

the above noted experts (cleanup specialists) and especially work with them on cleanups, through proposals, reports and recommendations.

Of the 14 contributors to the book, seven are members of or are associated with the firm of Eckenfelder, Inc. in Nashville, Tennessee. The other contributors are from academe, government, engineering firms or research laboratories.

The first two chapters discuss the fundamental principles on which remediation exists. The first chapter addresses groundwater hydrology and contaminated transport that provide the basis on which remediation occurs. Much of the chapter is devoted to DNAPLs (dense, nonaqueous phase liquids) which are difficult to remove from the subsurface. The second chapter discusses pump-and-treat processes, addressing some of the difficulties encountered in that technology entitled, "Problems with the Remediation of Diffusion-Limited Fractured-Rock Systems." The authors review some of the problems inherent in attempting to control and remediate contaminated fractured rock aquifers.

The truly innovative technology discussion material begins with Chapter 3. Discussed in that and subsequent chapters are the following technologies:

- chemical stabilization of contaminated soil
- soil vapor extraction
- thermally enhanced vapor stripping
- thermal desorption
- enhanced biodegradation
- saturated zone sparging
- in situ vitrification
- soil surfactant flushing/washing

Clearly the topic of contaminated waste site remediation is an important one – and this book is an important addition to the literature. It is timely, well written, well referenced and well focused on the topic of innovative technologies. Surprisingly, for a user-focused book it contains a goodly amount of theoretical material.

The editors are to be commended for their balance.

GARY F. BENNETT

In Situ Bioremediation: When Does It Work? Committee on In Situ Bioremediation, Water Science and Technology Board, Commission on Engineering and Technical Systems, National Research Council, National Academy Press, Washington, DC, 1993, 207 pages, price US\$ 29.95, ISBN 0-309-04896-6

The United States faces costs in the billions to clean up contaminated sites. Bioremediation offers the prospect of being a cheaper, faster, safer way of accomplishing the task.

Bioremediation is a rapidly developing field – but in common with all fast-moving technologies, it lacks scientific backup. As such, its application is more often an art than a science. Thus, the study carried out under the rigorous peer-reviewed

guidelines of the National Research Council is a valuable addition to the scientific literature.

The study focused on two aspects of bioremediation: (1) The use of microorganisms to remove contamination from groundwater and soils that remain in place. (2) The provision of guidance on how to evaluate when an in situ bioremediation provision is working or has worked.

I was impressed with the technique used by the committee of 14 (chaired by Bruce F. Rittmann of Northwestern University, Evanston, IL). Nine committee members prepared seven background papers (all are printed in the book) in advance of a week-long workshop that focused on these prepared papers. From that workshop, this book (report) evolved.

In this report, the Committee on In Situ Bioremediation (of the National Research Council) communicates the scientific and technological basis for in situ bioremediation with the goal of eliminating the mystery that shrouds this highly multidisciplinary technology. The report presents guidelines for evaluating in situ bioremediation projects for determining which projects will meet or are meeting cleanup goals.

The four principal chapter headings and subheadings illustrate the scope of the committee's work:

1. Principles of Bioremediation:
 - the role of microbes in bioremediation
 - contaminants susceptible to bioremediation
 - environments amenable to bioremediation
2. The Current Practice of Bioremediation:
 - bioremediation versus other technologies
 - basics of bioremediation process design
3. Evaluating In Situ Bioremediation:
 - techniques for demonstrating biodegradation in the (measurements, experiments, modeling)
 - limitations inherent in evaluating in situ bioremediation
4. Future Prospects for Bioremediation:
 - new frontiers in bioremediation
 - the increasing importance of evaluating bioremediation

The seven background papers (that were the basis of the committee's discussions) listed below provide an enhanced understanding of the topic:

1. A regulator's perspective on in situ bioremediation
2. An industry perspective on intrinsic bioremediation
3. Bioremediation from an ecological perspective
4. In situ bioremediation: the state of the practice
5. Engineering challenges of implementing in situ bioremediation
6. Modeling in situ bioremediation
7. Testing bioremediation in the field.