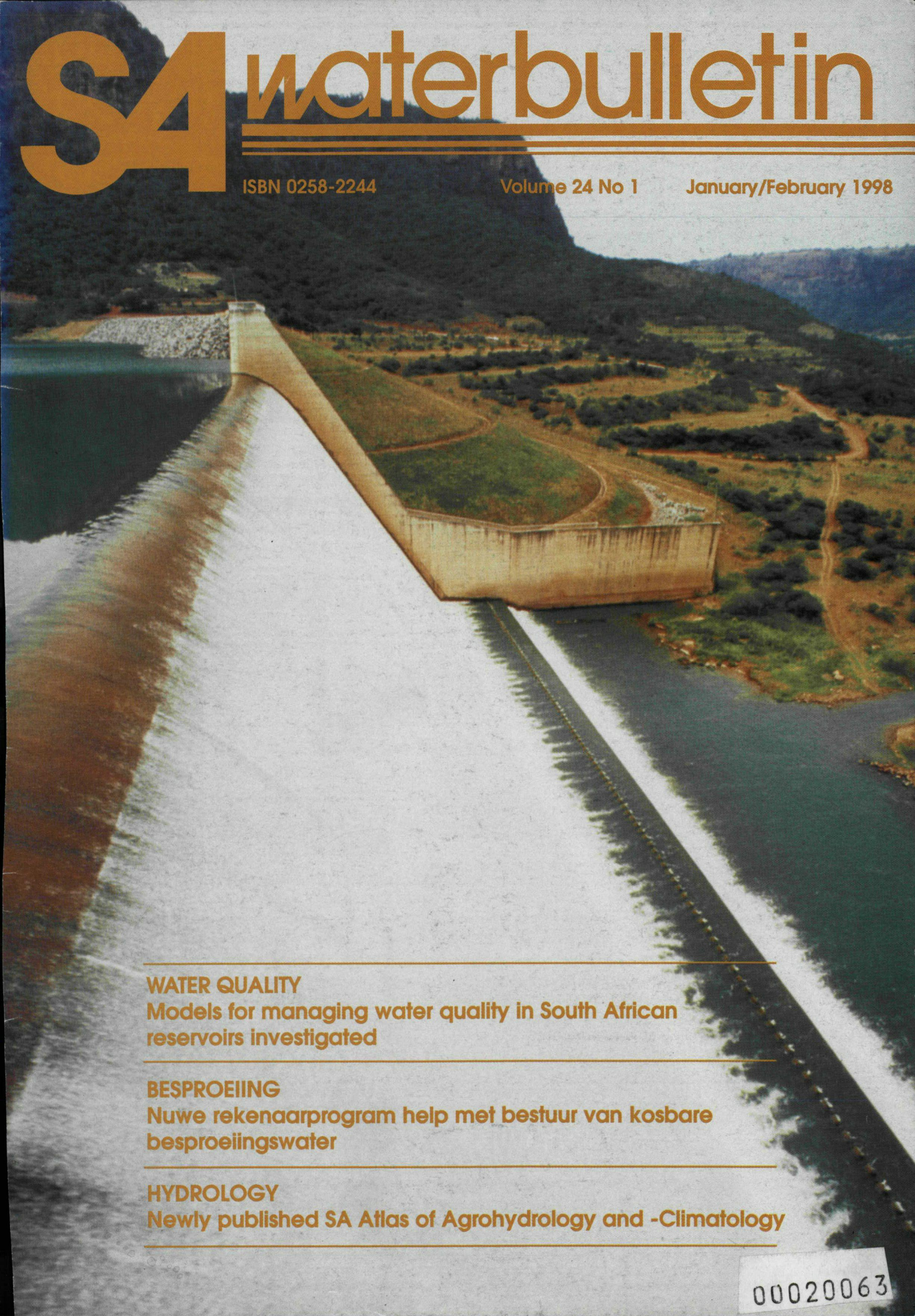
SA waterbulletin

ISBN 0258-2244 Volume 24 No 1 January/February 1998



WATER QUALITY
Models for managing water quality in South African reservoirs investigated

BESPROEIING
Nuwe rekenaarprogram help met bestuur van kosbare besproeiingswater

HYDROLOGY
Newly published SA Atlas of Agrohydrology and -Climatology

TECHNIKON PRETORIA

Department of Physical Resources: **Water Care**

Technikon Pretoria offers the following tertiary tuition programs in Water care:

Students attend classes on a block release basis; three block weeks during each semester

IMPROVE YOUR SKILLS AND BETTER YOUR QUALIFICATIONS

- **National Certificate (Year 1)**
- **National Higher Certificate (Year 2)**
- **National Diploma (Year 3)**
- **B Tech Degree (Duration: 2 Years - Starting 1998)**

NEWS FLASH

TECHNIKON PRETORIA intends to offer the **National Diploma : Water Care** in the following regions during **1999:**

- ❒ KwaZulu-Natal (Pietermaritzburg/Durban)
- ❒ Eastern Cape (East London/Bisho)
- ❒ Western Cape (Cape Town)

All prospective candidates, please contact Mrs Potgieter at Tel: (012) 318-6232, or Fax: (012) 318-6233 **before 30 June 1998.**

SHORT COURSES

OPTIMISATION OF A POTABLE WATER PURIFICATION PLANT
Pretreatment, Chemical Dosing, Coagulation, Flocculation, Settling, Filtration, Disinfection, Stabilisation, and Record Keeping

Date: 3 - 7 August 1998
Closing date: 21 July 1998
Fee: R2 200

OPERATION OF ACTIVATED SLUDGE PLANTS
Process principles and microbiology, Operational aspects of conventional, extended aeration and nutrient removal processes. Operational problems: Bulking scum, etc.

Date: 13 - 17 July 1998
Closing date: 22 June 1998
Fee: R2 200

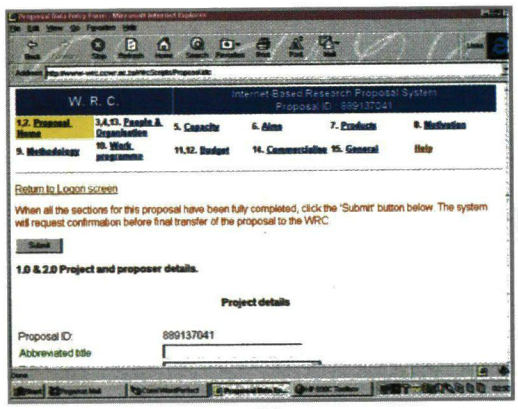
BASIC CHEMICAL WATER ANALYSIS
Laboratory Techniques, Sampling, Data Processing, Calculations, Analytical Procedure, and Practicals

Date: 30 November - 4 December 1998
Closing date: 16 November 1998
Fee: R2 200

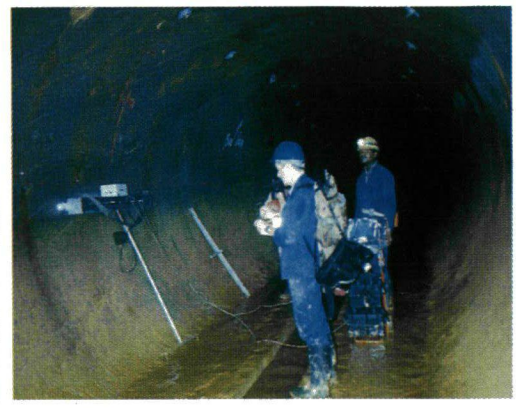
ENQUIRIES: Mochzell Potgieter at Department Physical Resources, Technikon Pretoria, Private Bag X680, Pretoria 0001. Tel: (012) 318-6232. Fax: (012) 318-6233.

Volume 24 No 1 **SA waterbulletin** Januarie/Februarie 1998

p 18



p 23



p 24

Contents

Cover: Inanda Dam, in the Valley of a Thousand Hills, overflowing. (Photo: Courtesy of Umgeni Water)

SA Waterbulletin is a two monthly magazine on water and water research published by the South African Water Research Commission (WRC), a statutory organisation established in 1971 by Act of Parliament. Subscription is free. Material in this publication does not necessarily reflect the considered opinions of the members of the WRC, and may be copied with acknowledgement of source. Editorial offices: Water Research Commission, PO Box 824, Pretoria 0001, Republic of South Africa. Tel (012) 330-0340. Fax (012) 331-2565. Editor: Jan du Plessis (E-mail: Jan@wrc.ccwr.ac.za). Asst Editor: Helene Joubert (E-mail: Helene@wrc.ccwr.ac.za). Ed Secretary: Rina Human (E-mail: Rina@wrc.ccwr.ac.za). Layout: Chilli Design 082 578-7257. Colour Separations: 4 Images. Printing: Beria Printers.

Workshop assesses safe water supply and quality

From left to right: Mr F Venter (UP), Dr Anneli Kuhn (DWAF), Mr M van Veelen (DWAF), Dr A Venter (BKS) and Mrs Annatjie Oelofse (WRC) were involved in the drafting of the Assessment Guide and in organising the workshop.

A Workshop on the Assessment of the Quality of Domestic Water Supply, was held early in February, in Pretoria. The two and a half day workshop under the auspices of the Water Research Commission was attended by more than fifty invited delegates, which represent[ing]ed most of the major role players in the field of domestic water supply.

The presentations and deliberations on the first day centred around the issue of safe water, and how the new water law will affect water supply and water quality in future. Many questions were raised about safe drinking water in terms of constitutional right, basic human needs, and legal implications. Minimum requirements for safe water supplies, and the implications thereof for water suppliers were also discussed, along with typical water quality problems encountered by water suppliers. A number of questions about future water quality standards for safe drinking water supplies were debated.

On the second day the workshop presentations and discussions were focussed on the updated Guide for the Assessment of the Quality of Domestic Water Supplies along with the supporting Interpretation and Sampling Guides.

The Guide, a joint publication of the Department of Water Affairs and the Water Research Commission, was first published in 1996. Reportbacks at a workshop, held in February 1997, revealed two major shortcomings as regards the user. Firstly users were unsure about how to interpret the Assessment Guide, and secondly a

general lack of know how with regard to the correct sampling methods for water quality sampling amongst those assigned to do the field sampling.

The Water Research Commission (WRC) assigned the task of addressing these deficiencies and making the Guide more user-friendly to a consultancy, along with teams representing Department of Water Affairs and Forestry, Department of Health, WRC, Universities, SA Bureau of Standards and other consultancies too. Two supporting documents were added to the Assessment Guide; an interpretation guide and a sampling guide. The updating of the assessment guide and addition of the two supporting guides were aimed at

- making the Assessment Guide more user friendly,
- setting guidelines for sampling - how, where, when, and, how often
- developing a more comprehensive water quality classification system, and
- setting a standard procedure for all water quality monitoring programmes.

In this process the need for clear definitions of terminology was noted.

At this most recent workshop the delegates indicated that both of the supporting documents are valuable contributions to water quality management in South Africa.

However, with these guides now available and having set guidelines for sampling and the assessment of the quality of domestic water supplies, the next question asked was how, and by whom, are the assessment guidelines to be applied eg. in the evaluation and decision whether a particular water source would be acceptable, or not, for domestic water supply.

On the last day of the workshop research needs were considered and a research programme was compiled, which includes monitoring protocols as well as risk assessment of domestic water. Priority was accorded to both the investigation of legal aspects arising from the Assessment Guide, and an Analytical Guide containing approved techniques and analyses.

A follow-up workshop is to be held next year.

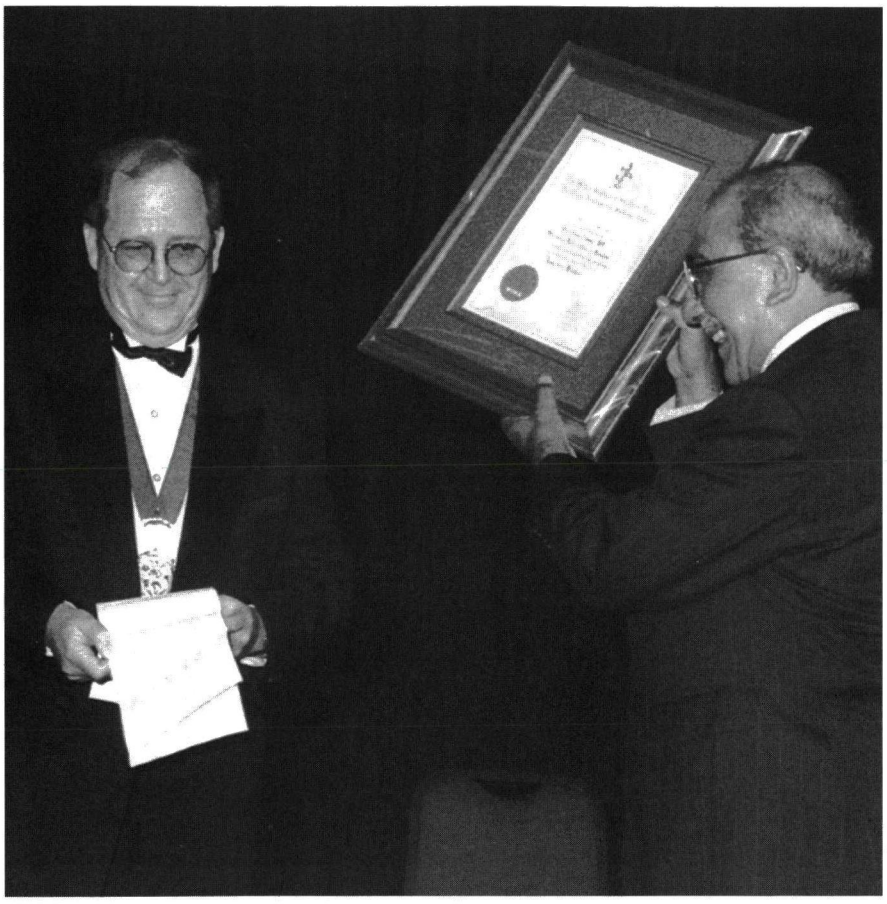
Some of the speakers at the workshop were, in front, Dr M Steynberg (Rand Water), Mr PE Odendaal (Executive Director, WRC), Mrs Linda Garlipp (DWAF), Mr T Ramaema (DWAF) and at the back Mr F van Zyl (DWAF) and Dr P Kempster (DWAF).

Other speakers at the workshop, which was held at Diep in die Berg, on the outskirts of Pretoria: Dr I Msibi (WRC), Ms Manu Pillay (Umgeni Water) and Mr T Pule (Dept of Health).

WISA celebrates ten years of excellence and service

The Water Institute of Southern Africa (WISA), at the end of last year, celebrated its 10th anniversary with a splendid banquet, sponsored by Rand Water, at the Gallagher Estate in Midrand. The highlight of the evening was the conferring of honorary membership of WISA on the Minister of Water Affairs and Forestry (DWAF), Prof Kader Asmal. Patron memberships were also conferred on Mr Dave Osborne, Rand Water, DWAF, the East Rand Water Care Company (ERWAT) and Water and Sanitation Services of South Africa (WSSA).

The President of WISA, Dr Chris Viljoen, said in his address that WISA had evolved over a period of sixty years since its inaugural meeting on 4 May 1937 in Johannesburg. "At this meeting it was unanimously agreed that an institution be formed as set forth in the Articles of Association of the British Institute of Sewage Purification. Since that date, the Association has undergone several name changes and has developed from being a branch of an international institution to a fully fledged South African Institution when it became the Water Institute of Southern Africa in May 1987." Today WISA has branches in Gauteng, Western and Eastern Cape, KwaZulu Natal and the Free State.



