15:16:34 OCA PAD AMENDMENT - PROJECT HEADER INFORMATION 03/22/92

Active

Project #: E-20-654 Cost share #: E-20-320 Rev #: 4
Center # : 10/24-6-R7157-0A0 Center shr #: 10/22-1-F7157-0A0 OCA file #:
Work type : RES
Contract#: BCS-9022205 Mod #: AMENDMENT 3 Document : GRANT
Prime #: Contract entity: GTRC

Subprojects ? : N CFDA: 47.041
Main project #: PE #:

Project unit: CIVIL ENGR Unit code: 02.010.116
Project director(s):
VOUDRIAS E A CIVIL ENGR (404)894-2265
CROSS W H CIVIL ENGR (404)-

Sponsor/division names: NATL SCIENCE FOUNDATION / GENERAL
Sponsor/division codes: 107 / 000

Award period: 910315 to 930831 (performance) 931130 (reports)

Sponsor amount	New this change	Total to date
Contract value	0.00	166,706.00
Funded	76,770.00	166,706.00
Cost sharing amount		8,278.00

Does subcontracting plan apply ?: N

Title: DISSOLUTION KINETICS OF NAPL POOLS IN SATURATED POROUS MEDIA

PROJECT ADMINISTRATION DATA

OCA contact: Mildred S. Heyser 894-4820

Sponsor technical contact	Sponsor issuing office
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Equipment title vests with: Sponsor GIT X

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Administrative comments -
AMENDMENT 3 ADDS 2ND YR FUNDING IAO $76,770 AND CHANGES GRANTS OFFICIAL. ALL OTHER TERMS AND CONDITIONS REMAIN UNCHANGED.

GEORGIA INSTITUTE OF TECHNOLOGY
OFFICE OF CONTRACT ADMINISTRATION

NOTICE OF PROJECT CLOSEOUT

Closeout Notice Date 02/03/94

Project No. E-20-654 Center No. 10/24-6-R7157-0A0

Project Director VOUDRIAS E A School/Lab CIVIL ENGR

Sponsor NATL SCIENCE FOUNDATION/GENERAL

Contract/Grant No. BCS-9022205 Contract Entity GTRC

Prime Contract No.

Title DISSOLUTION KINETICS OF NAPL POOLS IN SATURATED POROUS MEDIA

Effective Completion Date 930831 (Performance) 931130 (Reports)

Closeout Actions Required:	Y/N	Date Submitted
Final Invoice or Copy of Final Invoice	N	
Final Report of Inventions and/or Subcontracts	N	
Government Property Inventory & Related Certificate	N	
Classified Material Certificate	N	
Release and Assignment	N	
Other	N	

CommentsLETTER OF CREDIT APPLIES. 98A SATISFIES PATENT REQUIREMENT.

Subproject Under Main Project No.

Continues Project No.

Distribution Required:

Project Director	Y
Administrative Network Representative	Y
GTRI Accounting/Grants and Contracts	Y
Procurement/Supply Services	Y
Research Property Managment	Y
Research Security Services	N
Reports Coordinator (OCA)	Y
GTRC	Y
Project File	Y
Other CARL BAXTER-FMD	Y
	N

E20-654

ANNUAL PROGRESS REPORT

National Science Foundation Grant No. BCS-9022205
Georgia Institute of Technology Project E-20-654

February 1992

"DISSOLUTION KINETICS OF NAPL POOLS IN SATURATED POROUS MEDIA"

E. A. Voudrias, Principal Investigator
W. H. Cross, Co-Principal Investigator

Introduction

Nonaqueous phase liquids (napls) entering groundwater may form pools covering the bottom of an aquifer (dnapls) or floating at the capillary fringe above the water table (lnapls). Because groundwater flows above or below the napl pools, lower aqueous concentrations are expected from pool dissolution than if groundwater was flowing through a residual napl zone. Because of the low aqueous concentrations produced, cleanup by extracting contaminated groundwater (pump and treat) may be an ineffective and extremely long process.

The objective of the research is to study the dissolution kinetics of napls forming pools at the bottom of an aquifer or floating at the water table. The dissolution process will be studied for different pore water velocities in a 2-d model aquifer filled with sand. Aqueous concentrations will be determined as a function of time and distance from the napl pool. The experimental data will be used to determine mass transfer coefficients and validate a two dimensional mathematical model, incorporating advection in the longitudinal direction, dispersion in the longitudinal and transverse direction, and sorption. Both heavier and lighter than water napls will be used. The results will improve our understanding of napl pool dissolution kinetics and may be used for better planning of pump and treat operations.

Construction of Model Aquifer Sandboxes

A small artificial aquifer (35 cm x 61 cm x 20 cm) was constructed in order to initially evaluate the experimental methods to be used without having to manipulate the large volumes of sand

and water which would be required with the larger aquifer (100 cm x 100 cm x 20 cm) described in the project proposal. The small aquifer was built of 3/16 inch non-tempered glass. The aquifer is 61 cm long, 35 cm high, and 20 cm deep. The side, end, and bottom pieces were bonded together with epoxy for strength and supported along the joints with aluminum angle on the exterior of the box. The inner surfaces of the joints were sealed with a bead of silicone caulk for water retention. 1/8 inch sampling ports were drilled into one side of the box as shown in Figure 1. A 1 inch diameter hole was drilled in one end plate for the effluent tube.

