

McGraw-Hill STANDARD HANDBOOKS

Standard Handbook of
**Environmental
Science, Health,
and Technology**



JAY H. LEHR

CONTENTS

Contributors	xiii
Foreword	xxv
Preface	xxvii
About the Editors	xxxix

Part 1 The Interaction of Basic Scientific Disciplines on Contaminant Fate and Transport in the Environment

Chapter 1. Chemistry 1.3

- 1.1. Aquatic Chemistry *Stanley Manahan* / 1.3
- 1.2. Environmental Chemistry of the Atmosphere *Stanley Manahan* / 1.9
- 1.3. Soil Environmental Chemistry *Stanley Manahan* / 1.13
- 1.4. Environmental Biochemistry *Stanley Manahan* / 1.15
- 1.5. Toxicological Chemistry *Stanley Manahan* / 1.18
- 1.6. Geochemistry *William J. Deutsch* / 1.23

Chapter 2. Classes of Chemicals 2.1

- 2.1. Hydrocarbons *David Jeffrey* / 2.1
- 2.2. Pesticides and Polychlorinated Biphenyls *David Jeffrey* / 2.18
- 2.3. Chlorinated Solvents *Daryl Doyle* / 2.30
- 2.4. Radionuclides *Peter Collopy* / 2.33

Chapter 3. Geology 3.1

- 3.1. Geologic Principles *Stephen M. Testa, James A. Jacobs* / 3.1

Chapter 4. Hydrology 4.1

- 4.1. The Hydrologic Cycle *Robert M. Hordon* / 4.1
- 4.2. Precipitation and Runoff *Robert M. Hordon* / 4.9
- 4.3. Streamflow and Flood Control *Robert M. Hordon* / 4.17
- 4.4. Groundwater Flow *Milovan S. Beljin* / 4.25
- 4.5. Well Hydraulics *Milovan S. Beljin* / 4.34
- 4.6. Real-Time Soil Water Dynamics *Ioan C. Paltineanu, James L. Starr* / 4.45
- 4.7. Fate and Transport Modeling—Effectively Using Isotopes of Water to Solve Practical Hydrogeological Problems *Donald I. Siegel* / 4.58
- 4.8. Fate and Transport in Fractured Rock *Kent Novakowski* / 4.74

Chapter 5. Physical Transport**5.1**

- 5.1. Air Pollutants and Fugitive Dust *Zhen-Gang Ji / 5.1*
- 5.2. Mixing and Transport of Pollutants in Surface Water
Peter Shanahan, Sharron C. Gaudet / 5.6

Chapter 6. Biology**6.1**

- 6.1. Biology *J. Gordon Edwards / 6.1*

Chapter 7. Contaminant Effects**7.1**

- 7.1. Toxicity Testing *Peter Bruce / 7.1*
- 7.2. Ecological Risk Assessment *Jan Swider / 7.7*
- 7.3. Ecological Effects of Toxicants *Jan Swider / 7.14*
- 7.4. Air Pollutant Sources and Effects *Jan Swider / 7.20*

Chapter 8. Analysis and Modeling**8.1**

- 8.1. Geochemical Modeling *William J. Deutsch / 8.1*
- 8.2. Groundwater Flow Modeling *Henk Haitjema / 8.11*
- 8.3. Solute Transport Modeling *Geoff Freeze, Douglas D. Walker,
Milovan S. Beljin / 8.27*
- 8.4. Fate and Transport in Rivers, Lakes, and Estuaries *Zhen-Gang Ji / 8.47*
- 8.5. Geostatistics *Douglas D. Walker / 8.56*
- 8.6. Pharmacokinetic/Dynamic Modeling *Janusz Z. Byczkowski / 8.75*
- Appendix A. Selected Computer Codes, Software Description and Availability / 8.88
- Appendix B. Software for Compartmental Models / 8.90
- Appendix C. Computer Codes / 8.91
- 8.7. Geographic Information Systems *John Kramer, Erin Mutch, George Ball / 8.99*
- 8.8. Computing Optimal Pumping Strategies for Groundwater Contaminant
Plume Remediation *Richard C. Peralta, Alaa H. Aly / 8.106*
- Appendix A. Formation of Constraint Equations for Response Matrix Models
(Derived from Peralta and Aly, 1997) / 8.118
- Appendix B. Unique Features of REMAX (from Peralta and Aly, 1997) / 8.120
- 8.9. Economics *Kevin Wolka / 8.122*

