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Office of Research and
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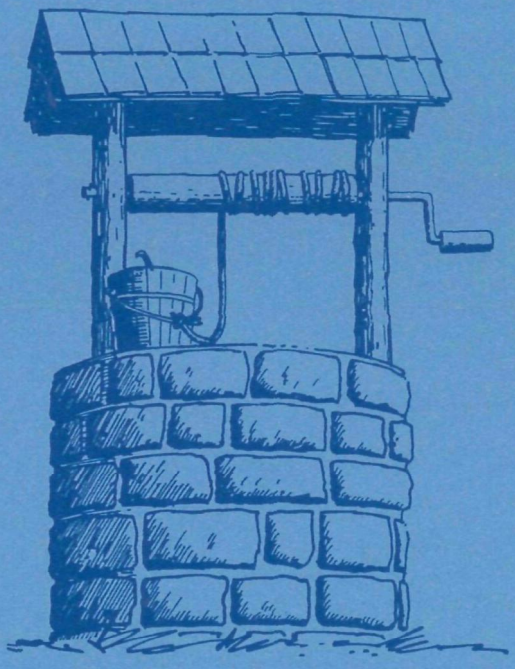
EPA/600/K-94/004
June 1994

EPA

Robert S. Kerr Environmental Research Laboratory

Research Program



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June 1994

Robert S. Kerr Environmental Research Laboratory

Revised

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Compiled by
Robert S. Kerr Environmental Research Laboratory

Office of Environmental Processes and Effects Research
Office of Research and Development
U.S. Environmental Protection Agency
Ada, Oklahoma 74820

CONTENTS

RSKERL Background 1

USEPA Office of Research and Development 3

RSKERL Organizational Chart 4

Active Projects 5

Project Descriptions

Site Characterization 15
Contaminant Transport and Transformation 24
Subsurface Remediation 33
Underground Injection Control 59
Wellhead Protection 60
Mathematical Modeling 67

Technical Assistance and Information Transfer 77

Publications (1992-1994) 78

RSKERL BACKGROUND

The enactment of the Federal Water Pollution Control Act in 1961 provided for the construction of a number of regional laboratories to address increasing water pollution problems indigenous to the areas they would serve. In 1966 one of these was placed in Ada, Oklahoma. It was named for Robert S. Kerr, a long time U.S. Senator from the State, in honor of his dedication and concern for conservation and the development of our natural water resources and his pioneering environmental legislation.

Initially the Laboratory provided technical assistance, presented training, and conducted research to solve water pollution problems in Arkansas, Louisiana, New Mexico, Oklahoma, and Texas. In 1970, the Laboratory's role was expanded and it became one of fifteen research facilities administered through EPA's Office of Research and Development in Washington, D.C. In 1979, the Robert S. Kerr Environmental Research Laboratory (RSKERL) was designated as EPA's center for ground-water research by the Assistant Administrator of the Office of Research and Development.

Today the Laboratory focuses its activities on research, technical assistance, and information transfer in the areas of soil and ground-water protection and restoration. Although the research activities at RSKERL are extremely varied, they center in great measure on understanding, modeling, and applying the basic principles involved in the physical, chemical, and biological processes which control contaminant transport and transformation in the subsurface. For the purposes of this document, the active research investigations are discussed according to the following categories.

Site Characterization

Contaminant Transport and Transformation

Subsurface Remediation

Underground Injection Control

Wellhead Protection

Mathematical Modeling

In addition to its inhouse researchers and support personnel, the RSKERL research mission is advanced by a cadre of extramural researchers representing universities, national laboratories, other federal agencies, the National Center for Ground Water Research, and on-site contractors. RSKERL currently has more than 50 active research projects. In addition to those being carried out by RSKERL scientists, others under the auspices of the Laboratory are being carried out in 18 states while working with 22 Universities, 7 other federal agencies, and 3 state agencies. RSKERL is conducting research cooperatively with Canada, Sweden, and the People's Republic of China.

Technical assistance at RSKERL falls within the purview of the Technology Support Center (TSC) which carries out its mission in close association with the Laboratory's research scientists. Assistance is provided by direct participation in field investigations and decision criteria primarily at specific Superfund and RCRA sites. Assistance is also provided to Regions, States, and municipalities related to the underground injection control and wellhead protection programs. Technology transfer endeavors include issue papers and briefing documents, workshops, seminars, conferences, and training courses. The RSKERL Technology Support Center consists of a core team of scientists and engineers supported by RSKERL and extramural researchers, the National Center for Ground Water

Research, the RSKERL Center for Subsurface Modeling Support (CSMoS), and an on-site technology support contractor with off-site subcontractors and consultants. The RSKERL TSC is discussed in greater detail elsewhere in this document.

While many inroads have been made toward the solution of environmental problems, new challenges are now in evidence for which there are no immediate answers. In addition to the myriad of hazardous waste sites which have contaminated the subsurface environment, other agricultural and domestic practices graphically illustrate a lack of knowledge concerning the disposal of waste products and the protection of ground-water quality.

U.S. Environmental Protection Agency
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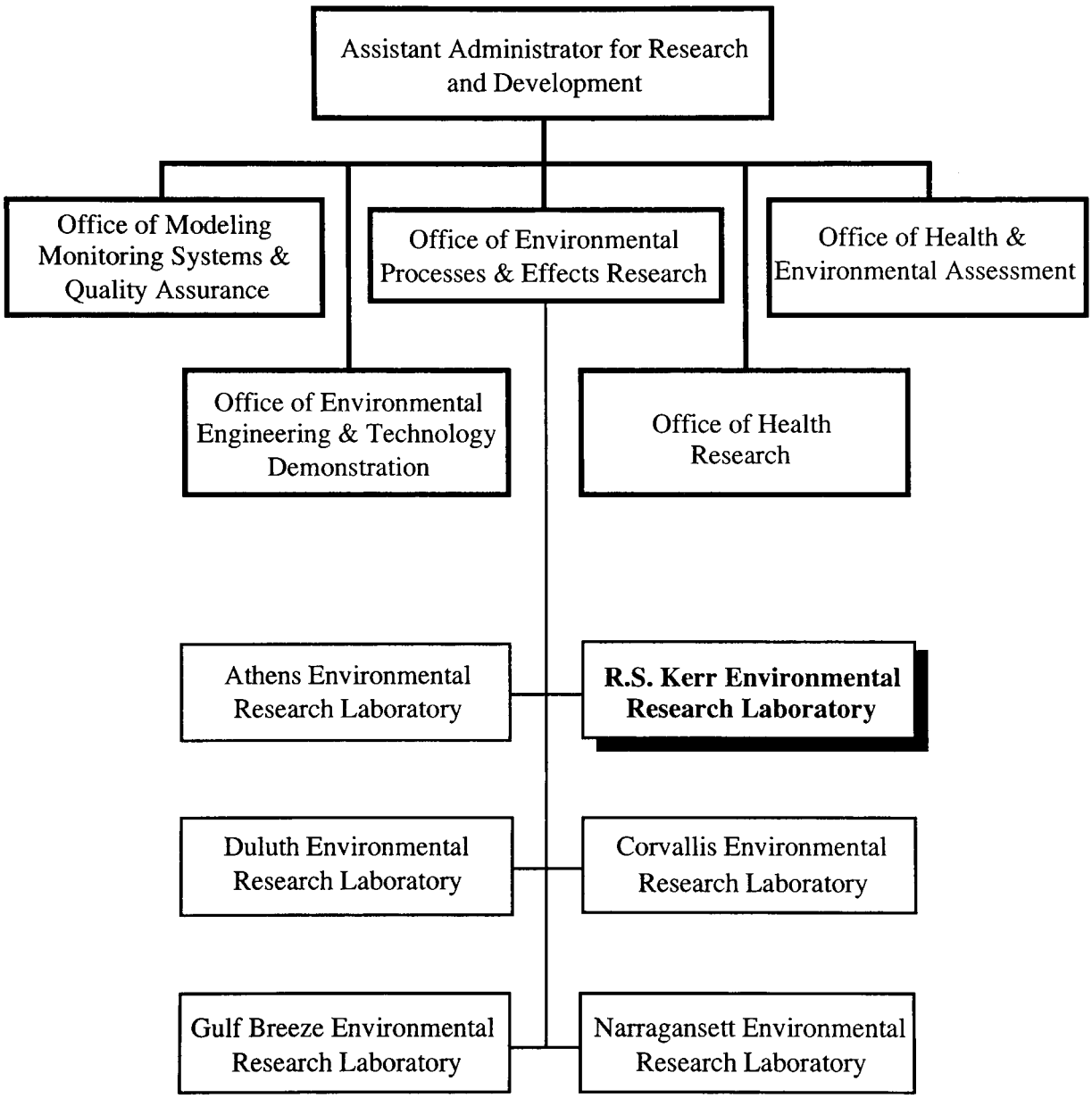
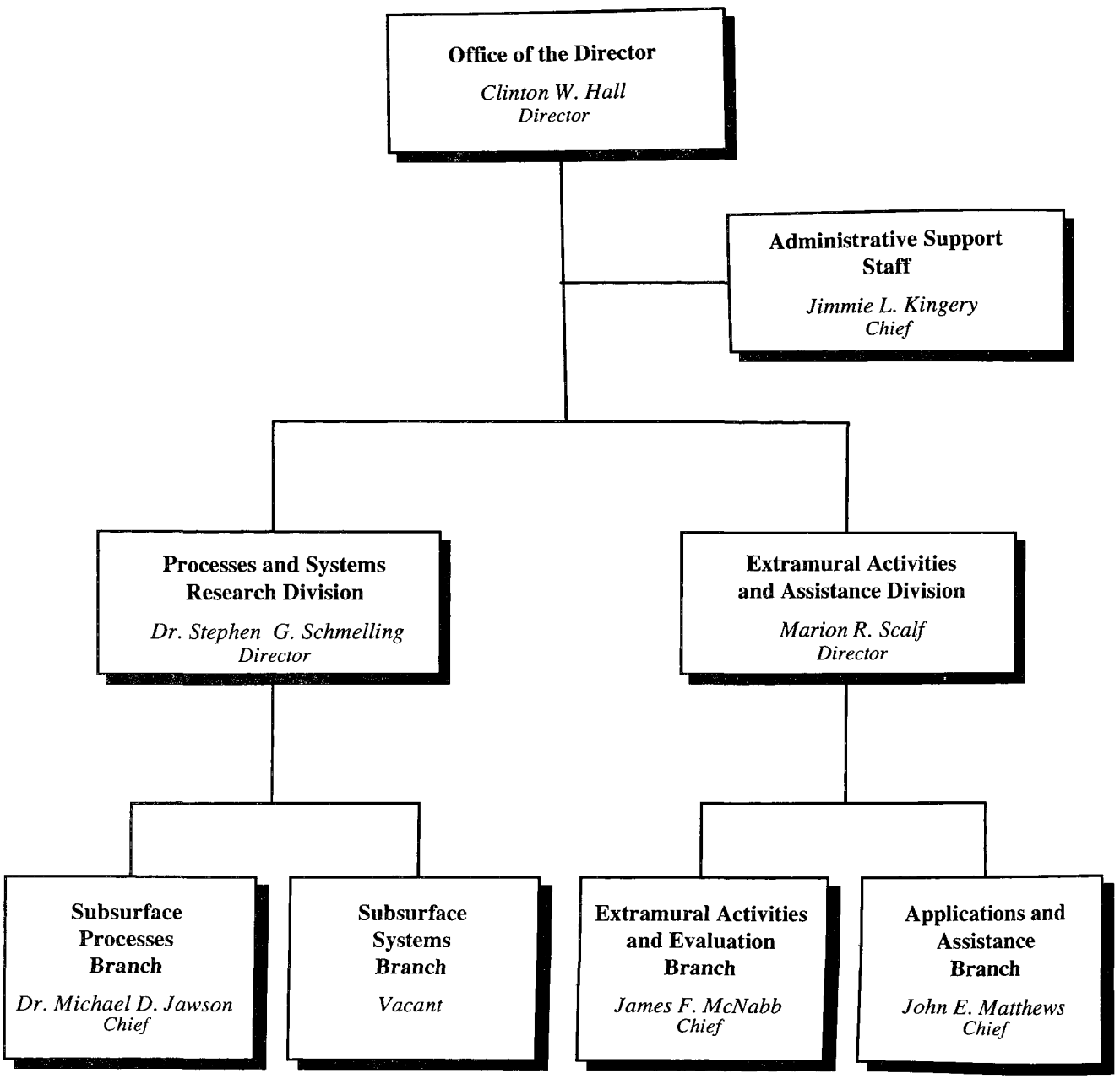


Robert S. Kerr Environmental Research Laboratory

Organizational Chart



ACTIVE PROJECTS

Site Characterization

Hydrological Studies and Data Base Development
for the Walnut Creek Watershed in Support of
the MASTER Project
USDA - National Soil Tilth Laboratory 15

The Impact of Agriculture on
Subsurface Ecology
Purdue University 16

Assessment of the Hydrology of Walnut
Creek Watershed near Ames, Iowa
USDA - National Soil Tilth Laboratory 16

Landscape Classification for Ground-Water Flow and
Nitrogen Load Modeling (Chesapeake Bay Watershed)
USGS Towson, Maryland 17

Fracture Characterization and Fluid Flow
National Research Council/National Academy of Sciences 17

Reclamation by Biopiling of Excavated Soil
Contaminated with Semivolatile Petroleum Organics
University of Texas 17

Laser Fluorescence EEM Probe for
Cone Penetrometer Pollution Analysis
Tufts University 18

Stable Isotope Evaluation of Soil Metal
Speciation by Selective Extraction
U.S. Army Corps of Engineers - Waterways Experiment Station 18

Capture Zone Delineation in a
Fractured Carbonate Aquifer
Undecided 19

Characterization of the Test Site at Hill AFB
for the Demonstration of Enhanced Source Removal
for Aquifer Restoration
Tyndall AFB 19

Implications of Colloidal Mobility for the
Collection of Representative Ground Water Samples
Cooperative Agreement 20

Mobilization of Naturally Occurring Heavy
Metals by Reductive Dissolution
Cooperative Agreement 20

Ground Water Sampling
RSKERL 20

Evaluation of Methods of DNAPL
Site Characterization
Cooperative Agreement 21

Site Characterization Using a
Cone Penetrometer
RSKERL 21

Dielectric and Resistivity Method for Detecting
Nonaqueous-Phase Liquid Contaminants in Multiphase Systems
RSKERL 21

Environmental Buffer Criteria for the
Assessment of Soil Quality in Agroecosystems
USDA 22

Subsurface Ecology
RSKERL 22

Geohydrology and Nitrate Loadings of the Ground-Water
Systems Impacting the Chesapeake Bay
RSKERL 23

Site Characterization Using a Hydraulically
Driven Soil Gas and Ground-Water Probe
RSKERL 23

Contaminant Transport and Transformation

Separation and Identification
of Aquifer Organic Matter
ManTech/RSKERL 24

Characterization of Organic Matter
in Soils and Aquifer Solids
Western Michigan University 25

Assimilative Capacity of Subsurface for the
Pesticides Atrazine, Alachlor, and Nitrate
USDA - National Tilth Laboratory 25

Spectroscopic Studies of Organic
Films on Mineral Surfaces
ManTech/RSKERL 26

Augmenting Natural Recharge of Ground Water
with Reclaimed Wastewater, Stormwater,
and Irrigation Return Flow
National Academy of Sciences 26

Three-Dimensional Modeling of Subsurface Flow,
and Fate and Transport of Microbes and Chemicals
Penn State University 27

Validation of the Approximate
Multiphase Flow Models
RSKERL 27

Heavy Metal Transport in a Sand and Gravel
Aquifer with Variable Chemical Conditions
U.S. Geological Survey 28

Transport and Transformation of Arsenic
and Chromium in Ground Water
RSKERL 28

Compilation of Saturated/Unsaturated Zone
Models and Development and Application of
Testing Methods and Benchmark Cases
Colorado School of Mines 29

Subsurface Processes Controlling Sorption and Transport
of Ionizable and Polar Organic Compounds
University of Florida 29

Use of the Assimilative Capacity Concept to
Develop Agrichemical Usage Guidance and
Determine the Fate of Atrazine in a Wet Meadow
in the Central Platte Valley Alluvium of Nebraska
Nebraska Department of Environmental Quality 30

Subsurface Transport Properties
in Layered Media
RSKERL 30

Laboratory Electronic Measurements and Data
Collection Systems for RSKERL Artificial Aquifers
RSKERL/ManTech 31

Transformation of Pesticides
RSKERL 31

Biodegradation of Pesticides
in Aquifers
RSKERL/ManTech 32

Subsurface Remediation

Anaerobic Processes in the
Subsurface Environment
RSKERL 33

Surfactant Enhanced Solubilization
of Chlorinated Hydrocarbons
RSKERL 34

Field-Evaluation of Cosolvent-Enhanced
In-situ Remediation
University of Florida 34

Development of a Data Evaluation/Decision Support
System for Bioremediation of Subsurface Contamination
Rice University 34

Assessment of Solvent-Enhanced Desorption
and Mobilization of Polychlorinated Biphenyls
RSKERL 35

Rapid Phase Identification of Mixed Crystalline
Solids Using Surface Analytical Techniques for
Assessment of In-Situ Aquifer Remediation
Oregon Graduate Institute 35

Decision Support System for Evaluating Remediation
Performance with Interactive Pump-and-Treat Simulator
Rice University 36

Modeling and Design of Bioremediation Systems for
a JP-4 Jet Fuel Spill at Eglin AFB, Florida
Rice University 36

Studies on the Sulfur Mediated Biological
Denitrification Process
Orange County Water District 37

Innovative Methods for Remediation of
Subsurface Chromium Contamination
Rice University and University of Oklahoma 37

Microbial Characterization and Treatability Study
for a JP-4 Jet Fuel Spill at Eglin AFB, Florida
Rice University 38

Great Plains-Rocky Mountain Hazardous
Substance Research Center, U. of Iowa
University of Iowa 38

Response of Subsurface Microbial Communities
to the Introduction of Contaminants
Cooperative Agreement 39

Surfactant Enhanced Remediation
of Subsurface DNAPL Contamination
University of Oklahoma 39

Evaluation of Technologies for Cleanup
of DNAPL Contaminated Sites
University of California 40

Site Characterization of Ground-Water Flow
and Transport in Fractured Rock Systems for
Improvement of Pump-and-Treat Remediation
Lawrence Berkeley Laboratory 40

Investigation of Surfactant Enhanced
Remediation of Aquifers Contaminated
by Dense, Non-Aqueous Phase Liquids (DNAPLs)
University of Michigan 41

Super Computer Simulation of Pump-and-Treat
Methods for Aquifer Restoration
University of North Carolina - Chapel Hill 41

Artificial Aquifer Studies - East Aquifer
ManTech/RSKERL 42

Passive Anaerobic Remediation of BTEX
Compounds in Ground Water
North Carolina State University 42

Forced Aeration for On-Site Remediation
of Hydrocarbon Spills
U.S. Park Service 43

Design and Operating Parameters for the
Remediation of a Fuel Oil Contaminated
Soil Using Composting Technology
Howard University 43