The large aquifer was constructed of 1/2 inch thick glass plates in a manner similar to that described above. Figure 2 shows the sample port spacing for the large aquifer. The large aquifer is supported 18 inches off the floor by an angle iron frame. This allows the bottom of the aquifer to be viewed during experimental runs.

Aquifer Appurtenances

Figure 3 shows the overall schematic of the small aquifer system. Clearwells of 5 cm x 20 cm horizontal cross section are formed at both the influent and effluent ends of the aquifer by means of specially constructed stainless steel screens which will not pass the sand size used in the experiments. Each screen is supported on a framework of 1/8 inch x 1/2 inch stainless steel rod.

The influent system consists of a water supply reservoir connected to the influent well by means of Tygon tubing and a 0 - 20 mL/min laboratory pump. The reservoir is a 60 L HDPE container.

The pump head is mounted with the suction side below the discharge side to prevent bubble collection on the suction side and thereby minimize flowrate variations.

Effluent is carried from the tank through a short length of copper tubing which emerges from the glass wall below the water surface in the effluent well. The effluent pipe is connected to a constant head reservoir via Tygon tubing and a three-way glass stopcock. The stopcock is used for collection of effluent samples. The constant head device is constructed of Plexiglas and is used to control the water level inside the effluent clearwell. In the future the copper effluent tube will be replaced with a perforated glass tube for better distribution of effluent flow and to reduce the possibility of contaminant adsorption or reaction with the pipe.

A stainless steel pan measuring 40 cm x 20 cm x 3.1 cm high was constructed to contain the DNAPL pool at the bottom of the sandbox. A copper tube enters the pan through the downstream end wall and runs to the other end of the pan. The pan is discussed in more detail in the section on DNAPL Pool Formation.

Building of Aquifer Medium

A saturated porous medium is formed in the same way for both DNAPL and LNAPL experiments. The sand is 20/30 mesh sand purchased from a local construction materials supplier. Prior to deposition in the sand box, the dry sand is poured into a large tub and mixed thoroughly with a garden hoe. A two inch layer of tap water equilibrated to 20°C is pumped into the bottom of the aquifer tank. Sand is then poured into the water from a beaker held just above the water's surface. This is an effective method for preventing air from being trapped in the sand and for preventing stratification of the sand by grain size. Sand is poured into the water until there is approximately 1/2 inch of water remaining above the top of the sand layer. At this point the sand is tamped with a mud knife, water is added to a depth of two inches over the top of the sand layer, and the process is repeated until the medium has been built up to a level several inches below the top of the tank. An unsaturated layer (vadose zone) of approximately 1 cm is left above the saturated zone. The medium is then covered with aluminum foil to minimize volatilization.

DNAPL Pool Formation

The effective formation of a homogeneous, flat pool of DNAPL in a water-saturated porous medium has been the single most difficult problem faced during the research. Several characteristics of trichloroethylene (TCE) complicate attempts to form such a pool. These characteristics are as follows:

A. TCE, in its pure form, is such an effective solvent that it quickly weakens or corrodes any epoxy or adhesive that is used to seal the panels of the glass tanks. A seamless metal pan has been fabricated to fit at the bottom of the tank, to prevent TCE from damaging the adhesive at the tank joints.

B. When TCE is forced into water-saturated sand, it has a strong tendency to migrate along the bottom and side walls of the tank and metal pan. It routinely spills over the edge of the pan prior to formation of a pool of reasonable and consistent thickness within the pan. The TCE then migrates along the glass tank walls, reaching the vulnerable adhesives and weakening the joint resulting in leaks. This migration is due to normal "wall effects" as well as the fact that TCE acts as the wetting fluid, on metal, relative to water.

C. Rather than forming a planar pool surface, which would facilitate mathematical modeling, TCE forms 'fingers' in water-saturated sand. The instability of the water-TCE interface in a porous medium is the reason for this. The result is a pool surface with peaks and valleys, whose elevation differences tend to be greater than a centimeter or more.

Several techniques of DNAPL pool formation have been formulated and investigated over the past year; a substantial amount of the research man-hours have gone into solving this problem. The techniques utilized can be grouped into two basic categories: 1. injection of TCE into saturated sand, and 2. variations on "Kueper's Method".

The first category is the preferred one, but it has posed a variety of difficulties. The original NSF proposal stated that DNAPL would be injected directly into the saturated sand, at the base of the tank, through a perforated metal pipe. However, this method was found to give rise to the problems previously stated.