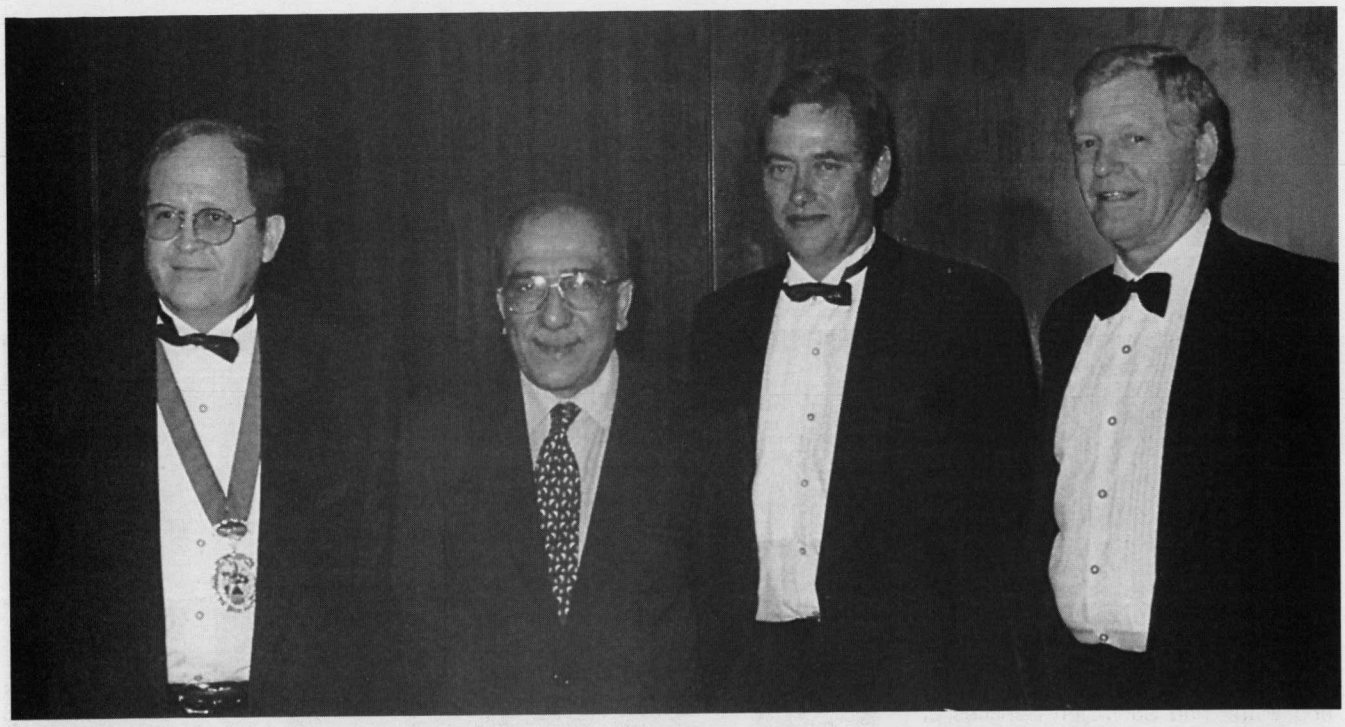
The Minister of Water Affairs and Forestry, Prof Kader Asmal (right) displaying his honorary membership certificate which he received from Dr Chris Viljoen, President of WISA.

Dr Viljoen said that in the preceding years WISA had done much to further the interests of the national water industry. "It has organised five very successful biennial conferences and numerous symposia, workshops and technical meetings. The symposia are normally arranged by WISA's technical divisions, of which there are fourteen.

"WISA is fortunate to have its own offices and staff. This has also enabled the Institute to render secretarial services to the national committees of international organisations such as IAWQ and IWSA as well as the local Vaal River Catchment Association (VAALCO). Pending the outcome of present negotiations WISA may soon also be providing these services to the Chartered Institute of Water Environment Managers (CIWEM).

The Institute has 1200 members ranging from professionals to operators and is able to fund all its activities from membership fees, interest on investments and the proceeds from its conferences and symposia.

Dr Viljoen said that through WISA's endeavours operator training manuals were developed, which are presently being used by various training institutions. WISA, in association with other sponsors, last year also awarded bursaries to three previously disadvantaged students to further their studies in water-related fields, "again illustrating WISA's commitment to the well-being of South Africa's water industry".



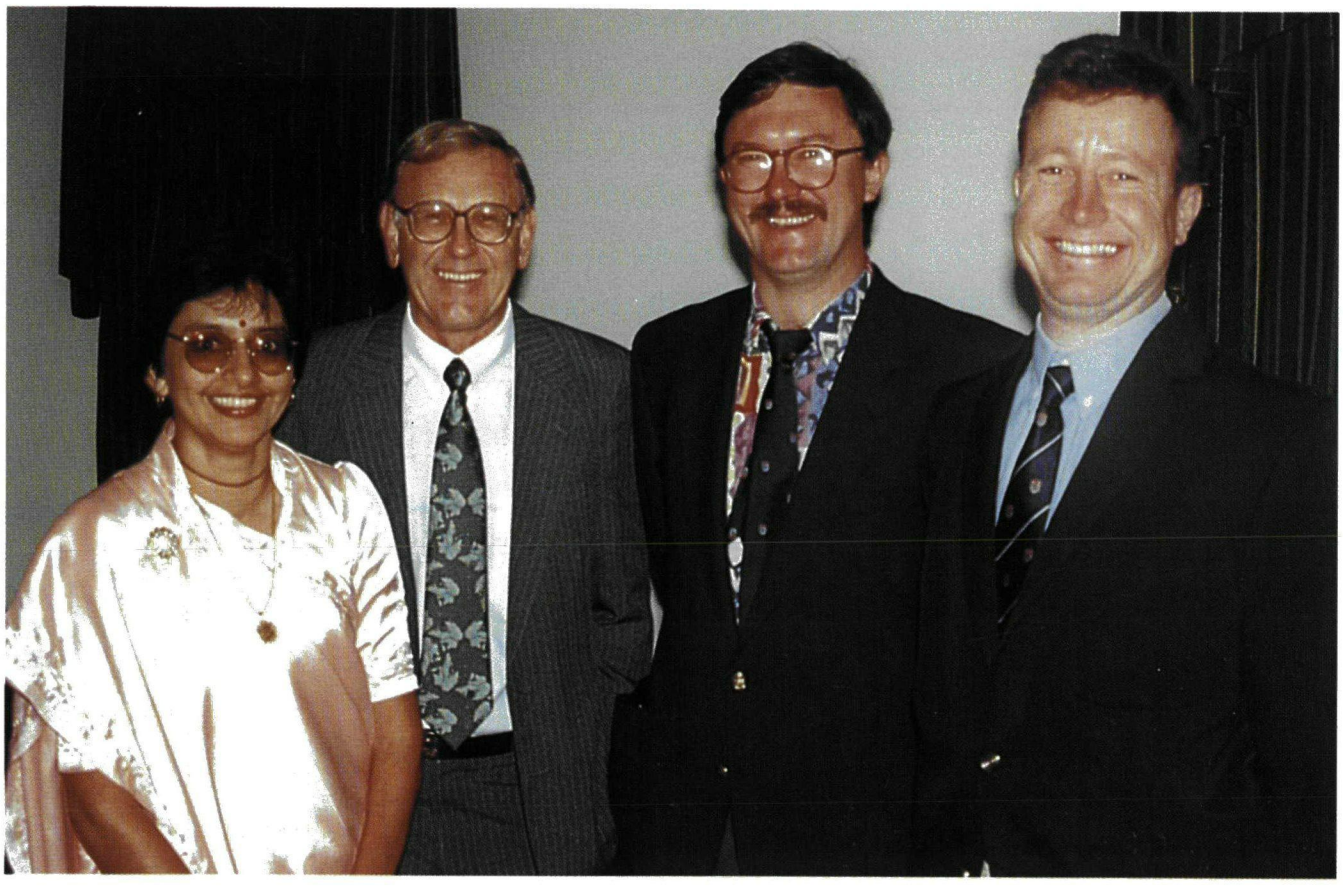
Dignitaries at the WISA banquet, which was sponsored by Rand Water. From left: Dr Chris Viljoen (WISA) with the Minister, Prof Kader Asmal, Mr Mike Muller, Director-General of the Department of Water Affairs and Forestry, and Mr Vincent Bath, Chief Executive of Rand Water.

Above left: Mr AW Korf, Managing Director of ERWAT,(right) receives ERWAT's patron membership from WISA President, Dr Chris Viljoen.

Above right: Dr Chris Viljoen, President of WISA, presenting WISA's patron membership to Rand Water Chief Executive, Mr Vincent Bath.

Left: Mr Jean-Claude Ambert, Chief Executive Officer of Water and Sanitation Services, South Africa (WSSA) (right) receiving his certificate from WISA President, Dr Chris Viljoen.

New Atlas of Agrohydrology and -Climatology launched



The "Atlas Team". From left: Mrs Manju Maharaj, Prof Roland Schulze, Mr Steve Lynch and Mr Brad Howe.

The launch of the new South African Atlas of Agrohydrology and -Climatology, under the authorship of Professor Roland Schulze from the Department of Agricultural Engineering at the University of Natal, took place at a University ceremony in Pietermaritzburg on 3 December 1997. The launch was attended by dignitaries from the Water Research Commission, the University of Natal as well as from the water and agricultural sectors.

Professor David Maughan Brown, principal of the Pietermaritzburg campus, said that "water and agriculture had been identified as key fields in which the University of Natal had major national and international contributions to make", while Mr Piet Odendaal, Executive Director of the WRC, emphasised the wide range of disciplines which could benefit from this Atlas - ranging from water and agricultural resource planners, environmentalists and various departments at all three tiers of the government.

Bridging the fields of climate, water and agricultural production, Professor Schulze said the Atlas was the culmination of five years' research funded by the WRC. The maps are accompanied by explanations, interesting facts, and in the words of one reviewer, "it is an almost never- ending permutation of fascinating and very relevant statistics".

Mr Piet Odendaal, Executive Director of the Water Research Commission, (left) receiving the new Atlas from Prof David Maughan Brown, the University of Natal's Pietermaritzburg Campus Principal.

Proud family at the Atlas launch. From left: Dr Claudia Schulze (daughter), Prof Roland Schulze and Mrs Waltraut Schulze.

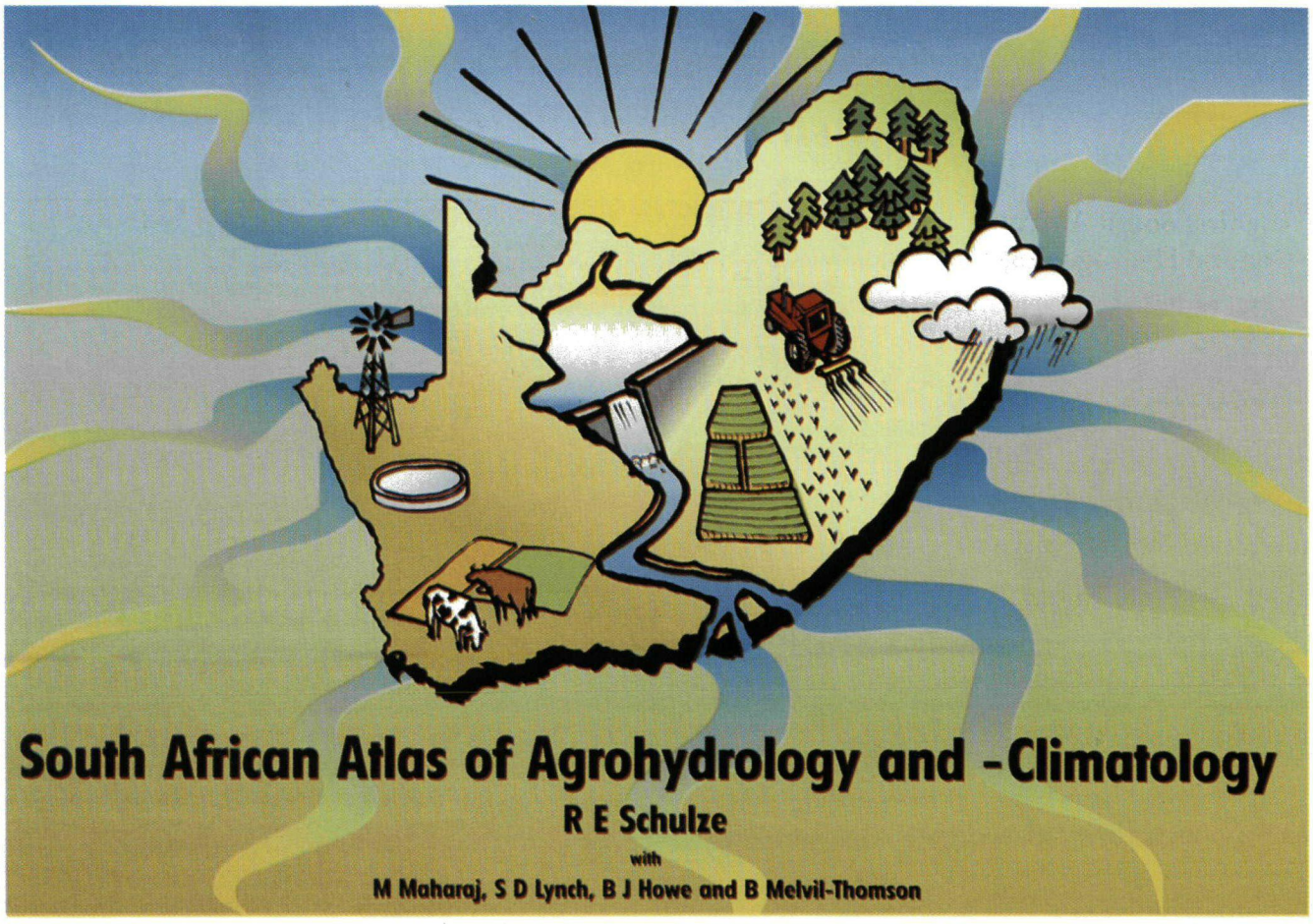
In the early 1980s the first atlas of this kind - "the Agrohydrology and -Climatology of Natal" was published by the Water Research Commission. It has proved to be a widely accepted and popular reference work, used by the water resources and agricultural planner, consultant and farmer alike, and also as a text at several tertiary institutions.

This new atlas of the Agrohydrology and -Climatology of southern Africa is an extension and considerable refinement of its 1983 predecessor.

As the Department of Agricultural Engineering's sphere of agrohydrological research expanded from small catchments to provincial scale and then to the region referred to in this Atlas as southern (rather than only South) Africa, defined here as the contiguous geographical entity comprising the nine provinces of the Republic of South Africa plus Lesotho and Swaziland, so the need for detailed spatial and temporal climatic information increased. Consequently databases on precipitation, temperature and potential evaporation were developed, initially to serve the Department's in-house research needs on spatial agrohydrological modelling and impact studies, but later to also form important information bases for WRC projects at other institutions. As a result the research on the contents of this Atlas became a component of a broader WRC funded project in the Department entitled "Modelling impacts of the agricultural environment on water resources".

OBJECTIVES

The objectives of this Atlas were to map, at regional level, climatic parameters which are important in agrohydrology and agroclimatology, and then to apply this information to resource planning, primarily in the fields of water and agriculture. The Atlas is intended as a functional user document to provide the "big picture" in southern Africa, but is sufficiently detailed to be useful in regional decision making. In adopting the regionalised approach, one of the methodologies used has been to relate climate parameters which are measured at relatively few irregular point



Copies of the Atlas can be obtained from the Water Research Commission, PO Box 824, Pretoria 0001. The price is R190 per copy (postage and VAT included). Foreign orders: US$ 70 per copy (via surface mail).

locations in the study area (e.g. temperature, potential evaporation), to known physiographically related variables such as altitude, latitude, longitude, distance from the ocean or topographic exposure, and then to apply these relationships to mapping at points where no measurements are made.

However, the Atlas presents more than maps only. Text on concepts and background regarding the parameters mapped is also included, plus statistical analyses and scientifically related information on methods used or verifications attained.