Remediation of Contaminated
Soils by Solvent Flushing
University of Florida 44

Microbial Metabolism of Munitions
Wastes in Anoxic Aquifers
Rice University 44

Three-Dimensional NAPL Fate
and Transport Model
University of Texas 45

Methods for Determining Multiphase Characteristic Curves
for Use in Designing Subsurface Bioremediation Systems
University of California at Davis 45

Development of a Data Evaluation/Decision Support
System for Bioremediation of Subsurface Contamination
MIT 45

Development of Techniques for In Situ Bioremediation
of Chromium Contaminated Soil and Groundwater:
Phase I Laboratory Evaluation
University of Oklahoma 46

Bioremediation of BTEX, Naphthalene, and
Phenanthrene in Aquifer Material Using Mixed
Oxygen/Nitrate Electron Acceptor Conditions
Johns Hopkins University 46

Bioremediation of Fuel-Contaminated Aquifers
Using Mixed Electron Acceptor Conditions
University of Waterloo 47

Evaluation of In-Situ Bioremediation of Chlorinated
Hydrocarbon Contaminated GW at Air Force Plant 44
Western Region Hazardous Substance Research Center, Stanford University 47

H_2O_2 and Microbial System Interactions
RSKERL/ManTech 48

A Pilot-Scale Demonstration of Surfactant-Enhanced
Subsurface Remediation of Chlorinated Hydrocarbons
University of Oklahoma 48

China-US Soils & Ground Water Remediation Research
Sino-US International Agreement 49

Treatment of Process Off-Gases Contaminated with
TCE Using Ex-Situ Soil Based Aerobic Bioreactors
USGS 49

Evaluation of Passive Remediation Techniques at
Mixed-Waste Sites Using Geochemical Barriers
Cooperative Agreement 49

Design Manuals for the Extraction of Contaminants
from Unconsolidated Subsurface Environments
Cooperative Agreement 50

Evaluation of Pulsed Pumping for Improving the
Efficiency of Pump-and-Treat Remedial Actions
US Air Force 50

Evaluation of Cosolvent Flushing for
Increasing Mobility of NAPLs
Cooperative Agreement 50

Transformation and Transport Processes of
Hydrocarbon Vapors in the Vadose Zone
RSKERL 51

Oxygen Consumption in Clay Soils
Contaminated by #2 Fuel Oil
RSKERL 51

Chemically Enhanced Dissolution and
Mobilization of Residual Contaminants
RSKERL 51

Remediation of Chromium Contaminated Soils
and Ground Water at a Chrome Plating Site
RSKERL 52

Sorption of Polar Organic Compounds
to Colloidal Particles
RSKERL 52

Pore-Scale Investigation of the Behavior
of Remedial Fluids
Cooperative Agreement 52

Changes in Subsurface Wetting Behavior
in the Presence of NAPLs
RSKERL/ManTech 53

Abiotic Reduction of Chrome from
Zero-Valence Iron Dissolution
RSKERL/ManTech 53

Evaluation of Proposed Closure
Criteria at Remediated Sites
Cooperative Agreement 54

Natural Attenuation of Ground Water
Contaminants at Air Force Installations
RSKERL (US Air Force) 54

Denitrification for Bioremediation of a
Refinery Spill Park City, Kansas
RSKERL 55

Bioventing to Remediate a JP-4 Spill at the
USCG Site at Elizabeth City, North Carolina
RSKERL 55

Feasibility Study on Enhancement of Nitrate-Based
Bioremediation Using Surfactants
RSKERL 56

Vinyl Chloride/TCE at St. Joseph, MI Site
RSKERL 56

Aerobic Co-Oxidation of TCE Vapors
RSKERL 56

Reductive Anaerobic Biological In-Situ Treatment
RSKERL 57

Petroleum Hydrocarbon Biodegradation Under
Mixed Denitrifying/Microaerophilic Conditions
RSKERL 57

Prepared Bed Bioremediation in Buried Lifts as
Affected by O_2 Concentrations in Soil Gas
Utah State University 57

Biological Treatment of Trichloroethylene
Contaminated Process Off-Gas
U.S. Army Corps of Engineers
Waterways Experiment Station 58

Underground Injection Control

Injection Well Mechanical Integrity
East Central University 59

Potential for Invasion of Underground Sources
of Drinking Water Through Mud-Plugged Wells:
An Experimental Appraisal
Oklahoma State University 59

Wellhead Protection

Hydrogeologic Mapping to Delineate
Wellhead Protection Zones Around Springs
State of Utah 60

The Development of a Risk Management
Strategy for Wellhead Protection
University of Miami 60

Determination of Subsurface Assimilative Capacity
RSKERL 61

Delineation of Wellhead Protection Zones:
Consideration of Virus Transport
University of Arizona 61

Demonstration of the Analytical Element
Method for Wellhead Protection
Indiana University 62

Capture Zone Delineation:
Models and Experiments
New Mexico Institute of Mining and Technology 62

Capture Zone Delineation Using the EPA
WHPA Model and Other Codes: A Comparative
Study in Ellis County, Kansas
RSKERL 63

Technical Assistance and Technology Transfer in Wellhead Protection
RSKERL 63

Contaminant Identification and Classification
University of Oklahoma 64

Ground-Water Flow in a Carbonate Aquifer, Southern Oklahoma
USGS 64

System Analysis for Evaluating Aquifer Assimilative Capacity
Rice University Consortium 65

Economic Value of Ground Water
National Research Council 65

Risk Management Decision Support System (RMDSS) for Wellhead Protection
RSKERL 66

Mathematical Modeling

Multiphase Flow in Soils: Modeling and Experimental Study
University of Colorado 67

Three-Dimensional Modeling of Subsurface Flow, and Fate and Transport of Microbes and Chemicals
Penn State University 67

Validation of the Approximate Multiphase Flow Models
RSKERL 68

Three-Dimensional Multiphase Flow and Contaminant Transport Mathematical Model
University of Vermont 68

Screening Methods for Hydrocarbon Spills and Recovery
Rice University and University of Texas 69

Compilation of Saturated/Unsaturated Zone Models and Development and Application of Testing Methods and Benchmark Cases
Colorado School of Mines 69

Evaluation of Ground-Water Pump-and-Treat Systems at the Gilson Road Superfund Site, Nashua, NH, with Ground-Water Models
University of Cincinnati 70

Application of Electromagnetic Tomography
to Monitoring DNAPL
University of Arizona 70

Four-Dimensional Electrical Imaging of Subsurface
Contaminants with Applications to a Controlled Spill
Massachusetts Institute of Technology 71

A Computer Program to Model Bioventing of Organic
Contaminants in Unsaturated Geological Material
University of Michigan 71

Modeling Flow through Fractured Media--Testing
Continuum vs. Discrete Conceptualizations
RSKERL 72

Evaluation of Multiphase Flow and Transport
Models in a Large Two-Dimensional Physical Model
Cooperative Agreement 72

Determination of Mass Transfer Rates between
Mobile/Immobile Soil-Air Regions
RSKERL 72

Evaluation of Dual Source Gamma
Ray Absorption System
RSKERL 73

Development of Lagrangian Methods for
Subsurface Contaminant Transport Analysis
RSKERL 73

Soil Vacuum Model
RSKERL 73

Intermediate-Scale Evaluation of Subsurface
Transport and Fate Models
Cooperative Agreement 74

Parameter Sensitivity Evaluation of Selected
Unsaturated Zone Models
RSKERL 74

Sensitivity of Model Predicted Chemical Transport
to Boundary Conditions at the Soil Surface
RSKERL 74

EIT Inverse Solution
RSKERL 75

SITE CHARACTERIZATION

Site characterization research is conducted in order to improve the ability to assess risks associated with a contaminated site, evaluate the need for corrective action, and select as well as evaluate the effectiveness of proper remediation technologies. Exposure assessments must be based on an awareness of the geologic, hydrologic, geochemical, and biological characteristics of the site. Research in this area is aimed at the development of methods of investigation and interpretation in order to determine the parameters which describe a site and define their spatial distribution.

Hydrological Studies and Data Base Development for the Walnut Creek Watershed in Support of the MASTER Project

INSTITUTE:	USDA - National Soil Tilth Laboratory (Michael Jawson, P.O.)	
TASK NO:	1067	
PROJECT PERIOD:	03/92 09/94	
PRINCIPAL INVESTIGATOR:	J.L. Hatfield	(515) 294-5723

ABSTRACT: With respect to hydrological studies, the object of the project is to quantify the coupling between the ground and surface water in the upper reaches of the Walnut Creek watershed and the movement of water in the shallow alluvium. Also included is the assessment of ground-water flow and quality in the Skunk River alluvium. Available information on ground-water will be compiled with respect to agricultural chemicals in the Western Cornbelt Ecoregion. Data elements collected by each MASTER investigator will be incorporated into a compatible and accessible data base for use by all investigators.

The Impact of Agriculture on Subsurface Ecology

INSTITUTE: Purdue University
(Michael Jawson, P.O.)

TASK NO: 1072

PROJECT PERIOD: 10/92 09/94

PRINCIPAL INVESTIGATOR: Ronald Turco (317) 494-8077

ABSTRACT: The objectives of the project are assess community diversity and size, and develop a set of ecological indicators that can be used to estimate the environmental status of the subsurface and changes which occur as a consequence of environmental stresses, particularly those resulting from agricultural chemicals and practices. The spatial variability in microbial activity and community structure will also be assessed. Microbial community structure and metabolic processes will be determined using root zone, vadose zone, and aquifer samples at the Indiana Water Quality Field Station and an Iowa Midwest System Evaluation Area site. Microbial community structure will be analyzed using whole bacteria population DNA-reassociation curves to assess species diversity, percent G+C content by DNA the bisbenzimide binding method to assess the bacterial community makeup, and phospholipid fatty acid pattern (PLFA) and fatty acid methyl ester (FAME) analysis to assess bacterial biomass size and community composition. Metabolic process studies will be used to assess the response to stresses imposed by agrichemicals. Microcosm samples will be spiked with radiolabelled 2,4-D and catechol. Small-scale spatial variability will be assessed using samples taken horizontally from the root and vadose zones which will be analyzed by PLFA and FAME procedures to determine microbial community structure, and 2,4-D mineralization to determine microbial activity. A final report on the impact of agriculture on subsurface ecology will be completed in December, 1994.

Assessment of the Hydrology of Walnut Creek Watershed near Ames, Iowa

INSTITUTE: USDA National Soil Tilth Laboratory
(Steve Kraemer, P.O.)

TASK NO: 1084

PROJECT PERIOD: 07/93 06/95

PRINCIPAL INVESTIGATOR: M.R. Burkhart (515) 294-5809

ABSTRACT: The specific objectives of this project include: (1) conduct a hydrogeologic reconnaissance of the watershed; (2) determine the ground water/surface water interactions in proximity of the Walnut Creek channel; (3) determine the influence of the loss of water in the stream bed on the Skunk River alluvial aquifer; (4) extend the development of the analytic element ground-water model of the watershed; and (5) screen, document, and qualify data that will be used to meet the objectives of MASTER and MSEA. Outputs of the project will be GIS coverages and Journal Articles.

Landscape Classification for Ground-Water Flow and Nitrogen Load Modeling (Chesapeake Bay Watershed)

INSTITUTE: USGS Towson, Maryland
(Steve Kraemer, P.O.)

TASK NO: 1085

PROJECT PERIOD: 10/93 09/94

PRINCIPAL INVESTIGATOR: L. Bachman (401) 828-1535

ABSTRACT: The objective of this project is to associate land use patterns with ground-water nitrate loadings to the Chesapeake Bay. The initial effort is on data reconnaissance and database creation. A hydrogeomorphic landscape classification system based on multivariate statistics is proposed. Outputs will include a Database and ARC/INFO GIS coverages.

Fracture Characterization and Fluid Flow

INSTITUTE: National Research Council/National Academy of Sciences (Stephen Schmelling, P.O.)

TASK NO: 2052

PROJECT PERIOD: 07/91 - 05/93

PRINCIPAL INVESTIGATOR: Peter Smealie (202) 334-3137

ABSTRACT: The purpose of this study is to review, synthesize, and integrate recent research concerning techniques and approaches to fractured rock characterization and fluid flow in fractured geologic settings. A committee composed of approximately 10 recognized experts from the fields of geology, geomechanics, geophysics, hydrology, and geochemistry met July 23-26, 1991, to review the status of current research, identify problem areas, explore mechanisms to advance the field, and offer guidance to federal agencies. The work will culminate in a report on Fracture Characterization and Fluid Flow.

Reclamation by Biopiling of Excavated Soil Contaminated with Semivolatile Petroleum Organics

INSTITUTE: University of Texas
(Don Kampbell/John Matthews, P.O.)

TASK NO: 2065

PROJECT PERIOD: 08/92 - 08/97

PRINCIPAL INVESTIGATOR: Ray Loehr (512) 471-5602

ABSTRACT: The objective of the project is to develop emergency response technology on the rate and extent of bioremediation of soil containing crude oil or heavy refined petroleum products by treatment cell bioventing at field spill sites. The first step of the project will be to locate a field site suitable for research studies. The contaminated material will be excavated and transferred to a forced aeration soil pile constructed on site. Kinetics information on depletion will be determined and compared with laboratory data. A Final Report of research activities will be completed.

Laser Fluorescence EEM Probe for Cone Penetrometer Pollution Analysis

INSTITUTE: Tufts University
(Bob Lien, P.O.)

TASK NO: 3076

PROJECT PERIOD: 10/93 09/96

PRINCIPAL INVESTIGATOR: J. Kenny (617) 627-3397

ABSTRACT: Locating and mapping the distribution of oily phase material in the subsurface is one of the most difficult and uncertain processes in the Remedial Investigation process at hazardous waste sites. Traditional methods using hollow stem auger rigs and core samples are much too expensive for extensive mapping of wastes. Monitoring wells often fail to detect oily phase material. Recently, multi-sensor cone penetrometers have been developed for hazardous waste characterization. Existing proof-of-concept cone penetration sensor modules have been developed that introduce a fiber optic cable into the subsurface with the cone penetrometer. Lasar light beamed down the fiber optic cable illuminates the subsurface material adjacent to the cone through a sapphire window. Certain oily wastes, such as TCE and naphthalene, will fluoresce. The fiber optic cable collects the fluorescence and brings it back to the surface for analysis by a spectrophotometer. Existing equipment is specific on one type of waste. This project will develop and field test a Raman shifter that will allow multiple channel spectral analysis of the returned fluorescence. This will allow for the simultaneous analysis of several compounds (up to ten) with different fluorescence responses. The following outputs will be produced: A user's manual for the new sensor system and a final report, describing the field scale performance of the new sensor system during characterization of oily waste at a hazardous waste site.

Stable Isotope Evaluation of Soil Metal Speciation by Selective Extraction

INSTITUTE: U.S. Army Corps of Engineers
Waterways Experiment Station
(Robert Puls, P.O.)

TASK NO: 3084

PROJECT PERIOD: 09/93 09/94

PRINCIPAL INVESTIGATOR: M. Bricka (601) 634-3799

ABSTRACT: Reliable, validated methods to discriminate between forms of metals in soil would be extremely valuable for assessing hazards of metals contaminated sites and evaluating alternatives for soil remediation. Extraction methods for isolating metals associated with various soil components have been used for many years to make decisions on soil nutritional status, toxicity, and environmental mobility. Unfortunately, very little definitive work has been performed to ascertain the validity and shortcomings of these extraction techniques. Stable isotope studies on model and amended natural soils offer a tool to investigate the selectivity and completeness of selective extraction techniques, and thus evaluate the usefulness of extraction in metal speciation/contaminated soil characterization. Inductively coupled plasma/mass spectrometry (ICP/MS) provides the analytical selectivity and sensitivity needed to effectively conduct the isotope studies. The proposed work would combine the analytical advantages of ICP/MS with metal stable isotope experimentation to evaluate and improve the usefulness of soil extraction procedures for metals speciation. A Final Report on Stable Isotope Evaluation of Soil Metal Speciation by Selective Extraction will be prepared.

Capture Zone Delineation in a Fractured Carbonate Aquifer

INSTITUTE: Undecided

TASK NO: 0384-001

PROJECT PERIOD: Proposal

PRINCIPAL INVESTIGATOR:

ABSTRACT: The objective of this task is to examine the capture zone of a pumping well in a carbonate aquifer. The project will integrate computer modeling with field observations. The field component will be broadly multidisciplinary including remote sensing, surface and borehole geophysics, and aquifer testing. The modeling component will emphasize both conceptual modeling and code development and application.

Characterization of the Test Site at Hill AFB for the Demonstration of Enhanced Source Removal for Aquifer Restoration

INSTITUTE: Tyndall AFB
(Carl Enfield, P.O.)

TASK NO. 0935-003

PROJECT PERIOD: 04/94 - 09/94

PRINCIPAL INVESTIGATOR: Capt. Jeffrey Stinson (904) 283-6254

ABSTRACT: An essential part of any aquifer remediation project is a site characterization that provides the information necessary to select, design, operate, and evaluate an appropriate remedial technology. Before the field demonstrations can be conducted, the test site must likewise be thoroughly characterized. Site characterization will involve the use of ground-penetrating radar, cone penetrometer, fiber optic spectroscopy, and possibly seismic techniques. The entire project will involve two different test sites to determine the feasibility of a number of technologies to enhance the performance of pump-and-treat systems. The first test site will be at Hill AFB, the second has yet to be determined.

Implications of Colloidal Mobility for the Collection of Representative Ground Water Samples

INSTITUTE: Cooperative Agreement

TASK NO: 0940-001

PROJECT PERIOD: Proposal

PRINCIPAL INVESTIGATOR:

ABSTRACT: The objective of this project is address the implications of colloidal mobility on the collection of ground water samples. The research would address factors such as the effects of low-flow purging and sampling techniques on sample quality, filtration effects, sampling methodologies in fractured rock, and sampling methodologies in tight formations. This project will complement ongoing in-house research at RSKERL. The investigation will result in a Project Report and Research Brief.

Mobilization of Naturally Occurring Heavy Metals by Reductive Dissolution

INSTITUTE: Cooperative Agreement

TASK NO: 0940-002

PROJECT PERIOD: Proposal

PRINCIPAL INVESTIGATOR:

ABSTRACT: The objective of this project will be to investigate those specific geochemical factors that promote surface chemical reactions that mobilize naturally occurring arsenic and other heavy metals at waste disposal sites. The approach will be largely laboratory based and will be coordinated with work at field sites where this phenomenon has been observed.

Ground Water Sampling

INSTITUTE: RSKERL

TASK NO: 0940-RSRP5

PROJECT PERIOD: 01/94 - 06/96

PRINCIPAL INVESTIGATOR: Robert Puls (405) 436-8543

ABSTRACT: The objective of this project is determine the impacts of different sampling methodologies and devices on contaminant concentrations in recovered ground-water samples. The approach will be to conduct field and laboratory studies to compare different sampling devices as well as different sampling methodologies. The investigation will result in a Project Report and a Research Brief.

Evaluation of Methods of DNAPL Site Characterization

INSTITUTE: Cooperative Agreement

TASK NO: 0946-005

PROJECT PERIOD: Proposal

PRINCIPAL INVESTIGATOR:

ABSTRACT: The objective of this project is to evaluate innovative direct and indirect methods that have been proposed or recently developed to characterize hazardous waste sites contaminated by DNAPLs. A Project Report or Research Brief, and an Issue Paper will be prepared.