A variation of this method was utilized for the first of the experimental trials that have been conducted to date. A 2-cm thick layer of coarse (4 mm) gravel was overlain by a piece of fine wire mesh with the rest of the aquifer sand above it. The entire system was saturated with water. TCE was injected into the gravel, whose greater permeability permitted the formation of a steadily rising DNAPL pool. However, once the pool reached the screen the TCE immediately migrated over the top of a protective glass shield, and began flooding the bottom of the tank. This occurred before the TCE had penetrated the sand to a sufficient degree to form a uniform pool.

Additional modifications to the pool formation process were made for the subsequent experimentals. A stainless-steel pan was fabricated and placed in the bottom of the model aquifer. The pan was filled with a 2-cm deep layer of gravel and overlain by a piece of screen bolted to a metal frame that fit within the stainless steel pan. Before the TCE pool passed through the screen to enter the sand, it migrated between the edge of the frame holding the screen and the pan wall, and again began migrating over the sides of the pan. TCE injection had to be terminated prior to formation of an appropriate DNAPL pool.

Currently the best alternative for DNAPL pool formation using this technique (injection of TCE into the bottom of the aquifer) would appear to be the use of silicone caulk to seal off the narrow space between the pan wall and screen frame edge, preventing TCE migration. There is concern, however, that dissolution of the caulk could alter the establishment of equilibrium.

The second category of pool-formation technique was suggested by Dr. B. Kueper of Queen's University in Kingston, Ontario. It involves first mixing water-dampened sand and TCE in the metal pan, then placing the full pan into the bottom of the tank, and then filling the rest of the tank with sand and clean water. A flow-through experiment, which is in progress, utilized this approach for the formation of an appropriate DNAPL pool. The technique shows a great deal of promise. However, this technique still has some problems with the DNAPL pool formation. These problems will be addressed in future flow-through experiments.

LNAPL Pool Formation

Toluene was used in the formation of all lnapl pools. A sand aquifer was first constructed, as described in the DNAPL pool formation section. The aquifer water level was raised to a predetermined level prior to any pool formation. The procedures for forming an lnapl pool were chosen after numerous attempts with several combinations of different methods utilized. A summary of the experiments to form lnapl pools is as follows:

A. <u>Utilizing the procedures described in the original proposal</u>.
Toluene was introduced into the capillary fringe approximately 3 cm above the aquifer water table by injecting it through perforated copper tubes laid parallel to the long axis of the sand aquifer. The results showed that the sand in the capillary fringe was wetted by water from the water table and formation of an appropriate lnapl pool was not possible.

B. <u>Utilizing uniform sand for forming pool</u>.
In these experiments a layer of uniform sand, such as 20 x 30 mesh Ottawa sand was used above the aquifer water table to form the lnapl pools. It was believed that the uniform sand would have more uniform pore spaces for containing napl and would form a better pool than the construction sand used in the previous attempts. The results of the experiments were similar

to those obtained using the finer construction sand for the entire aquifer.

C. Utilizing pre-napl saturated sand for forming the lnapl pool. Lnapl pool formation experiments indicated that the ability of sand in containing an lnapl pool was strongly affected by the material that first wetted the sand, water or lnapl. In the following experiments sand which was to contain the lnapl pool was first wet by the napl (toluene). The procedure used was to construct the sand aquifer as previously described and then add sand which has been presaturated with toluene to the top of the water table. Then, additional toluene can be added to the pre-napl saturated sand to ensure a sufficient amount of lnapl for completing the dissolution experiment. These experiments gave better results in forming lnapl pools than those described previously.

Confinement of lnapl pool.

Once an lnapl pool had been formed the problem of confining it was addressed. The lnapl would migrate laterally through the surface of contact, such as glass and steel and emerge from the influent and effluent ends of the aquifer tank. The best way found to confine the napl pool was to add moist sand to completely surround the pool. This satisfactorily confined the pool to a defined area. Covering of the lnapl pool with an additional layer of moist sand will be considered to minimize or prevent vaporization losses of the lnapl.

Based on the results of the above experiments, lnapl pools for use in the dissolution experiments will be formed as follows:

1. After an aquifer is constructed and the desired water table is established, pre-napl saturated sand will be added to water table to form an lnapl pool. Additional toluene will be added to the pool to ensure sufficient amount of napl for the dissolution experiment which will last several days.
2. The pool of lnapl will be surrounded by moist sand to prevent lateral migration of the lnapl.
3. A layer of moist sand will be placed atop of the lnapl pool to prevent the vaporization of the lnapl. A stainless steel cover will than be placed atop the moist sand layer, as stated in the original proposal.