**Part 2 Site Based Environmental Science,
Health and Technology**

Chapter 9. Pollution Prevention Concepts and Policies**9.3**

- 9.1. Pollution Prevention Science and Technology *Thomas T. Shen / 9.3*
- 9.2. Plant Operations *William B. Katz / 9.28*
- 9.3. Urban Stormwater Management and Nonpoint Source Pollution Control
Kirk R. Barrett / 9.42

Chapter 10. Environmental Regulations**10.1**

- 10.1. Basics of Environmental Law *Richard Gaskins / 10.1*

- 11.1. Site Evaluation, Auditing, and Assessment *Lisa Wadge / 11.1*
- 11.2. Applications of Global Positioning Systems in the Environmental Sciences
James A. Jacobs, Jefferson K. Phillips / 11.7
- 11.3. Indoor Air: Sick and Healthy Buildings *C. Richard Cothorn / 11.16*
- 11.4. Stream Sampling *D. Michael Johns, Frank S. Dillon, Bejuri J. Cassidy / 11.23*
- 11.5. Sediment Collection *D. Michael Johns, Beth A. Power, Bejuri J. Cassidy / 11.32*
- 11.6. Monitoring Well Construction and Sampling Techniques *James A. Jacobs / 11.46*
- 11.7. Aquifer Testing *John M. Shafer / 11.69*
- 11.8. Soil Vapor Principles *Blayne Hartman, James A. Jacobs / 11.87*
- 11.9. Applications and Interpretation of Soil Vapor Data to Volatile Organic Compound Contamination *Blayne Hartman, James A. Jacobs / 11.96*
- 11.10. Neutron Probes *John H. Kramer / 11.113*
- 11.11. Direct Sensing of Soils and Groundwater *Mark Kram, Stephen Lieberman, James A. Jacobs / 11.124*
- 11.12. Direct Push Technology Sampling Methods *James A. Jacobs, Mark Kram, Stephen Lieberman / 11.151*
- 11.13. Borehole Geophysics *W. Scott Keys / 11.164*
- 11.14. Surface Geophysical Methods for Site Characterization
Richard C. Benson, Lynn Yuhr / 11.177

Chapter 12. Toxicology and Risk

- 12.1. Decisions in the Face of Uncertainty *Jan Swider / 12.1*
- 12.2. Variability and Uncertainty *William A. Huber / 12.7*
- 12.3. Selecting Indicator and Surrogate Compounds *Robert Alan Haviland, Marlowe Dawag, David T. Hanneman / 12.18*
- 12.4. Selecting Indicator Pathways *David Jeffrey / 12.30*
- 12.5. The Dose Makes the Poison: Some Common Misconceptions
M. Alice Ottoboni / 12.33
- 12.6. Low Dose Response-Hormesis *T. D. Luckey / 12.40*
- 12.7. Microorganisms, Molecules, and Environmental Risk Assessment: Assumptions and Outcomes *Jane M. Orient / 12.50*

Chapter 13. Control Technologies

- 13.1. Hazardous Waste Handling and Disposal *David Lager / 13.1*
- 13.2. Hazardous Waste Dumping as it Relates to a Japanese Risk Management System
Takehiko Murayama / 13.9
- 13.3. Medical Waste Incineration *Charles R. Brunner / 13.27*
- 13.4. Control Technologies: Particulate Controls *Mark P. Cal / 13.43*
- 13.5. Control Technologies: Gas Controls *Mark P. Cal / 13.55*
- 13.6. Fundamentals of Odor Management *David A. Hill / 13.69*
- 13.7. Water Supply Treatment *Rumana Riffat / 13.88*
 - A. Design Flow and Loads / 13.88
 - B. Screens / 13.95
 - C. Chemical Reactors / 13.103
- 13.8. Water Supply Treatment *Leonard W. Casson / 13.110*
 - A. Coagulation, Flocculation, Mixing, and Mixers / 13.110
 - B. Sedimentation and Filtration / 13.116

Chapter 14. Remediation Technologies

- 14.1. Monitored Natural Attenuation (MNA) *Patrick V. Brady, Warren D. Brady / 14.1*
- 14.2. Passive In Situ Remediation Technologies *James A. Jacobs / 14.12*

- 14.3. Phytoremediation: A Promising Path to the Elimination of Heavy Metals and Radionuclides in Groundwater & Soil *Jay Lehr* / 14.26
- 14.4. Bioremediation of Hazardous Wastes: History and Applications *Walter W. Loo* / 14.30
- 14.5. Bioremediation *Steve Maloney* / 14.50
- 14.6. Pump-and-Treat Technologies *Milovan S. Beljin* / 14.60
- 14.7. Electrokinetic Treatment of Hazardous Wastes *Walter W. Loo* / 14.69
- 14.8. Surfactant-Enhanced Aquifer Remediation *Richard Jackson, Varadarajan Dwarakanath* / 14.85
- 14.9. Remediation of Metals-Contaminated Soils and Groundwater *Cynthia R. Evanko, David A. Dzombak* / 14.100
- 14.10. DNAPL Investigation and Remediation *Douglas R. Beal* / 14.135
- 14.11. Vertical Passive Groundwater Barrier Systems *David Lager* / 14.146
- 14.12. Aquifer Restoration via In Situ Air Sparging *Paul C. Johnson* / 14.156