Site Characterization Using a Cone Penetrometer

INSTITUTE: RSKERL

TASK NO: 0946-RSBL1

PROJECT Period: 08/93 09/95

Principal INVESTIGATOR: Bob Lien (405) 436-8555

ABSTRACT: The objective of this project is to develop methods and techniques for site characterization at hazardous waste sites using a cone penetrometer testing system. The development of methodology for site characterization will involve: (1) literature reviews, (2) basic cone penetrometer testing at local field site, (3) development of a site characterization strategy, (4) development and integration of innovative sensor modules, (5) upgrading of data acquisition systems, and (6) proof-of-concept field testing of an innovative cone penetrometer system at hazardous waste sites.

Dielectric and Resistivity Method for Detecting Nonaqueous-Phase Liquid Contaminants in Multiphase Systems

INSTITUTE: RSKERL

TASK NO: 0946-RSBL2

PROJECT PERIOD: 10/93 09/96

PRINCIPAL INVESTIGATOR: Bob Lien (405) 436-8555

ABSTRACT: The objective of this project is to investigate the feasibility of applying dielectric and resistivity methods to detection of nonaqueous phase liquid (NAPL) contamination at hazardous waste sites. The feasibility of using dielectric and resistivity methods for detecting NAPL contamination will be evaluated in both laboratory and field experiments. Laboratory column studies will be used to determine the feasibility and sensitivity of dielectric and resistivity methods. If these prove successful, the next step will be to construct probes that can be used with a cone penetrometer and test them in the field.

Environmental Buffer Criteria for the Assessment of Soil Quality in Agroecosystems

INSTITUTE: USDA
(Michael Jawson, P.O.)

TASK NO: 3190-001

PROJECT PERIOD: Proposal

PRINCIPAL INVESTIGATOR:

ABSTRACT: Soil, because of its position at the interface between air and water as well as its function in altering the composition and availability of air and water, is crucial to ecosystem well being. Soil is the basic resource necessary for sustainable agricultural systems, purifying water and support of terrestrial life. One of the major functions of soil is as an environmental buffer. This function is especially important in agroecosystems because of the intentional releases and stresses from agrichemicals. This recognition of the importance of soil in an ecosystem context is unfortunately quite recent and although implicitly recognized throughout the ages in terms of crop production it is not until recently (within the last 2 years) the concept and term "soil quality" has received attention of the soil science community. Criteria and methods to quantify soil quality are just beginning. This task is focused on determining the criteria important to the environmental buffer component of soil quality and will be tied into efforts where the sustainable agriculture component is being conducted. The research will result in a journal article on environmental buffer criteria for soil quality indexes and a report that assesses soil quality from an ecological effects view point.

Subsurface Ecology

INSTITUTE: RSKERL

TASK NO: 3190-RPMJ3

PROJECT PERIOD: 01/94 06/94

PRINCIPAL INVESTIGATOR: Michael Jawson (405) 436-8560

ABSTRACT: Determining ecological effects is a foremost scientific priority of EPA. The subsurface, considered here to extend from the soil surface through the saturated zone, is a basic component of the global ecosystem. Unfortunately, despite the essential roles played by subsurface ecosystems, it is the least characterized, quantified and appreciated component of the ecosystem. Despite our lack of knowledge of this environment, the subsurface receives more waste and contaminants annually by weight than any other medium. Life as we know it would not be possible without the biogeochemical cycling and other functions performed by subsurface microorganisms, yet only 5% of the earth's microbial species are known. Determining ecosystem risk will not be possible until the characteristics and activities of the subsurface component are quantified. This project is focused on the following two themes: (1) quantification of transformations within the subsurface and of the fluxes of materials to other ecosystem components; and (2) characterization of the subsurface ecosystem including the development of ecocriteria. Needed is an understanding of the subsurface components, both biotic and abiotic, and their interrelationships. Lack of knowledge about the structure and diversity of the subsurface has two important impacts. First, we do not have bioindicators (ecocriteria) of environmental stress in the subsurface and, therefore, must depend upon direct contaminant detection - a trying task given the physical, spatial and temporal obstacles. Secondly, modeling the processes and predicting risks is quite limited without an understanding of subsurface communities, their geo-physical and chemical environment, and their interactions with the other components of the ecosystem. A journal article on the importance of the subsurface in ecosystem analyses will be prepared as well as a report for the MASTER program that provides an assessment of subsurface (soil) quality at the Walnut Creek, Iowa MSEA site.

Geohydrology and Nitrate Loadings of the Ground-Water Systems Impacting the Chesapeake Bay

INSTITUTE: RSKERL

TASK NO: 3192-RSSK4

PROJECT PERIOD: 11/93 09/96

PRINCIPAL INVESTIGATOR: Steve Kraemer (405) 436-8549

ABSTRACT: The objective of this RSKERL in-house research project is to develop understanding of the hydrologic interactions between Atlantic Coastal Plain aquifers and the Chesapeake Bay and its tidal and non-tidal rivers, and use this understanding to estimate the potential loadings of nitrate via ground-water pathways. Computer models are being built to represent the shallow geohydrologic systems at the ground-water shed and drainage basin scales. A mass balance for nitrate will be estimated using the modeling approach. This research is being performed in collaboration with the USGS (Towson,MD) through Interagency Agreement. A USEPA Project Summary and Research Report on the Geohydrology and Nitrate Loadings of the Ground Water Systems Impacting the Chesapeake Bay will be prepared.

Site Characterization Using a Hydraulically Driven Soil Gas and Ground-Water Probe

INSTITUTE: RSKERL

TASK NO: 3364-RPDK2

PROJECT PERIOD: 10/92 12/95

PRINCIPAL INVESTIGATOR: Don Kampbell (405) 436-8561

ABSTRACT: Most conventional site characterization is two dimensional, while the distribution of contamination in aquifers is strongly three dimensional. New tools are needed that allow vertical characterization of the extent of contamination. This task will evaluate the Geoprobe, a new tool on the market that can rapidly and economically sample soil gas, ground water, and sediments from shallow unconsolidated aquifers. The tool also allows a measure of the local hydraulic or pneumatic conductivity at the depth interval that produces a sample. Field work will be conducted as an in-house research project by EPA staff. The following outputs will be produced, including: Text and slides for a training course on the use of a Geoprobe for site characterization and a journal article describing the use of the Geoprobe to determine the fluid flow properties of the subsurface.

CONTAMINANT TRANSPORT AND TRANSFORMATION

Research is aimed at describing the hydrologic, abiotic, and biotic processes which influence contaminant transport and transformation characteristics in the subsurface environment. A knowledge of subsurface transport and transformation processes is the foundation for all environmental protection activities related to the subsurface. The more commonly occurring processes are reasonably well understood, but predictions can only be made with reasonable certainty for simple hydrogeologic systems and dissolved contaminants. The knowledge of many other transport and transformation processes is emerging from laboratory and small-scale preliminary field experiments, but is not yet at a point where it can be generalized for routine application to remediation or prevention activities. Examples include facilitated colloidal transport, contaminant transport in complex wastes, gas-phase transport and transformation, subsurface transport of microorganisms, the interaction of separate processes, and natural degradation.

Separation and Identification of Aquifer Organic Matter

INSTITUTE:	RSKERL/ManTech (Candida West/Roger Cosby, P.O.)	
TASK NO:	1051	
PROJECT PERIOD:	03/90 10/94	
PRINCIPAL INVESTIGATOR:	Bill Lyon	(405) 436-8666

ABSTRACT: The objects of this project are to: (1) test density methods for separation of aquifer organic matter from sandy aquifer material; (2) scale-up the process to obtain sufficient material for bulk measurements; (3) obtain pyrolysis-GC/MS patterns for comparison to soil organic matter; (4) obtain IR and elemental analysis of the aquifer organic matter; and, (5) apply techniques to analyze the pyrolysis and IR data. The purpose of the project is to obtain analytical data that can be used to study the basic characteristics of aquifer organic matter in order to: (1) determine the validity of the normalization of sorption coefficients by total organic carbon for aquifer organic matter; and, (2) compare the variability in composition of aquifer organic matter to soil organic matter. Milestones include progress reports on GC-Pyrolysis and IR/Elemental Analysis. A final internal report will be prepared on the Separation and Identification of Aquifer Organic Matter.

Characterization of Organic Matter in Soils and Aquifer Solids

INSTITUTE: Western Michigan University
(Candida West, P.O.)

TASK NO: 1053

PROJECT PERIOD: 03/91 03/94

PRINCIPAL INVESTIGATOR: Michael Barcelona (616) 387-5501

ABSTRACT: The overall goals of the project are to develop and test a systematic methodology to characterize the organic matter in subsurface soil and aquifer solids. The methodology should provide a means to identify and quantify natural and anthropogenic organic matter in solid materials. A characterization methodology will be developed using TOC/TIC analyses, carbon isotopic methods to determine relative amounts of natural and anthropogenic organic compounds, and extraction techniques to determine sorbed, bound, and occluded fractions and the identification of specific organic compounds. In addition to interim reports, a final report will be prepared on Characterization of Organic Matter in Soils and Aquifer Material.

Assimilative Capacity of Subsurface for the Pesticides Atrazine, Alachlor, and Nitrate

INSTITUTE: USDA/National Soil Tilth Laboratory
(Michael Jawson, P.O.)

TASK NO: 1069

PROJECT PERIOD: 08/92 0/95

PRINCIPAL INVESTIGATOR: Thomas Moorman (515) 294-2308

ABSTRACT: Sites in Iowa, Minnesota, Missouri, Nebraska, and Ohio will be utilized to: (1) quantify the fate of atrazine and alachlor including their principal metabolites; (2) determine the kinetics of degradation or immobilization processes for atrazine and alachlor, and (3) determine if reliable indexes of assimilative capacity can be identified or developed. An integrated mass balance approach is being used to determine the fate of the herbicides. Measurements of parent compounds provided data on the amount of readily extractable and presumably available and/or leachable unaltered pesticide. The measurement of principal metabolites will supply data on the extent transformation proceeds to these intermediate stages. The measurement of $^{14}CO_2$ provides an indication of the amount of mineralization of the parent compound while the residual ^{14}C provides information on the amount of compound bound to surfaces and organic matter and presumably unavailable to microorganisms or leaching.

The Iowa Walnut Creek watershed will be used to: (1) determine the denitrification potential in the intermediate vadose zone, and (2) determine the denitrification activity in the upper reaches of the water table, and evaluate the source of the electron donors for this process. A series of incubation treatments and nitrate amendments will be used to determine factors limiting denitrification. Investigations will also be carried out to determine the magnitude of denitrification and the electron donor involved in the process.

Spectroscopic Studies of Organic Films on Mineral Surfaces

INSTITUTE:	RSKERL/ManTech (Candida West/Roger Cosby, P.O.)	
TASK NO:	1078	
PROJECT PERIOD:	01/91 09/94	
PRINCIPAL INVESTIGATOR:	Bill Lyon	(405) 436-8666

ABSTRACT: The project is designed to expand the current understanding of natural and anthropogenic organic carbon coatings on aquifer solid matrices and their capacity to retard the movement of organic contaminants in the subsurface. Artificial and natural coatings of humic and other organic materials will be characterized and studied spectroscopically. Sorption experiments will be conducted.

Augmenting Natural Recharge of Ground Water with Reclaimed Wastewater, Stormwater, and Irrigation Return Flow

INSTITUTE:	National Academy of Sciences (Carl Enfield, P.O.)	
TASK NO:	1083	
PROJECT PERIOD:	10/93 - 08/94	
PRINCIPAL INVESTIGATOR:	C. Elfring	(202) 334-3422

ABSTRACT: The objective of this project is to have an expert panel assess the current state of knowledge relative to the use of reclaimed wastewater, storm water, and irrigation return flows to augment natural recharge of ground waster.

Three-Dimensional Modeling of Subsurface Flow, and Fate and Transport of Microbes and Chemicals

INSTITUTE: Penn State University
(Thomas Short, P.O.)

TASK NO: 2055

PROJECT PERIOD: 10/91 10/94

PRINCIPAL INVESTIGATOR: George Yeh (814) 863-2931

ABSTRACT: The objectives of this project are to develop a three-dimensional numerical algorithm for the solution of the saturated-unsaturated transport equations for multiple components that undergo mutual reactions based on the LEZOOM approach and to analyze test data produced from physical model aquifers at RSKERL. A mathematical code will be developed which is capable of simulating experimental runs on RSKERL physical model aquifers. The results produced by the code will be compared with experimental data to determine if the proposed mathematical description of the mechanisms involved is adequate. A report with the same title as the project will be prepared.

Validation of the Approximate Multiphase Flow Models

INSTITUTE: RSKERL

TASK NO: 2059

PROJECT PERIOD: 09/91 10/94

PRINCIPAL INVESTIGATOR: James Weaver (405) 436-8545

ABSTRACT: The object of the project is to test the KOPT (Kinematic Oily Pollutant Transport) portion of the HSSM (Hydrocarbon Spill Simulation Model) by comparison with laboratory data. Several oils will be released into specially designed columns which are packed with various porous media. The ponding depth and depth of the oil front will be recorded as functions of time. Independent measurements of the model parameters will be made on the column. The average values of the parameters will be used as KOPT model input data. The model results will be compared with the laboratory data experiments. Monte Carlo simulation will be used to assess the impact of uncertainty in the values of the parameters.

Heavy Metal Transport in a Sand and Gravel Aquifer with Variable Chemical Conditions

INSTITUTE: U.S. Geological Survey

TASK NO: 2075

PROJECT PERIOD: 07/92 06/95

PRINCIPAL INVESTIGATOR: James Davis FTS: 459-4484

ABSTRACT: The objectives of the work are to obtain a more complete understanding of the geochemical processes that effect metal transport in ground water and the mechanisms that couple these processes with hydrologic processes. A large-scale tracer test will be conducted at the Otis Air Force Base USGS Field Site on Cape Cod in Massachusetts. This will be the first such large-scale tracer test performed using conservative and conservatively transported metal contaminants in such a highly instrumented field site. The large-scale tracer test will exploit the vertical gradient in ground-water chemistry at the site to study transport under variable chemical conditions. Prior small-scale tracer tests and related laboratory experiments will be analyzed to determine the exact composition of the tracer injections to achieve the stated objectives. Following the injection, subsequent sampling and data interpretation will follow for more than 14 months. Reactive transport modeling of the test will then be initiated. Products of the investigation will include a journal article describing the transport of chromium (VI), a journal article describing the transport of copper and zinc, and a final environmental research brief.

Transport and Transformation of Arsenic and Chromium in Ground Water

INSTITUTE: RSKERL

TASK NO: 2082

PROJECT PERIOD: 12/93 12/96

PRINCIPAL INVESTIGATOR: Robert Puls (405) 405-8543

ABSTRACT: The objective of this project is to determine the chemical and microbiological factors controlling arsenic and chromium transport and transformation on subsurface environments. Data will be collected in laboratory experiments using core material from hazardous waste sites where elevated levels of arsenic and chromium are observed to elucidate the processes responsible for their mobilization and transport. A journal article will completed at the end of the project.

Compilation of Saturated/Unsaturated Zone Models and Development and Application of Testing Methods and Benchmark Cases

INSTITUTE: Colorado School of Mines
(James McNabb, P.O.)

TASK NO: 3038

PROJECT PERIOD: 10/91 - 09/94

PRINCIPAL INVESTIGATOR: Paul van der Heijde (303) 273-3800

ABSTRACT: The objectives of this project are to enhance the existing knowledge of ground-water models and their utility and performance, develop guidance in applying quality assurance in model development, and address other scientific issues related to the use of ground-water models. The approach to carrying out this project will be: (1) to enhance existing data bases on ground-water models, (2) characterize and analyze models for their utility and performance, (3) develop and apply testing and validation procedures to prominent public domain models, (4) develop and provide detailed guidance in the development of models, and (5) develop issue papers on critical topics in ground-water modeling. A Report on Analytical Solutions will be prepared along with a Report on the Status of Ground-Water Models.

Subsurface Processes Controlling Sorption and Transport of Ionizable and Polar Organic Compounds

INSTITUTE: University of Florida
(Susan Mravik, P.O.)

TASK NO: 3083

PROJECT PERIOD: 10/93 09/96

PRINCIPAL INVESTIGATOR: P. Nkedi-Kizza (904) 392-1951

ABSTRACT: The objective of this project is to collect data on the mechanisms for the sorption of polar and ionizable organic compounds to subsurface materials. These data will be used to develop mechanistic models of the sorption process which can be used in subsurface transport and fate models. Batch and column studies will be used to provide data on both the extent and kinetics of the sorption process.

Use of the Assimilative Capacity Concept to Develop Agrichemical Usage Guidance and Determine the Fate of Atrazine in a Wet Meadow in the Central Platte Valley Alluvium of Nebraska

INSTITUTE: Nebraska Department of Environmental Quality (Michael Jawson, P.O.)

TASK NO: 5002

PROJECT PERIOD: 10/93 - 09/95

PRINCIPAL INVESTIGATOR: D. Jenson (402) 471-4700

ABSTRACT: This project supports two of Region VII's strategic directions for FY93-96: (1) Pesticide and Nitrate Risk Reduction and (2) Ecosystem Assessment and Protection (the Platte River Ecosystem Management Initiative). It also implements EPA's strategic themes of improved science/data, pollution prevention, and geographic targeting on an ecosystem basis. This project has two major objectives: (1) to study the transport and fate of atrazine in ground water through a selected wet-meadow area in the central Platte valley of Nebraska and (2) to develop decision aids to guide agrichemical usage which take into account the environment's assimilative capacity. A set-meadow area within the Kearney-to-Grand Island reach of the Platte valley will be selected for study. The wet meadow will be immediately downgradient from rowcrop-production land on which atrazine (and probably other chemicals) has been applied. Although data from adjacent areas likely will be useful, the primary study area will be an elongate area on the order of 0.5 mile along a ground-water flow path. A network of observation-well nests will be installed, for which water-level and water-quality data will be obtained to define spatial variations and seasonal and shorter-term temporal variations. The network will consist of about eight nests of two wells each. Age-dating and tracer techniques will be used to help determine flow patterns and velocities. Chemical parameters measured in the field will be temperature, specific conductance, pH, and dissolved oxygen. An immunoassay method will be used on all samples to determine atrazine and associated compounds semiquantitatively: GC-MS and complete inorganic chemical analyses will be conducted on selected samples. In addition, agrichemical usage guidance based upon assimilative capacity will be developed by the University of Nebraska-Lincoln Agronomy Department. Using an expert systems type of approach, the known effects of environmental parameters (such as pH, temperature, clay, and organic matter content) on agrichemical dissipation and transformation will be used to develop the decision aids for application levels of agrichemicals taking into account the amount of attenuation that occurs between the application point and the receptor locations (e.g., the water resources of the Platte Basin the Platte River, wetlands, and ground water). Outputs will include a Report and journal article on the fate of atrazine in wetlands and a Guidance document (e.g., decision aid fact sheet) and report on agrichemical use which will protect ground and surface waters.

Subsurface Transport Properties in Layered Media

INSTITUTE: RSKERL

TASK NO: 0932-1001

PROJECT PERIOD: Proposal

PRINCIPAL INVESTIGATOR:

ABSTRACT: The objective of this project is to conduct laboratory experiments to elucidate subsurface transport properties that result from the strong horizontal layering that is commonly found in natural geologic environments. This project will coordinate in-house EPA research and work with an extramural organization.

