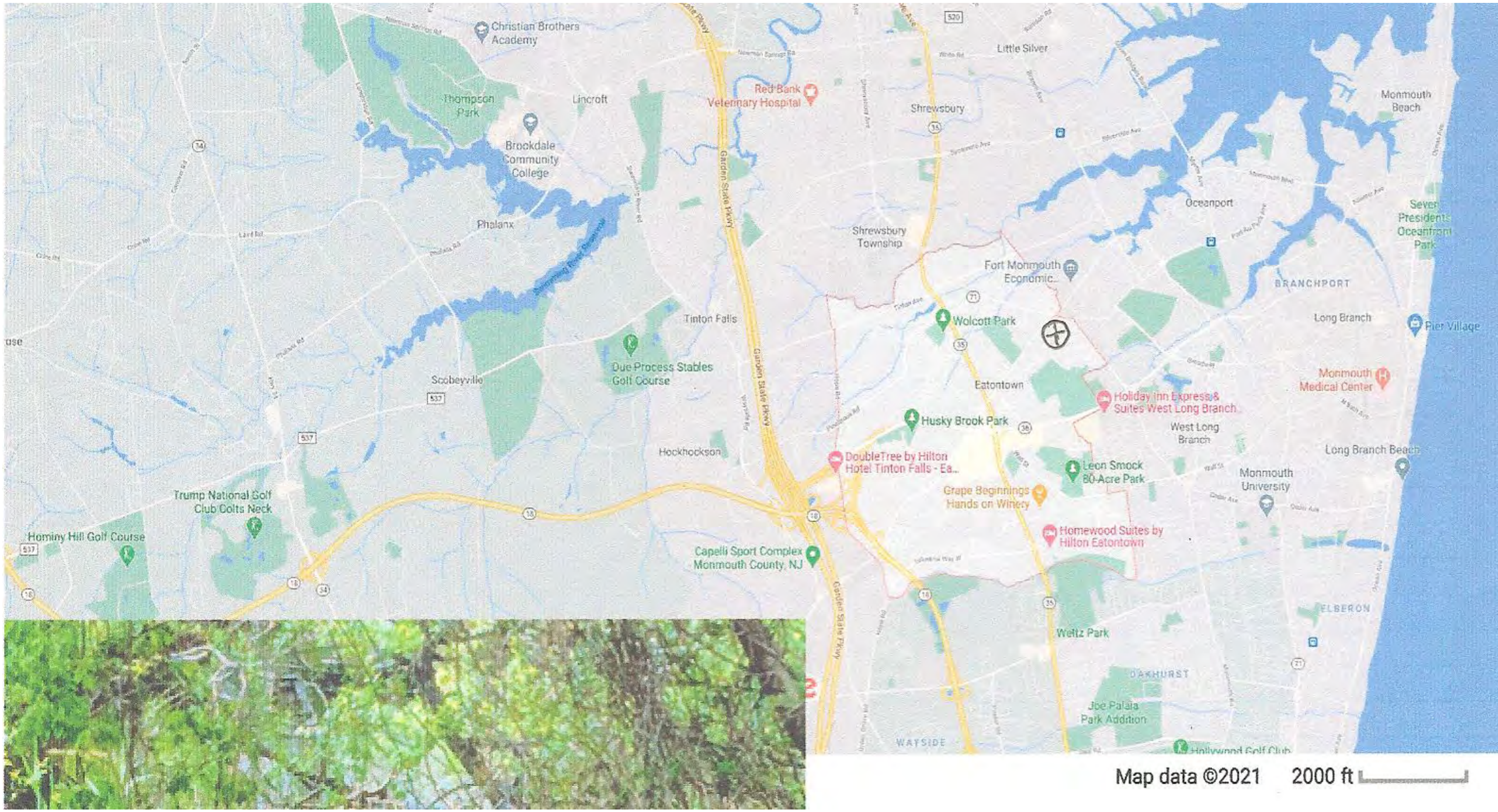
twelfth day of June, nineteen hundred and forty-nine.

Dean

President

RUTGERS

EATONTOWN, NJ & VICINITY



RUTGERS

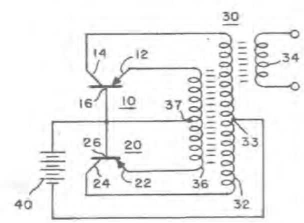
MONMOUTH BEACH, NJ

THE FIRST SOLID-STATE OSCILLATOR

Nov. 19, 1957 G. C. UCHRIN ET AL 2,813,976

TRANSISTOR OSCILLATOR

Filed Dec. 21, 1955



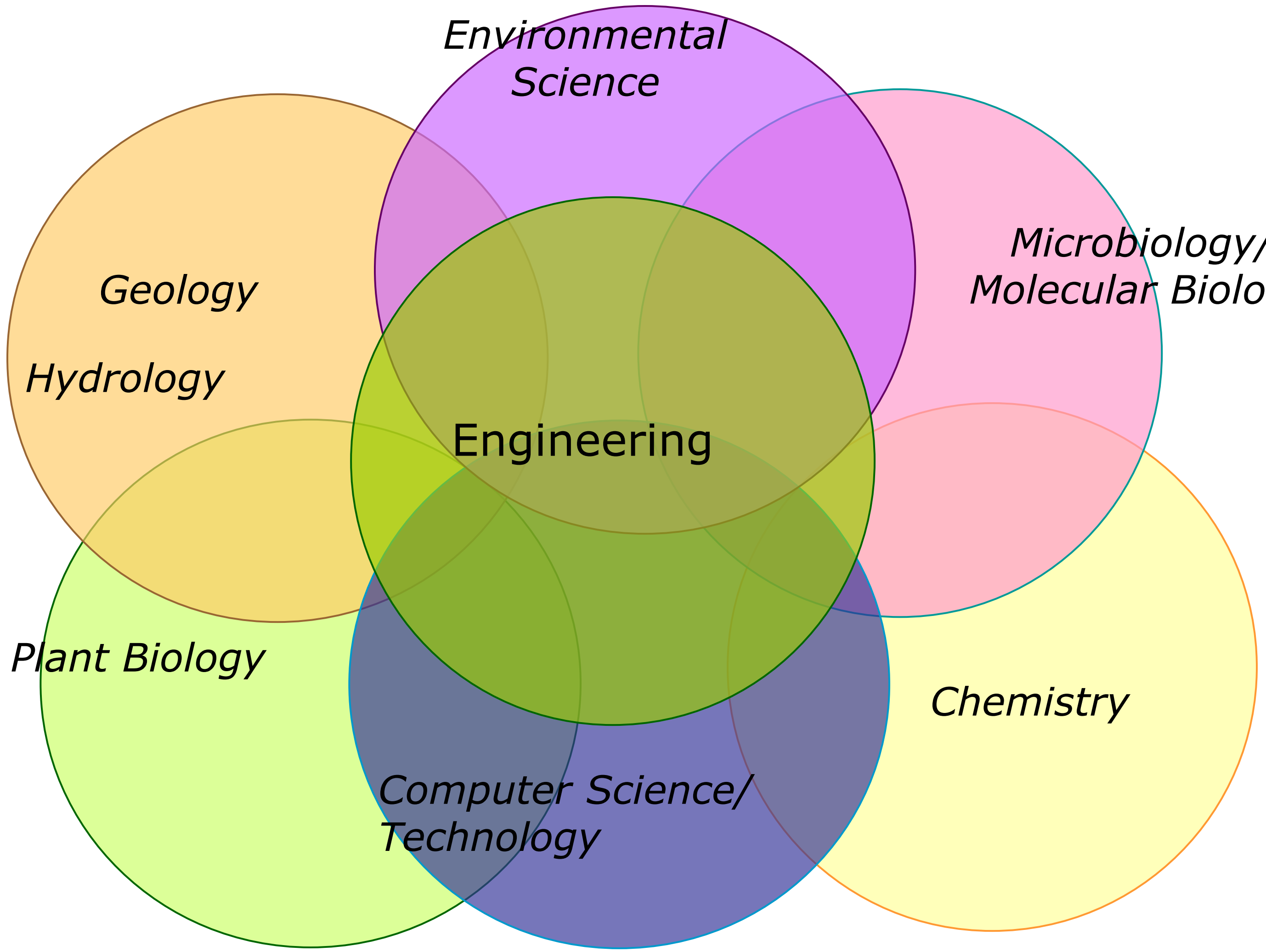
INVENTOR.
GEORGE C. UCHRIN
BY WILFRED O. TAYLOR
ATTORNEY

MENTOR

DR. ROBERT V. THOMANN

B.S., MANHATTAN COLLEGE
M.S., Ph.D., NYU

Environmental Engineering Is Interdisciplinary



MENTOR

Dr. RICHARD T. "DICK" DEWLING, P.E.