Dissolution of a TCE Pool in a Saturated Porous Medium

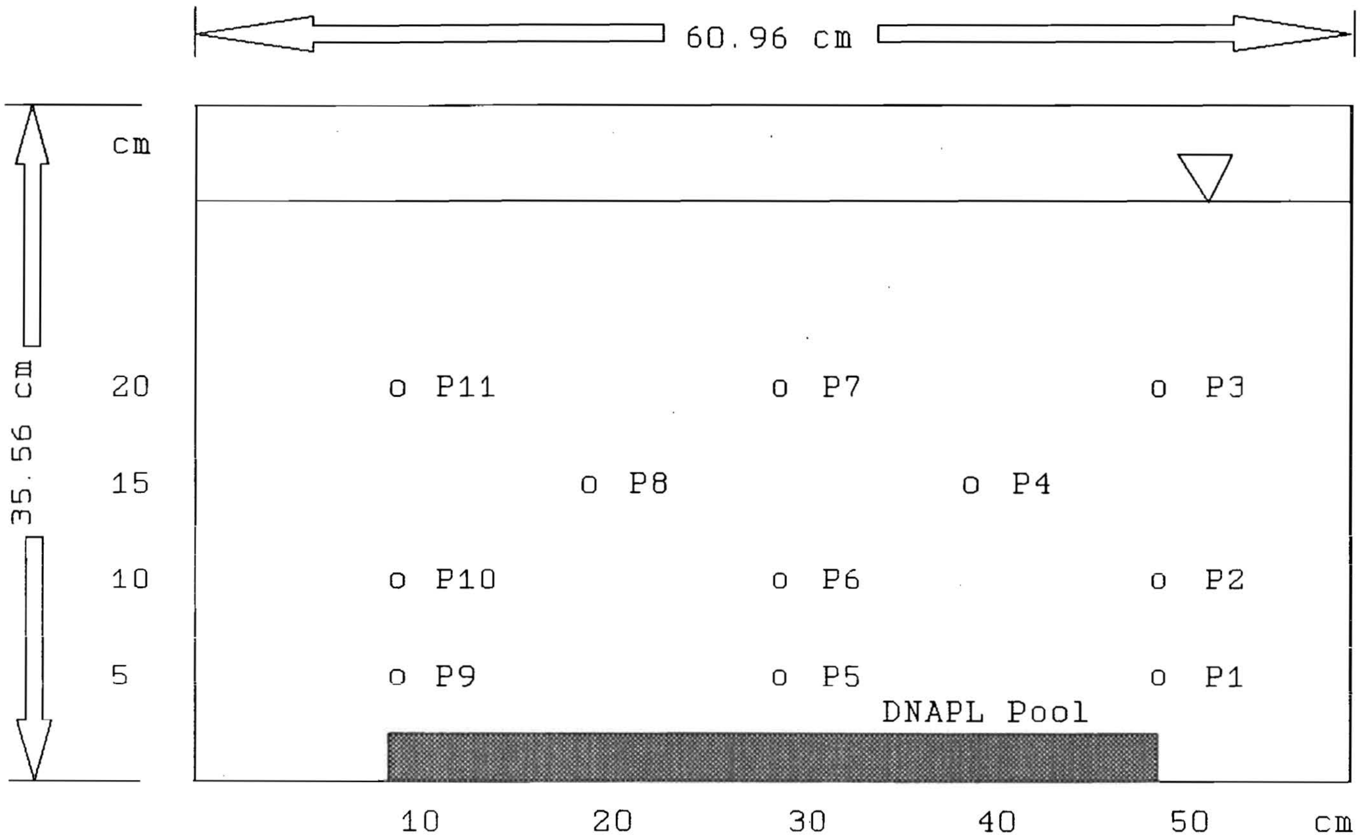
To date, two experimental pool-dissolution tests have been completed in the small sand tank. A third test is in progress and should be completed within the next two weeks. It must be stressed that the first two experiments were preliminary in nature, and even in the currently running third one, the overall procedure has yet to be perfected. Still, the concentration data that has been collected reveals some of the trends that may be expected in future pool dissolution experiments.

A summary of data from the second and third dissolution runs is included in Tables 1 and 2. Due to improvements in experimental and analytical technique, data from the third experimental test, which is ongoing, is considered to be the most reliable. These data illustrate the large TCE concentration gradients that have been found between the lowermost aquifer sample ports and those sample ports immediately above them. Although a concentration gradient was expected, its magnitude is somewhat surprising. Further work will help to clarify the magnitude of this gradient.

Future Work

To date, dissolution experiments with trichloroethylene (tce) have been conducted. In the second year of the project, dissolution experiments with tce will continue, along with other napls, such as 1,1,2-trichloroethane, toluene, chlorobenzene, and gasoline. Some column sorption experiments will be conducted to determine sorption coefficients, which will be used as input to the mathematical model.

Two masters and one doctoral student have been supported by the project. For the second year, one doctoral and one master student will be supported.



o: sampling port (1/8 in diam.)

