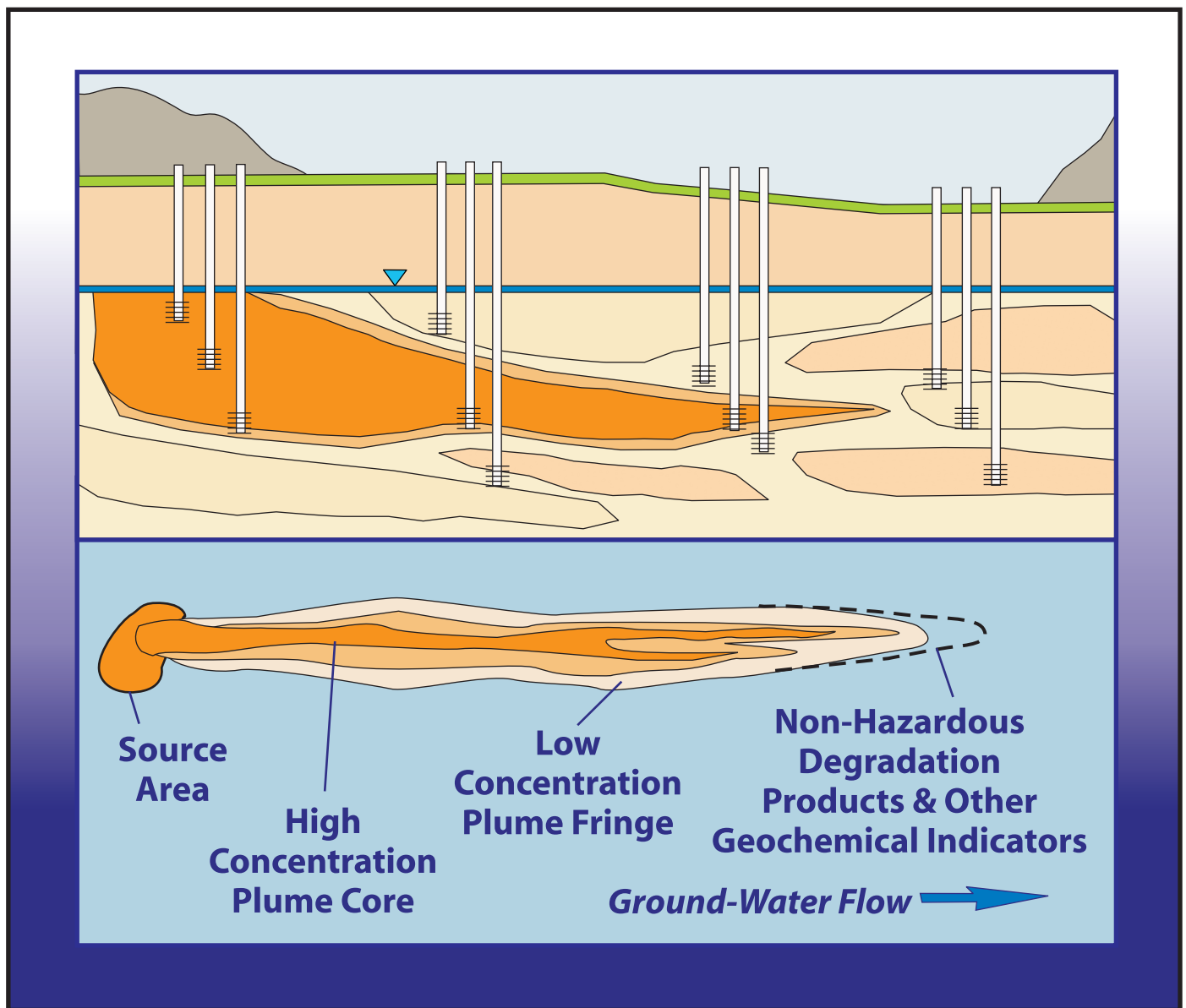


Performance Monitoring of MNA Remedies for VOCs in Ground Water



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All research projects making conclusions or recommendations based on environmental data and funded by the U.S. Environmental Protection Agency are required to participate in the Agency Quality Assurance Program. This project did not involve the collection or use of environmental data and, as such, did not require a Quality Assurance Plan.

FOREWORD

The U.S. Environmental Protection Agency is charged by Congress with protecting the Nation's land, air, and water resources. Under a mandate of national environmental laws, the Agency strives to formulate and implement actions leading to a compatible balance between human activities and the ability of natural systems to support and nurture life. To meet this mandate, EPA's research program is providing data and technical support for solving environmental problems today and building a science knowledge base necessary to manage our ecological resources wisely, understand how pollutants affect our health, and prevent or reduce environmental risks in the future.