The Atlas should not be used to obtain what may be perceived to be the "exact" parameter values at very specific locations of interest or at farm level. The reason why one should guard against this is that, while considerable spatial detail may sometimes be presented on a map, the values at a specific point were initially derived either by regression analysis or by other simulation models (some simple, other more complex), and this has resulted in a smoothing of local effects and dampening of outlier values. Values at a specific point should thus be viewed in relative rather than absolute terms.

LAYOUT

The Atlas comprises 18 sections of varying lengths and at varying levels of detail: The sections are: Background information, Physical environment, Solar radiation, Precipitation, Temperature, Heat units, Frost, Positive chill units, Relative humidity, Potential evaporation, Soils, Agricultural productionure yields, Agricultural and horticultural crop yields, Timber production, Natural hazards, Irrigation requirements and Water resources.

SUPPORT

Support services are available to users of this Atlas with specialised requests (e.g separate maps, enlargements or more detailed statistics). A time based levy will be charged to service requests. Special requests should be addressed to Prof RE Schulze (Attention: Atlas), Department of Agricultural Engineering, University of Natal, Pietermaritzburg, Private Bag X01, 3209 Scottsville. Fax: 0331-2605818. E-mail: schulze@aqua.ccwr.ac.za.

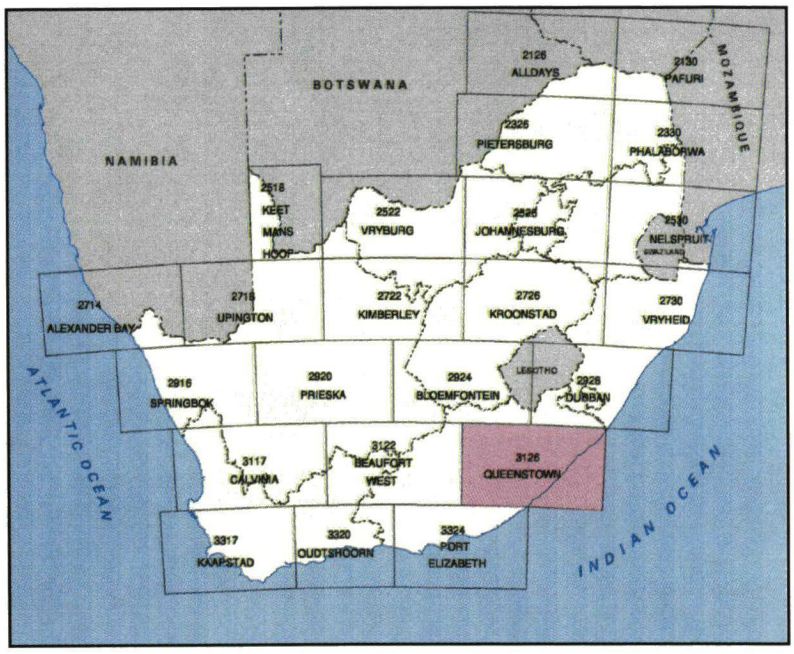
1: 500 000

HYDROGEOLOGICAL

MAP SERIES

OF THE REPUBLIC OF SOUTH AFRICA

The first South African 1 : 500 000 General Hydrogeological map, 3126 Queenstown, is now available



Prepared by the Department of Water Affairs and Forestry

The single A0 MAP SHEET COMPRISES:

INSET MAPS:

- Distribution of borehole data (Scale 1 : 2 000 000)
- Elevation above sea level (Scale 1 : 2 000 000)
- Mean annual precipitation (Scale 1 : 2 000 000)
- Groundwater quality (Scale 1 : 1 500 000)

MAIN MAP:

Groundwater occurrence (aquifer type and borehole yields) superimposed on a lithological background (Scale 1 : 500 000)

CONCEPTUAL ILLUSTRATION:

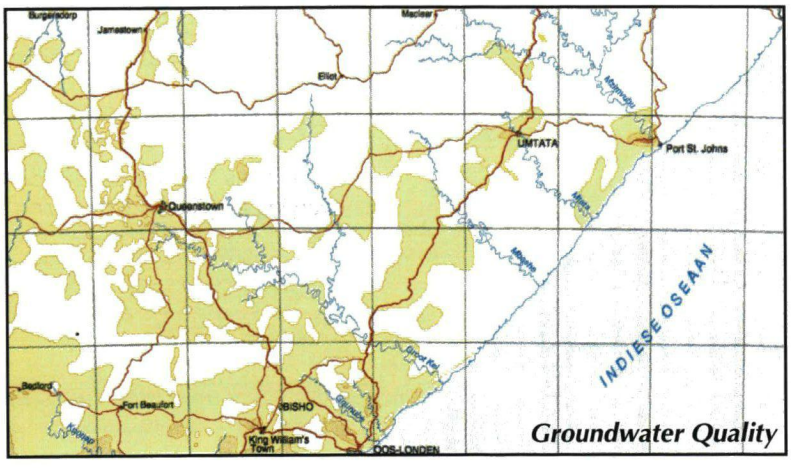
A schematic illustration of typical modes of groundwater occurrence (Not to scale)

Please note: The map depicts groundwater conditions on a regional scale and cannot be used for borehole siting or any other site-specific investigations or deductions.

Price:
R50.00 (VAT, postage and packing included) per map

Copies of the map are obtainable from:
Ms. M. van Wyk
Department of Water Affairs and Forestry
Directorate: Geohydrology
Private Bag X313
Pretoria
0001

Tel: (012) 338 7849
Fax: (012) 328 6397
E-mail: WB3@dwaf.pwv.gov.za



Predicting chlorine losses in potable water distribution systems

Chlorine is normally used at a water treatment works to disinfect the water and remove pathogenic organisms. A residual chlorine concentration is then kept in the piped water to ensure that this protection persists throughout the reticulation system, right up to the consumer's tap.

However, a decreasing rate of disinfection coupled with the decay of chlorine concentration are two of the well-known and most important changes to occur over time in water distribution systems. Three factors influence chlorine decay:

❒ the reaction between the chlorine and the impurities in the water. This reaction is independent of the medium through which the water flows.

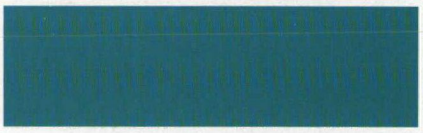
❒ the reaction between the chlorine and the pipe wall. This is a function of the area/volume relationship of the pipe, the pipe material and the presence and nature of any biofilm on the pipe wall; and

❒ the radial diffusion of the chlorine from the centre of the pipe towards the pipe wall could be a third contributing factor. The diffusion coefficient is dependent on the turbulence in the pipe, the pipe diameter and temperature, and is not thought to be a critical parameter for larger water supply pipelines.

To predict chlorine losses in complex distribution systems, it is necessary to develop and verify a mathematical model for the simplest case - a single pipe.

STUDY

In a study funded by the Water Research Commission and carried out by researchers from Rand Water and the Rand Afrikaans University, OJ Viljoen, J Haarhoff and JBH Joubert, the objectives were: to apply a comprehensive three-parameter chlorine decay rate model to a single pipeline; to develop procedures for the standardised measurement or calculation of the model parameters and to verify the mathematical model for a number of water types, pipeline types, temperature and chlorine species.



The Prediction for Chlorine Decay from Potable Water in Pipeline Systems

OJ Viljoen • J Haarhoff • JBH Joubert

Report to the Water Research Commission
by
Rand Water
and
Rand Afrikaans University

WRC Report No 704/1/97

RESULTS

Measurement

❒ The researchers found that all the chemical reactions associated with free chlorine and monochloramine do not occur at the same rate. To eliminate the initial fast reactions from the medium and long term reactions, the first free chlorine reading was taken only after the first hour and thereafter at hourly intervals. In the case of monochloramine, the first reading was taken after four hours and thereafter at four-hourly intervals.

❒ A good estimate of free chlorine decay can be made if the experimental test is continued for a period of eight hours (or longer). For monochloramine the test period should be at least 24 hours at four-hourly intervals and at daily intervals thereafter for five days or longer.

❒ Excellent results were obtained if three initial chlorine concentrations were used. For free chlorine the concentrations were fixed at 2, 4 and 8 mg per litre above the 20 minute breakpoint. In the case of monochloramine the initial concentrations were fixed at 2, 4 and 8 mg per litre as Cl2.

Modelling

❒ For both free chlorine and monochloramine substantially better data fits were obtained if an nth-order decay rate model were used instead of the customary first order decay rate model.

❒ The reaction orders are different for different water sources and even different for the same water source at different times. For a given sample, however, the reaction orders are independent of temperature.

❒ The rate constants, in all cases, are dependent on temperature. The higher the temperature, the higher the decay rate constants.

❒ The reaction order for free chlorine varied from 0.36 to 1.22 with no apparent underlying pattern. For monochloramine, the reaction order fell into two distinctively different categories. For monochloramine decay up to 24 hours (medium-term tests), the reaction order varied from 0.02 to 0.25. For monochloramine decay from 24 hours onwards (long-term tests), the reaction order varied from 0.92 to 0.95.

SHORT COURSE

UNIVERSITY OF PRETORIA

Water Utilisation Division

MANAGEMENT AND OPTIMISATION OF WATER TREATMENT PLANTS

Date: 25 - 29 May 1998

Venue: Water Utilisation Building
South Campus
University of Pretoria
(A map will be provided on request)

This course is aimed at the person(s) responsible and in charge of small, medium and large sized drinking water treatment plants. The main objective of the course is to provide the responsible person with the necessary tools and skills to effectively manage the technical, financial and human aspects involved in water treatment.

Main focus of the course

- Microbiological, physical and chemical quality of raw and treated water.
- Physical and chemical process unit operations.
- Hands-on computer applications and key laboratory tests and analysis.
- Plant sizing and process optimisation.
- Trouble-shooting and remediating actions.
- Management of in-plant water losses, recovery and balances.
- Financial management.
- Management of treatment plant personnel.

At the end of the course the student should be able to produce the required quality of potable water at the lowest possible cost per kiloliter. Successful students will receive a certificate upon completion of the course.

Lecturers

Prof W A Pretorius Tel: (012) 420-3566
Prof C F Schutte Tel: (012) 420-3571
Mnr G De Villiers Tel: (012) 420-3568

Language

The course notes are in English. Lectures and discussions will be conducted in both English and Afrikaans in order to ensure that students from both groups obtain full benefit from the short course.

Course Fees

R3 000,00 per person (excluding VAT).
Course fees include course notes, tea/coffee and lunch every day, but **excludes** accommodation.

Enquiries

Contact Mrs Elmarie Otto at:
Tel: (012) 420-3566, or
Fax: (012) 362-5089

SHORT COURSE

CONDITIONS OF ENTRY:

1. Unforseen circumstances may necessitate the appointment of different speakers to those indicated on this brochure.
2. Cancellations will be accepted **in writing** only, without penalty up to 7 work days prior to commencement of the course. **SUBSTITUTES** will be accepted.
3. Delegates cancelling **in writing** less than 7 work days prior to commencement of the course will be liable to pay a 20% cancellation fee.
4. If prior **written** notification is not received, default delegates will be liable to pay a 30% cancellation fee.
5. In case of insufficient applications for a course, LGI (Pty) Ltd. reserves the right to cancel the course. Applicants will be informed and all fees will be refunded immediately.
6. The number of applicants on the course is limited and acceptance will be based on a first-come, first-serve basis.
7. Laboratory work is done at the participant's own risk.

REGISTRATION FORM

Please complete and fax to: Prof W A Pretorius at Fax: (012) 362-5089

Name: .....

Organisation: .....

Address: .....

.....

Tel. no: ..... Fax No: .....

(Confirmation of registration will be sent to this fax number).

Course fees to be paid by: Company ☐ Self ☐

Company name: .....

Address: .....

.....

Invoice: .....

For Attention of: .....

Please Note: Cheques to be made payable to LGI (Pty) Ltd.

R

CONCLUSIONS

■ The free chlorine decay rates obtained in pipelines were higher than in parallel bulk decay rate tests, indicating that the pipe walls did contribute significantly to the total decay of free chlorine.

■ On the assumption that the bulk decay reaction order is equal to one, the mass transfer coefficient between the bulk flow and pipe wall could be calculated. With the exception of a single outlier, the coefficient varied between 0.0065 m/h and 0.0457 m/h.

GUIDELINE

Included in the final report, summarising the research results, is a short practical Guideline. The researchers say this Guideline is intended to summarise the information pertinent to water supply authorities who want to do first-hand measurements of chlorine decay at their own installations. It also provides, by way of practical examples, the mathematical tools required for chlorine decay predictions in pipeline systems. Two chlorine species are considered - free chlorine and monochloramine.

Copies of the report (together with the Guideline) entitled **The prediction of chlorine decay from potable water in pipeline systems** (WRC report 704/1/97) are available free of charge from the Water Research Commission, PO Box 824, Pretoria 0001. Foreign price: US$ 20, via surface mail. (E-mail order address: tineke@ wrc.ccwr. ac.za).

Impacts of afforestation in North-Eastern Cape reviewed

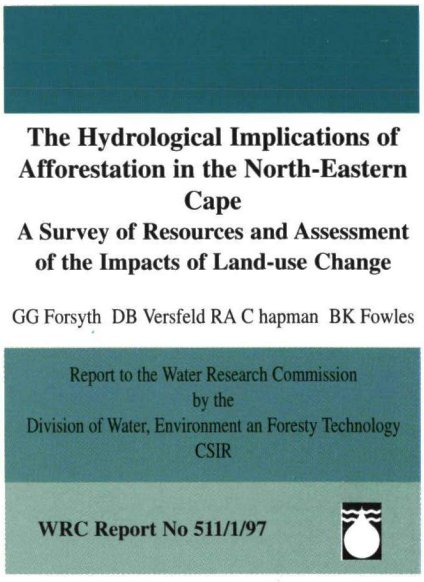
A report reviewing the hydrological impacts to be expected as a result of extensive afforestation within the North-Eastern Cape, and particularly in the upper reaches of the Bashee and Umzimvubu River catchments, has been published by the Water Research Commission in Pretoria. The report was compiled by researchers from the Division of Water, Environment and Forestry at the CSIR: GG Forsyth, DB Versfeld, RA Chapman and BK Fowles.

In addition to assessing the impacts of the current level of forestry in the area the report aims to establish a baseline of natural resource information against which the impacts of major land use change can be measured and evaluated. The report also provides guidelines for policy development, together with practical management guidelines to improve water quality and yield, and to ameliorate the impacts of afforestation on the natural environment.

CONTENTS

The report is divided into eight sections. Chapter 1 comprises the introduction, background and summary of research products, while Chapter 2 describes the research approach. Chapter 3 describes the baseline information as captured in a GIS for subsequent analysis, and what data is now available for assessments of the future impacts of land use change. Baseline information covers the physical characteristics, together with some social factors, which are likely to be impacted as a result of afforestation. Chapter 4 gets down to the actual impacts of afforestation. In Section 4.1 the establishment of a limnological baseline is described and the biological health of the major rivers determined. In Section 4.2 the impacts of current and expected afforestation on the water yield from 10 quaternary catchments is modelled and reviewed at local and regional scale.

Chapter 5 considers land management issues and options and offers guidelines for management and research, together with certain suggestions for policy development. Chapter 6 provides discussion of major issues raised in chapters 4 and 5, including the importance of certain forest management strategies and the benefits of strategic environmental assessment wherever a major development involving land use change is contemplated. Chapter 7 summarises the most important conclusions and discussion. Recommendations for future research are listed and discussed in Chapter 8. References are listed in Chapter 9. The report closes with an appendix indicating what data has been captured, what other data has been accessed and where it resides. A discussion on the custodianship, storage and maintenance of the data sets created through this project is included in the appendix.



