

# CONTAMINATED RIVERS

# Contaminated Rivers

*A Geomorphological-Geochemical Approach  
to Site Assessment and Remediation*

By

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*To Mary and Rebecca*

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## **PREFACE**

By the end of the 1960s, it became acutely apparent that major problems existed with the quality of both surface and subsurface waters on a world-wide scale. In response to these discoveries numerous legislative initiatives were enacted in most developed countries to limit the introduction of contaminants to the environment. It quickly became apparent, however, that not only was there a need to reduce the quantity of contaminants introduced to surface and subsurface waters, but previously contaminated resources had to be remediated to reduce the potential risks on human and ecosystem health. Effective remediation proved to be a difficult task that required an improved understanding of the transport and fate of contaminants in aquatic environments. This fact resulted in a wide range of analyses regarding contaminant transport and cycling in riverine environments during the past several decades. Nonetheless, in comparison to the enormous efforts which have been made to characterize, assess, and remediate contaminated soils and groundwater, contaminated rivers have received relatively little attention. This is in spite of the fact that polluted reaches may cover tens of kilometers of stream channel and the adjacent valley floor. Progress, however, in the soils and groundwater arena has recently produced a shift in emphasis from the subsurface to the surface environment, particularly with regards to cleaning up contaminated rivers.

Rivers and their associated drainage basins tend to be geological, hydrological, and geochemically more variable than either soil or groundwater systems. Perhaps more importantly, geomorphic processes play a much larger role in controlling the dispersal, distribution, and geochemical cycling of contaminants. Thus, the direct application of site assessment and remediation protocols developed over the past several decades for soils and groundwater to rivers is generally inappropriate. In fact, post-remedial reviews demonstrate that the application of approaches created for soil and groundwater contaminated sites to fluvial (river) systems often results in less than successful cleanup programs that have required unnecessarily large financial expenditures. What is needed is a more thorough incorporation of the catchment's geomorphology and surficial processes into the utilized site characterization, assessment, and remediation strategies.

The primary purpose of this book is to provide students and professionals with an introductory understanding of fluvial geomorphic principles, and how these

principles can be integrated with geochemical data to cost-effectively assess and remediate contaminated rivers. We stress the importance of needing to understand both geomorphic and geochemical processes. A process-oriented approach is required because it goes beyond the simple description of the river channel and its associated drainage basin to enhance the predictive capabilities of models used in the investigation of riverine environments. Thus, the overall presentation is first an analysis of physical and chemical processes and, second, a discussion of how an understanding of these processes can be applied to specific aspects of site assessment and remediation. We also emphasize the need to take a catchment-scale approach when conducting site investigations, and the potential for changes in process rates through time as a result of both natural and anthropogenic disturbances. Such analyses provide the basis for a realistic prediction of the kinds of environmental responses that might be expected, for example, during future changes in climate or land-use.

Although much of the discussion is derived from work in the United States with which we are most familiar, case studies from many other parts of the world have also been included, particularly studies from the U.K. We purposely include a large number of literature citations in the text to make it easier for those wishing to pursue a topic in more depth to begin their literature review. The hope is that the discussion provided herein, combined with the literature at large, will lead to more effective cleanup programs, and to innovate ways to assess and remediate contaminated rivers.

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