The National Risk Management Research Laboratory (NRMRL) is the Agency's center for investigation of technological and management approaches for preventing and reducing risks from pollution that threatens human health and the environment. The focus of the Laboratory's research program is on methods and their cost-effectiveness for prevention and control of pollution to air, land, water, and subsurface resources; protection of water quality in public water systems; remediation of contaminated sites, sediments and ground water; prevention and control of indoor air pollution; and restoration of ecosystems. NRMRL collaborates with both public and private sector partners to foster technologies that reduce the cost of compliance and to anticipate emerging problems. NRMRL's research provides solutions to environmental problems by: developing and promoting technologies that protect and improve the environment; advancing scientific and engineering information to support regulatory and policy decisions; and providing the technical support and information transfer to ensure implementation of environmental regulations and strategies at the national, state, and community levels.

Effective performance monitoring for remedies that rely on the natural attenuation of contaminants is a crucial element of remedial design and implementation. Effective monitoring system designs are formulated from an enhanced understanding of the migration and ultimate fate of the contaminants in the site-specific environment. This document provides technical recommendations regarding the types of monitoring parameters and analyses useful for evaluating the effectiveness of the natural attenuation component of ground-water remedial actions. The information will be helpful during the design of the performance monitoring plan as well as during its implementation.



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LIST OF ACRONYMS AND ABBREVIATIONS

<u>Acronym</u>	<u>Definition</u>
BTEX	Benzene, Toluene, Ethylbenzene, Xylenes
CERCLA	Comprehensive Environmental Response Compensation and Liability Act
COCs	Contaminants of Concern
DCE	Dichloroethene
DNAPL	Dense Nonaqueous Phase Liquid
DQA	Data Quality Assessment
DQO	Data Quality Objectives
EPA	U.S. Environmental Protection Agency
LNAPL	Light Nonaqueous Phase Liquid
MCL	Maximum Contaminant Level
MTBE	Methyl-t-Butyl Ether
MNA	Monitored Natural Attenuation
NAPL	Nonaqueous Phase Liquid
OSWER	Office of Solid Waste and Emergency Response
PCE	Perchloroethene (tetrachloroethene)
PRGs	Preliminary Remediation Goals
QA/QC	Quality Assurance/Quality Control
RAOs	Remedial Action Objectives
RCRA	Resource Conservation and Recovery Act
ROD	Record of Decision
TCE	Trichloroethene
TEA	Terminal Electron Acceptor
TICs	Tentatively Identified Compounds
VC	Vinyl Chloride

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ABSTRACT

Environmental monitoring is the major component of any remedy that relies on natural attenuation processes. The objective of this document is to identify data needs and evaluation methods useful for designing monitoring networks and determining remedy effectiveness. Effective monitoring of natural attenuation processes involves a three-dimensional approach to network design and clearly defined performance criteria based on site-specific remedial action objectives. Objectives for the monitoring program will be met through routine evaluations of institutional controls and measurements of contaminant, geochemical, and hydrologic parameters. These data are used to evaluate changes in three-dimensional plume boundaries, contaminant mass and concentration, and hydrological and geochemical changes that may indicate changes in remedy performance.

Data interpretation focuses on detection of spatial and temporal changes, and assessment of their impacts on the achievement of site-specific goals. Particular changes of interest include:

- Progress toward contaminant removal objectives and indications of additional contaminant releases,
- Contaminant detections at the horizontal and vertical plume boundaries that may indicate plume expansion,
- Geochemical changes (e.g., oxidation-reduction (redox) conditions) indicative of possible changes in contaminant transformation rates,
- Changes in ground-water flow rates or directions such that contaminants may move into previously unimpacted areas, and
- Changes in land and resource uses that threaten the effectiveness of institutional controls.

Decisions regarding remedy effectiveness and the adequacy of the monitoring program will generally result in either continuation of the program, program modification, implementation of a contingency or alternative remedy, or termination of the performance monitoring program. Such decisions are appropriately based on specific, quantifiable performance criteria defined in the monitoring plan. Continuation of the program without modification would be supported by contaminant concentrations behaving according to remedial expectations while ground-water flow and geochemical parameters remain within acceptable ranges. Modification of the program, including increases or decreases in monitoring parameters, frequency, or locations, may be warranted to reflect changing conditions or improved understanding of natural attenuation processes at the site. Situations that may trigger implementation of a contingency or alternative remedy include:

- Increasing contaminant concentrations or trends not predicted during remedy selection or indicative of new releases,
- Contaminant migration beyond established plume or compliance boundaries,
- Contaminants not decreasing at a rate sufficient to meet remediation objectives,
- Changes in land or ground-water use that have the potential to reduce the protectiveness of the remedy, and
- Contaminants observed at locations posing or having the potential to pose unacceptable risks to receptors.