Copies of the report entitled **The hydrological implications of afforestation in the North-Eastern Cape - A survey of resources and assessment of the impacts of land-use change** (WRC Report 511//1/97) are available free of charge from the Water Research Commission, PO Box 824, Pretoria 001. E-mail order address: tineke@ wrc.ccwr.ac.za (Foreign orders: US$ 25 per copy, via surface mail).

Reduction of Scaling scrutinised

Recent research has cast new light on the reduction of scaling by means of magnetic and electrostatic treatment. The research by PP Coetzee and J Haarhoff of the Rand Afrikaans University, is documented in a report to the Water Research Commission, entitled **Reduction of Scaling in Industrial Water Cooling Circuits by means of Magnetic and Electrostatic Treatment.**

According to the report by Coetzee and Haarhoff scale formation is a major problem in practically all systems where water is transported through conduits or treated in containers at temperatures even slightly above ambient. The problems caused by scaling range from reduction in heat transfer efficiency, blocked systems to wastage of large volumes of make-up and blowdown water.

SCALE REDUCTION

There are two methods of reducing scaling and the accompanying problems:

❒ The first option is **chemical treatment**, where the scale formation characteristics of water are inhibited by the addition of chemicals, for instance scale inhibitors like polyphosphates or polyacrylates. These chemicals are expensive, require sophisticated dosing and dosing control equipment with concomitant supervision, and also end up in the environment through the blowdown water.

❒ The second option is **physical water treatment** (PWT) which consists of a simple flow-through system in which the water is exposed to some form of electromagnetic field. It is then claimed that the properties of water are changed and/or dissolved or suspended solids present in the water undergo physical changes leading to a range of effects. An influence on scale and scale forming salts is only one, albeit predominant effect. This treatment, if successful, then circumvents the problem of chemicals, dosing control and environmental pollution.

PWT is a particularly attractive option for use in the thousands of small-scale heat exchange systems where the cooling water circuit is a small, minor component of the operation. It has also found application in large industrial installations like power stations and paper mills.

INCONSISTENCY

However, despite its potential benefits, PWT does not always have the same degree of success in all installations, and in some cases does not succeed at all. The literature abounds with reports, both from full-scale practical installations as well as research laboratories, which are in direct conflict. Some report substantial effects, others no effects at all. In South Africa local suppliers of PWT equipment offer a number of well documented case histories of successful industrial application.

LACK OF UNDERSTANDING

The current constraints on the use of PWT are basically twofold:

(i) the unpredictable behaviour of PWT devices in the industrial environment (reports vary from very successful to total failure), and
(ii) the total lack of understanding as to how PWT works.

The researchers say the important parameters for magnetic and electrostatic treatment fall into two general categories. The first category deals with the physical parameters of the treatment device, which would include factors such as a field strength, flow velocity, exposure time to the field, orientation of the field to the flow direction, and others. The second category deals with the chemical composition of the water to be treated, such as degree of supersaturation, temperature, nature and concentration of suspended solids, presence of precipitation nuclei, presence of trace elements of iron, zinc and vanadium, and others. It is fairly evident from the literature that the latter group plays the major role towards the success of the process.

PROJECT AIMS

In this research project the researchers concentrated on the role of chemical parameters.

The objectives of the project were :

❒ To determine the efficiency of electrostatic water treatment in a number of simulated industrial applications,

❒ To verify and test the efficiency of magnetic and electrostatic treatment devices under rigorously controlled laboratory conditions,

❒ To compile guidelines for the industrial application of magnetic and electrostatic treatment devices.

INVESTIGATIONS

The aim of this project as set out in the report, was to test the claims and effects made concerning physical water treatment for scale inhibition, to critically evaluate the theories put forward, to

explain these phenomena and then make recommendations with regard to the practical implementation of PWT.

The researchers used a two-pronged approach to achieve this aim, namely:
❒ laboratory investigations, where the problem was studied at the molecular level, and
❒ simulated full-scale investigations.

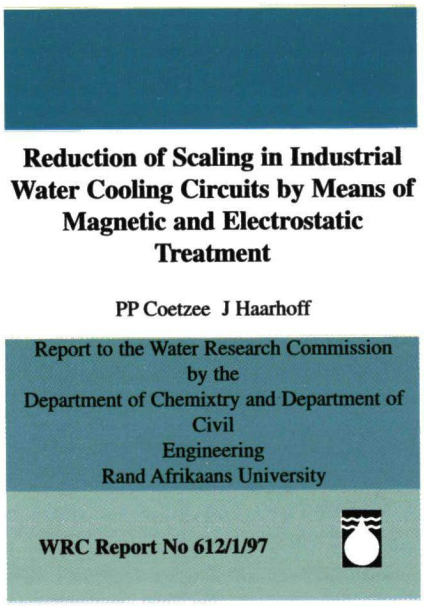
MAIN FOCUS

The main thrust of the laboratory investigations can be summarised as:
❒ Developing laboratory test methods to verify the effects of physical water treatment in experimental run times, as short as possible. The batch method based on measuring the rate of $CaCO_3$ precipitation (pH vs time), was developed for this purpose. These were run on 5 commercially available PWT devices (3 magnetic, 1 electric and 1 catalytic converter), and a 2 tesla variable laboratory electromagnet, using the above methods.
❒ Verifying, experimentally under controlled conditions, the occurrence of some effects listed in the literature. The effect of PWT on the rate of crystallisation (by implication scale formation), crystal morphology (by implication adhesion properties of scale), and the effect of impurities released by the devices were studied in detail.
❒ Evaluating the two main mechanistic models, namely the water structure model and the nucleation model.

In summary the focus of the simulated full-scale investigations was:
❒ to design, construct and optimize a full-scale testing system to measure scale formation in heat exchanger pipes rapidly and quantitatively,
❒ to evaluate selected PWT devices for industrial application.

RESULTS

❒ **Verification of effects.**
Results have shown that the emission of metal ions, in particular zinc ions from three different types of PWT devices can affect the rate of crystallisation of $CaCO_3$ and can cause changes to the crystal morphology of precipitates. Nucleation rates are decreased and the morphology of the scale changes from calcite rhombohedrons to aragonite needles, which exhibit lower adhesive properties. The researchers say that scale inhibition effects shown by these devices could therefore be attributed to these phenomena. Where devices released no measurable amounts of



impurities, no effects were observed.

❒ **Proposed mechanistic model**
Results from experiments designed to test the water structure model, proved negative. The devices had no measurable effect on surface tension, infrared spectra or nuclear magnetic resonance (NMR) of water which would have indicated structural changes to water. The fact that, after coating the inner surfaces of the devices with an impenetrable thin layer of polymer, the effects on the nucleation rate and crystal morphology disappeared, indicates that the release of impurities from inner surfaces were responsible for the observed effects. In view of these results, a mechanistic model based on the substoichiometric blocking of crystal surface growth sites, is proposed. This means that metal ions, in particular free metal ions with the right stereochemistry are preferentially absorbed as "kinks" and "steps" in the growing crystal. This blocks the preferred growth pattern of calcite, converting to an aragonite growth pattern at a slower rate.

❒ **Full-scale investigations**
A quick method was developed to determine the rate of scale formation in a full-scale test rig. The method comprised of stripping the scale from straight pipes with 10% acetic acid and determining the Ca content after acid stripping. The reproducibility amongst different pipes, and amongst different experiments, was not as good as expected. Further work should be conducted to improve the reproducibility of the test rig before meaningful verification of PWT could be done on this rig.

❒ **Free metal ion scale inhibitor**
In view of the results obtained, a scale inhibition procedure was proposed based on the controlled addition of µg/ℓ concentrations of metal ions, such as zinc, to scale forming water. Broad operating guidelines were established. In experiments done with tap water and deionised water both spiked with $CaCO_3$ at concentrations up to 500 mg/ℓ, scale reduction of between 50 and 80% was achieved. Strong ligands for Ca complexation, such as EDTA, when present in mg/ℓ quantities, will destroy the beneficial effect of µg/ℓ levels of active zinc. High concentrations of inorganic ions, such as chloride and sulphate may, however, be tolerated. The addition of free metal ions to feed water may be achieved by controlled electrolysis via a pulsed DC power supply. This has the advantage of controlling the concentration of free Zn^{2+} ions and preventing the zinc anode of becoming deactivated by formation of a protective ZnO coating or deposition of scale.

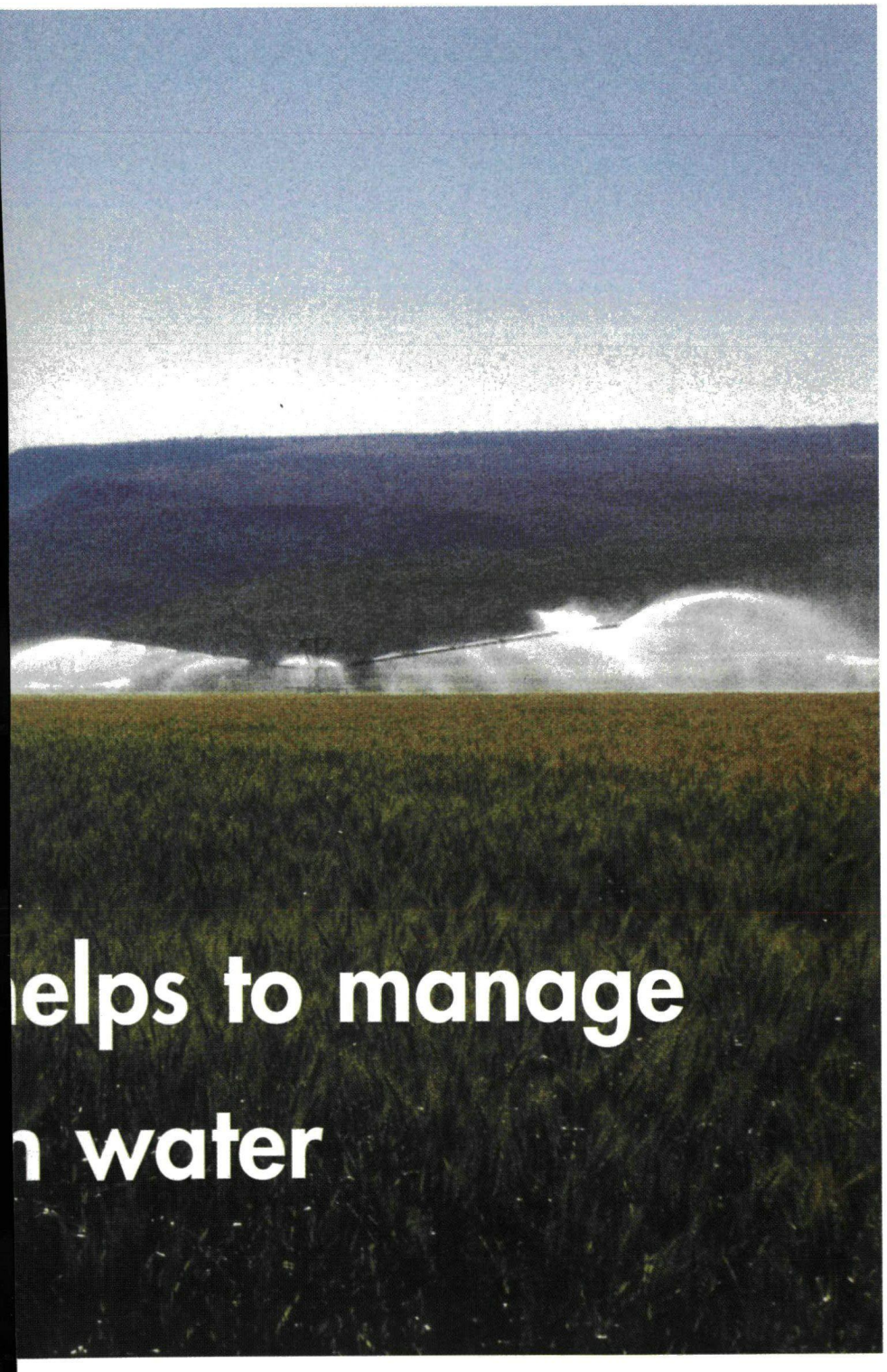
The report entitled **Reduction of Scaling in Industrial Water Cooling Circuits by Means of Magnetic and Electrostatic Treatment** (WRC Report 612/1/97) is now available, free of charge, from the Water Research Commission, PO Box 824, Pretoria 0001. E-mail order: tineke@ wrc.ccwr.ac.za (please remember to include a postal address). Foreign orders: US $20 per copy, via surface mail.

New computer program
precious irrigatio

Results of a research project aimed at identifying a suitable crop irrigation scheduling model to integrate into the water administration system of irrigation schemes, are now available.

Researchers from the Rand Afrikaans University and the University of Pretoria say in their report to the Water Research Commission: "Once an irrigation scheduling program is integrated into the optimisation system it would be possible to compare the volume of water requested by farmers with the actual water needed for all the crops on an irrigation scheme. This will give a more complete picture of water utilisation on an irrigation scheme. The integrated system will also be a useful tool in the hands of water administrators who may decide to initiate scheduling services should it become apparent that water is not managed efficiently.

"On the other hand, irrigation farmers would benefit from such a management aid which integrates a mechanistic scheduling model and a water administration system, because not only will crop requirements be accurately determined, but water orders (discharge rate and duration) can automatically be



calculated and printed."

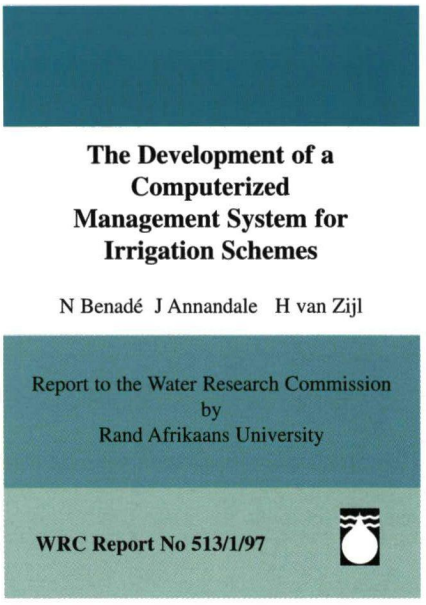
The researchers, N Benadé, J Annandale and H van Zijl, say that two separate irrigation research projects supported by the Water Research Commission were completed at the end of 1992 - one at the Rand Afrikaans University on an optimisation system for minimising distribution losses on irrigation schemes and the other at the University of the Orange Free State aimed at maximising irrigation efficiency on irrigation schemes.

The research at the Rand Afrikaans University focussed on water delivery and the main tools developed were:

❑ A computer program called PROCAN that simulates unsteady flow of water in any canal or river, and

❑ A water administration system called RAUDB/WAS which handles all water requests by farmers and is currently running on all major irrigation schemes throughout South Africa.

However, the water administration system never queries the amount of water requested by a farmer and the only limitation on the water delivered is the capacity of the canal system.



"There is only so much that can be done to minimise water losses in the canal system and discussions with water administrators on the Loskop irrigation scheme identified the need to query the amount of water that is requested by farmers to further optimise the water usage on the irrigation scheme.

"We knew a lot of research had already been done on irrigation scheduling and the main aim of this research project was therefore to identify a suitable scheduling model and integrate it into the water administration system."

Copies of the report entitled **The development of a computerised management system for irrigation schemes** (WRC report 513/1/97) are available free of charge from the Water Research Commission, PO Box 824, Pretoria 0001. E-mail order address: tineke@wrc.ccwr.ac.za (Please remember to include a postal address). Foreign orders: US$ 20 per copy, via surface mail.

Models for managing water quality in South African reservoirs

Water quality is increasingly being identified as an important consideration in the management and planning of river systems in South Africa. A number of factors have resulted in the overall deterioration in quality of the surface water resources in the country. These factors include river regulation, increased return flows from point and non-point sources and the processes which take place within water bodies and reservoirs.