Figure 1: Small Sandbox Dimensions and Sampling Port Layout

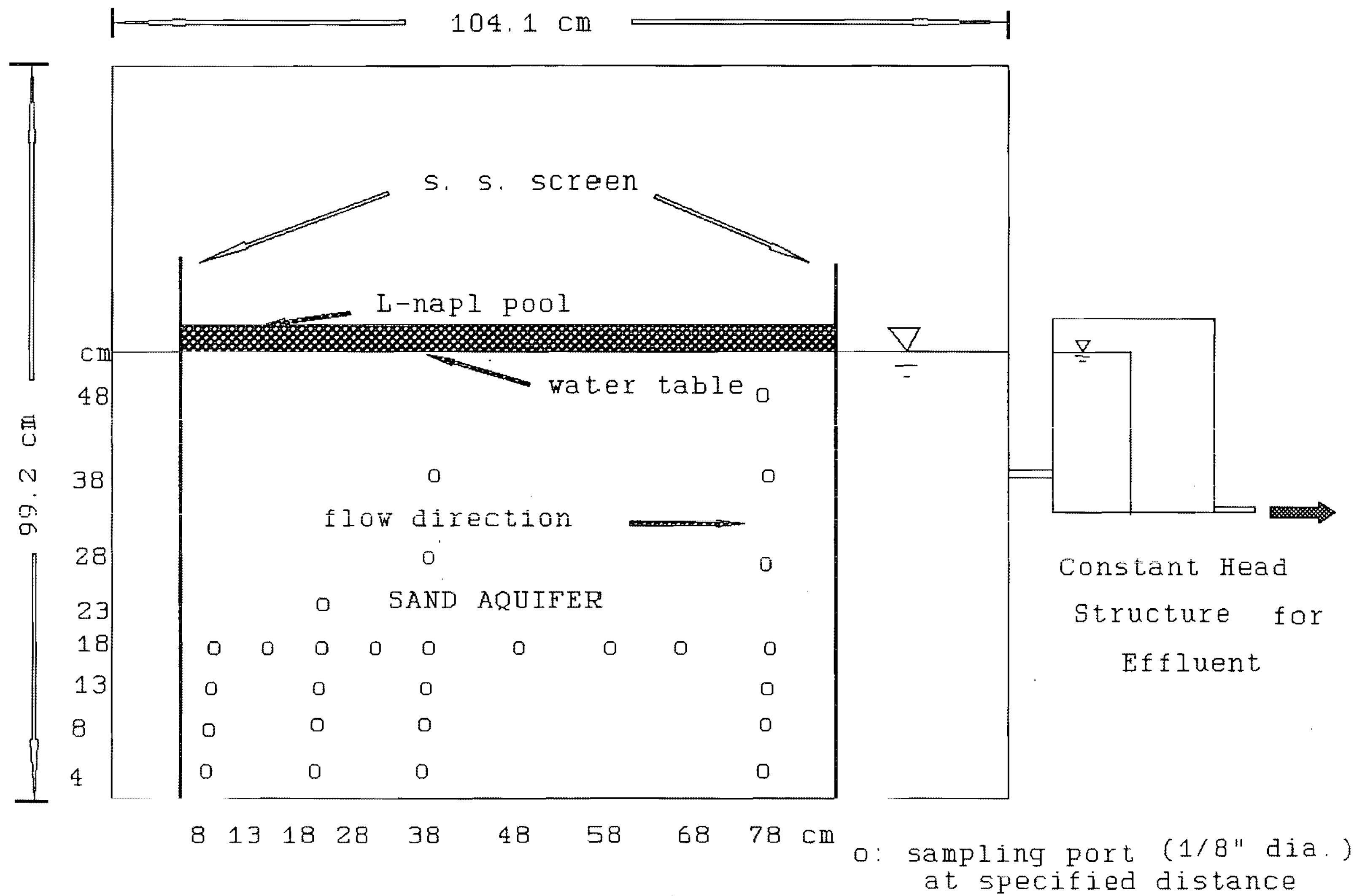


Figure 2. Typical Layout of Sand Box for L-Napl Pool Formation

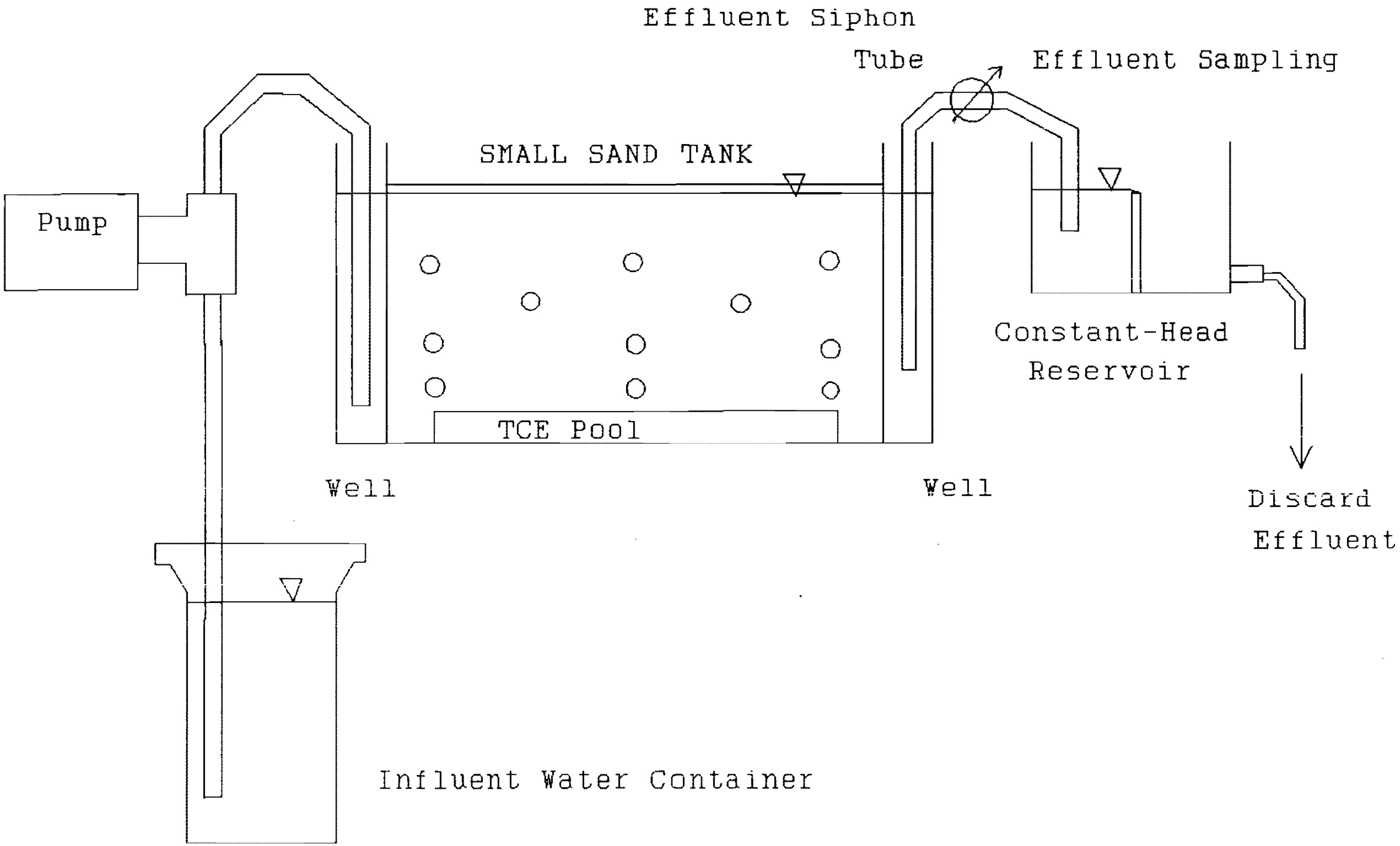


FIGURE 3. Schematic Illustration of Small-Tank Dissolution Set-up

TABLE 1. SUMMARY OF DATA FROM SMALL AQUIFER RUN #2

Pore Velocity = 40 cm/day
Pool level = 2.5 cm from base of aquifer

All concentrations are in mg/L.

Date:	1-Dec	2-Dec	3-Dec	4-Dec	5-Dec	7-Dec
Time:	1850	1130		1447	1134	1440
Port 1					(none)	
5			14	12	12	3
9		20	64	133	174	368.7
10					(none)	291.1
11						
E,valve						
E-mixed						

Date:	8-Dec	9-Dec	10-Dec	11-Dec	12-Dec	13-Dec
Time:	1440	1225	1238	1540		
Port 1						
5			(none)		(none)	
9	251	180.3	151.8	148.5	148.6	150.8
10	(none)		(none)			
11						
E,valve						
E-mix	197.2			95.5		

Refer to port diagram (Figure 1) for port numbers.