B.S., MANHATTAN COLLEGE
M.S., NYU
PhD., RUTGERS

SUMMER 1972 INTERNSHIP WITH EPA

- **NEWS ALERT: TARBALLS ON THE BEACH!**
- **MEDICAL WASTE AND SYRINGES ON THE BEACH!**

- **NJ WAS SUING NY CLAIMING NY'S POORLY TREATED WASTEWATER WAS WASHING UP ON NJ'S BEACHES.**

- **NY WAS COUNTERSUING NJ SAYING THE OPPOSITE. OR WAS IT *VICE-VERSA*? NO ONE SEEMED TO KNOW.**

SUMMER 1972 INTERNSHIP (cont'd)

- IT WAS WAR. IT WAS CRAZY.
- THE NEWS AND POLITICIANS WERE HAVING A FIELD DAY.
- WHO COULD SETTLE IT?

- **THE FLEDGLING USEPA WAS CALLED IN TO SETTLE THE SQUABBLE.**

- **REGION II’S SURVEILLANCE AND ANALYSIS DIVISION UNDER ITS DIRECTOR, RICHARD T. DEWLING, P.E., WAS COMMISSIONED TO DESIGN AND CONDUCT A DYE-STUDY IN THE HARBOR**

- THIRTY 50-GALLON DRUMS OF THE THE FLUORESCENT TRACER DYE, RHODAMINE B, WERE DUMPED INTO THE EFFLUENT OF NYC'S OWL'S HEAD STP IN BROOKLYN, WHICH DISCHARGED INTO NY HARBOR.

- THE HARBOR WATERS WERE THEN TO BE MONITORED CONTINUOUSLY USING REGION II’S 60-FT SAMPLING VESSEL “CLEANWATERS.”

RUTGERS

MY SUMMER INTERNSHIP WITH THE EPA STARTED JUST AFTER THE BEGINNING OF THE NEW FISCAL YEAR ON JULY 5, 1972. I SHOWED UP THAT DAY AND WAS IMMEDIATELY ASSIGNED TO THE OVERNIGHT DYE STUDY BOAT CREW WHICH WAS TO COMMENCE THE FOLLOWING WEEK.

I'LL NEVER FORGET TOOLING UP AND DOWN THE WATERS OF NY HARBOR, WITH ALL THE LIGHTS ON IN THE CITIES, THE HIGH-WAYS, AND BRIDGES, DOING IMPORTANT AND MEANINGFUL WORK MARKING DOWN LOCATIONS AND TIMES FOR THE DATA COLLECTION. I WAS IN HEAVEN!

- THE REST OF THE SUMMER WAS SPENT PERFORMING SAMPLING SURVEYS OF INDUSTRIES WITH SENIOR STAFF AND ROUTINE WEEKLY SAMPLING OF THE UPPER RARITAN RIVER WITH TECHNICIANS.

- **ON MY LAST DAY, I WAS SENT WITH A TECH TO CHECK ON A SIGHTING OF TARBALLS ON THE BEACH IN LAVALLETTE.**

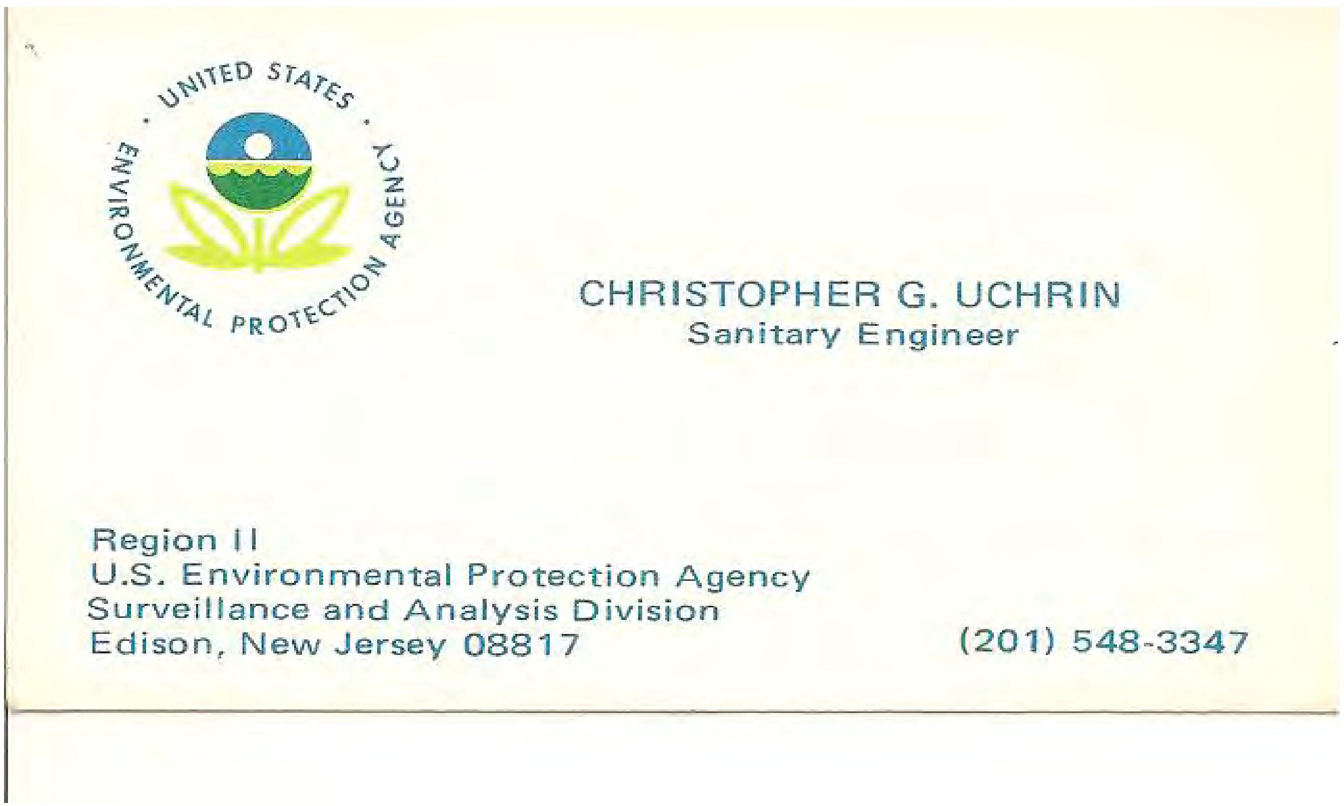
- **AFTER RETURNING EMPTY-HANDED, I WAS OFF TO GRAD SCHOOL.**

- AFTER COMPLETING 24 CREDITS, I CAME BACK TO THE EPA LABS FOR ANOTHER INTERSHIP. WHILE FINISHING MY FINAL SEMESTER, THEY KEPT ME ON AS A CO-OP AND HIRED ME FULL-TIME UPON RECEIVING MY M.E., Feb., 1974

I WAS NOW CAREER-CONDITIONAL

RUTGERS

FIRST BUSINESS CARD



- **A NEW MENACE WAS LURKING**

THE SLUDGE MONSTER OF 1974

'SLUDGE HAS BEEN DUMPED AT THE SLUDGE DUMPSITE IN THE NEW YORK BIGHT SINCE 1924, BUT WASN'T REALLY NOTICED UNTIL 1970 WHEN CONGRESSMAN OTTINGER RAN ON THE "DEAD SEA" PLATFORM AND 1974 WHEN THE "SLUDGE MONSTER" APPEARED.'