Laboratory Electronic Measurements and Data Collection Systems for RSKERL Artificial Aquifers

INSTITUTE: RSKERL/ManTech

TASK NO: 0946-1003

PROJECT PERIOD: Proposal

PRINCIPAL INVESTIGATOR:

ABSTRACT: The objective of this project is to design, assemble, install, and evaluate measurement systems that can be used to collect electromagnetic tomography and time domain reflectometry systems data for the movement of nonaqueous-phase liquids (NAPLs) in RSKERL's large physical models.

Transformation of Pesticides

INSTITUTE: RSKERL

TASK NO: 3191-RPMJ2

PROJECT PERIOD: 01/94 12/95

PRINCIPAL INVESTIGATOR: Michael Jawson (405) 436-8560

ABSTRACT: The objective of this task is to tie together RSKERL's pesticide projects to ascertain the comprehensive fate of pesticides in relationship to their vertical environment (surface soil, vadose zone and saturated zone) across an extensive (mid continent) area. This should also enable predictions to be made as to the transfer of the pesticides to other environmental media. When the results from all the studies in this project are available, the data will be analyzed to discern the "big picture" in terms of which factor determines the fate and assimilative capacity of the pesticides studied. Appropriate statistical and other data analysis approaches will be utilized after consultation with statisticians and QA specialists to resolve the comprehensive fate of these pesticides. The work will result in a report, journal articles, and decision support systems on the environmentally acceptable usage of pesticides.

Biodegradation of Pesticides in Aquifers

INSTITUTE: RSKERL/ManTech

TASK NO: 3191-RE104

PROJECT PERIOD: Proposal

PRINCIPAL INVESTIGATOR:

ABSTRACT: It is well established that the rate of biodegradation of xenobiotic organic substances decreases below the root zone. Relatively little work has been done on the fate of pesticides in the subsurface, however. Available studies have indicated that the rate of pesticide biodegradation also declines with depth. The objectives of this project are to determine if pesticide biodegradation occurs in the subsurface, at what rate, and what the products of the biodegradation are. These experiments are being carried out in sediments from several sites. Site specific differences as well as the history of pesticide application and other factors may affect the rate of pesticide biodegradation. Atrazine is only one of several pesticide contaminants of ground water, and its behavior in subsurface samples may differ from that of other pesticides. To find out how other pesticides besides atrazine biodegrade in subsurface samples, several known pesticide contaminants of ground water were selected for pesticide experiments. A journal article and report on the fate of pesticides in aquifer materials will be prepared.

SUBSURFACE REMEDIATION

In addition to developing technologies which protect and restore the subsurface environment, research in this area must assure that such methods are cost effective without being unnecessarily complex, and do not unduly resrtict other land use activities.

Anaerobic Processes in the Subsurface Environment

INSTITUTE:	RSKERL	
TASK NO:	1041	
PROJECT PERIOD:	03/89 10/95	
PRINCIPAL INVESTIGATOR:	Guy Sewell	(405) 436-8566

ABSTRACT: Anaerobic conditions predominate in contaminated aquifers and are common in uncontaminated areas. Comparatively little is known about degradative processes and nutrient cycling under anaerobic conditions. However, it is apparent that these processes are fundamentally different and more complex than aerobic processes. The objective of this research is to define and study anaerobic microbial metabolic processes which occur in the subsurface environment to further understand the fate of contaminants in that environment.

Three areas will be investigated using microbiological, biochemical, and molecular biological techniques, with emphasis in three major areas:

1. Metabolism of aromatic compounds under sulfate reducing conditions. In this study the breakdown and metabolism of fuel aromatics (primarily benzene, toluene, and xylenes) by sulfate-reducing isolates and consortia will be examined.

2. Metabolic processes at the aerobic/anaerobic interface. The role of mixed aerobic/anaerobic conditions on the metabolism of organic compounds is unclear. An attempt will be made to identify and spatially locate the processes and microbes which exist at and near the interface.

3. Effects of altered oxidation/reduction balance on anaerobic metabolism. Anaerobic chemoheterotrophs generate useable metabolic energy (ATP or electro-chemical gradients) from oxidizable substrates via fermentation or anaerobic respiration. Alterations in the O/R balance of these organisms may broaden the range of electron donors and acceptors.

Project outputs to date include an Article on Reductive Dechlorination of Tetrachloroethane and Trichloroethane in Fuel Spill Plumes, and a Journal Article on Reductive Dechlorination. A journal article is under way on Anaerobic Degradation.

Surfactant Enhanced Solubilization of Chlorinated Hydrocarbons

INSTITUTE: RSKERL

TASK NO: 1068

PROJECT PERIOD: 02/91 - 09/94

PRINCIPAL INVESTIGATOR: Candida West (405) 436-8551

ABSTRACT: The objective of the investigation is to examine interactions between chlorinated solvents and non-ionic surfactants in solution with emphasis being on determining the fundamental relationship between contaminant water solubility and structures on contaminant solubilization. Initial, batch sorption experiments will be conducted to determine solubilization of PCE, TCE, and DCE by selected surfactants. After single solute systems are completed a series of experiments will then be carried out to determine the effect of multiple solutes and temperatures on the solubilization of the solutes by the same series of surfactants.

Field-Evaluation of Cosolvent-Enhanced In-situ Remediation

INSTITUTE: University of Florida
(Lynn Wood, P.O.)

TASK NO. 1086

PROJECT PERIOD: 10/93 10/95

PRINCIPAL INVESTIGATOR: M. Annable (904) 392-3294

ABSTRACT: The objective of this project is to evaluate the feasibility of using miscible organic cosolvents such as alcohols to remediate subsurface environments contaminated by hydrophobic organic chemicals. The project will be carried out as a pilot-scale field study using sheet piling cells to provide hydraulic containment. A Report on the Feasibility of using Organic Cosolvents to Enhance Removal of Hydrophobic Organic Compounds will be prepared.

Development of a Data Evaluation/Decision Support System for Bioremediation of Subsurface Contamination

INSTITUTE: Rice University
(Mary Randolph, P.O.)

TASK NO. 1087

PROJECT PERIOD: 10/93 09/96

PRINCIPAL INVESTIGATOR: P. Bedient (713) 527-4953

ABSTRACT: Develop a computer based system which will accept both "hard" and "soft" data, in three-spatial dimensions plus time and allow interpretation into a conceptual model(s) of the hydrogeologic environment. It is desirable to be able to display graphically the confidence in the conceptual model(s) based on sound statistical techniques. Visualization of the conceptual model(s) will be on a platform. A Data Evaluation/Decision Support System for Bioremediation of Subsurface Contamination will be developed.

Assessment of Solvent-Enhanced Desorption and Mobilization of Polychlorinated Biphenyls

INSTITUTE: RSKERL

TASK NO: 2062

PROJECT PERIOD: 02/91 09/94

PRINCIPAL INVESTIGATOR: Lynn Wood (405) 436-8552
Susan Mravik (405) 436-8553

ABSTRACT: The objectives of this project are to assess the efficacy of solvent mixtures for desorbing and mobilizing polychlorinated biphenyls (PCBs) in contaminated soils and aquifer materials and to formulate a strategy for optimizing contaminant mobilization in laboratory systems. Soils and aquifer materials contaminated with PCBs will be obtained from appropriate field sites. Selected batch equilibration tests will be conducted as a screening tool to determine equilibrium distribution constants for various cosolvent mixtures and to assist in the selection of appropriate column experiments. Dynamic column experiments will be the primary technique used to evaluate solvent-mediated desorption and mobilization. These experiments will be used to determine cosolvency parameters for solvent/solute/sorbent systems used in the study, to assess the impact of nonequilibrium sorption on PCB removal, and to evaluate the effects of solvents on the inherent sorptive and hydrodynamic properties of the sorbents. If initial laboratory results are promising, and if support and funding are available, this technique will be evaluated in larger and more realistic systems in the laboratory or field. A Journal Article Describing the Experimental Procedures and Initial Results of Solvent Enhanced Desorption of PCBs will be written. This will be followed at the end of the project by a Journal Article on the Impact of Solvents on the Rate of PCB Desorption.

Rapid Phase Identification of Mixed Crystalline Solids Using Surface Analytical Techniques for Assessment of In-Situ Aquifer Remediation

INSTITUTE: Oregon Graduate Institute
(Bob Puls, P.O.)

TASK NO: 2066

PROJECT PERIOD: 07/92 02/94

PRINCIPAL INVESTIGATOR: Carl Palmer (503) 690-1977

ABSTRACT: The objective of this investigation is to develop computer software techniques at metal sites for scanning tunneling microscopy with x-ray analysis for rapid and routine use as a site characterization and aquifer remediation assessment tool.

Decision Support System for Evaluating Remediation Performance with Interactive Pump-and-Treat Simulator

INSTITUTE:	Rice University (David Burden/Dick Scalf, P.O.)	
TASK NO:	2069	
PROJECT PERIOD:	09/92 09/94	
PRINCIPAL INVESTIGATOR:	Philip Bedient	(713) 527-4953

ABSTRACT: The goal of the project is to develop a Decision Support System (DSS) for evaluating the effectiveness of pump-and-treat networks at Superfund sites. The approach is divided into two phases. Phase I focuses on developing the architecture and the different components of the DSS utilizing the OASIS system computing environment. Phase II involves porting the DSS into the PC environment. Extensive research and evaluation of programming tools will be completed in Phase I to ensure that portability can be successfully implemented in Phase II. An interim DSS report will be completed in late 1993 and the final DSS delivery will be completed approximately one year later.

Modeling and Design of Bioremediation Systems for a JP-4 Jet Fuel Spill at Eglin AFB, Florida

INSTITUTE:	Rice University (James McNabb/Stephen Hutchins, P.O.)	
TASK NO:	2073	
PROJECT PERIOD:	11/92 11/95	
PRINCIPAL INVESTIGATOR:	Herb Ward	(713) 527-4086
	Philip Bedient	(713) 527-4953

ABSTRACT: The objective of the project is to use site characterization and modeling to provide design for bioremediation systems to be used in field demonstration project "Nitrate-Based Bioremediation, Eglin Air Force Base." Cone penetrometery, aquifer tests, and infiltration tests will be conducted at the Eglin AFB to obtain physical and chemical information on the aquifer. This information will be used in modeling to design a spray irrigation/recirculation system for nitrate-based bioremediation treatment for iron precipitation. An interim nitrate-based bioremediation design report will be prepared followed by the final evaluation/corrective measures design in October 1994.

Studies on the Sulfur Mediated Biological Denitrification Process

INSTITUTE:	Orange County Water District (Stephen Hutchins, P.O.)	
TASK NO:	2074	
PROJECT PERIOD:	10/92 - 09/94	
PRINCIPAL INVESTIGATOR:	Mike Davidson	(714) 963-5661

ABSTRACT: The objective of the project is to conduct studies on denitrification with autotrophic microorganisms which use inorganic sulfur as an energy source, and to incorporate these process parameters into a reactor design for treatment of nitrate-contaminated ground water. Batch tests will be conducted to delineate basic process control parameters and reaction kinetics, and column studies will be conducted to evaluate reactor design and systems performance. If time permits, a laboratory-scale, complete treatment unit incorporating biological process and ion exchange will be constructed to test the treatment strategy and provide data for economic assessment. A final report on the feasibility of this treatment train will be prepared.

Innovative Methods for Remediation of Subsurface Chromium Contamination

INSTITUTE:	Rice University and University of Oklahoma (James McNabb, Robert Puls, P.O.)	
TASK NO:	2079	
PROJECT PERIOD:	09/72 08/95	
PRINCIPAL INVESTIGATOR:	Herb Ward David Sabatini	(713) 527-4086 (405) 325-5911

ABSTRACT: The project is designed to determine an optimal system that will significantly enhance the remediation of subsurface environments contaminated with chromium. Laboratory batch and column tests will be used along with some field testing to assess chromium desorption from soils and sediments and chromate recovery from contaminated ground water.

Microbial Characterization and Treatability Study for a JP-4 Jet Fuel Spill at Eglin AFB, Florida

INSTITUTE:	Rice University (Stephen Hutchins, P.O.)	
TASK NO:	2080	
PROJECT PERIOD:	11/92 11/95	
PRINCIPAL INVESTIGATOR:	Herb Ward J.M. Thomas	(713) 527-4086

ABSTRACT: The objective of the project is to conduct treatability studies to evaluate and optimize the remedial design and to determine the effects of nitrate-based bioremediation on the microbial ecology of subsurface material contaminated with JP-4 jet fuel. RSKERL will conduct an in-depth laboratory treatability study to determine the feasibility of using nitrate-based bioremediation for aquifer restoration at Eglin AFB, FL. Rate constants will be used to design the remediation system. Rice University will conduct microbial characterization during the project to assess changes in microbial ecology and ecotoxicity once remediation is complete. The treatability studies will be completed in June 1994, and the final project report will be issued in July 1995.

Great Plains-Rocky Mountain Hazardous Substance Research Center, U. of Iowa

INSTITUTE:	University of Iowa (John Wilson, P.O.)	
TASK NO.	2084	
PROJECT PERIOD:	10/93 05/94	
PRINCIPAL INVESTIGATOR:	L. Erickson	(913) 532-5584

ABSTRACT: The objectives of the proposed research include the following: (1) to determine the effect of redox conditions (electron acceptor) on transformation of CT; (2) to identify pathways and metabolites of CT transformation; (3) to investigate the abiotic degradation of CT under reduced conditions; and (4) to determine the effect of CT concentration on transformation of CT. A progress report on modeling development will be developed.

Response of Subsurface Microbial Communities to the Introduction of Contaminants

INSTITUTE:	Cooperative Agreement (Guy Sewell, P.O.)
TASK NO.	2085
PROJECT PERIOD:	09/95 09/96
PRINCIPAL INVESTIGATOR:	Undecided

ABSTRACT: The introduction of soluble contaminants into ground water initiates a series of complex and poorly understood responses by subsurface microorganisms. Field and laboratory research suggests that multiple, physiologically-defined-communities develop which are spatially and chronologically separate. These communities are most likely ecologically defined by the flux of biologically available electron donors and acceptors. Contaminants may serve as electron donors (e.g., fuel components), as electron acceptors (e.g., nitrate) or as both (e.g., 3,4-D). These biological processes are potentially useful as natural attenuation mechanisms and as indicators of the extent and severity of the release. The objective of this program will be to develop biological markers for native and contaminant induced microbial populations and to develop a conceptual model for the ecology of contaminant impacted populations in the subsurface and for native degradative capacities. A Report on the
Conceptual Model and Final Report of Study will be prepared.

Surfactant Enhanced Remediation of Subsurface DNAPL Contamination

INSTITUTE:	University of Oklahoma (Candida West, P.O.)	
TASK NO:	3035	
PROJECT PERIOD:	11/91 10/94	
PRINCIPAL INVESTIGATOR:	David Sabatini	(405) 325-5911

ABSTRACT: The project is designed to develop an environmentally acceptable surfactant system for enhancing pump-and-treat remediation technology specifically for dense, nonaqueous phase liquids. The approach involves measuring the efficiency and effectiveness of specific classes of surfactant systems for solubilizing and mobilizing residual and free phase DNAPLs. Studies will be conducted to test chosen systems for ionic matrix sensitivities, biodegradability, solid phase interactions and transport properties. Two outputs will result from this effort including a Journal Article on DNAPL/Surfactant/Soil Interactions from Batch Studies, and an Environmental Research Brief on Surfactant Enhanced Remediation of Subsurface DNAPL Contamination.

Evaluation of Technologies for Cleanup of DNAPL Contaminated Sites

INSTITUTE: University of California
(Steve Schmelling, P.O.)

TASK NO: 3039

PROJECT PERIOD: 09/91 - 06/93

PRINCIPAL INVESTIGATOR: Nicholas Sitar (415) 643-8623

ABSTRACT: The project is designed to prepare a comprehensive assessment of the current state of in-situ treatment technologies for the remediation of ground-water contaminated by DNAPLs. A review and compilation of information on in-situ DNAPL treatment technologies will be followed by an assessment of the applicability and limitations of these technologies. A synthesis of this information will be presented in a Final Report.

Site Characterization of Ground-Water Flow and Transport in Fractured Rock Systems for Improvement of Pump-and-Treat Remediation

INSTITUTE: Lawrence Berkeley Laboratory
(Steve Kraemer, P.O.)

TASK NO: 3040

PROJECT PERIOD: 10/91 09/94

PRINCIPAL INVESTIGATOR: Kenzi Karasaki (415) 486-4289

ABSTRACT: The project is designed to investigate the effects of fractured network complexity on the efficiency of the pump-and-treat methods of aquifer remediation. The approach is to make a step-wise progressive analysis of fractured rock conceptualizations against field observations and experiments. Geophysical and hydrologic tests will be compared to computer model simulations. A final report describing the Behavior of Pump-and-Treat Systems in Fractured Rock Settings.

Investigation of Surfactant Enhanced Remediation of Aquifers Contaminated by Dense, Non-Aqueous Phase Liquids (DNAPLs)

INSTITUTE:	University of Michigan (Candida West, P.O.)	
TASK NO:	3041	
PROJECT PERIOD:	10/91 09/94	
PRINCIPAL INVESTIGATOR:	Linda Abriola	(383) 763-9664

ABSTRACT: The objective of this investigation is to develop procedures for the design of effective, efficient, and environmentally sound surfactant enhanced aquifer remediation (SEAR) strategies. Using two model DNAPLs, surfactant systems will be systematically examined with respect to solubilization and mobilization enhancement. Various parameter effects such as system temperature, ionic strength, Krafft temperature, and cloud point and sorptive properties will be examined. After selection of an "optimal" surfactant system using batch and column experiments, model validation will be explored. A Research Brief will be prepared on the Design of Effective, Efficient, and Environmentally Sound Surfactant Enhanced Aquifer Remediation (SEAR) Strategies.

Super Computer Simulation of Pump-and-Treat Methods for Aquifer Restoration

INSTITUTE:	University of North Carolina - Chapel Hill (Eva Davis, P.O.)	
TASK NO:	3042	
PROJECT PERIOD:	10/91 08/93	
PRINCIPAL INVESTIGATOR:	Cass Miller	(919) 966-2643

ABSTRACT: The objectives of this project are to evaluate through a modeling exercise alternative pumping schemes for enhancing pump-and-treat ground-water remediation systems. Models will be used that take into account heterogeneity in the subsurface and non-ideal chemical transport phenomena, such as non-linear and non-equilibrium adsorption. A second objective is to evaluate the capital and operating costs associated with these alternative pump-and-treat schemes. The approach to be used for this project is to use 2- and 3-dimensional flow and transport models to simulate the effects of various conditions on pump-and-treat ground-water remediation. The analysis will include evaluation of different initial source conditions, different types of contaminants (NAPLs), and the effects of alternative pumping rates and schedules. Heterogeneity of the subsurface physical and chemical parameters, such as hydraulic conductivity, and sorption parameters and rates, will also be evaluated. An economic analysis will be performed for all simulations to show the cost for remediation as a function of the pump-and-treat scheme used. A Report on Enhancing the Efficiency of Pump-and-Treat Systems will be prepared.

Artificial Aquifer Studies - East Aquifer

INSTITUTE: ManTech/RSKERL
(Carl Enfield/Roger Cosby, P.O.)

