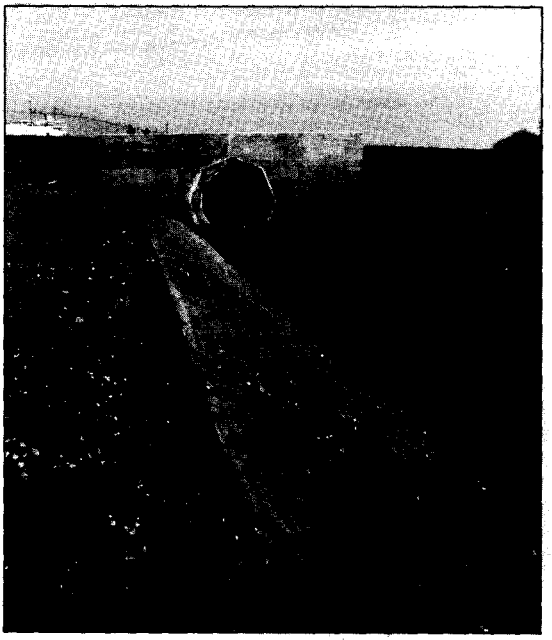
GROUNDWATER MANAGEMENT

EDITED BY

RANDALL J. CHARBENEAU



GROUNDWATER MANAGEMENT

Proceedings of the International Symposium sponsored by the Water
Resorces Engineering Division,
American Society of Civil Engineers, in conjunction with the ASCE's
First International Conference on
Water Resources Engineering in San Antonio, Texas.

San Antonio, Texas
August 14-16, 1995

Edited by Randall J. Charbeneau



Published by the
American Society of Civil Engineers
345 East 47th Street
New York, New York 10017-2398

ABSTRACT

This proceedings, Groundwater Management, contains papers presented at the International Symposium held in San Antonio Texas, August 14-16, 1995. It covers such issues as: 1) Models of remediation systems, 2) groundwater quality, 3) hydrologic models, 4) groundwater/surface water interactions, 5) non-aqueous phase liquids, 6) contaminant transport, and 7) wellhead protection.

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ISBN 0-7844-0107-1
Manufactured in the United States of America.

FOREWORD

The theme for the 1995 Symposium is Groundwater Management. The principal aim of the Symposium is to provide a forum for presentations and discussion of issues related to groundwater management technology, transboundary groundwater issues, contaminated site remediation, multiphase flow, bioremediation, geographic information systems, wellhead protection, agricultural contamination, surface water/groundwater interactions, aquifer storage and recovery, and case studies. The 70 papers are arranged into 18 technical sessions based on a common theme. The Symposium is sponsored by the Water Resources Engineering Division, American Society of Civil Engineers. The Groundwater Symposium Committee responsible for organizing and planning the Symposium consists of the following members:

Randall J. Charbeneau, Committee Chairman
Angelos N. Findikakis
Daene C. McKinney
John B. Robertson

Special thanks go to William H. Espey, Jr., for providing leadership and support in developing the Symposium, and to Viola AzZani for doing all the work. The final production of the proceedings is handled by Shiela Menaker, ASCE Book Production Manager.

Randall J. Charbeneau, Editor

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PAST, PRESENT, AND FUTURE OF WATER AND WASTEWATER

Herman Bouwer, M. ASCE[1]

Abstract

Development of water and wastewater management is traced from early history until now and concludes with predictions of future trends. Increasing populations can lead to severe water shortages, starvation, and atrocious health and sanitary conditions. Integrated management of water resources becomes increasingly critical, trying to achieve sustainability and balances between human health and well being, environmental effects, and economics.

Human waste and sewage treatment

Old civilizations are better known for their water works than for what they did with their sewage and human waste. Many people know about the Roman aqueducts, but not much about the cloaca maxima, the main sewer that carried wastewater from Rome and drainage water from the surrounding swamps to the Tiber downstream from ancient Rome. The old Persian ghanats are marvels of early groundwater development, and so are the Nabatean runoff enhancement systems and old cisterns. Sometimes, archeological excavations show early evidence of sewers, like the one a few hundred kilometers north of Karachi going back about 4,500 years, where sewer pipes and gutters leading to common cesspits were uncovered. Collecting human wastes and hauling it off to some place outside the settlements or cities also must have been a common practice, and it was still being done in European

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