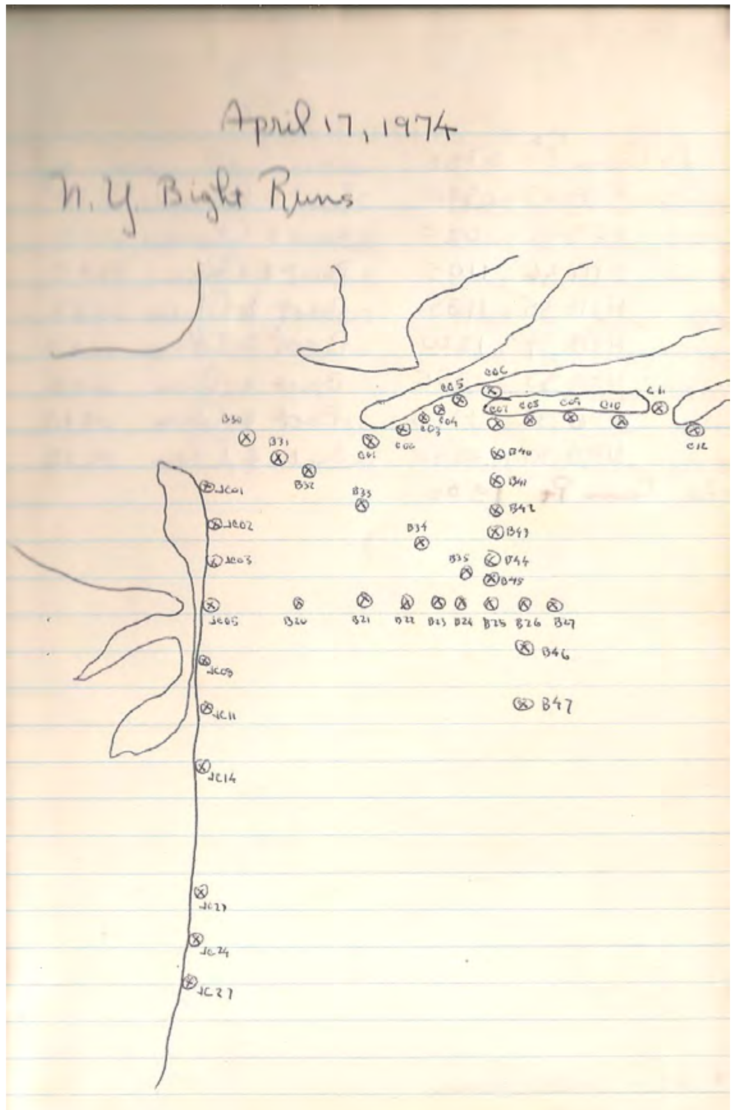
- D.F. Squires. 1983. *The Ocean Dumping Quandary: Waste Disposal in the New York Bight.* SUNY Press

RUTGERS

SLUDGE MONSTER THREATENS L.I.

Sewage Sludge Found Half-Mile Off L.I.

OCEAN SAMPLING STATIONS



FEMA (nee' FDAA) FIN. INSP. NOTES

April 22, 1974

FDAA - Final Inspection
Village of Almond, New York

Item 1, F-1, 100% complete at time of initial survey, no inspection done.

Item 2, F-2, 1) Main & curb stop replacement on Canacadea Streets — compl JUN 73
2) Repair Main St Crossing
3) Repair Mill St Crossing
4) New Well House - completed ~~March 1974~~ Dec 1973

Met w Louis Violanti (NYSHD) & James Winters (Town Hgwy Supt.) at 1030.

LOUIS M. VIOLANTI, P.E.
REGIONAL DIRECTOR OF
PUBLIC HEALTH ENGINEERING
BUFFALO REGIONAL OFFICE

STATE OF NEW YORK
DEPARTMENT OF HEALTH

584 DELAWARE AVENUE
BUFFALO, NEW YORK 14202
TEL: 842-4336

April 23, 1974

FDAA - Final Inspection
Village of Naples, New York

Item 1, Grimes St. Crossing
" 2, Access road, concrete enclosed pipe, repair chlorination ~~tank~~ house
" 3, 100% compl. at time of initial survey
" 4, Repair or replace chlorinator
Repair 60' stream crossing of reservoir creek
Repair 150' of stream crossing of 8" C.I. tr. main from "old res

All work satisfactorily completed by May 1973

Met w Tom Walker - NYSHD & William Vierhile - Village Mayor at 1030 for inspection

Exact dates of completion were unavailable at time of inspection. The best that the Mayor was able to do was to give a date by which all work had been completed

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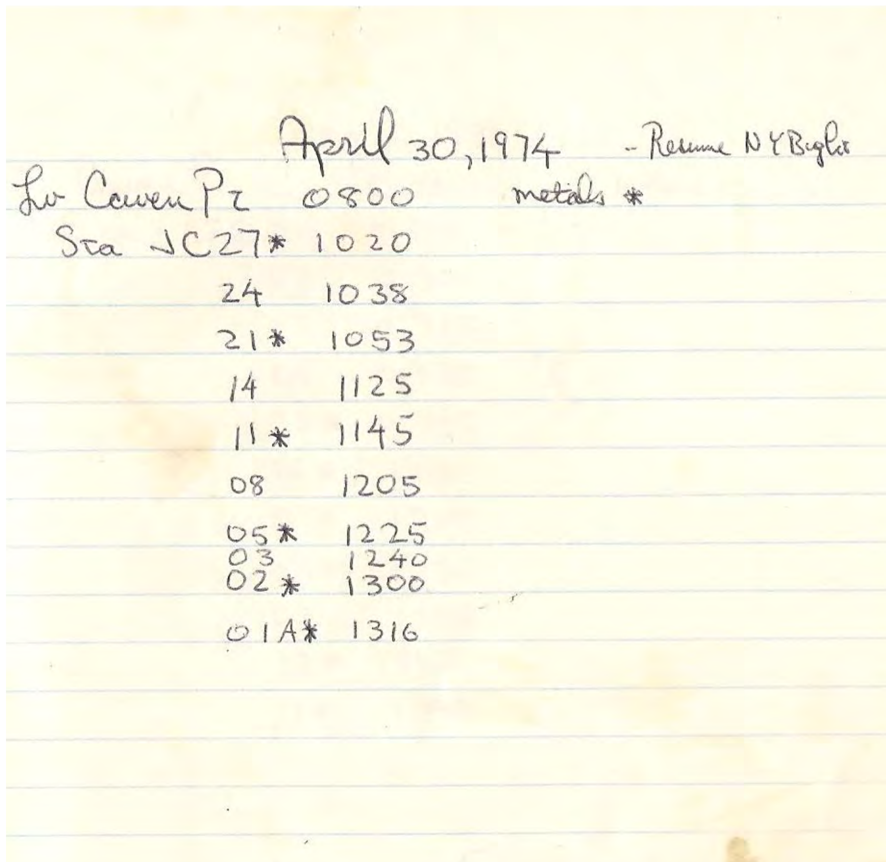
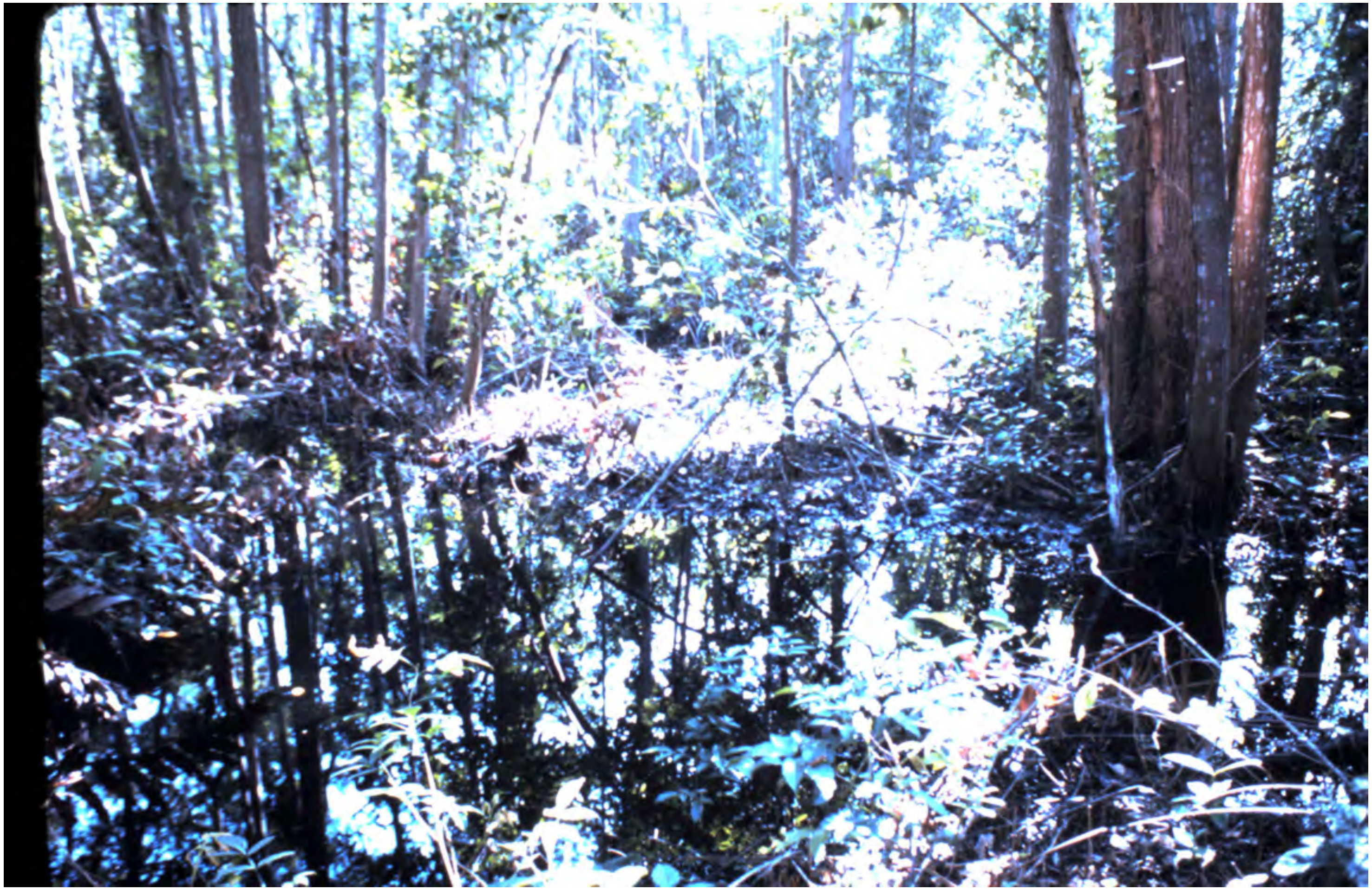
OCEAN SAMPLING RUN