TASK NUMBER: 3046

PROJECT PERIOD: 10/91 12/94

PRINCIPAL INVESTIGATOR: Debra Ross (405) 436-8677

ABSTRACT: The project aim is to evaluate the transport and fate of dense nonaqueous phase liquids (DNAPL) which are spilled or have leaked into the subsurface. Techniques for monitoring the flow of DNAPLs will be developed and evaluated as part of the experimental project. The remediation of the subsurface by means of pump-and-treat systems, vapor phase extraction, and surfactant addition will also be studied. Conductivity, time domain reflectometry, and conductivity tomography probes have been installed in the artificial aquifer. The hydraulic properties of the aquifer will be determined using tritium or conductivity tracer studies. DNAPL selection and method of application is to be determined by the use of applicable numerical models. A final DNAPL migration report will be prepared.

Passive Anaerobic Remediation of BTEX Compounds in Ground Water

INSTITUTE: North Carolina State University
(John Wilson, P.O.)

TASK NO: 3060

PROJECT PERIOD: 10/92 09/94

PRINCIPAL INVESTIGATOR: Robert Borden (919) 515-7665

ABSTRACT: The objective of the investigation is to generate data on the rate and extent of passive anaerobic bioremediation of BTEX compounds in ground-water plumes from fuel spills. The existing data base will be extended by examining plumes in more heavily weathered geological material with lower pH and little buffering capacity. Laboratory microcosm and field studies will be performed to determine the rate and extent of passive anaerobic bioremediation of BTEX compounds. Laboratory studies will be done with core material from existing plumes which show evidence of anaerobic processes. Field studies will compare the kinetics of depletion along flow paths in plumes to the laboratory data. An Internal Report will be completed followed by a Final Report 07/94.

Forced Aeration for On-Site Remediation of Hydrocarbon Spills

INSTITUTE: U.S. Park Service
(Don Kampbell, P.O.)

TASK NO: 3061

PROJECT PERIOD: 08/92 07/95

PRINCIPAL INVESTIGATOR: S. Yancho (616) 362-5134

ABSTRACT: The project is designed to develop, implement, and evaluate a system for on-site remediation of geological materials contaminated with fuel spills. A demonstration will be conducted at the Casey's Canoe Livery Site at Sleeping Bear Dunes National Lakeshore, Empire, Michigan. Contaminated material will be excavated and transferred to a forced aeration soil pile constructed on site. The Park Service and their contractor will develop and implement the system. A university researcher in Michigan will do the evaluation with support from the Great Lakes and Mid Atlantic Hazardous Research Center. An 08/92 Preliminary Internal Report will be followed by a Final Report in 08/94.

Design and Operating Parameters for the Remediation of a Fuel Oil Contaminated Soil Using Composting Technology

INSTITUTE: Howard University
(John Wilson/Dale Manty, P.O.)

TASK NO: 3066

PROJECT PERIOD: 05/92 08/94

PRINCIPAL INVESTIGATOR: James Johnson (202) 806-6570

ABSTRACT: The investigation will assess and determine the feasibility of composting fuel contaminated soil on site, as an alternative to excavation and removal or incineration. It will also provide engineering design parameters for a field-scale demonstration of forced aeration composting of a fuel spill. Soil from the demonstration site will be characterized. A laboratory-scale compost reactor will be used to define optimum operating ranges for moisture, aeration, bulking agents, inocula, and control of volatile emissions. A journal article on composting technology will be prepared.

Remediation of Contaminated Soils by Solvent Flushing

INSTITUTE:	University of Florida (Lynn Wood, P.O.)	
TASK NO:	3069	
PROJECT PERIOD:	10/92 03/94	
PRINCIPAL INVESTIGATOR:	P.S.C. Rao	(904) 392-1951

ABSTRACT: The project is designed to determine the ability of cosolvents to enhance the recovery of organic contaminants from waste disposal and spill sites by in situ solvent flushing. Computer models to describe the desorption, dissolution, and mobilization of organic chemicals from contaminated soils will be developed. Laboratory experiments will be conducted to obtain data for the evaluation of these models. The models will be used to assess the efficiency of in situ solvent flushing under various scenarios. A journal article will be prepared in June 1994.

Microbial Metabolism of Munitions Wastes in Anoxic Aquifers

INSTITUTE:	Rice University (Guy Sewell, P.O.)	
TASK NO:	3071	
PROJECT PERIOD:	05/94 - 04/97	
PRINCIPAL INVESTIGATOR:	Karen Petay	(405) 325-4757

ABSTRACT: The objective of the investigation is to determine the metabolic fate of munitions wastes under defined anaerobic conditions. The project will result in a number of outputs including:

- Journal Article on Pathways
- Journal Article on Stimulation
- Final Report on Microbial Metabolism of Munitions Wastes in Anoxic Aquifers

Three-Dimensional NAPL Fate and Transport Model

INSTITUTE: University of Texas
(Jong Soo Cho, P.O.)

TASK NO: 3075

PROJECT PERIOD: 10/93 09/96

PRINCIPAL INVESTIGATOR: Gary Pope (512) 471-3235

ABSTRACT: The objective of this project is to develop a three-dimensional model that describes subsurface contaminant transport and transformation in a ground-water aquifer with spatially and temporally varying conditions. The eventual use of the model will be as a planning and design tool for subsurface remediation projects. The model will incorporate physical, chemical, and microbiological processes that are known to occur in the real world but are not well accounted for in the current transport and fate models. A computer code with a user's manual will be developed and a workshop will be hosted for model users.

Methods for Determining Multiphase Characteristic Curves for Use in Designing Subsurface Bioremediation Systems

INSTITUTE: University of California at Davis
(James Weaver, P.O.)

TASK NO: 3077

PROJECT PERIOD: 10/93 09/96

PRINCIPAL INVESTIGATOR: Mark Grismer (916) 752-3243

ABSTRACT: The objective of this project is to develop rapid methods for determining capillary pressure/saturation curves for multiphase subsurface systems. The data from these measurement techniques is needed as input data for models of fluid flow and contaminant transport for multiphase fluid systems, such as water, air, and nonaqueous-phase liquids.

Development of Data Evaluation/Decision Support System for Bioremediation of Subsurface Contamination

INSTITUTE: Massachusetts Institute of Technology
(Mary Randolph, P.O.)

TASK NO: 3078

PROJECT PERIOD: 10/93 09/96

PRINCIPAL INVESTIGATOR: Dennis McLaughlin (617) 253-7176

ABSTRACT: The objective of this project is to develop computerized interpretation capabilities for both soft (qualitative) and hard (quantitative) field data of hydrogeologic environments. The computer aided conceptual model is to integrate knowledge of physical transport processes in terms of flow and transport model with statistical techniques and geologic formation processes. Output includes 3-D image of hydrogeologic environment, spatial and temporal distribution of contamination, and where to obtain samples to optimally refine the conceptual model.

Development of Techniques for In Situ Bioremediation of Chromium Contaminated Soil and Groundwater: Phase I Laboratory Evaluation

INSTITUTE:	University of Oklahoma (Guy Sewell, P.O.)	
TASK NO:	3079	
PROJECT PERIOD:	10/93 09/95	
PRINCIPAL INVESTIGATOR:	Michael McInerney	(405) 325-4321

ABSTRACT: Design, evaluate and develop an in situ treatment technology for the use of microorganisms to reduce Cr (VI) to the more immobile and less toxic Cr (III). Chromium contamination of the subsurface is a common environmental problem associated with its use in many different industries and products including: electro-plating, tanning, fungicides, corrosion inhibitors, printing inks, and photographic films. In the subsurface, chromium occurs in either the oxidized Cr (VI) or reduced Cr (III) forms. The reduced form is relatively insoluble and has low toxicity, while the oxidized form, chromate (CrO_4^{2-}), is highly soluble, mobile and carcinogenic. Conventional pump-and-treat technologies utilized to remediate chromium contaminated subsurface sites have limitations in terms of time, cost and effectiveness. Recently it has been recognized that some micro-organisms can utilize oxidized metal species [including Cr (VI)] as terminal electron acceptors for anaerobic respiration. Microbial based treatment technologies for the degradation of organic wastes have shown great promise as a method for dealing with these compounds in situ. While metals cannot be degraded by microorganisms, it is possible that the ability of microorganisms to alter the oxidation states of metals could be useful in controlling the mobility and relative toxicity of contaminant metals in the subsurface, thereby mitigating their potential human health and ecological hazard. Further information on microbial oxidation/reduction processes is needed before efficient treatment technologies can be designed. Outputs of the project will include a Biosystems Presentation and a Final Report.

Bioremediation of BTEX, Naphthalene, and Phenanthrene in Aquifer Material Using Mixed Oxygen/Nitrate Electron Acceptor Conditions

INSTITUTE:	Johns Hopkins University (Steve Hutchins, P.O.)	
TASK NO:	3081	
PROJECT PERIOD:	10/93 09/96	
PRINCIPAL INVESTIGATOR:	Edward Bouwer	(410) 516-8668

ABSTRACT: The objective of this research is to develop a better understanding of the effect of oxygen alone, nitrate alone or a combination of oxygen and nitrate on the biodegradation of certain mono- and polycyclic aromatic hydrocarbons in contaminated aquifer materials. Specifically, the proposed research will include batch studies to assess stoichiometry and kinetics of biodegradation of target compounds under strict aerobic, strict denitrifying and mixtures of oxygen and nitrate, column studies to simulate single continuous flow injection well, multiple injection wells and pulsed or intermittent injection schemes under mixed electron acceptor conditions. Outputs will include a Final Report on Bioremediation of BTEX, Naphthalene, and Phenanthrene in Aquifer Material Using Mixed Oxygen/Nitrate Electron Acceptor Conditions.

Bioremediation of Fuel-Contaminated Aquifers Using Mixed Electron Acceptor Conditions

INSTITUTE: University of Waterloo
(Steve Hutchins, P.O.)

TASK NO: 3082

PROJECT PERIOD: 10/93 09/96

PRINCIPAL INVESTIGATOR: J.F. Barker (519) 885-1211 x2103

ABSTRACT: This task will establish the role of nitrate as an electron acceptor for anaerobic biotransformation of BTEX compounds, and to investigate whether any advantage can be expected under mixed conditions where both nitrate and oxygen are provided. The specific objective is to evaluate the potential for degradation of benzene under conditions where both nitrate and oxygen are available. A final report will be prepared.

Evaluation of In-Situ Bioremediation of Chlorinated Hydrocarbon Contaminated GW at Air Force Plant 44

INSTITUTE: Western Region Hazardous Substance Research Center
Center, Stanford University
(Scott Huling, P.O.)

TASK NO: 3085

PROJECT PERIOD: 09/93 09/95

PRINCIPAL INVESTIGATOR: Perry McCarty (415) 723-4131

ABSTRACT: The USAF/CEVR is funding the U.S. EPA, RSKERL, Ada, OK, to develop a two-year project with EPA's Western Region Hazardous Waste Research Center (Stanford and Oregon State Universities) to evaluate the efficacy and efficiency of an in-situ bioremediation process for contaminated ground water at Air Force Plant 44. Activities will relate to treatability studies at Stanford University and Moffett Field, California, and full-scale design, operation, and evaluation at Plant 44 in Tucson, Arizona. A report will be prepared on the evaluation of in-situ bioremediation of chlorinated hydrocarbon contaminated ground water at Air Force Plant 44.

H_2O_2 and Microbial System Interactions

INSTITUTE:	RSKERL/ManTech (Roger Cosby, P.O.)	
TASK NO:	3086	
PROJECT PERIOD:	09/93 12/95	
PRINCIPAL INVESTIGATOR:	Scott Huling	(405) 436-8610

ABSTRACT: The objective is to quantify the oxidative potential of H_2O_2 decomposition during enzymatic and nonenzymatic catalyzed reactions and to evaluate H_2O_2 persistence in different chemical and biological solutions. The experimental data will greatly improve the conceptual model of the oxidative effects of H_2O_2 in microbially active aquifer material. This will help develop the theoretical and experimental framework for understanding and quantifying the effects of H_2O_2 on parameters influencing microbial mobility, i.e., microbial and collector surfaces, and ultimately, microbial mobility and activity in subsurface environments. Additionally, this will also help quantify the effects of microbial populations in engineered oxidation systems and to evaluate the effects of H_2O_2 on microbial toxicity. An Internal Report on H_2O_2 and Microbial System Interactions will be prepared.

A Pilot-Scale Demonstration of Surfactant-Enhanced Subsurface Remediation of Chlorinated Hydrocarbons

INSTITUTE:	University of Oklahoma (Candida West, P.O.)	
TASK NO:	3087	
PROJECT PERIOD:	03/94 - 02/95	
PRINCIPAL INVESTIGATOR:	Robert Knox	(405) 325-5911

ABSTRACT: A small-scale field study of surfactant-enhanced contaminant removal using a recirculating well system will be conducted at the US Coast Guard Station in Traverse City, Michigan. The choice of surfactant system to be used will be based on laboratory research conducted under Task 3035. A Report on Small-Scale Field Evaluation of Surfactant-Enhanced Contaminant Removal will be written as the output for this project.

China-US Soils & Ground Water Remediation Research

INSTITUTE: Sino-US International Agreement
(Bert Bledsoe, P.O.)

TASK NO: 4025

PROJECT PERIOD: Continuing

PRINCIPAL
INVESTIGATOR:

ABSTRACT: Strengthen scientific ties with the People's Republic of China (PRC) by conducting a cooperative research program to study the remediation of an aquifer contaminated with diesel fuel, soil contaminated with heavy oil, and their eventual impact on the beneficial use of the ground water. Outputs for this project include:

- Internal Report on Soils Remediation
- Internal Report on Aquifer Remediation
- Article on Soils & Aquifer Remediation

Treatment of Process Off-Gases Contaminated with TCE Using Ex-Situ Soil Based Aerobic Bioreactors

INSTITUTE: U.S.G.S.
(John Wilson, P.O.)

TASK NO. 5001

PROJECT PERIOD: 04/94 09/94

PRINCIPAL
INVESTIGATOR: Theodore Ehlke (609) 771-3924

ABSTRACT: This effort will develop information on the kinetics of biological TCE co-oxidation supported by JP-4, Stoddard Solvent, Technical Grade Toluene, and Phenol. An open-file USGS report will be written.

Evaluation of Passive Remediation Techniques at Mixed-Waste Sites Using Geochemical Barriers

INSTITUTE: Cooperative Agreement

TASK NO: 0935-001

PROJECT PERIOD: Proposed

PRINCIPAL
INVESTIGATOR:

ABSTRACT: The objective of this project is to evaluate the effectiveness of passive geochemical barriers for mixed waste composed of chlorinated solvents and chromium. The project will be conducted at field scale at a well-characterized waste site. The project will be closely interlinked with ongoing and planned laboratory research to elucidate and understand the mechanisms at work in the field setting. A Report on the Evaluation of Passive Geochemical Barriers for Mixed Waste Sites will be prepared.

Design Manuals for the Extraction of Contaminants from Unconsolidated Subsurface Environments

INSTITUTE: Cooperative Agreement

TASK NO: 0935-002

PROJECT PERIOD: Proposed

PRINCIPAL INVESTIGATOR:

ABSTRACT: The objective of this project is to do a side-by-side comparison of several enhanced extraction techniques for remediating sites with residual NAPL contamination. Techniques to be evaluated will include the addition of surfactants, the addition of cosolvents, and the addition of thermal energy. This will be a pilot-scale field study with supporting laboratory work. The various techniques will be compared using side-by-side cells made of sheet piling. The project will be conducted at two or more sites to determine the effect of hydrogeologic setting on the effectiveness of the remediation technology. A Design Manual for Extraction of Contaminants from Unconsolidated Subsurface Environments will be developed.

Evaluation of Pulsed Pumping for Improving the Efficiency of Pump-and-Treat Remedial Actions

INSTITUTE: US Air Force

TASK NO: 0935-003

PROJECT PERIOD: Proposed

PRINCIPAL INVESTIGATOR:

ABSTRACT: The objective of this project is to evaluate the improvement in efficiency that can be achieved for pump-and-treat remedial actions through the use of pulsed pumping. The project will be a pilot-scale field study that will compare a variety of pumping schemes. A Report on the Evaluation of Pulsed Pumping for Improving the Effectiveness of Pump-and-Treat Remedial Actions will be written.

Evaluation of Cosolvent Flushing for Increasing Mobility of NAPLs

INSTITUTE: Cooperative Agreement

TASK NO: 0935-004

PROJECT PERIOD: Proposed

PRINCIPAL INVESTIGATOR:

ABSTRACT: The objective of this project is to evaluate the feasibility of using miscible cosolvents to increase the mobility of residual NAPLS in subsurface environments. The project will be conducted as a pilot-scale field study using small sheet-piling cells to provide hydraulic containment.

Transformation and Transport Processes of Hydrocarbon Vapors in the Vadose Zone

INSTITUTE: RSKERL

TASK NO: 0935-RSFB3

PROJECT PERIOD: 10/93

PRINCIPAL INVESTIGATOR: Frank Beck (405) 436-8546

ABSTRACT: The objective of this project is to identify the volume of hydrocarbon vapors being transported to the soil surface by plants. The large lysimeters at the RSKERL field site will be used to examine emissions from plants growing above contaminated soil to monitor emission enhancement by plants. A journal article will result from this project.

Oxygen Consumption in Clay Soils Contaminated by #2 Fuel Oil

INSTITUTE: RSKERL

TASK NO: 0935-EADG2

PROJECT PERIOD: 03/94 03/95

PRINCIPAL INVESTIGATOR: Dominic DiGiulio (405) 436-8607

ABSTRACT: The objective of this project is to determine the feasibility of introducing air into silty clay soils contaminated by #2 fuel oil, and to determine the correlation of oxygen consumption rates with in-situ petroleum hydrocarbon degradation rates using a reference alkane. This project will be carried out in the field with supporting laboratory measurements.

Chemically Enhanced Dissolution and Mobilization of Residual Contaminants

INSTITUTE: RSKERL

TASK NO: 0935-RSLW3

PROJECT PERIOD: 10/93 12/96

PRINCIPAL INVESTIGATOR: Lynn Wood (405)436-8552

ABSTRACT: The objective of this project is to assess the ability of organic cosolvents to enhance the removal of residual-phase organic contaminants by in-situ soil flushing. Soil columns containing residual NAPLs will be eluted with mixtures of water and organic cosolvents. The rates and extent of NAPL dissolution and mobilization will be assessed under differing experimental conditions. Successful laboratory results will be evaluated in the field in cooperation with the University of Florida under Task 1086. Outputs for the project include a Journal article and a Research Brief or Issue Paper on Solvent Flushing for Subsurface Remediation.

Remediation of Chromium Contaminated Soils and Ground Water at a Chrome Plating Site

INSTITUTE: RSKERL

TASK NO: 2072

PROJECT PERIOD: 06/92 - 09/95

PRINCIPAL INVESTIGATOR: Robert Puls (405) 436-8543

ABSTRACT: The objective of this project is to use a chrome plating site at Elizabeth City, North Carolina to develop and test innovative remediation techniques for metal-contaminated waste sites. The project will include laboratory and field testing of soil washing, in-situ mobilization, and ground water sampling techniques. Project outputs will include a Journal article and an EPA Issue Paper on Remediation of Chrome Plating Waste Sites.

