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Water Resources and the Urban Environment–98

Edited by Thomas E. Wilson

WATER RESOURCES AND THE URBAN ENVIRONMENT—98

PROCEEDINGS OF THE 1998 NATIONAL CONFERENCE ON ENVIRONMENTAL ENGINEERING

June 7–10, 1998
Chicago, Illinois

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City of Chicago

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Abstract: This proceedings, *Water Resources and the Urban Environment-98*, contains papers presented at the 1998 National Conference on Environmental Engineering of the ASCE's Environmental Engineering Division held in Chicago, Illinois, June 7-10, 1998. This was part of a joint conference held with the ASCE's Water Resources Planning and Management Division. The focus of the conference was on the planning, development, and operation of engineered projects involving use of water resources in the urban setting. Papers presented covered a wide range of topics including: 1) drinking water and wastewater treatment and conveyance; 2) water reuse; 3) biosolids; 4) GIS information systems; 5) site remediation; 6) groundwater remediation; 7) air pollution; 8) small urban watersheds; 9) decentralized alternative wastewater management systems; and 10) general environmental issues.

Library of Congress Cataloging-in-Publication Data

National Conference on Environmental Engineering (1998: Chicago, Ill.)
Water resources and the urban environment-98: proceedings of the 1998 National Conference on Environmental Engineering / sponsored by the Environmental Engineering Division; co-sponsored by Metropolitan Water Reclamation District of Greater Chicago...[et al.]; in cooperation with DuPage County Department of Environmental Concerns...[et al.]; edited by Thomas E. Wilson.
p. cm.
"Chicago, Il, June 7-10, 1998."
Includes bibliographical references and index.
ISBN 0-7844-0349-X
1. Municipal water supply-Congresses. 2. Urban hydrology-Congresses. 3. Municipal water supply-United States-Congresses. 4. Urban hydrology-United States-Congresses. I. Wilson, Thomas E., 1942- . II. American Society of Civil Engineers. Environmental Engineering Division. III. Metropolitan Water Reclamation District of Greater Chicago. IV. DuPage County (Ill.). Dept. of Environmental Concerns.
TD201.N28 1998
333.91'15'091732-dc21 98-17827
CIP

Library of Congress Catalog Card No.: 98-17827
ISBN 0-7844-0349-X
Manufactured in the United States of America.

PREFACE

Water Resources and the Urban Environment -'98 is the proceedings of the *1998 National Conference on Environmental Engineering*. This is the 1998 version of an annual conference sponsored by the Environmental Engineering Division of ASCE. This volume is a companion volume to **Water Resources and the Urban Environment** that is the proceedings of the *25th Annual Conference on Water Resources Planning and Management*. Both conferences were held simultaneously as a joint conference. This joint conference represents a new, unique venture promoting interdivisional cooperation within ASCE.

The scope of the contents of these proceedings is both wide and varied. Over 135 papers are included from all over the world - including papers from the Netherlands, Denmark, Italy, Australia and Taiwan as well as Canada and the US. Papers range from pure research to examples of the successful implementation of large scale water projects. Subjects range from the treatment and conveyance of potable, ground and waste waters, to water reuse, biosolids and GIS information systems. Reflecting the conference theme, papers on local Chicago issues and issues from other large urban areas including New York and West Coast cities are well represented in the program; however the program also includes a symposium on the management of decentralized small scale alternative wastewater management systems.

Authors represent all parts of the community, including consultants, operating agencies, regulatory agencies, equipment suppliers, service providers, research institutes, state, local and federal agencies, law firms and academia.

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*** manuscript not available at time of publication**

Gas/Groundwater Interactions at Landfills

John A. Baker[1]

Introduction

The Waste Management Technology Center, Inc. (WM) has conducted over 60 groundwater quality assessments for solid waste landfills over the last three years due to the detection of VOCs in groundwater monitoring wells. State and Federal regulations for routine detection monitoring programs require additional assessment if VOCs are detected over background (or below detection or "ND" in most cases). The assessment is conducted to determine the origin or source of the VOCs, plume characterization, and an evaluation of remedial methods. Over 90 per cent of these studies showed that landfill gas was the source of the VOCs detected in downgradient monitoring wells.

Most of the landfills that had landfill gas/groundwater affects were from unlined or clay lined older areas of the site. Two of these landfills, which will be reviewed in this paper, had double geomembrane liners. Both sites also had drainage layers constructed below the double liner systems.

The two sites that had double liners were alternate Subtitle D liners approved by permit. The liners were constructed with a primary HDPE 60 mil thick liner under the leachate collection system, an underlying plastic mesh drain area (witness zone or secondary leachate collection zone), and underlain by another HDPE 60 mil thick liner.