April 30, 1974 - Resume NY Bight

Lv Cowen Pt	0800	metals *
Sta JC27*	1020	
24	1038	
21*	1053	
14	1125	
11*	1145	
08	1205	
05*	1225	
03	1240	
02*	1300	
01A*	1316	

P.R. MANGROVE JUNGLE, JAN. 1975



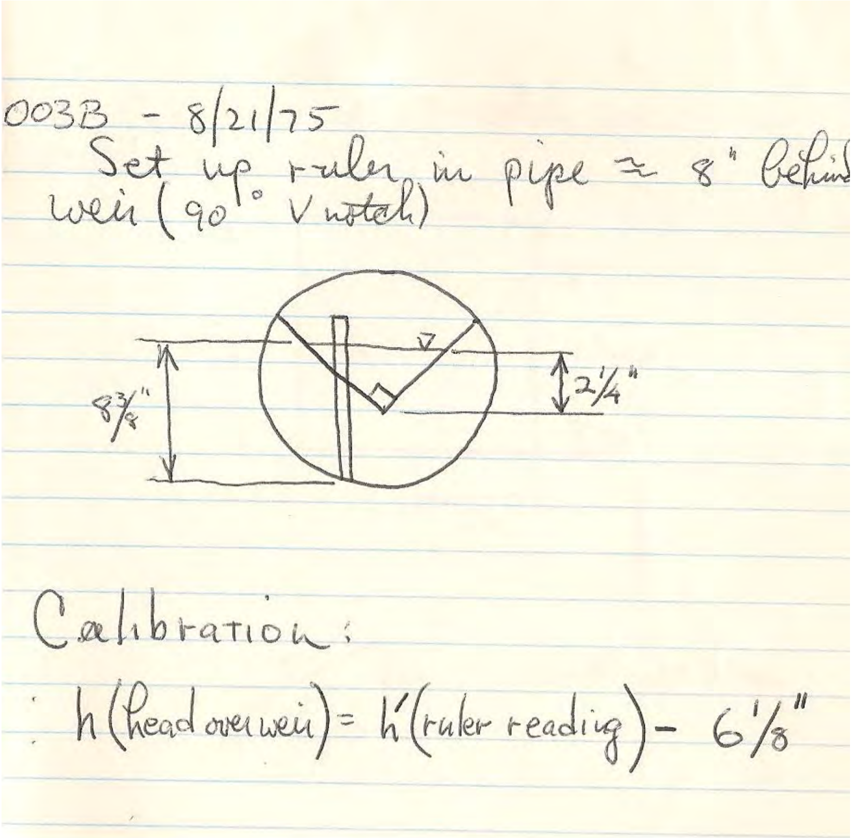
THE TALK

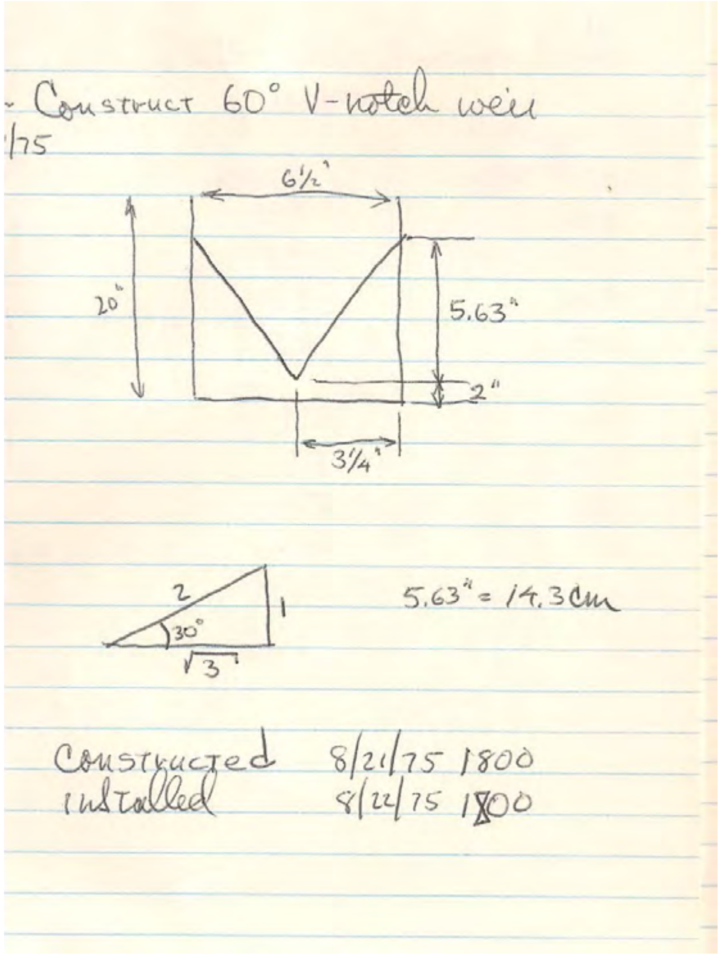
-

JANUARY 1975

PCBs IN THE HUDSON

FLOW MEASUREMENT WEIR FOR GE





1976

TRANSFER TO THE NYC

REGIONAL OFFICE AND

ROONEY'S LOONIES

RUTGERS

1977

DELEGATION OF TECHNICAL PROGRAMS TO THE STATES

TIME TO GO BACK TO SCHOOL

MENTOR

DR. WALTER J. WEBER, Jr., P.E.