Sorption of Polar Organic Compounds to Colloidal Particles

INSTITUTE: RSKERL

TASK NO: 0940-RSSM3

PROJECT PERIOD: 08/92 11/94

PRINCIPAL INVESTIGATOR: Susan Mravik (405) 436-8553

ABSTRACT: The objective of this project is to investigate the relationship between the characteristics of polar, ionizable organic compounds and their sorption to particles with different properties such as clay mineralogy, surface charge, and organic carbon content. The approach will be to select compounds for study that will cover a range of pK_a and log K_{ow} values. Sorbents that will provide a range in clay mineralogy and organic carbon content will be selected. The project will be initiated with batch studies at various values of pH. The results of the batch studies will be used to plan column studies to investigate transport of the ionic compounds.

Pore-Scale Investigation of the Behavior of Remedial Fluids

INSTITUTE: Cooperative Agreement

TASK NO: 0946-001

PROJECT PERIOD: Proposed

PRINCIPAL INVESTIGATOR:

ABSTRACT: Laboratory and numerical investigations will be carried out concerning the behavior of pore-scale phenomena that are expected to influence the successful application of chemical additives for the removal of nonaqueous-phase liquids. A Report on the Pore-Scale Behavior of Remedial Fluids will be developed.

Changes in Subsurface Wetting Behavior in the Presence of NAPLs

INSTITUTE: RSKERL/ManTech

TASK NO: 0946-002

PROJECT PERIOD: Proposed

PRINCIPAL INVESTIGATOR:

ABSTRACT: The wetting properties of aquifer materials are one of the important factors controlling the migration of NAPLs and the likelihood of successful removal. Although these materials are normally water wet, there is evidence that they may become oil wet under long-term exposure to NAPLs. This project will collect laboratory data to measure the extent of these changes in wetting behavior and the conditions under which it occurs. The output for this project will be a Report on Changes in Subsurface Wetting Behavior in the Presence of NAPLs.

Abiotic Reduction of Chrome from Zero-Valence Iron Dissolution

INSTITUTE: RSKERL/ManTech

TASK NO: 0946-004

PROJECT PERIOD: Proposed

PRINCIPAL INVESTIGATOR:

ABSTRACT: The objective of this project is to develop data on the mechanisms of chrome reduction kinetics in the presence of elemental iron, the kinetics of the electrolytic reduction process, the effect of sulfate and other anionic species on both processes, the effect of soil mineralogy, and the potential for reactivating the iron surface following the development of an oxidized coating. The work will be carried out in laboratory-scale stirred batch reactors to evaluate the effects of variations of critical parameters. The results of these laboratory studies will be used to plan possible field evaluation of this methodology for remediation of sites with chromium contamination.

Evaluation of Proposed Closure Criteria at Remediated Sites

INSTITUTE: Cooperative Agreement

TASK NO: 0948-001

PROJECT PERIOD: Proposed

PRINCIPAL INVESTIGATOR:

ABSTRACT: The objective of this project is to evaluate different approaches that have been proposed for establishing scientifically soil cleanup levels or closure criteria for hazardous waste sites. This effort will use a combination of laboratory work and evaluation of the approaches by an expert panel. The output from this task will be a report delineating the suitability of various screening tools for specific applications including site specific methodologies that would require a more detailed analysis of the hydrogeologic system. The project will result in a Report on the Evaluation of Proposed Soil Screening Level Criteria.

Natural Attenuation of Ground Water *Contaminants at Air Force Installations*

INSTITUTE: RSKERL (US Air Force)

TASK NO: 0949-001

PROJECT PERIOD: 06/93 - 09/94

PRINCIPAL INVESTIGATOR: John Wilson (405) 436-8532

ABSTRACT: The bioremediation research team of RSKERL has developed a provisional strategy to evaluate the rate and extent of natural attenuation of organic contaminants in ground water. Under this IAG, the bioremediation research team will apply the provisional strategy to two plumes located on U.S. Air Force Installations. Samples will be taken at locations extending from the source of each plume, along the midline to the periphery of each plume. Soil and ground-water samples from the plumes will be analyzed for the concentrations of contaminants, nutrients, and electron acceptors. This information will be input to the BIOPLUME II model, which will be used to estimate attenuation. The project will produce a Draft Guidance on Assessing Natural Attenuation of Ground Water Contaminants at Air Force Installations.

Denitrification for Bioremediation of a Refinery Spill - Park City, Kansas

INSTITUTE:	RSKERL	
TASK NO:	3031	
PROJECT PERIOD:	02/92 08/94	
PRINCIPAL INVESTIGATOR:	John Wilson	(405) 436-8532

ABSTRACT: The objective is to evaluate the relative efficacy of (1) BTEX fermentation, (2) BTEX denitrification, and (3) BTEX denitrification supplemented with oxygen for remediation of subsurface contamination with refined petroleum hydrocarbons. A spill from a refinery pipeline in Park City, Kansas will be subdivided into six plots of about an acre each. One plot will recirculate ground water amended with ammonium chloride to stimulate fermentation of BTEX compounds. A second plot will recirculate ammonium chloride and sodium nitrate, and a third plot will recirculate ammonium chloride, sodium nitrate, and oxygen. This task will provide the following output.

- A journal article describing the success of nitrate for bioremediation of a fuel spill in a full-scale remediation

Bioventing to Remediate a JP-4 Spill at the USCG Site at Elizabeth City, North Carolina

INSTITUTE:	RSKERL	
TASK NO:	3064	
PROJECT PERIOD:	06/92 09/93	
PRINCIPAL INVESTIGATOR:	John Wilson	(405) 435-8532

ABSTRACT: Air Sparging and Air Injection are new techniques for in situ bioremediation. They are finding wide application, but there is little documentation of their performance at field scale. This project will carry out Air Injection at a JP-4 spill site. We will document the performance of Air Injection with respect to reduction in contaminant mass in ground water and soil. A Journal Article Describing the Efficacy of Air Injection for Treatment of Subsurface Fuel Spills will be developed.

Feasibility Study on Enhancement of Nitrate-Based Bioremediation Using Surfactants

INSTITUTE: RSKERL

TASK NO: 0949-RPBW1

PROJECT PERIOD: 10/93 09/94

PRINCIPAL INVESTIGATOR: Barbara Wilson (405) 436-8993

ABSTRACT: Conduct laboratory studies of biorestoration supported by denitrification aided by use of surfactants. A series of experiments will be conducted to determine whether denitrification using nitrate can be significantly enhanced by increasing bioavailability of fuel components through the process of micellization. This process would be unique in that the surfactant chosen would be nonbiodegradable under denitrifying conditions (anaerobic), but would be readily degraded under aerobic conditions, and in fact, aid in the final "polishing" step, the aerobic biodegradation of any residual contaminant components. Studies will be conducted using contaminated aquifer materials collected from field sties. The results of these studies will be evaluated to determine if further studies are warranted. The investigation will result in the following outputs:

- ACS Presentation
- Journal Article

Vinyl Chloride/TCE at St. Joseph, MI Site

INSTITUTE: RSKERL

TASK NO: 0949-RPDK4

PROJECT PERIOD: 09/93 08/94

PRINCIPAL INVESTIGATOR: Don Kampbell (405) 436-8564

ABSTRACT: The project is designed to determine amount of TCE plume entering nearby Lake Michigan. A final report on on Vinyl Chloride/TCE at St. Joseph, MI Site will be prepared.

Aerobic Co-Oxidation of TCE Vapors

INSTITUTE: RSKERL

TASK NO: 0949-RPDK3

PROJECT PERIOD: 01/90 12/95

PRINCIPAL INVESTIGATOR: Don Kampbell (405) 436-8564

ABSTRACT: Demonstrate enhanced cometabolic degradation of TCE and other chlorinated analogs in the presence of petroleum hydrocarbon microbial utilizers. A Journal Article on Aerobic Co-Oxidation of TCE Vapors will be published.

Reductive Anaerobic Biological In-Situ Treatment

INSTITUTE: RSKERL

TASK NO: 0949-RPGS3

PROJECT PERIOD: 01/93 12/96

PRINCIPAL INVESTIGATOR: Guy Sewell (405) 436-8566

ABSTRACT: Design and field test (pilot scale) reductive anaerobic bioremediation. To date bioremediation technologies have focused on the use of bacteria to oxidize organic contaminants under both aerobic and anaerobic conditions. The organisms may utilize the contaminant as a metabolizable carbon source or nutrient, or be induced to co-metabolize it in the presence of the proper inducer. Biotransformation also can occur where the targeted contaminant serves as terminal electron acceptor and is thereby reduced. Many contaminants which are recalcitrant to bio-oxidative attack have been shown to undergo reductive biotransformations. These reductive biotransformations can lead to detoxification, mineralization and/or mobility alterations of the target compounds. Two model compounds have been identified for possible targets of reductive anaerobic bioremedial in-situ technologies (RABIT); chromate (CR VI) and tetrachloroethene (PCE). The investigation will result in the development of a Treatment Design and Operational Protocol.

Petroleum Hydrocarbon Biodegradation Under Mixed Denitrifying/Microaerophilic Conditions

INSTITUTE: RSKERL

TASK NO: 0949-RPDM3

PROJECT PERIOD: 03/93 10/94

PRINCIPAL INVESTIGATOR: Dennis Miller (405) 436-8567

ABSTRACT: To conduct laboratory treatability studies of biorestoration supported by mixed denitrifying/microaerophilic conditions for clean-up of a fuel spill in a selected aquifer. A Journal Article on Use of Low Oxygen Levels to Enhance Nitrate-Based Bioremediation will be published.

Prepared Bed Bioremediation in Buried Lifts as Affected by O_2 Concentrations in Soil Gas

INSTITUTE: Utah State University (Scott Huling, P.O.)

TASK NO: 0949-003

PROJECT PERIOD: 09/93 - 03/96

PRINCIPAL INVESTIGATOR: Ron Sims (801) 750-2926

ABSTRACT: The project is designed to determine whether contaminants in buried lifts in land treatment units continue to degrade with time. A project report will be developed at the end of the investigation.

Biological Treatment of Trichloroethylene Contaminated Process Off-Gas

INSTITUTE:	U.S. Army Corps of Engineers Waterways Experiment Station (John Wilson, P.O.)	
TASK NO:	0949-004	
PROJECT PERIOD:	04/94 - 09/94	
PRINCIPAL INVESTIGATOR:	Mark Zappi/Capt. R. Morgan	(601) 634-2856

ABSTRACT: This investigation is designed to evaluate a variety of candidate column packings for support of key microbial consortia for treatment of a TCE contaminated gas stream. A final report will be prepared.

UNDERGROUND INJECTION CONTROL

Research in support of the Underground Injection Control Program is directed at developing methods to assure the mechanical integrity of the injection well itself, and that wastes remain in the zone of injection. Research is also aimed at determining the fate of wastes that enter the injection zone.

Injection Well Mechanical Integrity

INSTITUTE: East Central University
(Jerry Thornhill, P.O.)

TASK NO: 1060

PROJECT PERIOD: 10/91 09/94

PRINCIPAL INVESTIGATOR: Bob Benefield (405) 332-8000

ABSTRACT: The objectives of this project are to test methods for determining internal (no significant leaks in casing, tubing, and packer) and external (no significant fluid movement through vertical channels adjacent to the injection well bore) mechanical integrity of injection wells to assure that the use of such wells will not endanger underground sources of drinking water, public health, or the environment. The approach to the project is to evaluate various production logging techniques to track fluid movement within and behind pipe, and through leaks to zones other than the designated injection zones. Specific well conditions will be simulated in a series of research wells. Tools and techniques will be evaluated to determine how they work, what they measure, and how these measurements are related to flow. At the end of the project a Report will be prepared discussing the Tests for Flow Behind Pipe.

Potential for Invasion of Underground Sources of Drinking Water Through Mud-Plugged Wells: An Experimental Appraisal

INSTITUTE: Oklahoma State University
(Don Draper, P.O.)

TASK NO: 1065

PROJECT PERIOD: 10/91 -09/94

PRINCIPAL INVESTIGATOR: Marvin Smith (405) 744-5711

ABSTRACT: The objective of the project is to determine whether a predictable relationship exists between the standard measured properties of drilling mud, the in-situ well plugging fluid, the adjacent reservoir permeability, and the differential pressure which causes invasion of reservoirs. In order to accomplish these objectives two systems and five subsystems are to be designed and constructed. Pre-test procedures will be required for cores and fluids. Tests to be performed will be well system simulation, mudcake, effective permeability, and mud setting. A final report of the findings will be prepared.

WELLHEAD PROTECTION

The 1986 Amendments to the Safe Drinking Water Act require the delineation of protection areas around public water wells to protect water systems. RSKERL is conducting research to advance the fundamental scientific knowledge of subsurface processes, develop new wellhead protection methods, and provide technical assistance on basic scientific and engineering wellhead protection issues. The audiences for research results are EPA's Regional Offices, state and local officials, and public water suppliers.

Hydrogeologic Mapping to Delineate Wellhead Protection Zones Around Springs

INSTITUTE: State of Utah
(Steve Acree, P.O.)

TASK NO: 1052

PROJECT PERIOD: 10/90 02/93

PRINCIPAL INVESTIGATOR: Mark Jensen (801) 531-6459

ABSTRACT: The project is designed to develop and field test an applicable hydrogeologic mapping method to delineate wellhead protection zones around springs. The use of hydrogeologic mapping techniques will be used to determine the zone of contribution to two springs in differing hydrogeologic settings, then verify the zone of contribution with chemical analyses and hydrologic studies. A Final Report titled "Methods for Delineating Wellhead Protection Zones Around Springs" will be prepared.

The Development of a Risk Management Strategy for Wellhead Protection

INSTITUTE: University of Miami
(David Burden, P.O.)

TASK NO: 1054

PROJECT PERIOD: 09/91 08/93

PRINCIPAL INVESTIGATOR: David Chin (305) 284-3391

ABSTRACT: The principal objective of the project will be to develop a risk-management strategy for wellhead protection that can be directly utilized in formulating land use controls within a protection area. Using the risk management strategy, contaminant source fluxes and attenuation characteristics are taken as random variables, and the probability distribution of the resulting contaminant concentration in the pumped water is then estimated. By defining maximum allowable contaminant levels at the wellhead, the risk of exceeding these allowable levels for given land uses may be calculated. As a consequence to defining an acceptable level of risk, land use controls may then be implemented within the protection area based on a clearly defined quantitative measure. A Final Report titled "Development of a Risk-Management Strategy for Wellhead Protection" will be prepared.

Determination of Subsurface Assimilative Capacity

INSTITUTE: RSKERL

TASK NO: 1057

PROJECT PERIOD: 01/91 12/94

PRINCIPAL INVESTIGATOR: Michael Jawson (405) 436-8560

ABSTRACT: This project is designed to develop a method for delineating wellhead protection areas based on the use of the assimilative capacity criterion which; (a) can be applied by the majority of the states, (b) is scientifically defensible, and (c) can be used to address significant contamination threats to public water supply wells. The initial tasks are the identification and classification of contaminants that currently present the greatest health threat to public ground-water supplies, and to evaluate the processes which contribute to the assimilative capacity in order to develop integrated assimilative capacity precepts. Eventually, a model incorporating assimilative capacity into the delineation of wellhead protection zones will be developed either by modifying an existing model or through the development of a new model. An Interim Report for the Application of Assimilative Capacity Criteria to Wellhead Protection Delineation Methods will be prepared as well as a Report on Contaminant Identification and Classification.

Delineation of Wellhead Protection Zones: Consideration of Virus Transport

INSTITUTE: University of Arizona
(Guy Sewell, P.O.)

TASK NO: 1058

PROJECT PERIOD: 10/91 05/94

PRINCIPAL INVESTIGATOR: Charles Gerba (602) 621-6906

ABSTRACT: The objective of the study is to enable EPA to delineate wellhead protection zones with respect to source areas contributing bacteria and viruses into ground water. The approach will be to examine the effects of changes in pH, ionic strength, and water content on the retention and release of sorbed viruses. The Final Report will discuss the Delineation of Wellhead Protection Zones with Respect to Virus Transport.

Demonstration of the Analytical Element Method for Wellhead Protection

INSTITUTE: Indiana University
(Stephen Kraemer, P.O.)

TASK NO: 1059

PROJECT PERIOD: 06/91 12/93

PRINCIPAL INVESTIGATOR: Henk Haitjema (812) 855-0731

ABSTRACT: The purpose of the project is to demonstrate and adopt the new solution technique known as the Analytical Element Method for application in wellhead protection. The objective will be accomplished by developing a public domain model with manual and user's guide supporting EPA personnel in developing proficiency with the technique, and demonstrating the applicability of the technique at a field site to be selected in consultation with EPA staff. The following outputs will result from this investigation:

- Prototype versions of programs released for testing.
- Beta version with on screen editor and draft manuals.
- *Final version of programs.*
- Final Report of the Demonstration of the Analytical Element Method for Wellhead Protection.

Capture Zone Delineation: Models and Experiments

INSTITUTE: New Mexico Institute of Mining and Technology
(Stephen Kraemer, P.O.)

TASK NO: 1062

PROJECT PERIOD: 07/91 01/94

PRINCIPAL INVESTIGATOR: John L. Wilson (505) 835-5308

ABSTRACT: A series of field experiments and computer modeling simulations will be applied at the Borden Site in Ontario, Canada. The objectives include: (1) the validation or invalidation of existing capture zone delineation methods, (2) an improvement in understanding the behavior and nature of capture zones in real aquifers, and (3) the investigation of new and improved concepts and methods for delineation. The field experiments will involve detailed head measurements and observations of tracer breakthrough curves during pumping at a well. The experimental design will be assisted by the use of existing computer programs. The observed time-of-travel delineated capture zones will be compared to the predicted zones in order to contribute a level of validation of existing modeling techniques. Improvement of existing models will be suggested by the field results. A Final Report on the Validation of Models for Delineating Capture Zones in Wellhead Protection will be prepared at the end of the project.

Capture Zone Delineation Using the EPA WHPA Model and Other Codes: A Comparative Study in Ellis County, Kansas.

INSTITUTE: RSKERL

TASK NO: 1063

PROJECT PERIOD: 09/90 09/92

PRINCIPAL INVESTIGATOR: David Burden (405) 436-8606

ABSTRACT: The objective of this project was initially to assist the City of Hays, Kansas, in the establishment of a Wellhead Protection Program. Since the initial meeting with the Ellis County Water Wellhead Protection Committee, RSKERL has been providing assistance in the form of actual computer modeling of the wellfield. The purpose is to conduct in-house research on the effectiveness of EPA's WHPA Model and compare the results with other popular delineation codes being used in wellhead protection. The approach will initially consist of using EPA's WHPA Model Version 1.0 to delineate capture zones. This will be followed by using the Version 2.0 of the WHPA Model and comparing the results of both WHPA models with other computer codes used to delineate capture zones. The final phase of the project will involve incorporating the results of the capture zones into a Geographic Information System. The Final Report will be an Evaluation of the Wellhead Protection Area Delineation Methods, including the use of the WHPA Code at Hays, Kansas.