The interaction of processes and driving forces which determine the water quality patterns in reservoirs is complex. Consequently there has been a growing awareness of the need for a greater range in decision support tools for water quality management and planning in South Africa.

In response to this need, the Water Research Commission appointed Ninham Shand Pty Ltd in association with the Department of Civil Engineering, University of Cape Town, in 1990 to conduct an investigation into the applicability of hydrodynamic reservoir models for water quality management of stratified water bodies in South Africa. The agreement with Ninham Shand was susequently extended to demonstrate the use of these models for management purposes.

AIMS

The research had the following aims:

❒ Investigation of the predictive abilities of selected existing hydrodynamic reservoir models by verification on selected water bodies in South Africa for which water quality depth profile data and associated hydrometeorological records were available.

❒ Adaptation of the selected models for application under South African conditions.

❒ Application of the selected models to specific water quality management and planning problems in South African reservoirs.

MODELS

In total, four models were implemented using a data base created from scratch for four water bodies. The work carried out was successful in that at least two models were identified which were capable of simulating the water quality and hydrodynamics in a number of reservoirs, these being CE-QUAL-W2 and DYRESM.

DYRESM-1D is a one-dimensional hydrodynamic reservoir simulation model for the prediction of the daily vertical temperature and salinity distribution in small to medium size lakes and reservoirs, developed at the University of Western Australia. The model uses a one-dimensional Lagrangian layer structure which allows for varying layer thickness and the model design is based on parameterisations of the individual processes that contribute to the hydrodynamics of a water body.

DYRESM-2D is a quasi two-dimensional, laterally averaged, hydrodynamic reservoir simulation model and uses a Lagrangian layer structure in which each layer is divided into "parcels". These parcels are only changed when layers are combined or split, or when parcels become too large or too small. Key features of the current versions of the DYRESM models and supporting software include:

❒ Simulation of density, temperature and salinity profiles;

❒ Applicability to water bodies with multiple off-takes;

❒ Simulation of bubble plume dynamics as generated by any given aerator design;

❒ The ability to simulate extended time periods (months or years); and

❒ User friendly input requirements and graphical and plotting utilities for output.

CE-QUAL-W2 is a two-dimensional, laterally averaged, fixed grid, hydrodynamic and water quality simulation model which uses horizontal layers and vertical columns to delineate each computational cell. The model has been under continuous development by the US Army Corps of Engineers since 1975 and used in a number of countries for the water quality assessment of reservoirs, rivers and estuaries. Key features of the model include:

❒ The simulation of 21 water quality constituents in addition to water temperature and water movement;

❒ Flexible design of the model allowing the application to water bodies of complex physical form;

❒ Applicability to water bodies with multiple branches, withdrawals , releases and abstractions;

❒ The ability to simulate extended time periods (months or years); and

❒ User friendly input requirements and graphical and plotting utilities for output.

In line with their mechanistic nature, these type of reservoir models require:

❒ Hydrometeorological input data of a daily time resolution to represent the reservoir driving forces;

❒ A number of water quality depth profiles in the water body of interest for calibration and verification of the models;

❒ Certain physical and water quality process representations in the models are represented by coefficients or parameters of a site-specific nature;

❒ Spatial information on the dimensions, volume, morphology and outlet configuration of the reservoir basin and its embankment.

APPLICATION OF MODELS

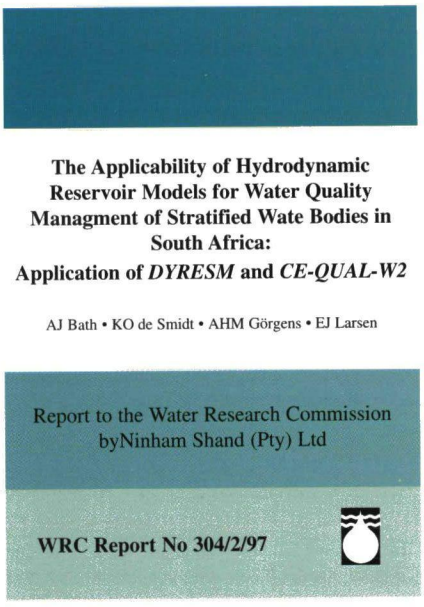
No field work or field gathering of data was undertaken as part of this project and all modelling data bases were assembled from the original data sets. For application purposes, the models were matched to reservoirs both in terms of their particular data needs and in terms of their appropriateness to deal with a likely water quality management challenge.

The study was carried out by calibrating or verifying the hydrodynamic models using the data sets for six reservoirs: Inanda, Roodeplaat, Hartbeespoort, Laing and Rooipoort Dams as well as the Vaal Barrage. These reservoirs were selected because of their water quality characteristics, available data sets and the existence of water quality problems. The calibrated and verified models were then used to provide information on a number of management and planning options for each of the reservoirs. This information and findings, along with the implications thereof, were discussed further with the end users.

CONCLUSIONS

For one or more of the reservoirs selected in this study, the models provided acceptable simulation of at least one of the following processes: reservoir volume balance, thermal stratification, hydrodynamic mixing, non-conservative constituents (including nutrients, oxygen regime and algal biomass), conservative constituents and sediment-water interactions. The combination of predictive ability and model structure allowed the evaluation of a range of reservoir management options such as destratification by bubble plume aeration, selective abstraction, control of reservoir operating level, hypolymnetic releases, freshening options and changes to reservoir input loading.

Six reservoir case studies are presented in the report. The case studies provided insights into the data requirements for model configuration, time varying input data and model calibration. The available hydrometeorological data sets were generally found to be adequate for the configuration and calibration of the models. Specific issues relating to the data for each dam studied are described in the report.



MANAGEMENT

The researchers say that internationally mathematical modelling has become an accepted part of the process of establishing and evaluating scenarios for water quality management and decision making. These models have been used in the design phase of reservoir construction to preempt water quality problems in the operation of reservoirs and the development of operating rules, destratification systems and the evaluation of management strategies and also to manage the chemical process interactions taking place within a water body. The increasing use of models, worldwide, is in recognition of the fact that:

❒ Each and every water body has a unique water quality character and response and empirical "rule-of-thumb" methods have certain limitations.

❒ Reservoirs exhibit comparatively complex interactions between physical, chemical and biological processes and these can be explored using models.

❒ The response of a reservoir to a given management practice is difficult to predict reliably without a detailed understanding of the governing processes and driving forces and that modelling can provide refinement of particular management practices to suit local conditions.

❒ Reservoir modelling is relatively cheap in comparison to the cost of implementing a management option, the cost of water and wastewater treatment and the cost of water paid by consumers.

❒ Reservoir modelling exposes monitoring and data collection inadequacies.

In South Africa, in the past, great emphasis has been put on the management of water quantity resulting in the development of system operating rules. It is now being recognised that the decision making process must be enhanced to address the management of both water quality and water quantity. This study clearly shows how hydrodynamic reservoir models can be used to provide information which can be used in the management of water quality. Specific recommendations are given in the report regarding the use of models in the management process.

Copies of the report titled **The applicability of hydrodynamic reservoir models for water quality management of stratified water bodies in South Africa: Application of DYRESM and CE-QUAL-W2** (WRC Report 304/2/97) are available free of charge from the Water Research Commission, PO Box 824, Pretoria 0001. E-mail order address: tineke@wrc.ccwr.ac.za (please remember to include a postal address when ordering). Foreign orders: US$ 30 per copy, via surface mail.

Researchers look at protein production from pulp mill effluent

Various high-volume industrial effluent streams were identified in a Water Research Commission funded study at the University of Pretoria (UP), as a potential source of protein to augment agriculturally produced protein in South Africa.

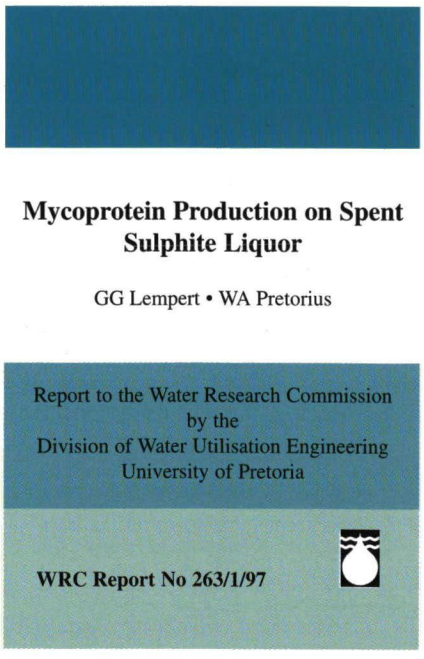
One of the effluents, the effluent from a pulp mill utilising a calcium-based sulphite pulping process, was selected by the researchers as a high-strength organic waste stream that could be utilised as a substrate for single-cell protein production.

The effluent was successfully treated, using a unique cross-flow sieve reactor system and a filamentous fungal organism, *Aspergillus fumigatus*. Using this system, effluent quality is improved and the excess fungal organisms ("the sludge") are available as a single-cell protein source.

The researchers, GG Lempert and WA Pretorius from the Division of Water Utilisation Engineering at UP, say in their report to the Water Research Commission that South Africa will have to augment its agriculturally produced protein to feed its ever increasing population.

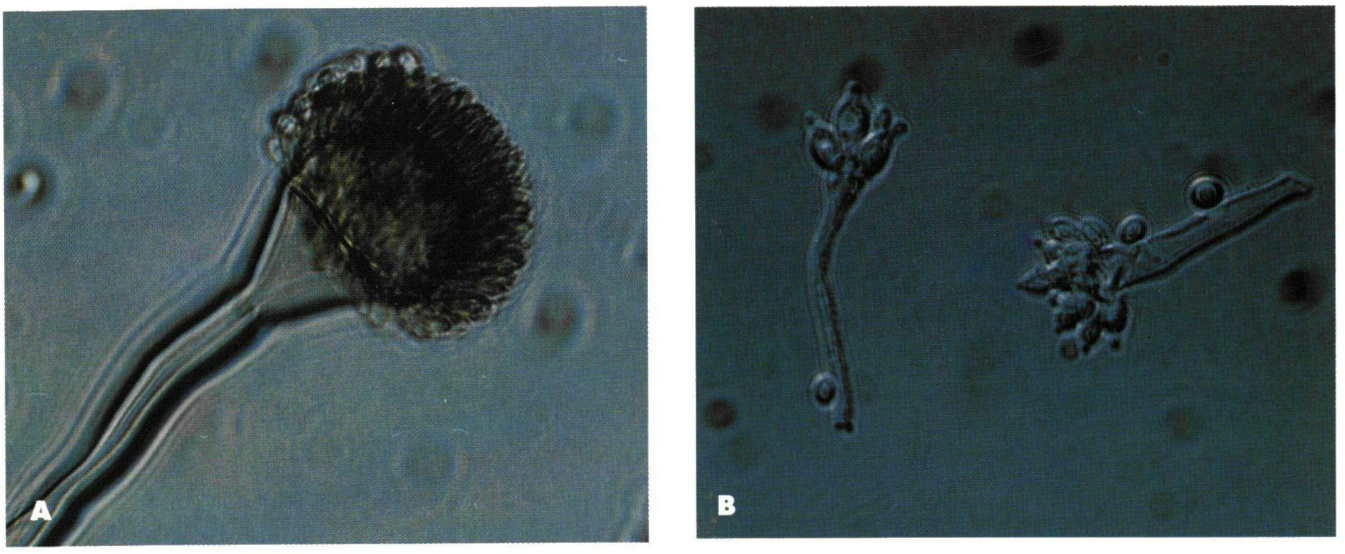
"The high population growth and expected general upliftment of the people of South Africa will result in ever increasing animal protein consumption, necessitating higher protein imports in future. If the high population growth rate is maintained it is estimated that the total feed protein deficit by the year 2000 will be approximately 400 000 t/annum."

Alternative protein sources include the recovery of waste proteins from plant and animal-processing plants, exploiting alternative marine sources and the possible production of non-conventional proteins such as single-cell proteins (SCP) from certain identified industrial effluents.



SCP

Cells from algae, bacteria, fungi and yeasts, produced to substitute or augment the protein contents in human and animal diets, fall under non-conventional proteins and are generally known as "single-cell proteins". Initially the term single-cell protein was appropriate because unicellular organisms like yeasts were used to produce microbial biomass for food and food products. Nowadays single and multicellular micro-organisms are mass cultivated for this purpose. Though "cultured microbial biomass" would therefore be a more appropriate term, the term sin-



Streaked-plate cultures: A) Aspergillus fumigatus, *a thermotolerant fungus that is able to utilise spent sulphite liquor as a food, and B) an unknown* Aspergillus sp.

gle-cell protein has generally been accepted in the scientific community.

Interest in single-cell protein has existed since the turn of the century. Food shortages experienced during and after World War I and II caused several governments to finance projects to produce microbial protein for human and animal nutrition. Later the production of a cheap alternative for meat and animal feed ingredients seemed possible and attracted renewed interest in single-cell protein production. This interest was further encouraged by estimates of future protein demands. Some scientists predicted a global shortfall of some 14 million tons of feed protein by the year 2000.

Many studies were undertaken and numerous experimental pilot and full-scale single-cell protein production processes were developed. However, there are no large-scale plants to date that produce single-cell protein in any country where a free-market economy prevails. The reason being that many problems were encountered that rendered full-scale single-cell protein production not economically viable.

In South Africa single-cell protein is produced on a small scale, mainly to serve as food extract or for pilot studies. However, researchers have studied the utilisation of waste as a substrate for single-cell protein production from the synthetic fuel industry, the pulp and paper industry and the sugar industry.

From the identified effluents with potential for single-cell protein production spent sulphite liquor appears to be a good choice. Independent surveys have shown that spent sulphite liquor, which is discharged to sea, is harmless to the environment, although it can cause localised aesthetic nuisance conditions when residual foam, which develops during turbulent seas, is deposited on the beach.

The effluent mainly consists of sugars (hexoses and pentoses), short-chain alcohols and fatty acids, calcium lignosulphonate, sulphur dioxide and cellulose residues. Although the sugars and short-chain carbon compounds are easily biodegradable, lignosulphonates are not easily removed from spent sulphite liquor by microbial decomposition. The reason is because lignin, which strengthens cell walls in plants, also protects the microfibrils of these walls from chemical, physical and biological attack. Lignin compounds such as lignosulphonates show a similar resistance to biological degradability.

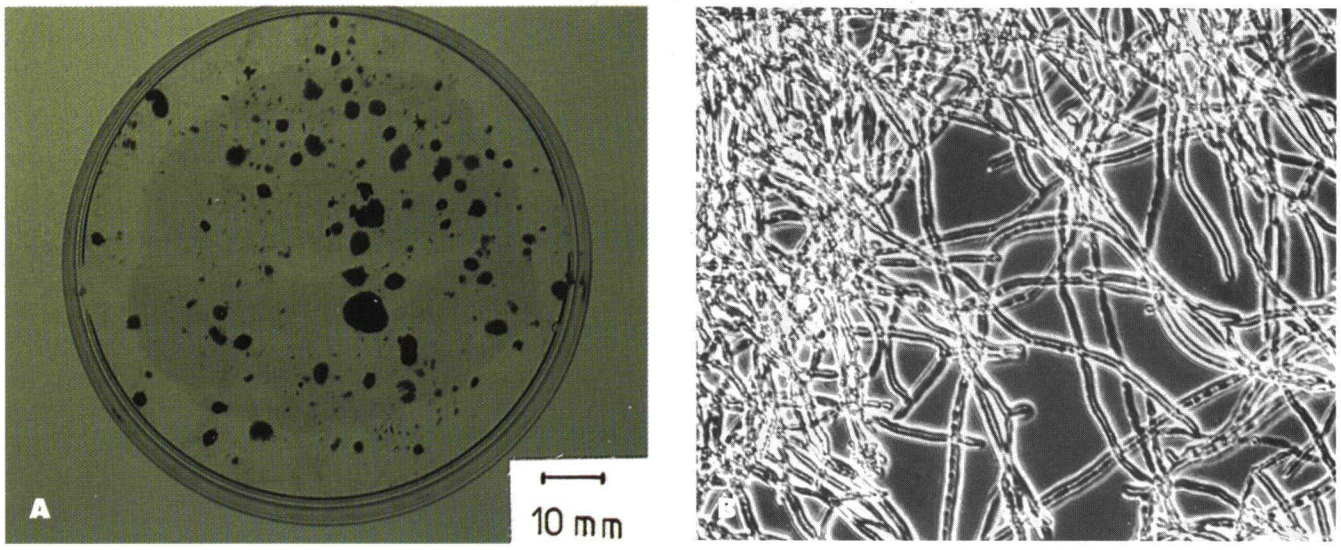
SCP PRODUCTION

Many reactor types and processes have been developed for single-cell protein production. Most of these processes have made use of a single micro-organisms which was grown under aseptic culture conditions requiring expensive equipment.