B.S., BROWN UNIVERSITY

M.S., RUTGERS UNIVERSITY

M.S, PhD., HARVARD UNIVERSITY

RUTGERS

FIRST PUBLICATION

DYNAMICS, EXPOSURE
and
HAZARD ASSESSMENT
of
TOXIC CHEMICALS

RIZWANUL HAQUE
Editor

ANN ARBOR SCIENCE
PUBLISHERS INC
P.O. BOX 1425 • ANN ARBOR, MICH. 48106
1980

15

TRANSPORT AND DIFFERENTIAL ACCUMULATION OF TOXIC SUBSTANCES IN RIVER-HARBOR-LAKE SYSTEMS

Walter J. Weber, Jr., James D. Sherrill,
Massoud Pirbazari, Christopher G. Uchrin
and Tin Y. Lo

Environmental and Water Resources Engineering
Department of Civil Engineering
The University of Michigan
Ann Arbor, Michigan 48109

INTRODUCTION

Increased awareness of the environmental impacts of halogenated hydrocarbons such as DDT, Aldrin, Dieldrin, PCBs and PBBs has led to severe restrictions on the use of these materials. Nonetheless, for a variety of reasons, the distribution and accumulation of such substances in the aquatic environment continues. Compounds of this type have extremely long half-lives because of their resistance to biological oxidation. Past applications provide sources which continue to leach into groundwater and surface runoff. PCBs and certain other selected chlorinated organics have a long history of prior use in diverse applications and are incorporated in many finished goods; thus, their distribution to the environment continues as the finished goods deteriorate and are discarded. Further increases result from time lags in environmental transport and dissipation.

Chlorinated organic compounds such as PCBs can thus enter a water body from a variety of point and nonpoint sources, including surface runoff, direct industrial discharge, municipal discharge, aerial fallout, use of marine antifouling paints, etc. Once in the system, regardless of source, transport becomes critical with respect to distribution and environmental impact.

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FIRST ADSORPTION ISOTHERMS

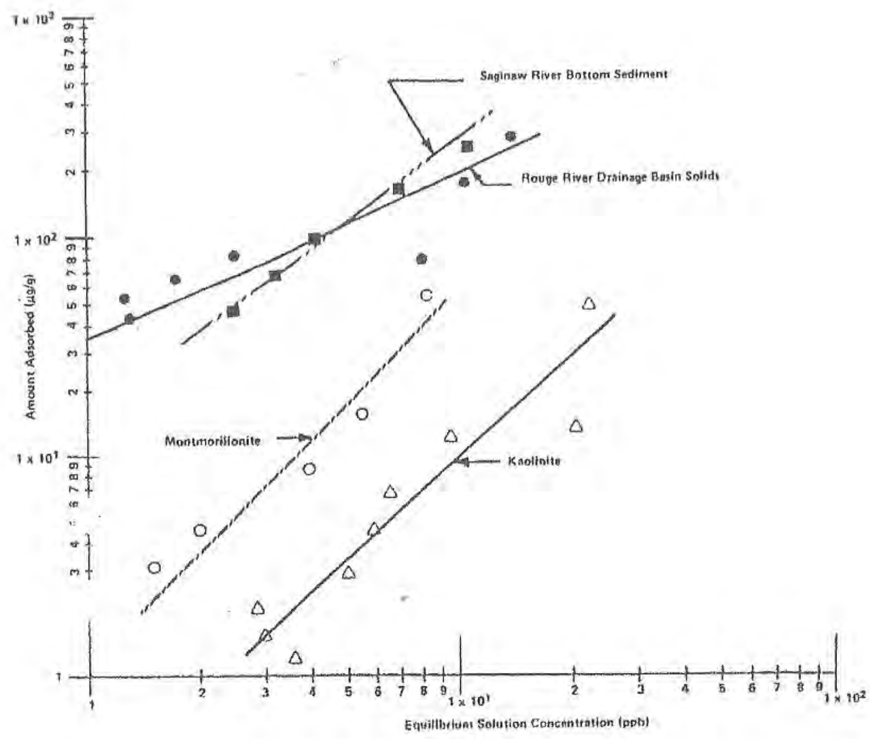


Figure 5. Freundlich isotherms for adsorption of Aroclor 1254 on different solids.

RUTGERS

FIRST PRIMARY AUTHORED PAPER

CONTAMINANTS AND SEDIMENTS Volume 1

Fate and Transport, Case Studies, Modeling, Toxicity

Edited by
Robert A. Baker

ANN ARBOR SCIENCE
PUBLISHERS INC / THE BUTTERWORTH GROUP
P.O. BOX 1425 ▪ ANN ARBOR, MICHIGAN 48106

CHAPTER 19

MODELING OF TRANSPORT PROCESSES FOR SUSPENDED SOLIDS AND ASSOCIATED POLLUTANTS IN RIVER–HARBOR–LAKE SYSTEMS

C. G. Uchrin and W. J. Weber, Jr.
Environmental and Water Resources Engineering
The University of Michigan
Ann Arbor, Michigan 48109

INTRODUCTION

The transport dynamics of particulate solids have long been of concern from the perspectives of sedimentation operations in water and wastewater treatment, and bed-load movement and siltation processes in rivers, streams and dredged channels. Only recently, however, has attention focused on detailed description of the behavior of suspended solids in natural water systems from the perspective of water quality transformations. This interest is predicated largely on increased awareness of the role of particulate solids in the transport of pollutants in rivers, harbors and lakes.

Pollutants adsorbed on, or contained within, particulate solids constitute a separate phase in a heterogeneous system and behave quite differently—chemically, biochemically, hydrodynamically and toxicologically—from dissolved pollutants. Yet virtually all water quality models used to describe the behavior and fate of pollutants account only for the transport and distribution dynamics of homogeneous-phase, or dissolved, pollutants. It has become increasingly clear that accurate description of the environmental distribution and accumulation of solids-associated pollutants, of the impact of these pollutants on the food webs of the aquatic ecosystem, and of their toxicological implications to man, must take account of the dynamics of transport of suspended solids. This chapter describes research on the development of a mathematical model to describe the transport and distribution of suspended solids and associated pollutants in river–harbor–lake systems.

THE BASIC HYPOTHESIS

THE SETTLING OF SUSPENDED PARTICULATES IS MORE ACCURATELY MODELED AS A <u>STATISTICAL DISTRIBUTION</u> RATHER THAN A SINGLE PARAMETER, i.e., MEAN SETTLING VELOCITY

RUTGERS

FIRST REFEREED JOURNAL ARTICLE

MODELING SUSPENDED SOLIDS AND BACTERIA IN FORD LAKE[a]

By Christopher G. Uchrin,[1] and Walter J. Weber, Jr.,[2] Members, ASCE

INTRODUCTION

The transport dynamics of particulate solids have been of traditional concern from the perspectives of sedimentation operations in water and wastewater treatment, and bed-load movement and siltation processes in rivers, streams, and dredged channels. Only recently has attention focused on detailed description of the behavior of suspended solids in natural water systems from the perspective of water quality transformations. This interest is predicated largely on the increased need to determine the ultimate fate of anthropogenic pollutants in aquatic ecosystems, vis-á-vis determination only of their rates of disappearance from the water column.

Pollutants adsorbed on, or contained within, suspended solids constitute a separate phase in a heterogeneous system, and behave differently—chemically, biochemically, hydrodynamically, and toxicologically—from dissolved pollutants. Yet most contemporary water quality models account only for the transport and distribution dynamics of homogeneous phase, or dissolved, pollutants. This approach has met with reasonable success in the past for modeling of certain solids associated pollutants, such as bacteria and BOD, because it is possible to incorporate sedimentation removal kinetics in an overall "bulk" removal kinetic structure. However, for known nonreactive, or conservative, substances, such as PCB's, a bulk removal kinetic structure is inappropriate, and accurate description of the sedimentation dynamics becomes important. It is becoming increasingly clear that accurate description of solids-associated pollutants, of the impact of these pollutants on the food webs of the aquatic environment, and of their toxicologic implications to man, must take into account the dynamics of transport of suspended solids.