The use of (none) indicates that no TCE was detected in the sample. Such samples had low TCE concentrations and were over-diluted before GC analysis.

TABLE 2. SUMMARY OF DATA FROM SMALL AQUIFER RUN #3

Pore Velocity = 100 cm/day
Pool level = 2.6 cm from base of aquifer
(NOTE: Pan was raised 5 mm with layer of sand; top of pan was 3.6 cm above aquifer base)

All concentrations are in mg/L.

Date:	31-Jan	1-Feb	1-Feb	1-Feb	2-Feb	3-Feb
Time:	1730	0035	0830	1729	1433	1552
Port 1	27.3					
5	80.9	112	16.2	20.6	7.08	
9	(?100?)	(?350?)	195.2	292	204.4	170.4
10	37.8				(<0.071)	0.156
11						
E,valve				80		
E-mixed						

Date:	4-Feb	5-Feb	6-Feb	7-Feb
Time:	1510	0930	1215	1431
Port 1	(<0.071)			
5	5.26	3.31	0.842	
9	131.2	126.5	143.8	
10	(<0.071)	(<0.071)		
11	(<0.071)			
E,valve		75.3		76.15*
E-mixed		293.8	265.8*	241.7*

Refer to port diagram (Figure 1) for port numbers.

Numbers in parentheses were outside the calib. curve.
* Perforated glass tube used to carry effluent from aquifer.