Different micro-organisms have different physiological and physical properties, which make it possible to select, from a diverse microbial population in nature, one or more micro-organisms that can utilise a specific effluent better than others. Primary selection factors are physiological properties. Secondary selection factors are physical properties of the micro-organism to be selected. Physiological properties that can be varied to favour growth of a specific micro-organism include environmental conditions such as pH, temperature, oxygen availability and specific nutrient concentrations, for example, carbon, nitrogen and trace elements.

DYNAMIC SELECTION

Secondary selection is a dynamic selection process which makes use of the physical properties of micro-organisms, such as their electrical charge, mass, size and growth rate. A dynamic



Biomass during selection of thermophilic fungi: A) Sclerotic pellets, and B) a Pulp-like fungal biomass.

selection process has been developed at the University of Pretoria with which mono-cultures can be selected from a multi-species culture and maintained indefinitely under non-aseptic growth conditions. This process employs a cross-flow microsieve reactor to achieve dynamic selection.

The microsieve reactor relies on a relatively large pore size (100 µm) microsieve and short hydraulic retention times to selectively wash small-sized micro-organisms, such as contaminating yeasts and bacteria out of the biomass whilst retaining large filamentous micro-organisms such as fungi. The reactor is ideally suitable for application with relatively low substrate concentrations, such as most industrial effluents carrying organic material. However, one serious drawback of the microsieve process is that oxygen becomes the limiting substrate at relatively low fungal biomass concentrations in the microsieve reactor.

RESULTS

Prior to the research phase of this project, three major drawbacks for commercial application of the microsieve process were identified, namely:

❒ Mesophilic fungi were employed that required extensive cooling to maintain optimum growth temperatures;

❒ It was difficult to maintain a monoculture due to excessive contamination by bacteria and yeasts at the low operating temperatures; and

❒ Dilution of high substrate concentrations was needed to prevent oxygen from becoming the limiting substrate.

However, this research at least partially solved some of these problems:

❒ The pulp-mill effluent's biodegradable chemical oxygen demand (COD) was found to be approximately 40 per cent of the total COD, which translates into 234 000 t/annum COD that will be available as substrate COD for single-cell protein production.

❒ A thermotolerant fungus that can utilise diluted spent sulphite liquor as food, *Aspergillus fumigatus*, could be isolated from a mixed culture. The fungus was found to have optimum growth at a temperature of 45°C and a pH of between 5,25 and 5,75.

❒ *Aspergillus fumigatus* was able to utilise only 33,6 per cent of the pulp mill's total COD concentration. The amino-acid composition of the fungus compares well with other protein sources generally used as feed for animals.

❒ The elevated operating temperature exerted additional selection pressure on the biological system and it was possible to maintain monoculture growth of *A. fumigatus* indefinitely in a microsieve reactor.

The researchers concluded that maximum theoretical single-cell protein production utilising the pulp-mill effluent as substrate (flow equals about 80 000 m3 per day, with biodegradable COD about 6,8 g/ℓ) and *Aspergillus fumigatus* as fungus can be obtained in a microsieve process and would total approximately 120 000 t per annum. This figure represents almost 30 per cent of South Africa's estimated total feed protein deficit in the year 2000.

Copies of the report entitled **Mycoprotein production on spent sulphite liquor** (WRC report 263/1/97) are available free of charge from the Water Research Commission, PO Box 824, Pretoria 0001. Overseas price: US$ 25, inclusive of surface mail. E-mail orders: tineke@wrc.ccwr.ac.za - please remember to include a postal address.

First Announcement and Call for Papers

CONFERENCE

National Rivers Research Initiative

29 June - 1 July 1998

Formation of a National Rivers Research Initiative

Hosted by the Southern African Society of Aquatic Scientists (SASAQS) and supported by:

Water Research Commission

Department of Water Affairs and Forestry

Foundation of Research Development

Department of Environmental Affairs and Tourism

This conference is a concerted attempt to bring together aquatic scientists from throughout South Africa to discuss and make recommendations on the concept and form of a co-ordinated national rivers research effort.

Rivers include all natural and artificial freshwater and brackish water-bodies that are either static or flowing, including the adjacent riparian zones, but excluding the marine environment.

EXPECTED OUTPUT FROM THE CONFERENCE

- proceedings;
- document describing all aspects of river research and management in South Africa, identifying strengths and weaknesses, and outlining a way forward into the next millennium;
- recommendations for the better management of rivers, identification of glaring deficiencies in our knowledge, and determining priorities for the future;
- recommendations for an "umbrella" structure that will oversee and co-ordinate all river research in South Africa;

INVITATION TO PRESENT A PAPER

This is an invitation to present a paper at the workshop. **Please note that this is NOT a general conference, but a specific working conference with specific objectives.** The paper you offer must give an indication of how you see yourself or your organisation fitting into a National Rivers initiative. Parallel sessions will be kept to a minimum but will depend on the response to this invitation.

The first two days of the conference will be devoted to presentations on the topics outlined below, and thereafter the final day will be devoted to the compilation of the workshop document.

PAPER CATEGORIES

The paper you offer MUST fall into one of the following categories:

- monitoring river condition(s)
- understanding rivers
- conservation
- development and management of rivers
- organisational structures for a national rivers programme

In addition to the focus on an above mentioned subject category, your paper should also briefly cover, the following aspects:

- Background to your own/your organisation's field of expertise.
- How your field of expertise fits into the picture of a national research initiative, on the whole.
- The contribution you could make to the National Rivers initiative.
- Research needs in your field.

REGISTRATION

Please submit your name, affiliation, address and the title of your proposed paper (if relevant) to the address below. If you are not planning to present a paper, please send your details to register as a participant.

ABSTRACTS

All submissions must be supported by an electronic or camera ready abstract. (Faxed copies unacceptable). Abstracts should not exceeding one A4 page of single spaced typing. These abstracts must be submitted to the organisers on or before 20 May 1998. The presentation of each paper will be limited to 15 minutes. There will **not** be any poster sessions.

PUBLICATION OF PAPERS

In order to document the proceedings, extended abstracts will be published. These must reach the organisers by the end of the conference at the latest and must be in electronic or camera ready form. Due to financial constraints it has been decided, initially to make the papers accessible via a dedicated site on the World Wide Web. Printed publication will depend on sponsorship and the wishes of the participants. Details of the publication format will be sent to prospective authors.

COST

As there will be few frills attached to the conference, it is envisaged that registration costs will be low.

VENUE

The conference will be held in the Life Sciences Buiding at the University of Natal, Pietermaritzburg from Monday to Wednesday, 29 June - 1 July 1998.

ENQUIRIES

For all enqueries please contact:

Dr Chris Dickens
Tel. 0331-3411151
Fax 0331-3411349 or
e-mail: chrisd@umgeni.co.za

REGISTRATION

Registrations and submission of abstracts should be forwarded to:

- Mr Mark Graham
  e-mail: markg@umgeni.co.za,

or

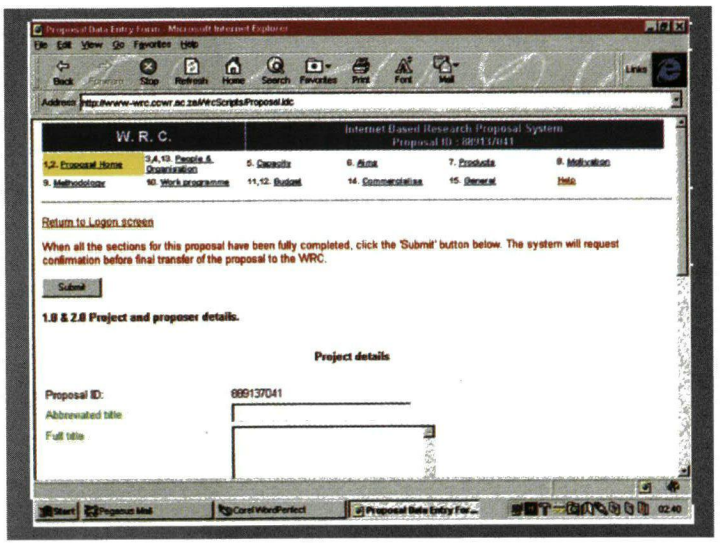
- Fax: 0331-3411349 - for registration only!
  Please NO faxed abstracts!

- Abstracts in camara ready form,
  should be posted to:

  Mark Graham
  SASAQS Secretary
  c/o Umgeni Water
  PO Box 9
  Pietermaritzburg
  3200

SUBMIT RESEARCH PROPOSALS
Now - on INTERNET!

The Water Research Commission (WRC) is extending an invitation to research organisations and individuals to submit water research proposals to the WRC for consideration for research funding during 1999. Direct electronic completion and submission of the research proposal form via the Internet web site of the WRC is now available, to ease and speed up the submission procedure. A document entitled *'Procedures for the Internet Submission of a Research Proposal to the WRC'* provides clear instructions to assist researchers in completing and submitting their research proposals via the Internet.



How to submit a research proposal via the Internet

All the documentation required for research proposal submissions is directly accessible on the WRC's web site at the following Internet address:

http://www-wrc.ccwr.ac.za

❒ **Step 1: Register** a new research proposal, by entering an abbreviated title for the proposed project. The system will confirm registration of the proposal and display a unique ID number for the proposal. **Please note this ID reference number for future use.**

Researchers are advised to collect all the necessary information before starting the process to enter the information into the Internet form. The document *'Guidelines for Compiling Research Proposals'* (also on the Internet) lists and explains, in detail, all of the information required.

When all the information required for the submission of the research proposal have been prepared, the details of the proposal can be entered onto the Internet form.

Please read the instructions appearing on the screen, thoroughly and carefully, to avoid any confusion.

❒ Get access to the submission form by returning to the opening screen: **Step 2 : Retrieve** a registered proposal for data entry/modification. Enter the proposal ID reference number which has been allocated by the system in Step 1, and click on 'Continue'.

❒ The next screen brings up the actual proposal form (See figure above). The form contains 15 Sections which have to be completed **before** submitting the form to the WRC. Use the navigation bar at the top of each page for easy navigation through the various sections and pages of the proposal form. Please note that all sections appearing in *green* on the computer screen are mandatory, and no form is to be submitted until all these sections have been completed.

After data entry or editing, each individual page has to be updated before proceeding to another page. A **HELP** facility on screen will provide specific information to facilitate data entry on each page. On pages requiring extensive text inputs, text editing assistance (for italics, paragraph indents, etc.) is provided.

❒ When all sections have been completed, press 'Submit' (on first page) to finally transfer the proposal to the WRC.

Updating or change

If at any stage, **before** the closing date for submissions, the information in your proposal needs to be changed or updated, enter the project ID number in the appropriate space at Step 2 on your screen, and the system will provide access to the initial project proposal for updating.

Alternative route

Researchers experiencing difficulty with the Internet route, may draft their proposal as a WordPerfect 5 (or higher) or MS Word 6 (or higher) document and submit it on diskette, together with a printed copy, addressed to the Executive Director at the WRC.

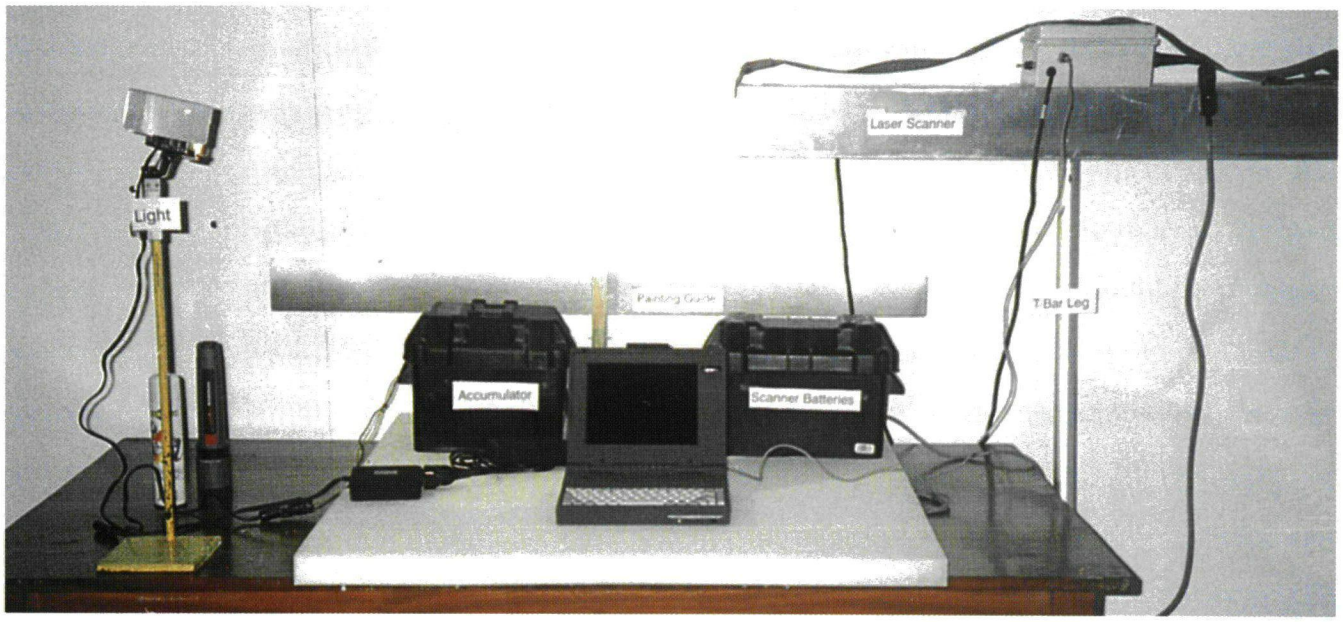
Assistance/Enquiries

For assistance in completing the Internet project proposal submission form, please contact:

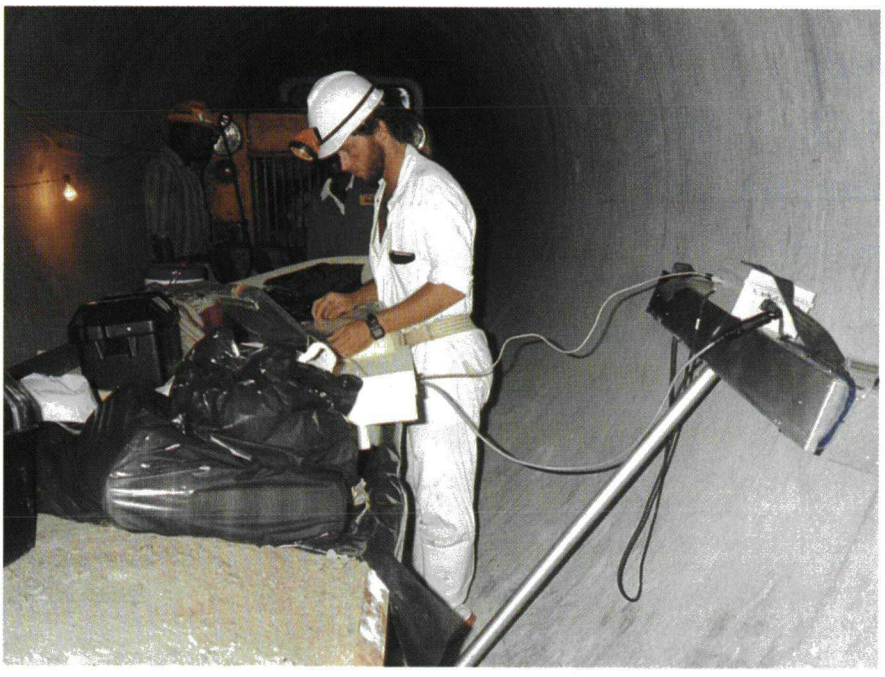
❒ Francette Myburgh
E-mail: fmyburgh@wrc.ccwr.ac.za