Subsystem Model.—The behavior of suspended solids in open channels has

[a]Presented at the July 8–10, 1980, ASCE National Conference on Environmental Engrg., held at New York, N.Y.

[1]Assistant Professor of Civ. and Environmental Engrg., Rutgers Univ., Piscataway, N.J. 08854.

[2]Prof. of Environmental and Water Resources Engrg. and Chairman, Univ. Program in Water Resources, The Univ. of Michigan, Ann Arbor, Mich. 48109.

Note.—Discussion open until March 1, 1982. To extend the closing date one month, a written request must be filed with the Manager of Technical and Professional Publications, ASCE. Manuscript was submitted for review for possible publication on December 3, 1980. This paper is part of the Journal of the Environmental Engineering Division, Proceedings of the American Society of Civil Engineers, ©ASCE, Vol. 107, No. EE5, October, 1981. ISSN 0090-3914/81/0005-0975/$01.00.

PROFESSOR

DECISION TIME

RUTGERS vs. STEVENS

RUTGERS

PARTING ADVICE FROM $(WJ)^2$

- "WHEN YOU GET TO NEW BRUNSWICK, GO SEE JOE HUNTER."

I DID

MENTOR

M.S., ST. JOHNS UNIVERSITY
M.S., NYU
Ph.D, RUTGERS

- **JOE HELPED ME GET STARTED BY COLLABORATING ON RESEARCH PROPOSALS EVEN THOUGH WE WERE LABLESS DURING MY FIRST YEARS AT RU. WITH THE DEDICATION OF THE "NEW WING" (AS IT WAS CALLED) I WAS GIVEN A SHELL.**

- **ONE OF JOE'S GRAD STUDENTS, GARY MANGELS, HAD ACCESS TO A SCINTILATION COUNTER AT HIS LAB AND VOLUNTEERED TO RUN SOME ADSORPTION ISOTHERM EXPERIMENTS. ONE OF OUR FIRST SUBSTANCES WAS THE NOTORIOUS ALDICARB (UNION CARBIDE).**

ALDICARB

WE TESTED ITS SORPTION CHARACTERISTICS TO NJ COHANSEY SAND FOUND IT TO BEHAVE SIMILAR TO L.I. COHANSEY SAND

WE THEREFORE STRONGLY RECOMMENDED AGAINST ITS USE IN NJ.

PAPER PUBLISHED IN BULL. NJAS

Bull. New Jersey Acad. Sci.
Vol. 30, No. 2, pp. 71-75, Fall 1985

SORPTION CHARACTERISTICS OF ALDICARB TO NEW JERSEY COASTAL PLAIN AQUIFER SOLIDS

Christopher G. Uchrin and Gary Mangels
Department of Environmental Science
Cook College — New Jersey Agricultural Experiment Station
Rutgers, The State University of New Jersey
New Brunswick, NJ 08903

Abstract. *Studies examining the sorption characteristics of aldicarb residues to New Jersey coastal plain aquifer solids were performed. The aldicarb residues showed little affinity to associate with the solids. Adsorption to the Cohansey aquifer soil, a coarse to fine grade sand with a 4.4 percent organic content, was characterized by a singular linear isotherm with a partition coefficient of 0.74 ml/g. Adsorption to the Potomac-Raritan-Magothy soil, a sandy loam with a 2.2 percent organic content, displayed a dependence on the adsorber soil mass. A series of Freundlich isotherms was fitted to the data. Desorption experiments showed the association to be weak and suggested that the adsorption/desorption processes are completely reversible for these systems.*

KEY WORDS. Adsorption; Aldicarb; Desorption; Groundwater; Models, Sorption; TEMIK

INTRODUCTION

Contamination of ground water in New Jersey is an issue of great concern since the state ranks seventh in the nation in terms of pumpage per square mile (Singer, 1982). Contamination of ground water is also a national concern, as approximately 50% of the nation's drinking water comes from wells (Pye and Patrick, 1983). Of particular concern is the contamination of drinking water supplies by the so-called toxic and hazardous substances including organic chemicals and heavy metals. Large scale contamination of ground water by synthetic organic compounds has been identified in New Jersey as well as Massachusetts, Connecticut, Pennsylvania, New York, and California (USEPA, 1980).

Prediction of the transport and fate of organic contaminants in ground water systems can be accomplished through the use of mathematical models. Mathematical models of pollutants in porous media all include a reaction term to account for not only chemical and biochemical reactions but also sorption kinetics (Uchrin, 1984). Certain organic compounds may tend to be non-reactive but are hydrophobic and will tend to associate with solid particulates. Other substances may be strongly attracted to functional groups which are present on the solids. Knowledge of a substance's sorptive characteristics is critical for the prediction of its transport and fate in ground water systems.

The pesticide TEMIK (the registered trademark of Union Carbide Corporation for aldicarb pesticide) is generally used for the control of certain insects, mite and nematodes on a variety of crops including potatoes, oranges, cotton and sugar cane (Farm Chemicals Handbook, 1983). It has been used in potato fields on Long Island (Zaki, *et al.*, 1982) and citrus groves in Florida (Jones and Back, 1984). Traces of aldicarb residues have been found in potable ground water supplies in Long Island (Guerrera, 1981; Porter, *et al.*, 1984) and Wisconsin (Rothschild, *et al.*, 1982).

Under normal conditions of use, aldicarb rapidly oxidizes to aldicarb sulfoxide which can be further oxidized to aldicarb sulfone (Back, *et al.*, 1984). This paper examines the sorptive behavior of all three residues to aquifer solids from the New Jersey Coastal Plain.

MATERIALS AND METHODS

Carbon14 labeled aldicarb [Temik-methylthio -14c (S.A. = 4.91 mCi/mmol] was purchased from Pathfinder Laboratories, St. Louis, MO. A stock solution of 50.1 ppm concentration was made using deionized water from a Milli-Q water Purification System (Millipore Corporation).

Soils from two New Jersey coastal plain aquifer systems were used. The soil from the Cohansey aquifer system was taken from a site located at the Rutgers University Cranberry Culture Experiment Station near Chatsworth, NJ. This soil is a coarse to fine grade sand with an organic content of 4.4 percent. The soil from the Potomac-Raritan-Magothy aquifer system was taken from an excavation site near Princeton, NJ and is typical of a

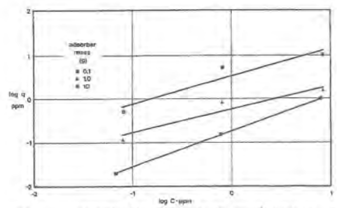


Figure 3. Adsorption Equilibrium Isotherms—Aldicarb on Potomac-Raritan-Magothy Aquifer Soil.

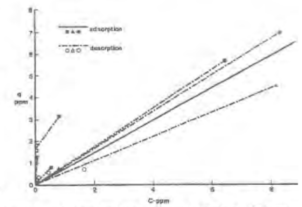


Figure 4. Desorption Isotherms—Aldicarb on Cohansey Aquifer Soil.

Freundlich isotherms was fitted and these are displayed in Figure 3 with appropriate parameters listed in Table 2. This mass dependency phenomenon was reported by O'Connor and Connolly (1980) for a variety of organic substances adsorbed to sediments, DiToro, *et al.* (1982) for hexachlorobiphenyl to Saginaw Bay sediments, and Carter and Suffet (1982) for DDT to dissolved humic materials. This phenomenon appears in this instance to be dependent on the characteristics of the soil. Again, however, the aldicarb residues showed little affinity for the soil.

Table 2. Adsorption equilibrium isotherm parameters for aldicarb on Potomac-Raritan-Magothy aquifer solids.