4118

E-20-654
2

Name and Address

Evangelos Voudrias
~~Civil~~ Engineering C.E. Dept
~~GA Tech Res Corp~~
Atlanta GA 30332

NATIONAL SCIENCE FOUNDATION
FINAL PROJECT REPORT

PART I - PROJECT IDENTIFICATION INFORMATION

1. Program Official/Org. Edward H. Bryan - BCS

2. Program Name ENVIRONMENTAL & OCEAN SYSTEMS PROGRAM

3. Award Dates (MM/YY) From: 03/91 To: 08/93

4. Institution and Address

[redacted]
Administration Building
Atlanta GA 30332

5. Award Number 9022205

6. Project Title

Dissolution of Kinetics of NAPL Pools in Saturated Porous Media

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E. A.
Professor Voudrias
School of Civil Engineering
Georgia Tech
Atlanta, GA 30332

4118

PI Name and Address

Evangelos Voudrias
~~Civil~~ Engineering C.E. DEPT
[illegible]
Atlanta GA 30332

NATIONAL SCIENCE FOUNDATION FINAL PROJECT REPORT

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1. Program Official/Org. Edward H. Bryan - BCS

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[illegible]
Administration Building
Atlanta GA 30332

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6. Project Title

Dissolution of Kinetics of NAPL Pools in Saturated Porous Media

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Grant Conditions (Article 17, GC-1, and Article 9, FDP-11) require submission of a Final Project rt (NSF Form 98A) to the NSF program officer no later than 90 days alter the expiration of the d. Final Project Reports for expired awards must be received before new awards can be made Grants Policy Manual Section 677).

or on a separate page attached to this form, provide a summary of the completed projects and technical information. Be include your name and award number on each separate page. See below for more instructions.

PART II - SUMMARY OF COMPLETED PROJECT (for public use)

mmary (about 200 words) must be self-contained and intelligible to a scientifically literate reader. Without restating the title, it should begin with a topic sentence stating the project's major thesis. The summary should include, if pertinent project being described, the following items:

primary objectives and scope of the project
techniques or approaches used only to the degree necessary for comprehension
findings and implications stated as concisely and informatively as possible

PART III - TECHNICAL INFORMATION (for program management use)

ferences to publications resulting from this award and briefly describe primary data, samples, physical collections, ons, software, etc. created or gathered in the course of the research and, if appropriate, how they are being made available esearch community. Provide the NSF Invention Disclosure number for any invention.

o the best of my knowledge (1) the statements herein (excluding scientific hypotheses and scientific opinion) are true and complete, and ext and graphics in this report as well as any accompanying publications or other documents, unless otherwise indicated, are the original the signatories or of individuals working under their supervision. I understand that willfully making a false statement or concealing a fact in this report or any other communication submitted to NSF is a criminal offense (U.S. Code, Title 18, Section 1001).

(Evangelos A. Voudrias)	30 November 1993
Principal Investigator/Project Director Signature	**Date**

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mation from Part I, Block 1 to the Attention ...

PART II - SUMMARY OF COMPLETED PROJECT

Dissolution Kinetics of NAPL Pools in Saturated Porous Media

Non-Aqueous Phase Liquids (NAPLs) entering groundwater may form pools covering the bottom of an aquifer (DNAPLs, denser than water) or floating above the water table (LNAPLs, lighter than water). The primary objective of this project was to study the dissolution of DNAPL and LNAPL pools, under conditions simulating aquifer remediation by pump-and-treat.

A procedure was developed to create a DNAPL or LNAPL pool in a specially designed experimental aquifer, housed in a glass tank. The porous medium was silica sand with length varying from 65 to 85 cm, height varying from 30 to 36.8 cm, and width equal to 21 cm.

Dissolution experiments with 1,1,2-trichloroethene (TCE), 1,1,2-trichloroethane (TCA), and toluene pools conducted under steady and uniform flow showed that the dissolved NAPL concentrations decreased with increasing vertical distance from the pool, resulting in steep concentration gradients. The vertical extent of the dissolved plume increased with increasing distance along the pool and decreasing groundwater velocity. In all cases, measured concentrations were a small fraction of the respective NAPL solubility. In pulsed pumping experiments, dissolved NAPL concentrations increased significantly during zero flow conditions and, when the flow was resumed, they gradually decreased to the same levels as before the flow was stopped. Under the experimental conditions used, comparison between the pulsed and continuous pumping showed that the total mass removal would be higher for continuous pumping and would result in shorter toluene removal times. However, the total volume of water pumped and needed to be treated would be lower for pulsed pumping.

An existing two-dimensional steady-state mathematical model successfully predicted the experimental data of the NAPL dissolution experiments. A new mathematical model for transient contaminant transport resulting from dissolution of single component NAPL pools was also developed and successfully simulated the data of the TCA dissolution experiment.

PART III - TECHNICAL INFORMATION

Peer-Reviewed Publications

1. Whelan, M.P., Voudrias, E.A., Pearce, A. (1994). DNAPL pool dissolution in saturated porous media: Procedure development and preliminary results. *Journal of Contaminant Hydrology* (In Press).