❒ Jenny Shelwell
E-mail: jshelwel@wrc.ccwr.ac.za
or
Tel.(012) 330 0340 Fax (012) 331 2565

Estimating **Hydraulic Resistance** for machine bored tunnels



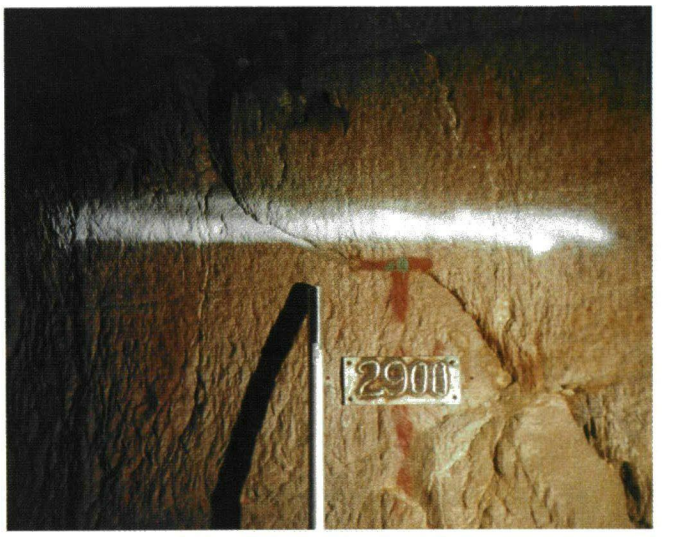
Water tunnel excavation using tunnel boring machines has been shown to be faster and more efficient than the traditional drill-and-blast methods. Moreover, bored tunnels have the added advantage of, in many cases, not requiring a lining of any sort.



As this technology is relatively new in its application to hard rock, there is little data available relating the physical roughness of the bored tunnels to their hydraulic resistance. The Water Research Commission (WRC) therefore contracted researchers from the Department of Civil Engineering at the University of Natal to find out what the expected roughness of machine bored tunnels is likely to be and also to provide a method for calculating hydraulic resistance of such surfaces by comparing them with physical roughness measurements made on other similar surfaces.

The researchers, GGS Pegram and MS Pennington, say in their final report to the WRC that the hydraulic engineer who is presented with the problem of designing a tunnel to be excavated by a tunnel boring machine has, among others, the following question to answer: "What is the hydraulic resistance of the tunnel walls likely to be in situations where head loss is important?" (given the route or alignment of the tunnel and the quantity of water it is to transport, and given a geological prediction of the rock-types likely to be encountered in the tunnel). To answer this question, the researchers say, the answer to another new question must be found, namely, "How rough is the surface inside the tunnel likely to be, and how is this physical roughness related to hydraulic resistance?"

Banded Gneiss in the Emolweni tunnel



Natal Group Sandstone in the Claremont tunnel

Left: The apparatus used in scanning wall roughness of bored tunnels.

Below left: The working arrangement in the Emolweni tunnel.

To collect the data necessary for answering these questions, the study was timed for a period in which there has been a large amount of tunnelling activity in southern Africa and many tunnels were potentially available for roughness measurement "in the dry" before commissioning.

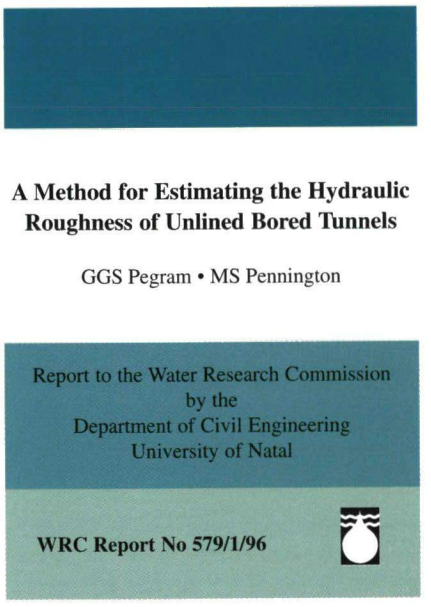
All in all, the following actions were taken by the researchers and are reported on in the publication:

❒ An extensive literature search was undertaken to find out what had already been done in directly relating physical roughness to hydraulic resistance;

❒ A methodology using a laser scanner was developed to collect accurate roughness data at 0,5 mm (scanning) intervals, over a one metre base length, and to store them directly in a file in a notebook computer while in the tunnel;

❒ Roughness samples and accompanying photographs were collected at 100 m (spacing/sampling) intervals in 15,1 kilometres of freshly bored tunnels in Lesotho and KwaZulu-Natal during 1994;

❒ Several statistical parameters for quantifying physical roughness of the tunnel wall from the measured data were defined and studied using time series analysis and spectral analysis;



❒ Theoretical fluid dynamics investigations were made into the nature of flow in large water conduits and an improved velocity distribution for turbulent flow in conduits was developed;

❒ By comparing predictions of resistance with those obtainable in the literature, a selection was made between the various roughness statistics as to which was best for predicting hydraulic resistance; and

❒ Recommended values of hydraulic resistance are offered for a range of surfaces, including concrete lining, sandstone, granite and shotcrete.

The report is divided into three main parts - the executive summary, the body of the report (in which the main findings appear) which comprises four short chapters, and the appendices, where the theoretical and more detailed aspects of the study appear. There are five appendices and the two most important ones are Appendix B, describing physical roughness measurement and interpretation and Appendix C, describing the hydraulic resistance of closed conduits flowing full at equilibrium and at high Reynolds numbers.

Copies of the report entitled **A method for estimating the hydraulic roughness of unlined bored tunnels** (WRC report 579/1/96) are available free of charge from the Water Research Commission, PO Box 824, Pretoria 0001. Foreign price: US$ 25 (via surface mail).

Science and Technology in South Africa today

- Impressions from a Review Workshop -

The Associated Scientific and Technical Society of South Africa (AS & TS) recently organised a workshop to review the state of Science and Technology in South Africa today. The workshop, held in January, comprised fifteen status reports, followed by review comments and an overview on the next day, which was linked to the AS & TS annual meeting. Mr Eberhard Braune attended as national representative for the SA National Committee of the International Association of Hydrological Sciences (SANCIAHS), an associate society of AS & TS.

Readers of SA Waterbulletin can gain brief glimpses and impressions from the review workshop, with the following notes from Mr Braune's pen, as he sketches the present situation in South Africa, for the Sanchias News column:

Illiteracy and shortage

The science illiteracy of the world's population and its leaders is increasing. There needs to be a refocus onto science and technology. This requires a much higher level of public understanding of science.

South African science and technology has suffered a number of blows through big down-scaling, e.g. arms, uranium enrichment and chemistry research. This has an immediate impact on brain drain. School interest in science is also immediately affected, with a negative reponse to such high profile publicity events.

There is a critical shortage with regard to technically-skilled manpower in South Africa.

	Total number of teachers	Percentage of teachers not qualified (%)
Physical Science	14 000	42%
Mathematics	16 000	50%

	Pupil enrollment number	%	Pass rate at African schools
Physical Science	108 000	24%	7%
Mathematics	190 000	42%	7%

Table 1

Schools

There is major concern about the poor quality of maths and science output of South African schools. Twenty percent of high schools do not offer mathematics and more are going in that direction to push up their overall pass rates.

The statistics in Table 1 illustrate the problem.

University students

The number of physics students has been declining since 1990 and is approaching critical proportions. Chemistry on the other hand shows a satisfactory growth. Presently very few students choose engineering as a career.

Students respond very quickly to perceived opportunities. The University of the Witwatersrand suddenly has a hundred first year students in Geology after a big decline in the previous years. This

is related to the fast-growing off-shore opportunities and chance to work overseas. In general, black students want to come into science because they see the gap that has developed over years.

Universities are concerned about the shortage of quality students for Honours level studies.

Mining and Industry

In the present economic situation only big companies invest in education and training. Presently there is a trend amongst companies to do away with their in-house training capacity, and rather to outsource it as required.

Because of this situation and the regular swings between glut and shortage there is presently a lot of job-hopping going on.

The international opening-up is starting to have its effect. Observers perceive a silent revolution in South Africa of small, world class undertakings coming to the fore. The transfer of skills into uplifting is also producing a lot of innovation.

While mining and industry appear to have strong ties with universities and specific chairs that meet their needs, the relationship with technikons is not so strong. The new B-Tech degree does not meet industry's requirements and appears to have been developed without client consultation. There is also concern about the lack of University/Technikon cooperation and a greater linking of programmes.

Government

There is general appreciation for the government's major initiatives in the science and technology field, eg.:

❑ a new Department and Minister of Arts, Culture, Science and Technology (DACST);
❑ the Science and Technology policy White Paper;
❑ the Innovation Strategy and Foresight Initiative;
❑ the technology debate at highest political level (eg. a Ministerial advisor out of the Engineering Association ranks, and a National Science and Technology Forum);
❑ the 1998 Year of Science and Technology;
❑ major Science and Technology links with USA and Germany shortly.

However, decreased direct government funding for science and technology is a world-wide phenomenon which requires innovative solutions from all role-players.

Survival Strategies

❑ The importance of natural sciences as the basis for science and technology, and the importance of science and technology as the basis for development, must be realised. We should all work towards a culture of technology for South Africa;

❑ There is general agreement that the science and technology community of South Africa must unite
- to speak with one voice,
- to have an impact with its strategies, and
- to respond to the new government initiatives;

❑ Many more integrated approaches to scientific endeavor are required. Integrated Catchment Management (ICM) is a good example of this. Responses to this need would be, for example, more schools of environmental sciences and moves to link professions. The scope of science students should also be broadened. The University of Pretoria, for example, wants to offer modules of law, economics and communication to their chemistry students, to be incorporated in their study courses as part of a science degree.

❑ The science and technology community of South Africa should urgently involve themselves in the development of the school curricula under the Curriculum 2005 programme.

❑ There must be a strong joint effort towards greater public awareness and understanding of science and its role. Opportunities like the many new Science Centres, the Science Expo and the year of Science and Technology should be used and created.

Facts of science which capture the public imagination, should be utilised to carry a broader message. Even nursery and primary schools should lay a foundation through focus on the wonders of creation.

❑ Every effort must be made to support the education system to boost science education in schools, focussing on teachers, pupils, facilities, bridging colleges, etc.

Industry has a number of initiatives to help with the upliftment of maths and science in schools. One of these is the PROTEC initiative launched by the engineering associations in the 80's.

❑ Bursaries should be used a lot more constructively and in partnership with schools and universities. There should also be much more flexibility to cater for excellent candidates for bursaries who often drop out, simply because they do not know the system and channels, and fail to find bursaries available.

❑ Government should have good chances to obtain top candidates because many industries at this stage give bursaries only from second year onward.

❑ In several cases an industrial sector as a whole has produced high quality recruiting material for schools eg. the video of the Electrical Engineers, and the brochure of the Geological Society.

❑ Some industries are already using the qualifications forum concept to good effect, eg. the Mines Qualification Forum. This will assist to create transportability of qualifications and to cross compartments and to give credit for education and training.

❑ In strategic planning for education and training far more attention should be given to regional needs and cooperation.

SA WATERKALENDER

The Water Research Commission is placing this calender in order to assist with the co-ordinating of water events in South Africa.

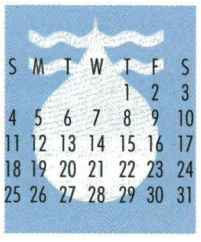
You are invited to send information about conferences, symposia or workshops to the SA Waterbulletin.

Address:
The Editor,
SA Waterbulletin,
P.O. Box 824,
0001 Pretoria
Tel (012) 330-0340
Fax (012) 331-2565

Legend:
- ❍ An SA Water Event arranged for these dates.
- ❑ 2nd SA Water Event scheduled for these dates.
- × 3rd SA Water Event scheduled for these dates.

See conferences and symposia pages for events.

1998



S	M	T	W	T	F	S
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31

S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28

S	M	T	W	T	F	S
1	❍	❍	❍	❍	❍	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

S	M	T	W	T	F	S
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30		

S	M	T	W	T	F	S
					1	2
3	❍	❍	❍	❍	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	❍	❍	❍	❑	❍	30
31						

S	M	T	W	T	F	S
	1	2	3	4	5	6
7	❍	❍	❍	❍	❍	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	❍	❍				

S	M	T	W	T	F	S
			❍	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	

S	M	T	W	T	F	S
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31					

S	M	T	W	T	F	S
		1	2	3	4	5
6	7	8	9	10	11	12
❍	❍	❍	❍	❍	❍	❍
20	21	22	23	24	25	❍
27	28	29	30			

S	M	T	W	T	F	S
				1	2	3
4	5	❍	❍	8	9	10
11	12	❍	❍	❍	16	17
18	19	❍	❍	22	23	24
25	26	27	28	29	30	31

S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30					

S	M	T	W	T	F	S
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	

S	M	T	W	T	F	S
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31					

Die Waternavorsingskommissie plaas hierdie kalender om te help met die koördinering van water-gebeurtenisse in Suid-Afrika.

Alle belanghebbendes word uitgenooi om inligting aan SA Waterbulletin te stuur.

Adres:
Die Redakteur
Posbus 824
0001 Pretoria
Tel: (012) 330-0340
Fax: (012) 331-2565

Gids:
- ❍ Een SA Watergeleentheid vir hierdie dae.
- ❑ 'n Tweede SA Watergeleentheid vir dié datums.
- × 'n Derde SA Watergeleentheid vir dié datums.

Sien Konferensies- en Simposiumbladsy vir aangeduide geleenthede.

1999

S	M	T	W	T	F	S
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31						

S	M	T	W	T	F	S
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28						

S	M	T	W	T	F	S
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

S	M	T	W	T	F	S
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31

S	M	T	W	T	F	S
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31					

S	M	T	W	T	F	S
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30			

S	M	T	W	T	F	S
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	14	15
18	19	20	21	22	23	24
25	26	27	28	29	30	31

S	M	T	W	T	F	S
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31					

S	M	T	W	T	F	S
					❍	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31						

S	M	T	W	T	F	S
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	22
21	22	23	24	25	26	27
28	29	30				

S	M	T	W	T	F	S
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	

SOUTHERN AFRICA

1998

WISA '98
MAY 4 - 7 1998
The biennial conference and exhibition of the Water Institute of Southern Africa (WISA) will be held in Cape Town.
Enquiries: Conference Planners, PO Box 36782, Menlo Park 0102. Tel: (012) 348-4493. Fax: (012) 348-1563. E-mail: wissing@iafrica.com

WATER TREATMENT
MAY 25 - 29
A short course on the management and optimisation of water treatment plants will be presented by the University of Pretoria. See insert in this Bulletin,
Enquiries: Prof WA Pretorius. Fax: (012) 362-5089.

SHORT COURSE
MAY 28
A short course on fluoride in drinking water will be held at the Rand Afrikaans University in Johannesburg. See advert on page 31 in this Bulletin.