In order to determine the source of VOCs, additional analytical work was performed. A profile of the groundwater and leachate was determined from geochemical and isotopic composition of the waters. Upgradient/background and downgradient wells to the existing landfills and landfill leachates were sampled for major anions and cations, and stable and radioactive environmental isotopes. Land-

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fill gas samples were collected at gas vents, gas probes, and in the headspaces of select primary, secondary, and subdrain sampling ports to determine if landfill gas migration is the source of the vinyl chloride in the groundwater at Site 1 and the source of VOCs in the subdrain at Site 2.

Geochemical Characterization

In order to determine if the source of VOCs in groundwater is from leachate or landfill gas, the geochemistry of groundwater and leachate was studied. Major anions and cations (i.e., Ca, Mg, Na, K, SO_4, Cl, & alkalinity) were sampled in groundwater and leachate at select monitoring wells. These geochemical parameters are useful in determining if "mixing" is occurring between adjacent aquifers or water bearing zones or if hydraulic connection has occurred vertically between aquifers or different water bearing zones (after Davis and DeWiest, 1966). The landfill and leachate are considered to be separate from the underlying groundwater regime since it represents a unique formation (i.e., garbage).

Similar patterns on Stiff diagrams suggest water of the same origin or groundwater bearing zone while waters with different patterns most likely are from unique geologic water bearing zones (Stiff, 1951). Trilinear diagrams are plotted also for the major anions and cations. Groundwater that shows distinct aquifers or distinct origins of groundwater will plot in separate clusters. Mixing of two different water bearing zones will be shown as a straight line joining the "clusters" of data on different areas of the diagram (Piper, 1944 and Hill, 1940). Leachate data is plotted as a distinct water bearing zone and evaluated as in Baedecker and Back, 1979.

Natural Isotopes

Stable and radioactive isotopes can be used in interpreting the geochemistry of groundwater at the two landfills. Stable isotopes are useful in determining if groundwater in different lateral or vertical locations has been derived from precipitation from different climatic periods over geologic time. The use of natural isotopes in investigating a variety of groundwater issues is discussed in detail in "Application of Natural Isotopes in Groundwater for Solving Environmental Problems" by Michael Szpakiewicz, March, 1990, National Institute for Petroleum and Energy Research, Bartlesville, Oklahoma, NTIS, NIPER-450 (DE90000223).

Carbon-13

Carbon-13 will be used to confirm the findings of the geochemical results. Baedecker and Back, 1979 also have shown that ^{13}C is enriched in landfill leachates showing ^{13}C levels up to +30 o/oo (most natural groundwater present at these two sites should have ^{13}C between -20 to -10 o/oo except in the presence of calcium carbonate that could elevate ^{13}C up to 0 o/oo. Landfill impacts to groundwater tend to enrich background groundwater and "shift" ^{13}C into positive readings at impacted wells.

Tritium

This radioactive isotope has been most commonly applied in environmental studies. Studies conducted by WM of landfill leachates from older sites have shown tritium levels ranging from 200 to greater than 10,000 TU. Background tritium levels in groundwater at the two sites studied is in the range of 10 to 20 TU and impacts from older landfill leachate will greatly elevate these levels in downgradient wells.

Results of the Geochemical and Isotopic Groundwater Study at Double-Lined Landfills

Select monitoring wells and leachates were sampled for geochemical and isotopic parameters at the two landfills. Vinyl chloride has been detected in several downgradient wells. Sample points ugradient to or representing background in the area of the two landfills. Leachate was collected at primary and secondary sampling points. The objective of this study was to determine if the leachate was the source of VOCs detected in the groundwater at Site 1 and the subdrain at Site 2.

Geochemistry

Trilinear Diagrams

The data from all the sample points were plotted on a Piper (trilinear) diagram for each site. For the purposes of the geochemical interpretation, leachate is treated as an "aquifer" separated from the natural aquifer by the landfill liner, which acts as the aquitard. If downgradient monitoring wells or other fluids are affected by mixing of leachate with upgradient wells or background samples, they would plot in a line between the upgradient/background samples and leachate (as in Baedecker and Back, 1979).

The leachate data is typical for municipal solid waste and is dominated by sodium-potassium and chloride-bicarbonate. The variability in the groundwater is apparent since even the upgradient wells are not clustered on the same portion of the graph. The groundwater "type" is primarily bicarbonates of calcium though there are varying concentrations of chlorides, sodium and magnesium at each well. The downgradient wells at Site 1 and subdrain of Site 2 plot near the upgradient /background samples and not on a flow line between the leachate and the upgradient samples. It is not evident from the trilinear plot that the downgradient wells or subdrain samples of concern are mixing with leachate.

Stiff Plots

The results for the Stiff plots confirm that the monitoring wells and subdrain fluids are of calcium bicarbonate type groundwater while the leachate is sodium-potassium chloride-bicarbonate type water. The heterogeneity in the constituent concentrations is evident with these plots also. The natural variation of the anions and cations can be seen across the site.