Technical Assistance and Technology Transfer in Wellhead Protection

INSTITUTE: RSKERL

TASK NO: 1064

PROJECT PERIOD: Continuing

PRINCIPAL INVESTIGATOR: David Burden (405) 436-8606

ABSTRACT: The objective of this project is to provide technical assistance and technology transfer to communities, towns, and cities desiring to know and learn more about establishing a wellhead protection program in their area. The basic approach includes conducting seminars and making presentations about the EPA Wellhead Protection Program. Presentations typically consist of explaining the basic idea of a wellhead protection program, discussing RSKERL's current research activities in this area, and if requested, providing software demonstrations of EPA's WHPA Model.

Contaminant Identification and Classification

INSTITUTE: University of Oklahoma
(Michael Jawson, P.O.)

TASK NO: 1066

PROJECT PERIOD: 09/91 12/92

PRINCIPAL INVESTIGATOR: Larry Canter (405) 325-5202

ABSTRACT: The primary objectives of this project are to identify and prioritize those contaminants and their associated sources which present the greatest health threat in public ground-water supplies. Five tasks will be undertaken. The initial task involves specific decision making and detailed planning to be done in conjunction with EPA Headquarters. Task two involves the documentation of problems experienced with public ground-water supplies including the identification of contaminants and their sources as well as potential future contaminants. The third Task consists of the development of a classification system. Task four will highlight case studies selected from the survey of Task two and will be used to illustrate those findings and the applicability of the classification system. The final Task will be to prepare the summary report. The first output of the project will be the Identification and Classification Report. This will be followed by a report of findings of the Survey of Major Contaminants Impacting Public Drinking Water Wells.

Ground-Water Flow in a Carbonate Aquifer, Southern Oklahoma

INSTITUTE: USGS
(Stephen Kraemer, P.O.)

TASK NO: 1074

PROJECT PERIOD: 03/93 02/94

PRINCIPAL INVESTIGATOR: Ronald Hanson (405) 231-4256

ABSTRACT: The overall objective of this study is to develop, improve, and test methods to quantify and describe deeply circulating ground-water flow in carbonate aquifers. The tools and technologies will be used to characterize the Simpson Arbuckle Aquifer in south-central Oklahoma. Activities include: database construction; borehole logging of a single open hole; design packer hydraulic tests and a geochemical sampling; and sampling three wells for carbon, hydrogen isotopes, dissolved cations and anions to assist in age dating the water. Reports will be prepared describing the results of the investigation.

System Analysis for Evaluating Aquifer Assimilative Capacity

INSTITUTE: Rice University Consortium
(David Burden, P.O.)

TASK NO: 1075

PROJECT PERIOD: 10/92 09/94

PRINCIPAL INVESTIGATOR:

	Herb Ward	(713) 527-4086
	Phil Bedient	(713) 527-4953

ABSTRACT: The result of this research will be a highly organized system of models and databases which will be applied to a demonstration aquifer for defining and calculating assimilative capacity under a variety of assumptions. Aquifer data will be mapped using a GIS and models will be applied from the surface through the unsaturated and saturated zones to the nearest major water supply well having a wellhead protection zone. Dilution, sorption, and biodegradation of a variety of organic contaminants will be carefully evaluated, as they relate to transport and fate mechanisms in the subsurface. As a result, the project will combine both computational and experimental approaches to evaluating aquifer and subsurface assimilative capacity. Ground-water flow and transport models, aquifer databases from fate and transport research, and decision support tools will be integrated in a systems analysis approach of aquifer assimilative capacity. Activity will center on a specific aquifer selected on the basis of available data, appropriateness of descriptive models, and use.

Economic Value of Ground Water

INSTITUTE: National Research Council
(James McNabb, P.O.)

TASK NO: 1081

PROJECT PERIOD:

PRINCIPAL INVESTIGATOR:

ABSTRACT: The objective of this effort is to evaluate approaches for assessing the long-term economic value of ground water and the economic impacts if ground water is contaminated or depleted. The study will be carried out by the National Academy of Sciences/National Research Council over a period of two-years. The NRC will appoint a committee of experts to (1) review and critique various approaches for estimating the future value of the subsurface and uncontaminated ground water; (2) delineate preferred approaches; (3) outline what needs to be done to implement the recommended approaches; and (4) illustrate through examples how recommended procedures would be applied in practice for representative applications. The investigation will result in a NAS/NRC Report on Assessing the Future Value of Ground Water

Risk Management Decision Support System (RMDSS) for Wellhead Protection

INSTITUTE: RSKERL

TASK NO: 1082

PROJECT PERIOD:

PRINCIPAL INVESTIGATOR: David Burden (405) 436-8606

ABSTRACT: The objective of this project is to build a decision support system for calculating the risk to ground water caused by numerous types of human activities. The system will correlate commercial/residential activities and land use with the probability of a deleterious effect at the wellhead. The probability of occurrence of an accident within the zone of contribution will be incorporated into existing codes that estimate the risk that the ground water at the wellhead will be contaminated and the path and arrival time of that contaminant at the wellhead. A Risk Management Decision Support System (RMDSS) for Wellhead Protection will be produced by the project.

MATHEMATICAL MODELING

RSKERL scientists are developing and testing a variety of mathematical models that describe and predict contaminant transport in porous and fractured media under a variety of conditions from biodegradation to immiscible flow. From planning and evaluating remediation scenarios, to identifying wellhead protection areas and permitting injection wells, mathematical modeling is becoming an increasingly important tool in Agency decision making.

Multiphase Flow in Soils: Modeling and Experimental Study

INSTITUTE:	University of Colorado (James Weaver, P.O.)	
TASK NO:	2036	
PROJECT PERIOD:	07/90 05/92	
PRINCIPAL INVESTIGATOR:	Tissa Illangasekare	(303) 492-6644

ABSTRACT: The purpose of this project is to make detailed laboratory measurements of the distribution of water, an oily phase, and air during and after simulated spills and rainfall events. The purpose is also to measure the necessary model parameters so that experiments can be used to test simple models developed at CU and RSKERL. The existing dual-gamma system at UC-Boulder will be used to determine fluid distributions in laboratory columns after intermittent applications of the oily phase and water. Several scenarios, which correspond to assumptions in the models to be tested, will be simulated. Saturated conductivities and capillary pressures will be measured using a flow-pump technique in order to determine the basic data needed by the models. Experiments will also be run in a two-dimensional tank to evaluate the usage of one-dimensional models. A final report will be prepared on Laboratory and Modeling Studies of Multiphase Flow.

Three-Dimensional Modeling of Subsurface Flow, and Fate and Transport of Microbes and Chemicals

INSTITUTE:	Penn State University (Thomas Short, P.O.)	
TASK NO:	2055	
PROJECT PERIOD:	10/91 12/94	
PRINCIPAL INVESTIGATOR:	George Yeh	(814) 863-2931

ABSTRACT: The objectives of this project are to develop a three-dimensional numerical algorithm for the solution of the saturated-unsaturated transport equations for multiple components that undergo mutual reactions based on the LEZOOM approach and to analyze test data produced from physical model aquifers at RSKERL. A mathematical code will be developed which is capable of simulating experimental runs on RSKERL physical model aquifers. The results produced by the code will be compared with experimental data to determine if the proposed mathematical description of the mechanisms involved is adequate. A report with the same title as the project will be prepared.

Validation of the Approximate Multiphase Flow Models

INSTITUTE: RSKERL

TASK NO: 2059

PROJECT PERIOD: 09/91 09/93

PRINCIPAL INVESTIGATOR: James Weaver (405) 364-8545

ABSTRACT: The object of the project is to test the KOPT (Kinematic Oily Pollutant Transport) portion of the HSSM (Hydrocarbon Spill Simulation Model) by comparison with laboratory data. Several oils will be released into specially designed columns which are packed with various porous media. The ponding depth and depth of the oil front will be recorded as functions of time. Independent measurements of the model parameters will be made on the column. The average values of the parameters will be used as KOPT model input data. The model results will be compared with the laboratory data experiments. Monte Carlo simulation will be used to assess the impact of uncertainty in the values of the parameters.

Three-Dimensional Multiphase Flow and Contaminant Transport Mathematical Model

INSTITUTE: University of Vermont
(Thomas Short, P.O.)

TASK NO: 2076

PROJECT PERIOD: 10/92 10/95

PRINCIPAL INVESTIGATOR: George Pinder (802) 656-3390

ABSTRACT: The objective of this project is to develop mathematical modeling of the processes involved in the movement of mixtures of nonaqueous phase liquids through the vadose zone into the aquifer. The model will include the presencs of a vapor phase, solid phase, and the nonaqueous phase. The model will be three-dimensional and be applicable to both dense nonaqueous phase liquids (DNAPLs) and light nonaqueous phase liquids (LNAPLs). This model will be used to evaluate experimental data being collected in an ongoing research project using a large-scale physical model aquifer. In addition, the model will be applicable to full-scale contamination sites. A final report of the investigations will be issued in October 1995.

Screening Methods for Hydrocarbon Spills and Recovery

INSTITUTE: Rice University and University of Texas
(Jim Weaver, P.O.)

TASK NO: 2078

PROJECT PERIOD: 02/92 -12/95

PRINCIPAL INVESTIGATOR:

Herb Ward	(713) 527-4086
Randy Charbeneau	(713) 471-0070

ABSTRACT: The objective of the project is to extend the Hydrocarbon Spill Screening Model to include additional processes and geologic settings. Five areas are proposed for the extension of the model. These include heterogeneous media in the vadose zone, volatilization of the chemical, flow of dense nonaqueous phase liquids (DNAPLs), biodegradation in the saturated zone, and flow of nonaqueous phase liquids (NAPLs) in the capillary fringe. For each of these extensions, the current understanding of the processes involved will be used to develop further conceptualizations. Based on the qualitative and quantitative understanding, an appropriate mathematical model will be developed. The models will, to the degree that is possible, be based on analytic or semi-analytic solutions of the mathematical models. The resulting models will be incorporated into existing Microsoft Windows user interface. The computer simulation models, user documentation, and Window user interface will be completed in December, 1995.

Compilation of Saturated/Unsaturated Zone Models and Development and Application of Testing Methods and Benchmark Cases

INSTITUTE: Colorado School of Mines
(James McNabb, P.O.)

TASK NO: 3038

PROJECT PERIOD: 10/91 10/94

PRINCIPAL INVESTIGATOR:

Paul van der Heijde	(303) 273-3800

ABSTRACT: The objectives of this project are to enhance the existing knowledge of ground-water models and their utility and performance, develop guidance in applying quality assurance in model development, and address other scientific issues related to the use of ground-water models. The approach to carrying out this project will be: (1) to enhance existing data bases on ground-water models, (2) characterize and analyze models for their utility and performance, (3) develop and apply testing and validation procedures to prominent public domain models, (4) develop and provide detailed guidance in the development of models, and (5) develop issue papers on critical topics in ground-water modeling. A Report on Analytical Solutions will be prepared along with a Report on the Status of Ground-Water Models.

Evaluation of Ground-Water Pump-and-Treat Systems at the Gilson Road Superfund Site, Nashua, NH, with Ground-Water Models

INSTITUTE: University of Cincinnati
(Randall Ross, P.O.)

TASK NO: 3068

PROJECT PERIOD: 10/92 09/94

PRINCIPAL INVESTIGATOR: Milovan Beljin (513) 556-5421

ABSTRACT: The objective of the project is to maximize the efficiency of the existing ground-water pump-and-treat system by modifying and enhancing previous ground-water modeling efforts at the site and to recommend system modifications to increase system efficiency. A database will also be prepared for use with GIS. Historical site information will be used to modify and enhance previous ground-water modeling efforts at the site to evaluate the performance of the existing ground-water remediation and determine the changes necessary to increase the efficiency of that system. A database will also be constructed to be utilized during future site assessments. An interim report will be prepared and a final report on the investigation will be prepared in September 1994.

Application of Electromagnetic Tomography to Monitoring DNAPL

INSTITUTE: University of Arizona
(Carl Enfield, P.O.)

TASK NO: 3073

PROJECT PERIOD: Proposal

PRINCIPAL INVESTIGATOR:

ABSTRACT: The objective of this project is to develop methods of mapping the movement of NAPLs through unconsolidated soils. The approach will be to evaluate the use of changes in dielectric permittivity to assess the spatial location of DNAPLs as a function of time. Data to evaluate the method will be supplied from studies taking place in RSKERL's large physical models. Output from this project will be available for evaluating models of DNAPL movement.

Four-Dimensional Electrical Imaging of Subsurface Contaminants with Applications to a Controlled Spill

INSTITUTE: Massachusetts Institute of Technology
(Carl Enfield, P.O.)

TASK NO: 3074

PROJECT PERIOD: Proposal

PRINCIPAL INVESTIGATOR:

ABSTRACT: The objective of this project is to develop methods for three-dimensional mapping of the movement of NAPLs through unconsolidated soils. The approach will be to use low frequency current and evaluate induced polarization by organic chemistry. Data for this project will be supplied by RSKERL from studies taking place in its large physical models. Output from this project will be available for evaluating models of vadose zone transport of NAPLs.

A Computer Program to Model Bioventing of Organic Contaminants in Unsaturated Geological Material

INSTITUTE: University of Michigan
(Candida West, P.O.)

TASK NO: 3080

PROJECT PERIOD: Proposal

PRINCIPAL INVESTIGATOR:

ABSTRACT: Bioventing is the process of delivering oxygen to the unsaturated zone through the advective flow of air. This task will develop and validate a 2-dimensional (vertical cross section) computer model that describes the transport and biotransformation of volatile organic compounds in the unsaturated zone. The model will incorporate physical, chemical, and microbiological processes that are known to occur in the real world, but are not well accounted for in current transport and fate models. This task will provide an improved computer model of bioventing (source codes and compiled versions, including a user's manual).

Modeling Flow through Fractured Media--Testing Continuum vs. Discrete Conceptualizations

INSTITUTE: RSKERL

TASK NO: 0384-RSSK1

PROJECT PERIOD: Pending

PRINCIPAL INVESTIGATOR: Steve Kraemer (405) 436-8549

ABSTRACT: The objective of this task is to build conceptual understanding of flow through fractured media by testing mathematical representations within a computer model. The computer program will be used to test discrete fracture networks for their replacement by equivalent porous medium representations. Graphical output from the computer program will be used to document the emergence of preferred flow pathways within random distributions of fractures. Discrete flow can be a critical factor when designing wellhead protection areas or pump-and-treat systems for aquifer remediation.

Evaluation of Multiphase Flow and Transport Models in a Large Two-Dimensional Physical Model

INSTITUTE: Cooperative Agreement

TASK NO: 0939-001

PROJECT PERIOD: Proposal

PRINCIPAL INVESTIGATOR:

ABSTRACT: The objective of this project is to evaluate subsurface multiphase flow and transport models in a large two-dimensional physical model. A dual gamma system will be used to provide quantitative data on fluid composition and movement. Visual observations will be made to provide qualitative information on the fluid behavior. Many of the most commonly used multiphase codes are two dimensional, but there is a paucity of data with which to evaluate these models to determine their suitability for risk assessment and other decision making needs.

Determination of Mass Transfer Rates between Mobile/Immobile Soil-Air Regions

INSTITUTE: RSKERL

TASK NO: 0939-EADG1

PROJECT PERIOD: Pending

PRINCIPAL INVESTIGATOR: Dominic DiGiulio (405) 436-8607

ABSTRACT: The objectives of this project are: (a)to modify mobile/immobile soil-water theory for application in gas flow models; quantify mass transfer rates between immobile gas/liquid regions and mobile gas regions in unsaturated soils; and (c) determine mass transfer rates as a function of volumetric moisture content and pore-gas velocity. Laboratory studies will be conducted using conservative gas tracers in soil columns to assess the effects of selected parameters on mass transfer rates. Models used for aqueous systems will be modified for gas flow use.

Evaluation of Dual Source Gamma Ray Absorption System

INSTITUTE: RSKERL

TASK NO: 0939-RSED1

PROJECT PERIOD: Pending

PRINCIPAL INVESTIGATOR: Eva Davis (405) 436-8548

ABSTRACT: The objective of this project is to test, and calibrate a dual energy gamma ray absorption system for making both quantitative and qualitative measurements of multiphase fluid flow in one- and two-dimensional physical models. The output for the project will be a User's Guide Dual Source for Gamma Ray Absorption.

Development of Lagrangian Methods for Subsurface Contaminant Transport Analysis

INSTITUTE: RSKERL

TASK NO: 0939-RSJW4

PROJECT PERIOD: Pending

PRINCIPAL INVESTIGATOR: James Weaver (405) 436-8545

ABSTRACT: The objective of this project is to evaluate the use of specific Lagrangian methods for the simulation of subsurface contaminant transport in heterogeneous porous media. A numerical model of subsurface contaminant transport which is particularly suited for coding for massively parallel computers will be developed using the concepts of Lagrangian fluid mechanics. A second phase of the project will particularly emphasize solutions for heterogenous geologic settings. The results of the model will be compared with known analytic solutions or data from physical models. A journal article will be published.

Soil Vacuum Model

INSTITUTE: RSKERL

TASK NO: 0935-RSJC1

PROJECT PERIOD: Pending

PRINCIPAL INVESTIGATOR: Jong Soo Cho (405) 436-8547

ABSTRACT: The objective of this project is to obtain data for parameters for a first-order kinetic model of soil vacuum extraction (SVE) under the operating conditions of laboratory soil columns, and for removal rates of volatile organic compounds from these columns under various operating conditions. The output chemical concentrations and residual mass of VOCs inside the soil will be fit to the proposed model with the least square method. The output of the project will be a peer-reviewed journal article.

Intermediate-Scale Evaluation of Subsurface Transport and Fate Models

INSTITUTE: Cooperative Agreement

TASK NO: 0948-002

PROJECT PERIOD: Proposal

PRINCIPAL INVESTIGATOR:

ABSTRACT: The objective of this project is to use large-scale physical models or pilot-scale field sites to develop data sets that can be used to evaluate subsurface transport and fate models. The intermediate-scale evaluations will be conducted in conjunction with necessary laboratory work to independently evaluate model parameters. A Report on the Intermediate-Scale Evaluation of Subsurface Transport and Fate Models will be developed.

Parameter Sensitivity Evaluation of Selected Unsaturated Zone Models

INSTITUTE: RSKERL

TASK NO: 0948-EAJW1

PROJECT PERIOD: Pending

PRINCIPAL INVESTIGATOR: Joe Williams (405) 436-8608

ABSTRACT: The objective of this project is to evaluate the ability of various unsaturated zone models to predict the transport and fate of hazardous constituents remaining in soils following remediation. Sensitivity analysis will be performed on ten unsaturated zone models to quantitatively evaluate model result sensitivity to variations in model input parameters. Activities carried out under this task will compile the findings of related activities under Task Nos. 3036, 3037, and 3058.

Sensitivity of Model Predicted Chemical Transport to Boundary Conditions at the Soil Surface

INSTITUTE: RSKERL

TASK NO: 0948-EAJW2

PROJECT PERIOD: Pending

PRINCIPAL INVESTIGATOR: Joe Williams (405) 436-0608

ABSTRACT: The objective of this project is to evaluate the sensitivity of contaminant flux within the soil profile and at the water table to surface boundary conditions for water and chemicals. The approach will be to use the LEACHM model for the prediction of water movement and contaminant transport in the unsaturated zone to determine the degree of detail needed in surface boundary conditions for water recharge. Information will be developed to base decisions for recharge estimates for the determination of soil cleanup levels for remediation design purposes. The work will result in a project report or issue paper.