	Adsorber Mass (g)		
Parameter	0.1	1.0	10
K	3.32	0.588	0.178
n	1.54	1.84	1.19
r	0.977	0.980	1.00

The consecutive desorption experiments showed that the association of the aldicarb residues to the soils was very weak as desorption readily occurred. Complete desorption was obtained after the first elutriation for the Potomac-Raritan-Magothy soil system. A slightly stronger association was noted for the Cohansey soil, but permanent or irreversible binding, as found by DiToro and Horzempa (1982) for PCB, Uchrin and Katz (1985a) for lindane, and Uchrin and Katz (1985b) for trichloroethylene was not evidenced. The resultant desorption data are displayed in Figure 4. The fitted desorption isotherms do not evidence a marked hysteresis in comparison to the linear adsorption isotherm suggesting complete reversibility. Figure 5 shows normalized desorption isotherms for this system. Both linear and Freundlich isotherms are fitted to the data with appropriate parameters listed in Table 3.

Table 3. Normalized desorption isotherm parameters for aldicarb on Cohansey aquifer solids.

Parameter	Linear	Freundlich
K	1.00	0.996
n	—	1.74
r	0.901	0.954

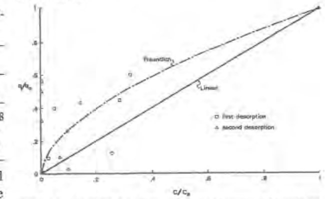


Figure 5. Normalized Desorption Isotherms—Aldicarb on Cohansey Aquifer Soil.

SUMMARY

Batch equilibrium adsorption/desorption studies for carbon-14 labeled aldicarb residues to solids from New Jersey coastal plain aquifer systems were performed. Aqueous phase concentrations were determined using a liquid scintillation counter. Adsorption to either the Cohansey and Potomac-Raritan-Magothy soils was small and weak. A dependency on the adsorber mass was noted for the Potomac-Raritan-Magothy system but not the Co-

OVER THE YEARS OUR GW RESEARCH WAS FUNDED BY

- NJ WATER RESOURCE RESEARCH INST
- NJ HAZARDOUS WASTE INSTITUTE
- NJ DEPT. ENVIRON. PROTECTION
- DARPA (WITH DAVE KOSSIN)
- NIEHS (EOHSI)
- GERHETY AND MILLER
- USDA (WITH GEORGE WINNETT)

OVER THE YEARS OUR RESEARCH WAS PRESENTED NATIONALLY AND INTERNATIONALLY:

- COPENHAGEN, DENMARK
- ALEXANDRIA, EGYPT
- LEUVEN, BELGIUM
- LUBLIN, POLAND
- VANCOUVER, CANADA
- TORINO, ITALY
- SEOUL, SOUTH KOREA

W.E. AND C.U. AT LEUVEN BELGIUM, 1985

RUTGERS

THE GROUNDWATER GANG

RUTGERS

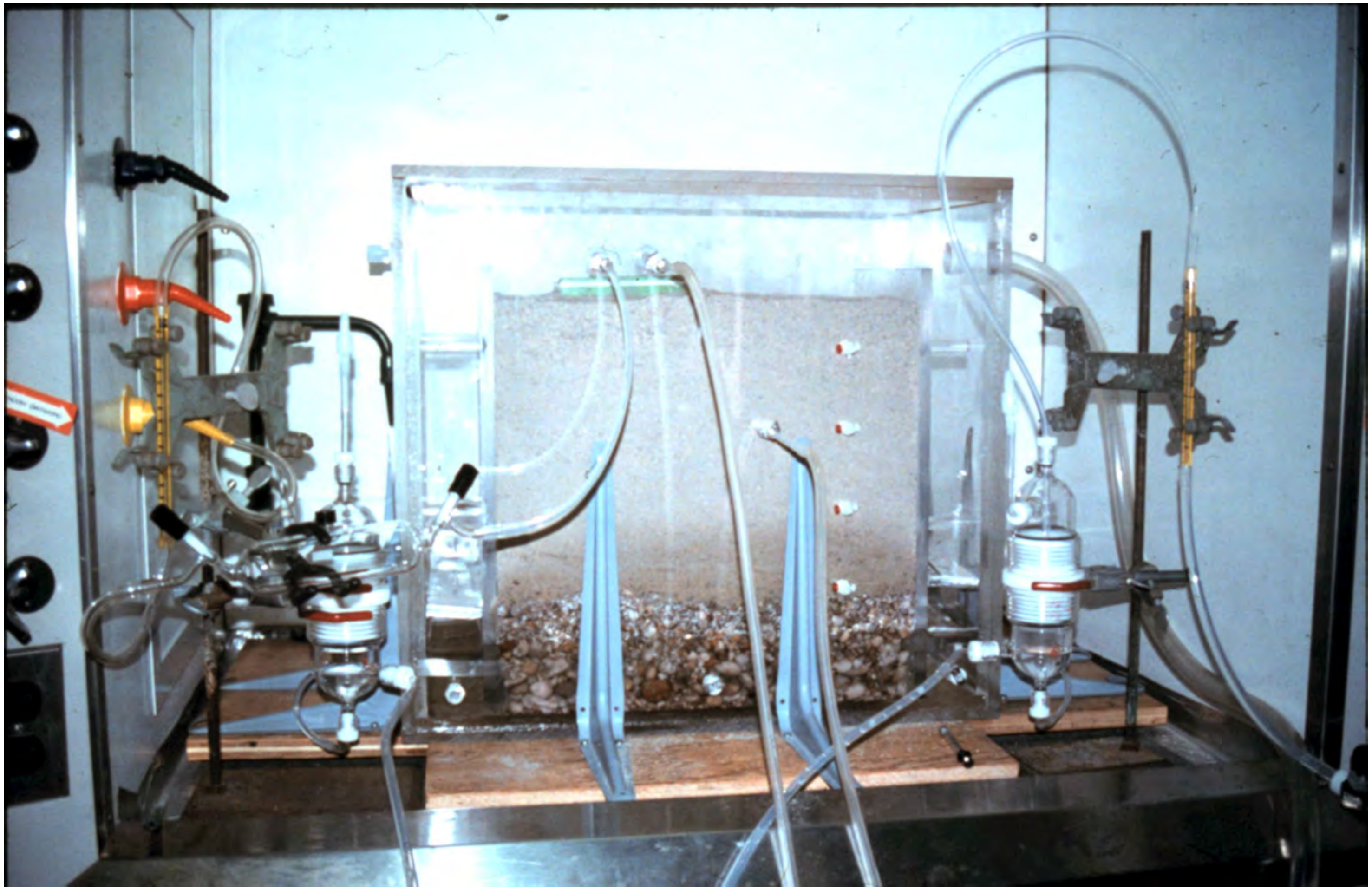
THE NIEHS FUNDING WAS OF PARTICULAR SIGNIFICANCE AS IT WAS PART OF EOHSI’S GRANT:

"NEUROTOXICOLOGY OF SUPERFUND CHEMICALS (H.E. LOWNDES, P.I.)" NIEHS SUPERFUND BASIC RESEARCH PROGRAM, 4/1/92-3/30/95

•

FOR THIS PROJECT, WE PHYSICALLY MODELED POTENTIAL VAPOR INTRUSION OF TCE INTO HOME BASEMENTS THROUGH CRACKS USING A PLEXIGLAS MODEL "BASEMENT."

‘THE SANDBOX”



"THE SANDBOX" SIDE

RESEARCH RESULTS FROM THESE EXPERIMENTS WERE PUBLISHED IN THE ACS FLAGSHIP ENVIRONMENTAL JOURNAL:

ENVIRONMENTAL SCIENCE AND TECHNOLOGY.

- **THE ARTICLE CAUSED A BIT OF A STIR. IT WAS EVENTUALLY PICKED UP BY *POPULAR SCIENCE* WHO PUBLISHED A SHORT PIECE ON IT UNDER THE *SOBRIQUET:***

"THE UNINVITED GUEST."

ES&T

POP. SCI.

