GUEST EDITOR'S PREFACE

THEME ISSUE ON URBAN GROUNDWATER

by

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INTRODUCTION

As Guest Editor, I am pleased to present this collection of articles on urban groundwater. The studies were mainly derived from the activities of the International Association of Hydrogeologists (IAH) and especially its Commission on Groundwater in Urban Areas (CGUA). Most of the articles are expanded versions of presentations made to the 25th Congress of IAH in Adelaide, Australia, in November, 1994. Others arose from the Commission's 2½-day workshop in September, 1995, held in Aachen, Germany; still others are the products of invitations from members of the Commission. All have been through the refereeing and editorial process of *Hydrogeology Journal*.

Definition of urban groundwater

Some of our colleagues have questioned whether "urban groundwater," or groundwater that underlies urban areas, is a distinct and legitimate field of study. Do not the same laws of groundwater flow and chemistry apply to all groundwater, irrespective of land use? At one level, these colleagues are correct -- we are all earth scientists, and we should be able to turn our hands to all hydrogeological problems. In reality, though, this view is too purist and impractical. The hydrogeology of karst, mineral waters, arid zones, wetlands, and irrigated lands, for example, lie in subdomains of the overall scientific space defined by

hydrology, geology, chemistry, and hydraulics. In each specialised subdomain, certain effects, interactions, and outcomes predominate, and so relevant knowledge and experience of similar cases should aid in making correct interpretations and decisions. For example, wetlands are very sensitive to groundwater levels, chalk and limestone waters are well buffered in pH, karstic systems are dominated by conduit flows, and arid recharge has distinctive spatial and temporal variability.

We are beginning to see that the same is true of groundwater beneath urban areas, and that a unique combination of hydrology and chemistry exists that leads to unusual effects. We do not claim to have a complete description of the science, engineering, and management of urban groundwater yet, but some of the features that give the study of urban groundwater an unusual character are:

- 1) Recharge, which is affected by extensive sealing of surfaces, leaking water mains, sewers, and stormwater recharge, is often greater beneath cities than beneath equivalent rural areas. Large spatial variability in recharge rates over short distances can be expected.
- 2) Geotechnical interactions often occur, including such aspects as interference with flow by extensive deep basements, tunnels, and pilings; subsidence, resulting from excessive abstraction; and rising

groundwater levels, due to augmentation of recharge.

3) Groundwater quality is affected by the point, multipoint, and linear inputs of chemicals from the multiplicity of urban features, such as industrial and residential sources, waste-water systems, gardens and parks, and landfills. The density and complexity of urban sources exceed those of any other regional land use. Because of the heterogeneity of land-use and surface conditions in urban areas, chemical inputs are unlikely to occur that are uniformly distributed in space.

4) Management of groundwater protection is difficult and complex. Conflicts often exist between the economic need to abstract groundwater near areas of demand and the multiplicity of potential pollution sources, such as factories, sewers, dense transportation networks, and the numerous small commercial enterprises that seem to defy regulations in many older cities or rapidly urbanising areas.

5) The problems of investigation are distinctive, because of highly heterogeneous sources of recharge and pollution, interferences with surface geophysics, and difficulties of access to private, valuable, and intensively-used land.

Articles

The cases presented in this issue are predominantly from Australia, because the issue originated principally from the Adelaide Congress. Perhaps too many examples are from the developed world, but it has been extremely difficult to obtain suitable material from elsewhere. The papers that are included cover a wide range of problems in more developed societies, at scales that range from local to national, as follows:

- The complexity of groundwater protection at an urban wellfield, and the application of GIS systems to help understand the hydrogeologic system and plan a strategy (Perth; Barber et al.).
- How an industrial-pollution problem was first identified by hydrogen-sulfide odors from a residential borehole, and the subsequent involvement of residents in the investigation of the problem and future management of the resource (Perth; Benker et al.).
- A regional overview of a rapidly developing city where management of urban groundwater is still in its infancy (Brisbane; Cox et al.).
- A regional review of Dresden, Germany, a city in transition to Western European styles of management, and where the effects of a centralised heating system on groundwater can be observed (Grisechek et al.).
- A study of the actual and potential impacts of landfills on groundwater in southern Ontario, Canada, where more than 1,200 sites exist, and specifically in 700 km² of urban Toronto, which contains 82 sites (Howard et al.).
- A national overview of the recharge, geotechnical, and pollution problems associated with urban groundwater in the United Kingdom (Lerner and Barrett).
- The use of nitrogen isotopes to distinguish between rural and sewer sources of nitrogen (Nottingham; Rivers et al.).
- The significant impact of lawn fertilisers on groundwater quality, as the result of leaching excess nitrogen and phosphorus, as quantified by the use of lysimeters (Perth; Sharma et al.).
- Management of an integrated scheme to recharge and subsequently reuse stormwater and treated sewage, in order to sustain the industrial city of Atlantis, located in an arid part of South Africa (Wright and du Toit).

Commission on Groundwater in Urban Areas

Since its founding in Oslo in 1993, the CGUA has conducted workshops in Adelaide, Edmonton, and Aachen, and the Commission plans to hold an autumn meeting in Sweden this year. Work continues on a bibliography on urban groundwater, and a database of case histories is being compiled for Internet access. The major event in the next few years will be the XXVII IAH Congress in Nottingham in 1997; the principal theme is urban groundwater. Any member of IAH is welcome to join CGUA by contacting the Chairman -- we particularly encourage volunteers who are willing to take an active role!