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# SA waterbulletin

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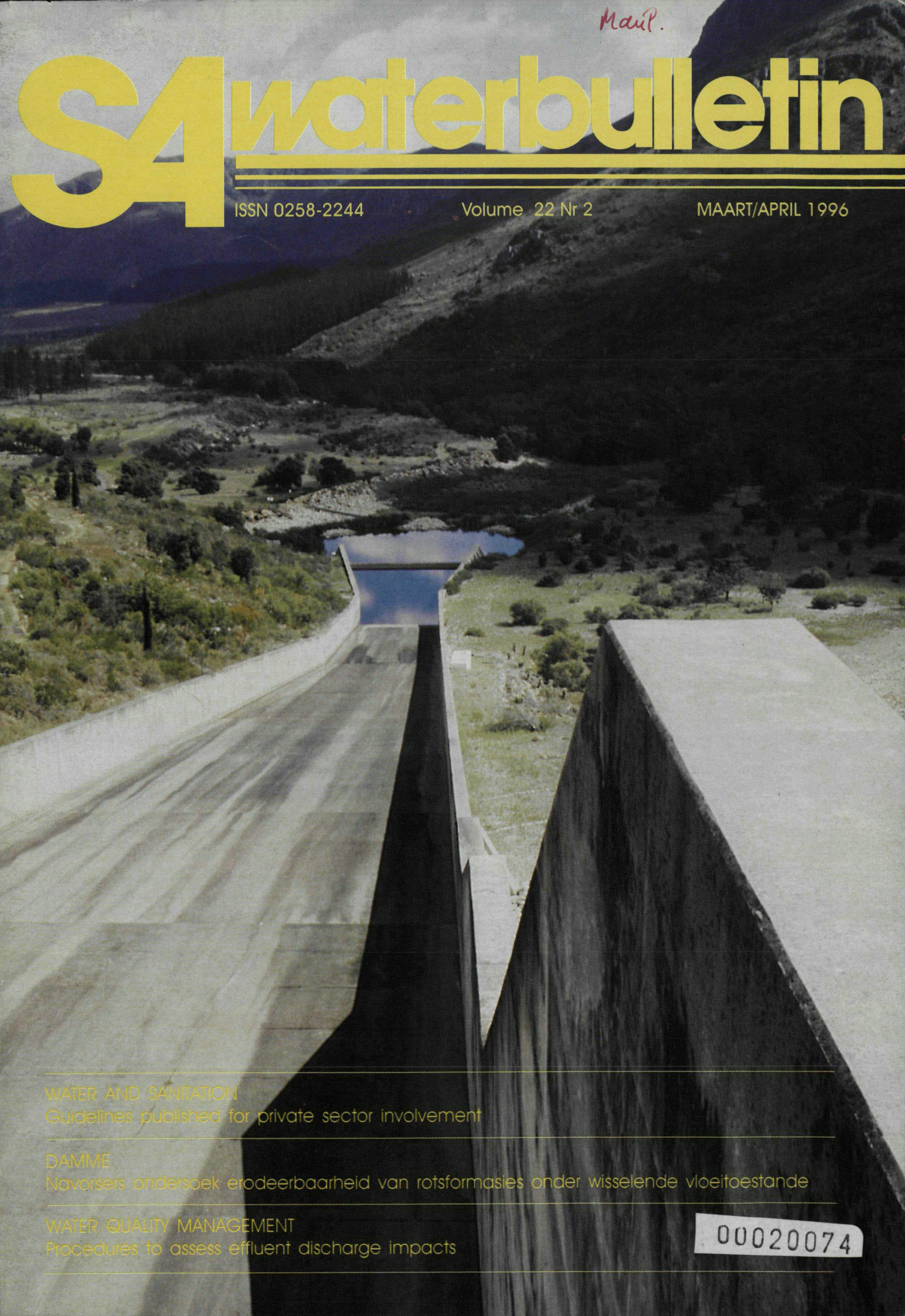

WATER AND SANITATION
Guidelines published for private sector involvement

DAMME
Navorsers ondersoek erodeerbaarheid van rotsformasies onder wisselende vloeitoestande

WATER QUALITY MANAGEMENT
Procedures to assess effluent discharge impacts

Department of Agricultural Engineering, University of Natal

# 2-Day Hands-on Course

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## Agrohydrological Modelling System

*26-27 September 1996*

The daily time step *ACRU* system can simulate, with risk analysis, daily/monthly/annual soil water budgets for use in hydrological and agrohydrological applications, including

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**Practical:**
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### DAY TWO

**Lectures:**
Peak Discharge, Sediment Loss, Irrigation Demand/Supply, Reservoir Yield, Flow Routing, Wetlands, Crop Yield, Extreme Value Analysis.
**Practical:**
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## COST

R1 250,00 including documentation (*ACRU* Text 552 pp; User Manual 362 pp), *ACRU* Software (including Utilities), lunches, teas and computing facilities. Cost reductions available to *bona fide* postgraduates and WRC funded researchers as well as to participants who have already purchased *ACRU* documentation and/or software.