2. Pearce, A.E., Voudrias, E.A., Whelan, M.P. (1994). Dissolution of TCE and TCA pools in saturated subsurface systems. *Journal of Environmental Engineering, ASCE* (In Press).

3. Voudrias, E.A., Yeh, M.F. (1994). Dissolution of a toluene pool under constant and variable hydraulic gradients with implications for aquifer remediation. *Ground Water* (In Press).

4. Chrysikopoulos, C.V., Voudrias, E.A., Fyrillas, M. (1993). Modeling of contaminant transport resulting from dissolution of nonaqueous phase liquid pools in saturated porous media. *Transport in Porous Media* (Under Review).

Conference Presentations

1. Yeh, M. F., Voudrias, E.A. (1992). Dissolution kinetics of toluene pools in saturated porous media. Poster presentation in Hazardous Waste Conference, University of Notre Dame and Miles, Inc., Notre Dame, IN, August 31 - September 4.

2. Yeh, M. F., Voudrias, E.A. (1993). Dissolution kinetics of toluene pools in saturated porous media. Proceedings of the 1993 Industrial Pollution Control Conference, February 22 - 24, Volume I.

3. Yeh. M. F., Voudrias, E.A. (1993). Toluene pool removal under constant and pulsed pumping conditions. Presented in the Quadrangle Conference, Clemson University, Clemson, SC, February 19 - 20.

4. Yeh, M. F., Voudrias, E.A. (1993). Dissolution kinetics of toluene pools in saturated porous media. Proceedings of the 1993 Georgia Water Resources Conference, pp. 366 - 368, The University of Georgia, Athens, Georgia.

5. Chrysikopoulos, C.V. (1993). Transport of contaminants from the non-aqueous phase liquid pool dissolution in subsurface formations. In Water Pollution II: Modelling, Measuring and Prediction (Second International Conference, Milan, Italy), edited by L.C. Wrobel,and C.A. Brebbia, pp. 27 - 36, Computational Mechanics Publications, Southampton, UK.

PART IV -- FINAL PROJECT REPORT -- SUMMARY DATA ON PROJECT PERSONNEL

(To be submitted to cognizant Program Officer upon completion of project)

The data requested below are important for the development of a statistical profile on the personnel supported by Federal grants. The information on this part is solicited in resonse to Public Law 99-383 and 42 USC 1885C. All information provided will be treated as confidential and will be safeguarded in accordance with the provisions of the Privacy Act of 1974. You should submit a single copy of this part with each final project report. However, submission of the requested information is not mandatory and is not a precondition of future award(s). Check the "Decline to Provide Information" box below if you do not wish to provide the nformation.

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	Senior Staff		Post-Doctorals		Graduate Students		Under-Graduates		Other Participants[1]	
	Male	Fem.	Male	Fem.	Male	Fem.	Male	Fem.	Male	Fem.
A. Total, U.S. Citizens	2				3					
B. Total, Permanent Residents										
U.S. Citizens or Permanent Residents[2]:										
American Indian or Alaskan Native										
Asian.					1					
Black, Not of Hispanic Origin.										
Hispanic										
Pacific Islander										
White, Not of Hispanic Origin	2				2					
C. Total, Other Non-U.S. Citizens	1									
Specify Country 1. Greece										
2.										
3.										
D. Total, All participants (A + B + C)	3				3					
Disabled[3]										

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[1] Category includes, for example, college and precollege teachers, conference and workshop participants.

[2] Use the category that best describes the ethnic/racial status fo all U.S. Citizens and Non-citizens with Permanent Residency. *(If more than one category applies, use the one category that most closely reflects the person's recognition in the community.)*

[3] A person having a physical or mental impairment that substantially limits one or more major life activities; who has a record of such impairment; or who is regarded as having such impairment. *(Disabled individuals also should be counted under the appropriate ethnic/racial group unless they are classified as "Other Non-U.S. Citizens.")*

AMERICAN INDIAN OR ALASKAN NATIVE: A person having origins in any of the original peoples of North America and who maintains cultural identification through tribal affiliation or community recognition.

ASIAN: A person having origins in any of the original peoples of East Asia, Southeast Asia or the Indian subcontinent. This area includes, for example, China, India, Indonesia, Japan, Korea and Vietnam.

BLACK, NOT OF HISPANIC ORIGIN: A person having origins in any of the black racial groups of Africa.

HISPANIC: A person of Mexican, Puerto Rican, Cuban, Central or South American or other Spanish culture or origin, regardless of race.

PACIFIC ISLANDER: A person having origins in any of the original peoples of Hawaii; the U.S. Pacific territories of Guam, American Samoa, and the Northern Marinas; the U.S. Trust Territory of Palau; the islands of Micronesia and Melanesia; or the Philippines.

WHITE, NOT OF HISPANIC ORIGIN: A person having origins in any of the original peoples of Europe, North Africa, or the Middle East.