Chapter 15. Ubiquitous Environmental Contaminants

15.1

- 15.1. Endocrine Disruptors *Jenifer S. Heath* / 15.1
- 15.2. Radon in Air *Bernard L. Cohen* / 15.7
- 15.3. Radon and Radon Daughters *Thomas J. Aley* / 15.20
- 15.4. Chlorofluorocarbons *S. Fred Singer* / 15.30
- 15.5. Methyl Bromide *S. Fred Singer* / 15.42
- 15.6. Subsurface Petroleum Spills *James M. Davidson* / 15.47
- 15.7. Ionizing Radiation *William Andrew Hollerman* / 15.58
- 15.8. Mortality in Male and Female Capacitor Workers Exposed to Polychlorinated Biphenyls *Renate D. Kimbrough, Martha L. Doeland, Maurice E. LeVois* / 15.73

Part 3 Place Based Environmental Science, Health and Technology

Chapter 16. Managing Place Scale Problems

16.3

- 16.1. Decision Making *Geoff Freeze* / 16.3
- 16.2. Ecosystem Management *Robert T. Lackey* / 16.11
- 16.3. Brownfields *Leah Goldberg, James A. Jacobs* / 16.21
- 16.4. Guidelines for Emergency Response *Donald Fawn Jr.* / 16.33
- 16.5. Environmental Communication *Richard R. Jurin* / 16.42
- 16.6. Ecological Engineering *Michael G. Crowe* / 16.53

Chapter 17. System Level Risk Assessment

17.1

- 17.1. Probabilistic Safety in Government and Industry *Ralph Fullwood* / 17.1
- 17.2. Risk Assessment in the Broader Context *Herbert Inhaber* / 17.19
- 17.3. Risk Management in View of Economic Aspects *Takehiko Murayama* / 17.28
- 17.4. Weighing the Risks of Remediation *David Jeffrey* / 17.41

Chapter 18. Environmental Science in the Legal System

18.1

- 18.1. Environmental Science, Toxic Torts, and the Legal System *Rolf R. von Oppenfeld* / 18.1

Chapter 19. Sensitive Environmental Systems

19.1

- 19.1. Karst Systems *Thomas J. Aley* / 19.1
- 19.2. Alpine Lakes *Peter Shanahan* / 19.11

- 19.3. Wetlands *Margaret A. McBrien, Kirk R. Barrett / 19.20*
19.4. Plants and Population: We Have the Time. Do We Have the Will?
Dennis T. Avery / 19.48

Chapter 20. Sensitive Environmental Problems

20.1

- 20.1. Agricultural Runoff *George F. Czapar / 20.1*
20.2. Test of the Validity of the Linear-No Threshold Theory of Radiation Carcinogenesis with a Survey of Radon Levels in U.S. Homes *Bernard L. Cohen / 20.12*
20.3. Acid Rain—The Whole Story To Date *John J. McKetta / 20.21*
20.4. The Ozone Layer *Hugh W. Ellsaesser / 20.28*
20.5. Greenhouse Warming (GHW) *Hugh W. Ellsaesser / 20.40*
20.6. Controversies Surrounding the Endangered Species *J. Gordon Edwards / 20.57*

Chapter 21. Misconceptions About Environmental Pollution

21.1

- 21.1. Misconceptions about Pollution, Pesticides, and the Prevention of Cancer
Bruce N. Ames, Lois Swirsky Gold / 21.1
21.2. Science, Pesticides, and Politics *J. Gordon Edwards / 21.17*
21.3. Simple Truths of Environmental Facts and Fallacies *Jack W. Dini / 21.33*

Chapter 22. Global Perspectives and Trends

22.1

- 22.1. The Road from Rio to Kyoto: How Climate Science Was Distorted to Support Ideological Objectives *S. Fred Singer / 22.1*
22.2. Natural Forces versus Anthropogenic Change *Hugh W. Ellsaesser / 22.7*
22.3. Controlling Hazardous Pollutants in a Developing Context: The Case of Arsenic in Chile
Raúl O'Ryan, Ana Maria Sancha / 22.13
22.4. Emerging Environmental Issues from the Perspective of Industry
Martin Whittaker / 22.29