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26-27 September 1996

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Attention: *ACRU* Course, Prof RE Schulze
University of Natal, Pietermaritzburg
Private Bag X01
3209 SCOTTSVILLE

Tel: 0331-2605489
Fax: 0331-2605818
E-mail: schulze@aqua.ccwr.ac.za

**MY MAIN OBJECTIVES IN ATTENDING THE COURSE ARE TO:**

| | | | |
|---|---|---|---|
| OBTAIN AN OVERVIEW OF *ACRU*s CAPABILITIES | GET PRACTICAL EXPERIENCE IN RUNNING *ACRU* | GET SPECIALIST KNOWLEDGE OF ..... | OTHER (PLEASE SPECIFY) ..... |

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# Contents



*Voorblad: Damoorloop by die Wemmershoekdam, naby Franschoek in die Wes-Kaap. (Foto: Jan du Plessis)*

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. Asst Editor: Helene Joubert. Ed Secretary: Rina Human. Layout: Chilli Design (012) 345-1155. Colour Separations: Lithotechnik. Printing: Beria Printers.

# RAND WATER ANALYTICAL SERVICES ACCREDITED

The Scientific Services Division of Rand Water has recently been awarded the certificate of accreditation from the National Calibration Service (NCS). This accreditation means that the Scientific Services Division meets with international (ISO), local (SABS) and European (EN) standards for testing laboratories.

The accreditation is valid for the chemical, microbiological and hydrobiological analyses of water, done at Rand Water laboratories. The laboratories comply with the SABS 0259 (1990), ISO Guide 25 and EN 45001 (1989) code of practice. Each code of practice encompasses general requirements pertaining to the competence of calibration and testing laboratories.

The Vereeniging based analytical facilities of Rand Water was audited in November 1995. After less than 12 months' preparation of the quality systems, the "commitment to excellence" of Scientific Services managers and laboratory staff alike was rewarded with the accreditation by NCS.

The five sections of the Division accredited in terms of SABS 0259 for calibration and testing laboratories are: laboratory services, hydrobiology, microbiology, inorganic and organic chemistry.

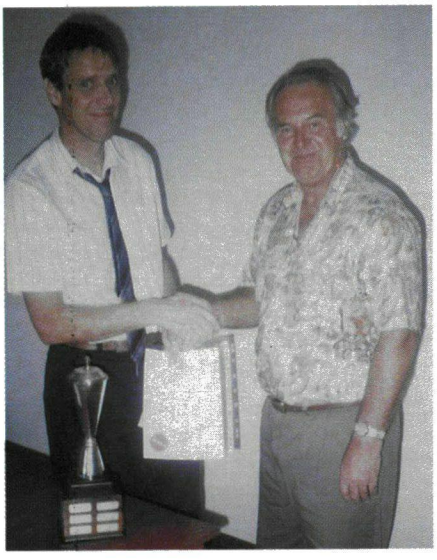
The Scientific Services Division is responsible for monitoring the quality of raw water, the treatment processes and the potable water in the distribution system.

Rand Water currently purifies and supplies a daily average of 2800 million litres of potable water to meet the needs of more than nine million consumers mainly centred in the Gauteng metropolitan area, but also as far afield as Mpumalanga, the Free State and North West Province.

*Rand Water's Scientific Services Division management (from left to right): Mr Alwyn Husselman (Manager: Water Treatment), Dr Machiel Steynberg (Manager: Biological Services), Dr Jacques Kataboa (Head: Inorganic Chemistry), Mr Ralph Heath (Head: Hydrobiology), Mrs Chrissie de Wet (Head: Microbiology), Mr Leon Christodoulou (Head: Laboratory Services), Dr Elsie Meintjies (Manager: Chemical Sciences), Mr Francois van Wyk (Head: Pollution Control), Dr Chris Viljoen (Manager: Water Environment).*

*From left: Prof. Kader Asmal, Minister of Water Affairs and Forestry, Mr Arthur Clayton (City Engineer of Cape Town and WRC Commissioner) and Alderman William Bantam (Mayor of Cape Town) at the opening of the Riviersonderend-Palmiet Water Augmentation Scheme at Faure.*