EIT Inverse Solution

INSTITUTE:	RSKERL	
TASK NO:	0948-RSJC3	
PROJECT PERIOD:	Pending	
PRINCIPAL INVESTIGATOR:	Jong Soo Cho	(405) 436-8547

ABSTRACT: The objective is to solve the inverse resistivity problem for a three dimensional heterogeneous media based on experimental data obtained from physical model at RSKERL. Future allocations will be used to expand the solution to include dialectric properties in addition to the resistive properties. The electrical properties of an aquifer are made up of two primary components: resistivity and permittivity.

TECHNICAL ASSISTANCE AND INFORMATION TRANSFER

The application of research results through technical assistance on a variety of environmental issues has been a tradition at the RSKERL since its beginning in 1965. Even though the Laboratory gained a national and international reputation for its research, it was not until 1986 that events occurred which led to a structured program in technical assistance and made it an integral part of the Laboratory's activities, particularly with regard to the remediation of soil and ground water at hazardous waste sites.

Following the Superfund Amendments and Reauthorization Act of 1986, Regional decision makers, charged with administering cost-effective and permanent restoration technologies at Superfund Sites, quickly became overburdened by the technical complexity of this responsibility. Informed decisions concerning soils and ground-water remediation required a broad, interdisciplinary, state-of-the-science level of expertise in a rapidly developing and complex environmental field.

In 1987, in order to make EPA's Office of Research and Development scientists more accessible to Regional decision makers, the Office of Solid Waste and Emergency Response (OSWER) provided direct funding to ORD laboratories in Las Vegas, Cincinnati, Athens, and Ada to establish Superfund Technology Support Centers.

The goal of the RSKERL Technology Support Program is to provide state-of-science technical support to those charged with making decisions concerning ground water protection and restoration, especially site remediation decision makers, Remedial Project Managers (RPMs), and On-Scene Coordinators (OSCs). This is accomplished through (1) direct, site-specific technical assistance, (2) state-of-the-science information on subsurface remedial technologies and the transport and fate of subsurface contaminants, and (3) improved modeling and assessment tools for dealing with Superfund sites. The RSKERL Technology Support Program completed its sixth year of service at the end of 1993. In addition to its technology transfer activities, the TSC has 725 active or completed site specific projects encompassing an involvement at a total of over 375 Superfund and RCRA sites.

The RSKERL-Ada Technology Support Program operates the Center for Subsurface Modeling Support (CSMoS), the Subsurface Remediation Information Center (SRIC), and the Ground Water Remediation Technologies Analysis Center (GWRTAC). CSMoS provides direct technical support to EPA and State decision makers in subsurface model applications, in addition to managing, distributing and supporting the ground water and vadose zone models and databases resulting from research at RSKERL. SRIC is a database designed to provide site specific information concerning subsurface contamination and remediation activities presently being conducted or proposed at hazardous waste sites throughout the United States. GWRTAC is a joint undertaking with industry, academia, professional societies, EPA and other Federal Agencies to develop a knowledge base of the status of ongoing in-situ ground-water remediation technology development and demonstration efforts with emphasis on evaluating those efforts with respect to their applicability to remediating subsurface contamination at hazardous waste sites.

In addition to Superfund, which remains the major client, the RSKERL TSC provides assistance to Headquarters, Regional, and State personnel responsible for RCRA corrective actions, Underground Storage Tanks, Pesticides, the Underground Injection Control Program, and the Wellhead Protection Program.

PUBLICATIONS

During RSKERL's tenure of operation, a large number of reports and other types of documents dealing with environmental problems have been published. A list of those publications for the period 1992 to the present is presented in this section. These can be obtained as described below. A full list of publications (1967-1994) is available upon request from RSKERL.

Publications containing an NTIS number should be obtained from:

National Technical Information Service
U.S. Department of Commerce
Springfield, VA 22161
(703) 557-4560

Other publications can be requested from:

Robert S. Kerr Environmental Research Laboratory
P.O. Box 1198
Ada, OK 74820
(405) 436-8651

1992 ABIOTIC TRANSFORMATION OF CARBON TETRACHLORIDE IN THE PRESENCE OF SULFIDE AND MINERAL SURFACES

M.R. Kriegman-King and M. Reinhard
American Chemical Society, Division of Environmental Chemistry; preprints of papers presented at the 203rd ACS National Meeting; April 5-10, 1992, San Francisco, CA, 2(2):495-498
EPA-600/A-92-097, NTIS PB 92-179738

ACQUISITION OF REPRESENTATIVE GROUND WATER QUALITY SAMPLES FOR METALS

R.W. Puls and R.M. Powell
Special "focus" issue of Ground Water Monitoring Review, Summer 1992, 12(3):167-176
EPA-600/J-92-308, NTIS PB 92-227487

AN EXACT PEAK CAPTURING AND OSCILLATION-FREE SCHEME TO SOLVE ADVECTION-DISPERSION TRANSPORT EQUATIONS

G. Yeh, J. Chang and T.E. Short
Water Resources Research, 28(11):2937-2951
EPA-600/J-92-409, NTIS PB 93-131845

AN OPTIMAL ADAPTIVE LOCAL GRID REFINEMENT APPROACH TO MODELING CONTAMINANT TRANSPORT

G. Yeh, K.A. Kane and T.E. Short
Computational Methods in Water Resources IX (1): Numerical Methods in Water Resources, Computational Mechanics Publication, pp. 659-667
EPA-600/A-92-182, NTIS PB 92-217314

APPLIED GEOLOGIC, MICROBIOLOGICAL, AND ENGINEERING CONSTRAINTS OF IN-SITU BTEX BIOREMEDIATION

L. Kennedy and S.R. Hutchins
Remediation, Winter 1992/1993, 3(1):83-107
EPA-600/J-92-450, NTIS PB 93-141497

*BASIC CONCEPTS OF CONTAMINANT SORPTION

Superfund Technology Support Center for Ground Water, Robert S. Kerr Environmental Res. Lab.
EPA-540/S-92-016, NTIS PB 93-146835

*BEHAVIOR OF METALS IN SOILS

J.E. McLean and B.E. Bledsoe
EPA-540/S-92-018, NTIS PB 93-131480

*BIODEGRADATION OF ATRAZINE IN SUBSURFACE ENVIRONMENTS

J.L. Sinclair and T.R. Lee
EPA-600/S-91-001

BIOREMEDIATION

J.M. Thomas, C.H. Ward, R.L. Raymond, J.T. Wilson and R.C. Loehr
Book Chapter in the Encyclopedia of Microbiology, 1(A-C): by Academic Press, Inc., 1992
EPA-600/A-93-004, NTIS PB 93-149193

**Publications denoted by an asterisk (*) are readily available from RSKERL.*

BIOSORPTION OF DICHLORODIPHENYLTRICHLOROETHANE AND HEXACHLOROBENZENE IN GROUND WATER AND ITS IMPLICATIONS FOR FACILITATED TRANSPORT

R. Lindqvist and C.G. Enfield
Applied and Environmental Microbiology, 58(7):2211-2218
EPA-600/J-92-452, NTIS PB 93-141513

*A BIOVENTING APPROACH TO REMEDIATE A GASOLINE CONTAMINATED SUBSURFACE

D.H. Kampbell, J.T. Wilson and C.J. Griffin
Published in: Emerging Technologies for Hazardous Waste Management, 1991 Book of Abstracts for the Special Symposium, Atlanta GA, Industrial & Eng. Chemistry Div., American Chemical Society, Oct. 1-3, 1991
EPA-600/A-92-220, NTIS PB 93-119816

BIOVENTING RECLAMATION PILOT PROJECT-AVIATION GASOLINE SPILL

D.H. Kampbell, J.T.Wilson, C.J. Griffin and D.W. Ostendorf
Tech Trends, June 1992

CAPTURE ZONE DELINEATION USING THE ANALYTIC ELEMENT METHOD: A COMPUTER MODELING DEMONSTRATION FOR THE ELLIS COUNTY (KANSAS) WELLHEAD PROTECTION COMMITTEE

Stephen R. Kraemer and David S. Burden
Ground Water Mgmt. Book 9 of the Series Proceedings of the 1992 Solving Ground Water Problems with Models Conference, p. 697

CELL DENSITY AND NON-EQUILIBRIUM SORPTION EFFECTS ON BACTERIAL DISPERSAL IN GROUND WATER MICROCOSMS

R. Lindqvist and C.G. Enfield
Microbial Ecology, 24:25-42, Nov. 1992
EPA-600/J-92-451, NTIS PB 93-141505

*CHEMICAL ENHANCEMENTS TO PUMP-AND-TREAT REMEDIATION

C.D. Palmer and W. Fish
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COLLOIDAL TRANSPORT IN SANDY AQUIFER MATERIAL: SURFACE AND AQUEOUS CHEMICAL EFFECTS

R.W. Puls, D.A. Clark and C.J. Paul
In: Proceedings,1992 Fall Meeting American Geophysical Union, A Supplement to EOS, H12A, p. 167, Oct. 1992

COLUMN STUDIES ON BTEX BIODEGRADATION UNDER MICROAEROPHILIC AND DENITRIFYING CONDITIONS

Stephen R. Hutchins, S.W. Moolenaar and D.E. Rhodes
Ground Water: The Problem and Some Solutions, Proceedings: 4th Annual Symposium The Gulf Coast Hazardous Substance Research Center, Beaumont, TX, April 2-3, 1992, pp. 67-90
EPA-600/A-92-080, NTIS PB 92-179050
Jnl. of Hazardous Materials, 32:195-214, 1992, Elsevier Science Publishers B.V., Amsterdam
EPA-600/J-93-042, NTIS PB 93-158962

COMPARISON BETWEEN MODEL SIMULATIONS AND FIELD RESULTS FOR IN-SITU BIORESTORATION OF CHLORINATED ALIPHATICS: PART 2. COMETABOLIC TRANSFORMATIONS

L. Semprini and P.L. McCarty
Ground Water, 30(1):37-44, January-February, 1992

COMPARISON OF GROUND-WATER SAMPLING DEVICES BASED ON EQUILIBRATION OF WATER QUALITY INDICATOR PARAMETERS

C. Paul and R. Puls
In: Proceedings, National Ground Water Sampling Symposium, Washington, DC, 11-30-92, pp. 21-39
EPA-600/A-93-005, NTIS PB 93-149201

CRITICAL EVALUATION OF TREATMENT TECHNOLOGIES WITH PARTICULAR REFERENCE TO PUMP-AND-TREAT SYSTEMS

S.G. Schmelling, C.G. Enfield and J.W. Keeley
Elsevier Applied Science, London and New York, for SCI Water and Environmental Group. Proceedings of Contaminated Land Treatment Technologies, pp. 220-234
EPA-600/A-92-224, NTIS PB 93-119857

*DENSE NONAQUEOUS PHASE LIQUIDS--A WORKSHOP SUMMARY

Robert S. Kerr Environmental Research Laboratory
EPA-600/R-92-030, NTIS PB 92-178939

*DETECTING WATER FLOW BEHIND PIPE IN INJECTION WELLS

J.T. Thornhill and B. G. Benefield
EPA-600/R-92-041, NTIS PB 92-239532

DISTRIBUTION, SPECIATION, AND TRANSFORMATION OF CHROMIUM IN CONTAMINATED SOILS

Robert W. Puls, D.A. Clark, and C.J. Paul
203rd American Chemical Society National Meeting, San Francisco, CA, April 5-10, 1992, 32(1):455-457
EPA-600/A-92-084, NTIS PB 92-179092

EPA's MASTER RESEARCH PLAN

M.D. Jawson, R. Swank, A.R. Carlson, C.A. Ribic and M. Hewitt
Agronomy Abstracts, Nov. 1-6, 1992, Minneapolis, MN, p. 328

EPA's SUPERFUND TECHNICAL SUPPORT PROJECT

M.R. Scalf
Journal of Hazardous Materials, 32(2+3): 313-319, Elsevier Science Publishers B.V., Amsterdam
* Not available NTIS

ESTIMATING AQUIFER PROPERTIES BY NONLINEAR LEAST-SQUARES ANALYSIS OF PUMP TEST RESPONSE

R.A. Johns, L. Semprini, and P.V. Roberts
Ground Water, 30(1):68-77, January-February 1992

*EVALUATION OF SOIL VENTING APPLICATION
D.C. DiGiulio
EPA-540/S-92-004, NTIS PB 92-232362

*FUNDAMENTALS OF GROUND-WATER MODELING
J. Bear, M.S. Beljin and R.R. Ross
EPA-540/S-92-005, NTIS PB 92-232354

*GENERAL METHODS FOR REMEDIAL OPERATION PERFORMANCE EVALUATION
Robert S. Kerr Environmental Research Laboratory
EPA-600/R-92/002, NTIS PB 92-166842

IMPROVED METALS SAMPLING TECHNIQUES FOR GROUNDWATER
R.W. Puls
Tech Trends, 7:2, December 1991
EPA-540/M-91-005

INHIBITION OF ALKYLBENZENE BIODEGRADATION UNDER DENITRIFYING CONDITIONS BY USING THE ACETYLENE BLOCK TECHNIQUE
S.R Hutchins
Applied and Environmental Microbiology, 58(10):3395-3398, Oct. 1992
EPA-600/J-92-393, NTIS PB 93-121242

*IN-SITU BIOREMEDIATION OF CONTAMINATED GROUND WATER
J.L. Sims, J.M. Suflita and H.H. Russell
EPA-540/S-92-003, NTIS PB 92-224336

*IN-SITU BIOREMEDIATION OF GROUND WATER
Superfund Technology Support Center for Ground Water
EPA-540/S-92-017, NTIS PB 93-146850

IN-SITU TRANSFORMATION OF CARBON TETRACHLORIDE AND OTHER HALOGENATED COMPOUNDS RESULTING FROM BIOSTIMULATION UNDER ANOXIC CONDITIONS
L. Semprini, G.D. Hopkins, P.L. McCarty, and P.V. Roberts
Env. Sci. and Tech., 26:2454-2461, 1992

LANDFILL LEACHATE EFFECTS ON SORPTION OF ORGANIC MICROPOLLUTANTS ONTO AQUIFER MATERIALS
T. Larsen, T.H. Christensen, F.M. Pfeffer and C.G. Enfield
Jnl. Contaminant Hydrology, 9(4):307-324, April 1992
EPA-600/J-92-235, NTIS PB 92-198597

LANDFILL LEACHATE EFFECTS ON TRANSPORT OF ORGANICS IN AQUIFER MATERIALS
F.M. Pfeffer and C.G. Enfield
Transport and Remediation of Subsurface Contaminants, ACS Symposium Series 491, June 1991, pp. 194-204
EPA-600/A-92-142, NTIS PB 92-198225

LARGE-SCALE NATURAL GRADIENT TRACER TEST IN SAND AND GRAVEL, CAPE COD, MASSACHUSETTS. 3. HYDRAULIC CONDUCTIVITY VARIABILITY AND CALCULATED MACRODISPERSIVITIES

K.M. Hess, S.H. Wolf and M.A. Celia
Water Resources Research, 28(8):2011-2027, August 1992
EPA-600/J-92-359, NTIS PB 93-107050

LIMITING FACTORS IN GROUND-WATER REMEDIATION

C.W. Hall and J.A. Johnson
Journal of Hazardous Materials, 32(1992):215-225, Elsevier Science Publishers B.V., Amsterdam
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*LNAPL DISTRIBUTION AND HYDROCARBON VAPOR TRANSPORT IN THE CAPILLARY FRINGE

D.W. Ostendorf, E.E. Moyer, R.J. Richards, E.S. Hinlein, Y. Xie and R.V. Rajan
EPA-600/R-92-247, NTIS PB 93-157550

* A MANUAL OF INSTRUCTIONAL PROBLEMS FOR THE U.S.G.S. MODFLOW MODEL

P.F. Anderson
EPA-600/R-93-010

METALS IN GROUND WATER: SAMPLING ARTIFACTS AND REPRODUCIBILITY

R.W. Puls, D. Clark, B. Bledsoe, R.M. Powell and C.J. Paul
Hazardous Waste & Hazardous Materials, 9(2):149-162
EPA-600/J-92-307, NTIS PB 92-227479

*METHODOLOGIES FOR EVALUATING IN SITU BIOREMEDIATION OF CHLORINATED SOLVENTS

L. Semprini, D. Grbic-Galic, P.L. McCarty, and P.V. Roberts
EPA-600/R-92-042, NTIS PB 92-146943

MICROBIAL DEGRADATION OF TOLUENE UNDER SULFATE-REDUCING CONDITIONS AND THE INFLUENCE OF IRON ON THE PROCESS

H.R. Beller, D. Grbic-Galic and M. Reinhard
Applied and Environmental Microbiology, 58(2):786-793, March 1992
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Poster Presentation at ASA-CSSA-SSSA 1992 Annual Meeting, November 1-6, 1992, Minneapolis, MN
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EPA-600/A-92-086, NTIS PB 92-179118
Jnl. of Haz. Materials, 32(1992):293-311, EPA-600/J-93-027, NTIS PB 93-156313

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J.W. Weaver and B.K. Lien
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*MULTIPHASE CHEMICAL TRANSPORT IN POROUS MEDIA
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2: Mathematical Modeling in Water Resources, June 1992, pp. 281-288
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1: Numerical Methods in Water Resources, June 1992, pp. 713-720
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L. Semprini, G.D. Hopkins, P.V. Roberts, and P.L. McCarty
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J.S. Cho and D.C. DiGiulio
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EPA-600/J-92-391, NTIS PB 93-121234

PROCEEDINGS OF THE SYMPOSIUM ON SOIL VENTING
Sponsors: Robert S. Kerr Environmental Research Laboratory, Ada, OK and National Center for Ground Water Research, Rice University, Houston, TX
Presented at the Symposium on Soil Venting, Houston, TX, April 29-May 1, 1991
EPA-600/R-92-174, NTIS PB 93-122323

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D. Kampbell and J. Wilson
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R.J. Charbeneau, J. Tauxe, J.W. Weaver and B.K. Lien
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T.C. Harmon, L. Semprini, and P.V. Roberts
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R.W. Puls, R.M. Powell and T.F. Rees
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S.A. Gibson and G.W. Sewell
Applied and Environmental Microbiology, 58(4):1392-1393, April 1992
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J.W. Weaver and S.G. Huling
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R.W. Puls and R.M. Powell
American Chemical Society, ACS Symposium Series 491, pp. 40-54
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C.C. West and J.H. Harwell
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C.C. West
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H.H. Russell, J.E. Matthews and G.W. Sewell
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M. Kriegman-King
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D.H. Kampbell and B.H. Wilson
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EPA-600/A-93-175, NTIS PB 93-221935

*BIOREMEDIATION USING THE LAND TREATMENT CONCEPT

D.E. Pope and J.E. Matthews
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S.R. Hutchins
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D. Kampbell , D. Fine and J. Anderson
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EPA-600/A-93-172, NTIS PB 93-221901

COMPARISON OF BIOVENTING AND AIR SPARGING FOR IN-SITU BIOREMEDIATION OF FUELS

D. Kampbell, C.J. Griffin, F.A. Blaha
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EPA-600/R-93-054

*COMPILATION OF GROUND-WATER MODELS

P.K.M. van der Heijde and O.A. Elnawawy
EPA-600/R-93-118, NTIS PB 93-209401

*COMPLEX MIXTURES AND GROUND WATER QUALITY

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