ENVIRONMENTAL AUDIT
JUNE 8 - 12
The ISO 14001 environmental management and auditor training course will be held at the Eskom Conference Centre in Midrand, Gauteng. The course is accredited by EARA UK and presented by Aspects International UK.
Enquiries: Crystal Clear Consulting, PO Box 1982, Bramley 2018. Tel: 011-882-3368. Fax: 011-882-3395. E-mail: crystal.clear@pixie.co.za.

RIVERS RESEARCH
JUNE 29 - JULY 1
A working conference on the formation of a national rivers research initiative will be held in Pietermaritzburg, KwaZulu-Natal. See insert in this Bulletin.
Enquiries: Mark Graham. Fax: (0331)-3411349. E-mail address: markg@umgeni.co.za.

AQUACULTURE
SEPTEMBER 13 - 19
An international conference on African fish and fisheries - diversity and utilisation will be held in Grahamstown in the Eastern Cape. The objectives of the conference are to address and discuss issues surrounding African fish biodiversity and sustainable utilisation of marine and inland fisheries resources and to consider recent advances in aquaculture in Africa.
Enquiries: JLB Smith Institute of Ichthyology, Private Bag 1015, Grahamstown 6140. Tel: +27 461 311002 or Fax: 0461-22403. E-mail: fishcon@ru.ac.za Website: http://www.ru.ac.za/affiliates/jlb/fishcon

SHORT COURSE
OCTOBER 6 - 7
A short course on water quality modelling in water supply systems will be held at the Rand Afrikaans University in Johannesburg. See advert on page 31 in this Bulletin.

WASTECON '98
OCTOBER 13 - 15
This international conference will be held at the World Trade Centre in Kempton Park and is intended to explore new perspectives in waste management, particularly those applicable to the southern African region. Topics will include management aspects such as auditing, reporting, monitoring, environmental management systems, legal institutional and policy developments, alternative and appropriate technologies and public participation.
Enquiries: Piet Theron or Sonja Havenga at the Institute for Waste Management. Tel: (011) 787-1151. Fax: (011) 787-1086.

SHORT COURSE
OCTOBER 20 - 21
A short course on dissolved air flotation in water treatment will be held at the Rand Afrikaans University in Johannesburg. See advert on page 31 in this Bulletin.

1999

CORROSION
SEPTEMBER 26 - OCTOBER 1
The 14th international corrosion congress on "Co-operation in Corrosion Control" will take place in Cape Town. A trade exhibition will also be held for the duration of the congress. **Call for papers**. Deadline 31 July 1998.
Enquiries: The Secretary, The Corrosion Institute of Southern Africa, PO Box 966, Kelvin 2054. Tel: (011)8025145. Fax: (011) 8043484. E-mail address: norust @ futurejhb.co.za

OVERSEAS

1998

STORM DRAINAGE
MAY 4 - 6
A conference on innovative technologies in urban storm drainage (Novatech 1998) will be held in Lyon, France.
Enquiries: GRAIE, BP 2132, 69603 Villeurbanne Cedex, France. Tel: +33 472 438368. Fax: +33 472 449277. E-mail address: graie@urgc-hu.insa-lyon.fr

DRINKING WATER
MAY 10 - 13
The first international symposium on technology, operation and economics of providing safe drinking water in small systems will be held in Washington DC, USA.
Enquiries: NSF International, 3475 Plymouth Road, Ann Arbor, MI, USA 48105. Fax: 202-289-2149. E-mail: cotruvo@nsf.org

CHLORINATED COMPOUNDS
MAY 18 - 21
The first international conference on remediation of chlorinated and recalcitrant compounds will be held in Monterey, California, USA.
Enquiries: The Conference Group, 1989 West Fifth Avenue Suite 5, Columbus, Ohio 43212-1912 USA. Tel: 614-424-5461. Fax: 614-488-5747. E-mail: 102632.3100@compuserve.com

WATER QUALITY
MAY 20 -23
An international conference on water quality management in national parks and other protected areas will be held in Primosten, Croatia.
Enquiries: Bojan Zmaic, Rakusina 1, 10000 Zagreb, Croatia. E-mail: bzmaic@zg.igh.hr Tel: +385-161-19-588.

ECWATECH-98
MAY 25 - 30
The third international congress and exhibition on water, ecology and technology will take place in Moscow, Russia.
Enquiries: The organising committee, PO Box 173, Moscow 107078, Russia. Tel/fax: +7 (095) 207 6360 E-mail address :ecwatech @sibico.msk.ru

RADAR
MAY 27 - 30
An international conference on ground-penetrating radar will be held in Lawrence, Kansas.
Enquiries: Richard Plumb. Tel.: 913-864-7735.

WATER RESOURCES
JUNE 3 - 6
An international conference on world water resources at the beginning of the 21st century: Water - a looming crisis? will be held in Paris, France.
Enquiries: UNESCO, Division of Water Sciences, 1 rue Miollis, 75732 Paris Cedex 15, France. Fax: +33-145-68-5811.

WATER QUALITY
JUNE 8 - 12
A short course on the Design of Water Quality Monitoring Networks will be presented at the Colorado State University, USA.
Enquiries: TG Sanders, Dept of Civil Engineering, Colorado State University, Fort Collins CO 80523. Tel: (970) 491-5448. Fax: (970) 491-7727. E-mail: TGS@engr.Colostate.Edu

MEMBRANE SCIENCE
JUNE 9 - 12
An international conference on membrane science and technology (ICMST '98) will be held in Beijing, China.
Enquiries: Mrs Yanqiao Shi, ICMST'98, c/o Institute of Chemistry, Chinese Academy of Sciences, Zhongguancun, Beijing 100080, China. Fax: +86-10-62569564 or: +86-10-62559373.

IWSA
JUNE 17 - 18
An IWSA specialised conference on master plans for water utilities will be held in Prague, Czech Republic.
Enquiries: Mr Lubomir Macek, Faculty of Civil Engineering, CTUThakurova 7, CZ 16629 Praha 6, Czech Republic. E-mail: macek@fsv.cvut.cz Tel: +420-2-2435-4608. Fax: +420-2-2435-4607.

IAWQ
JUNE 21 - 26
The 19th biennial conference of the International Association on Water Quality will be held in Vancouver, BC Canada.

Enquiries: IAWQ, Duchess House, 20 Mason Yard, Duke St., St James's, London SW1Y 6BU, United Kingdom. Tel: 44 (0) 171-839 8390. Fax: 44 (0) 171-839 8299.

MINERAL WATER

JUNE 24 - 27

An international symposium on mineral and thermal groundwater will take place at Miercurea Ciuc, Romania.

Enquiries: Romanian Association of Hydrogeologists, Symposium Secretariat, c/o Iulian Popa, 6 Traian Vuia Str, R-70139 Bucharest, Romania. Fax: +40-1-212-3385.

WATER AFRICA '98

JUNE 30 - JULY 2

An international exhibition and conference "Water Africa 98" will be held in Nairobi, Kenya.

Enquiries: African Conference, 37 Upper Duke Street, Liverpool L1 9DY, England. E-mail: africon@robart.demon.co.uk Tel: +151 709-9192. Fax: +151 709 7801.

GROUNDWATER

JULY 12 - 16 1998

An international conference with the theme: Future groundwater resources at risk, will be held in Changchun, China.

Enquiries: Professor Lin Xueyu, Changchun University of Earth Sciences, Changchun, Jilin 130 026, China. Fax: 86 431892 8327.

ACTIVATED SLUDGE

JULY 13 - 17

A short course entitled Activated Sludge Process Control, will be presented in Estes Park, Colorado.

Enquiries: TG Sanders, Dept of Civil Engineering, Colorado State University, Fort Collins CO 80523. Tel: (970) 491-5448. Fax: (970) 491-7727. E-mail: TGS@engr.Colostate.Edu

FOG COLLECTION

JULY 19 - 24

The first international conference on fog and fog collection will be held in Vancouver, Canada. Scientific sessions will include: Fog physics and chemistry; Fog - vegetation interactions; Fog deposition to temperate forests; Fog deposition to tropical forests; Fog contributions to sub-surface water supplies; Construction and use of fog collectors; Measurement of fog fluxes and collection rates and the Assessment of the role of fog in specific ecosystems.

Enquiries: Dr Robert S Schemenauer, Conference chair, Environment Canada. Tel: (416) 739-4606 Fax: (416) 739-4211. E-mail address: robertss@armph3. dow.on.doe.ca

IRRIGATION

JULY 20 - 25

The 10th Afro-Asian regional conference on irrigation and drainage will be held in Bali, Indonesia.

Enquiries: Dr A Hafied A Gany, c/o Director-General, Water Resources Development, JL Pattimura 20, Kebayoran 12067, Indonesia. Tel: +62-21-739-6616. Fax: +62-21-726-1956.

BRACKISH WATER

JULY 23 - 24

An international workshop on the use of saline and brackish water for irrigation - implications for the management of irrigation, drainage and crops will be held in Bali, Indonesia.

Enquiries: ICID Workshop, Dr R Ragab, Institute of Hydrology, Wallingford Oxon. 0X10 8BB UK. Tel: +44 1491 692303. Fax: +44 1491 692424. E-mail: R.Ragab@ua.nwl.ac.uk

STOCKHOLM WATER

AUGUST 10 - 13

The 8th Stockholm water symposium with the theme "Water - the key to socio-economic development and quality of life" will be held in Stochkolm, Sweden.

Enquiries: Symposium Secretariat, SE-106 36 Stockholm, Sweden. Tel: +46 8 7362021. Fax: +46 8 7362022. E-mail: sympos@siwi.org

CLIMATE & WATER

AUGUST 17 - 20

The second international conference on climate and water will be held in Espoo, Finland.

Enquiries: Risto Lemmela, HUT/Water Res. Eng., Huhtatie 12, 04300 Tuusla, Finland. Tel: +358 9 275 3835. Fax: +358 9 451 3827. E-mail: rlemmela@ahti.hut.fi

HYDROINFORMATICS

AUGUST 24 - 26

This is the third in a series of conferences held every two years on all aspects of data and information management related to hydrology. It will be held in Copenhagen, Denmark.

Enquiries: Dr Vladan Babovic, Danish Hydraulic Institute (DHI), Agern Alle 5, 2970-DK Horsholm, Denmark. Tel: +45 45 179133. Fax: +45 45 762567. E-mail: vmb@dhi.dk

IAHR

AUGUST 26 - 28

The biennial conference of the International Association of Hydraulic Research (IAHR), African Division, is to be held in Hurghada on the Red Sea, Egypt. Theme: Coping with water scarcity. Topics: Integrated management in arid zones; Environmental impact; Surface and groundwater hydraulics and Alluvial hydraulics.

Enquiries: Hydraulics Research Institute, Delta Barrage 13621, Egypt. Fax: (202) 218-9539

or

Professor D Stephenson, PO Box 277, WITS 2050. Fax: (011) 403-2062.

WEDC

AUGUST 31 - SEPTEMBER 4

The 24th WEDC conference with the theme "Sanitation and water for all" will be held in Islamabad, Pakistan.

Enquiries: Water, Engineering and Development Centre, Loughborough University, Leicestershire LE11 3TU UK. Tel: +44 (0) 1509 222885. Fax: +44 (0) 1509 211075.

POLLUTION

AUGUST 31 - SEPTEMBER 4

The 3rd IAWQ specialist conference on diffuse pollution will be held in Edinburgh, Scotland.

Enquiries: Caryl Jackson, Scottish Environment Protection Agency, Erskine Court, the Castle Business Park, Stirling, FK9 4TR, Scotland. E-mail: cjackson@sepa.org.uk Tel: +44 1786 457700. Fax: +44 1786 448040.

WETLANDS

SEPTEMBER 98

A conference on wetland systems for water quality control will be held in Sao Paulo, Brazil.

Enquiries: Dr Samia Maria Tauk-Tornisielo, Centro de Estudos Ambientals/UNESP, Avenida 24-A, 1515 Bela Vista, CEP 13506-900, Rio Claro (SP), Brazil. Tel: +55 019 534 7298. Fax: +55 019 534 2358. E-mail address: cea@life. ibrc.unesp.br

WATERSHED MANAGEMENT

SEPTEMBER 7 - 10

An international symposium on comprehensive watershed management (ISWM-'98) will be held in Beijing, China.

Enquiries: Mr Tan Ying, IRTCES, PO Box 366, Beijing 100044, China. Tel: +86-10-68413372. Fax: +86-10-68411174. E-mail: irtces@public2.bta.net.cn

HEALTH RISKS

SEPTEMBER 7 - 10

The 2nd international symposium on assessing and managing health risks from drinking water contamination will be held in Santiago, Chile.

Enquiries: Dr EG Reichard, USGS, 5735 Kearny Villa Road, Suite O, San Diego, CA 92123, USA. E-mail: egreich@ s101 pcasnd.wr.usgs.gov Fax: +56-2-689-4171.

NATURAL DISASTERS

SEPTEMBER 7 - 11

An international conference to plan for the 21st century on Early warning systems for the reduction of natural disasters, will take place in Potsdam, Germany.

Enquiries: GeoForschungs Zentrum Potsdam (GFZ), Secretariat of LOC-EWC98, Telegrafenberg, D-14473 Potsdam, Germany. Tel: +49 331 2881523. Fax: +49 331 2881504. E-mail: ewc98@gfzpotsdam.de Web-site: http//www. gfz-potsdam. de/ewc98/

RIVER BASINS

SEPTEMBER 13 - 16

The 8th river basin conference - Management of large river basins will be held in Budapest, Hungary.

Enquiries: TRIVENT Conference Office, Szamoca u6/b, H-1125 Budapest, Hungary. E-mail address: trivent@mail.elender.hu Fax: +36-1-156-6240.

WASTEWATER TREATMENT

SEPTEMBER 14 - 16

A conference on advanced wastewater treatment, recycling and reuse will be held in Milan, Italy.

Enquiries: ATW98, Scientific Secretariat, DIIAR - Sezione Ambientale, Piazza Leonardo da Vinci 32, 20133, Milano, Italy. Tel: +39 2 23996416. Fax: +39 2 23996499. E-mail adress: milano98@amb1.amb.polimi.it

SHORT COURSES

WATER QUALITY & TREATMENT

The Water Research Group at the Rand Afrikaans University will be presenting three short courses during 1998, directed at the specific needs of engineering designers and managers working in the field of drinking water treatment and distribution. International experts will participate in the courses. The courses are scheduled for the afternoons and early evening to minimize disruption of professional activities.

Fluoride in Drinking Water

28 May 1998

A one-day course focused on the engineering aspects of fluoride in drinking water, such as fluoride chemistry, fluoride addition, dosing technology and control, fluoride removal, with local and international case studies. Presented in conjunction with McGill University and the CSIR.

Water Quality Modelling in Water Supply Systems

6 & 7 October 1998

A two-day course on water quality modelling in bulk supply systems, reservoirs and distribution systems, with emphasis on underlying modelling assumptions, current limitations, and engineering issues such as optimal booster chlorination, and in-line monitoring of water quality. Hands-on computer assignments with EPANET software will be included. Presented in conjunction with the University of Cincinnati.

Dissolved Air Flotation in Water Treatment

20 & 21 October 1998

A two-day course on the theory, design and operation of dissolved air flotation systems in drinking water treatment. Covers all practical aspects such as chemical dosing and flocculation requirements, contact zone and flotation zone processes, and detailed analysis of the recycle system and air injection nozzles. Presented in conjunction with Prof. James K. Edzwald from the University of Massachusetts at Amherst.

For more information, please contact:

Zelna van Aswegen
e-mail:
zelna@scotty.rau.ac.za
tel: (011) 489-2599
fax: (011) 489-2466

Johannes Haarhoff
e-mail: jh@ing1.rau.ac.za
tel: (011) 489-2148
fax: (011) 489-2466