Laboratory Simulation of VOC Entry into Residence Basements from Soil Gas

DAVID FISCHER AND
CHRISTOPHER G. UCHRIN*

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Pollutants in groundwater can be a source of exposure to residents of houses overlying contaminated aquifers. Volatile compounds may migrate through soil gas and enter below-grade basements under negative pressure. A three-dimensional apparatus was built to simulate intrusion of volatile organics from groundwater into residence basements. Three reference soil materials were used to fill the model, each with different air permeabilities and organic matter contents. A simulated basement was equipped with holes in the floor, which were sealed in three configurations to represent different size cracks. Experiments were run on each soil, with each hole configuration, at several levels of depressurization. Soil permeability was found to be the overriding factor controlling advective TCE intrusion into basements. Soil porosity as well as particle size and shape distribution will dictate the diffusive migration of TCE through the soil profile and toward the building superstructure. Basement crack size does not appear to be a significant variable, and degree of depressurization is only significant in terms of dilution at higher rates of flow. The experiments also served to verify previous hypotheses proposed by mathematical models and field experiments.

Introduction

Soil gas overlying a contaminated aquifer may contain significant concentrations of the contaminant, especially in the case of highly volatile compounds. Volatile organic compounds (VOCs) are widely found in groundwater systems and in the vadose zone above the groundwater table due to spills, leaks, and improper usage and disposal practices. When present in soil gas, VOCs can enter residences that normally exist under negative pressure and may pose a source of exposure to the occupants. This route of entry is similar to that of radon, whose presence in indoor air is thought to be primarily due to the entry of soil gas into residences (*1*). Soil gas may infiltrate a home by advective (pressure-driven) entry through cracks in the building's substructure, by diffusive entry through those cracks, or by diffusion through the actual building material, which may be porous (*1–4*).

Recently, more interest has been focused on this phenomenon, and several investigators have monitored actual (*2, 4–9*) or experimental (*10, 11*) structures in the field in an attempt to quantify the risk factors and significant variables involved in radon or VOC transport from soil gas into basements. Additionally, mathematical models have been developed (*3, 12–15*) to simulate soil gas intrusion into basements and attempt to accurately predict VOC or radon concentrations in houses overlying contaminated soils or groundwater. To better understand the mechanisms involved in this phenomenon, however, it is preferable to be able to control the variables that significantly impact soil gas intrusion, such as basement construction, degree of depressurization, and soil properties. This paper describes the construction and operation of a physical-scale model that simulates VOC entry into a basement via soil gas volatilizing from groundwater and discusses the results of experiments with this apparatus utilizing three different soils.

Several factors may affect depressurization of basements: Wind loading on the superstructure of a house, temperature differences between the soil and the basement, barometric pressure changes due to the weather, and precipitation (*1*) as well as unbalanced ventilation due to operation of furnaces or exhaust fans (*8, 16*). Arnold (*17*) found wind loading to be a significant source of pressure differential, with temperature differences becoming important on cold calm days. Narasimhan et al. (*18*) found large barometric pressure fluctuations to be most significant in cases of low soil permeability. The degree of underpressurization may vary between 0 and 10 Pa (*4*), with a typical value being 5 Pa or less (*9*).

Experiments conducted in the field (*2, 4, 6, 8, 11*) have shown a pressure "coupling" between the basement and surrounding soil, which creates disturbances in the pressure field in the soil, influencing the degree and direction of air movement toward the basement. Loureiro et al. (*14*) used mathematical modeling to develop contours of disturbance pressures in the soil originating from the basement depressurization. This pressure field was used to simulate radon flux across the soil-gap interface and showed that convective flux will increase dramatically with increased pressure differential while diffusive flux will become insignificant. It was also shown that radon concentrations in the soil gas along the perimeter of the gap may increase with increasing pressure disturbance, until a point at which a dilution effect begins to be noticed. This increase is least noticeable with lower permeability soils and only becomes significant at permeabilities over 10^{-8} cm^2, where diffusion becomes less important. Revzan et al. (*15*) later modified this model to include convection of soil gas resulting from the heating of the basement in the winter. Garbesi and Sextro (*2*) found that pressure-driven air flow is a significant

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HOME TECHNOLOGY

The Uninvited Guest

IS YOUR HOUSE being invaded by invisible, subterranean substances? No, this isn't an X-Files plot. It's something scarier—it's the subject of a recent study on the movement of groundwater toxins.

For years, various industries have used a solvent called trichloroethylene for the cleaning of equipment and other jobs. Over time, this suspected carcinogen has migrated from industrial dump sites into groundwater. Now, researchers at Rutgers University and the Environmental and Occupational Health Sciences Institute in Piscataway, New Jersey, have constructed a mock basement to simulate the movement of trichloroethylene from groundwater, through soil, and into basements.

Researchers David Fischer and Christopher Uchrin filled a two-foot-long Plexiglas box with soil and "groundwater," and inserted a second, smaller box into the soil to represent the basement. They then varied the level of the water table, the concentration of trichloroethylene, the soil type, and the size of cracks in the "basement" floor, measuring contamination levels for each set of conditions.

Basements showed the greatest trichloroethylene concentrations when the water table was close to the basement floor, when the groundwater contained high levels of the chemical, and when the soil was permeable, as sandy soils are. "Soils with high organic materials absorb organic compounds," says Fischer, "so they tend to retard the movement of trichloroethylene." In addition, computer models showed that the air pressure within the basement played a role as well. Often, unbalanced ventilation in a house causes the basement to be under slightly negative pressure, he says, which pulls the gas into the house.

More research is needed to determine the effects of other potential factors, like the moisture content of the soil. And this study didn't attempt to determine how much trichloroethylene constitutes a health hazard. Remedies for contaminated basements might be as simple as increasing the ventilation—in effect, steadily flushing the house out with fresh air—or employing more complex strategies now used to combat another suspected basement menace, radon.—J.A.C

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RECENT RESEARCH

Case Study

In-Stream Dissolved Oxygen Impacts and Sediment Oxygen Demand Resulting from Combined Sewer Overflow Discharges

Robert Miskewitz, Ph.D.[1]; and Christopher Uchrin, Ph.D., P.E., M.ASCE[2]

Abstract: Combined sewer overflows (CSOs) are a major source of contamination to urban waterways. Discharges from CSOs represent a major source of chemical oxygen demand, biological oxygen demand, nutrients, toxics, and bacteria to receiving waters. The impacts of these discharges to ecosystem health include deposition of sewer sediment on the stream bed, anoxic events, and algal blooms. A case study is presented, which analyzed in-stream dissolved oxygen and sediment oxygen demand (SOD) in an urban stream in Philadelphia, Pennsylvania, to observe short-term and long-term water-column oxygen depletion caused by CSO discharges. Multiple SOD measurements were collected at six locations in a 5.61-km reach. Continuous in-stream dissolved oxygen measurements indicate that water-column dissolved oxygen concentration in the reach is depleted as it flows through the study section. This depletion appears to be the result of elevated SOD downstream of the CSO outfalls. **DOI: 10.1061/(ASCE)EE.1943-7870.0000739.** *© 2013 American Society of Civil Engineers.*

CE Database subject headings: Oxygen demand; Sediment; Combined sewers; Water quality; Dissolved oxygen; Overflow.

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Design of a GIS-based rating protocol to assess the potential for landfill closure using dredge material in post Hurricane Sandy New Jersey

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ABSTRACT

New Jersey is rapidly running out of capacity for storage of dredged material. A potential solution to this lack of storage space is to remove and reuse the dredged material for some beneficial use. Results from a Rutgers University project performed for the New Jersey Department of Transportation, Office of Maritime Resources, designed to assess the potential for closure of New Jersey landfills using dredge material from existing Confined Disposal Facilities (CDFs) are presented and discussed. The project included an update of the existing NJDEP landfill database, the development of a rating system to identify landfills with the highest potential to utilize dredged material for their closure, and the identification and preliminary investigation of the top candidate landfills based on this rating system.

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SOLIDS RESIDUALS REDUX

Containers loaded with tons of sewage sludge sit simmering in the sun last week in Parrish, Ala. More than two months after the "poop train" rolled in from New York City, Parrish Mayor Heather Hall says the material is leaving town.

Jay Reeves/AP

It's not often a town of roughly 1,000 makes national news. But then, it's not often a town faces a plight so ripe for media attention as Parrish, Ala.

https://www.npr.org/sections/thetwo-way/2018/04/18/603718526/the-poop-trains-reign-of-terror-in-small-t... 6/8/2021