*Members of the Western Cape Branch of WISA enjoying a social get-together after their March quarterly meeting held at the University of Cape Town.*

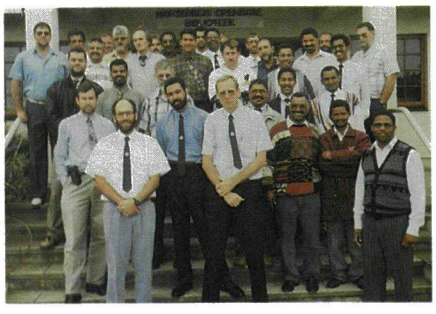


# 1996 WATER WEEK ACTIVITIES IN THE WESTERN CAPE

**The Western Cape Branch and various Technical Divisions of the Water Institute of Southern Africa (WISA) were involved with numerous water activities during March to promote the National Water Week.**

*Dr Bill Ross (Chairman: Western Cape Group of Anaerobic Processes Technical Division) (right) presents the Dr GG Cillie Floating Trophy, Certificate and Book Prize for 1995 (WISA Award) to Dr Andy Pitt (UCT).*

*Mr Henk Beekman (Vice-Chairman: WISA, Western Cape) and Alderman William Bantam (Mayor of Cape Town) officiated at the prize-giving function of the Water Week Poster Competition for all high and primary schools in the Cape Peninsula. The competition was organised and spnsored by the Fairest Cape Association in coordination with WISA.*



*A Technology Transfer Workshop of the Water Care Technical Division (Southern Cape) was held at Hartenbos.*

*The quarterly meeting of the Water Care Technical Division (Western Cape) was held at Athlone.*

# BIOFOULING:

## new information and monitoring method

**In recent years water consumption in industrial systems has been reduced, often by re-using the water in the system. The circulation of such water results in the concentration of dissolved and suspended substances, which promote the growth of waterborne microbes, biofouling and subsequent macrofouling of the system and concomitant microbially induced corrosion.**

In the light of industry's problems with biofouling and the need for more information on bacteria and biofouling, the Water Research Commission has funded a research project on biofouling control under the leadership of Prof TE Cloete, Environmental Biotechnology Programme, Department of Microbiology and Plantpathology at the University of Pretoria.

The subject of biofilm formation and the mechanisms of microbially induced corrosion has been well researched. However, there is a lack of information on the community structure and physiology of biofilms. Although many advances have been made from planktonic bacterial monitoring to sessile bacterial monitoring, the monitoring of biofouling is still a major problem area.

Recent studies have indicated that biofilm ecosystems respond to stress (i.e. application of biocides) in ways similar to macro-ecosystems. Generally there is a decline in species diversity and a selection of more tolerant isolates.

*Biofouling on a heat exchanger.*

### AIMS

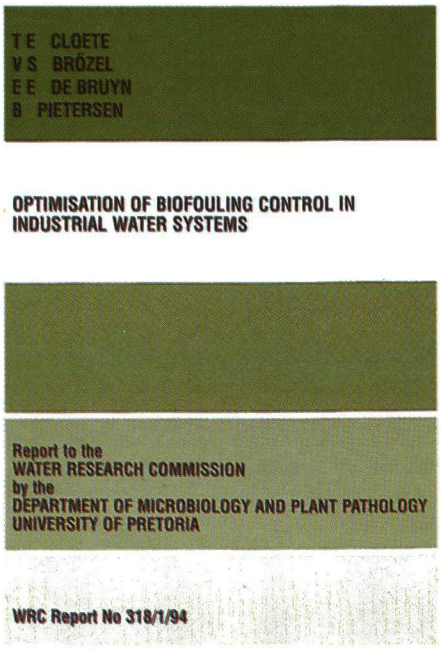
The aims of this project were:

❑ to develop an *in situ* biocide concentration monitoring technique which could be used by field personnel. This technique would be aimed at determining biocidal activity, rather than pure chemical analysis. This technique would also be used for determining the influence of other water treatment chemicals on the biocidal activity of biocides;

❑ to determine the sessile microbiological tolerance level before biofouling sets in. In practice this technique would be used to monitor the efficiency of biocide programmes;

❑ to determine whether bacteria develop a resistance to biocides and how this would influence biocide programmes;

❑ to develop a rapid, easy-to-use tech-



nique for identifying an enumerating sulphate reducing bacteria (SRB) *in situ* and to determine their role in microbial induced corrosion (MIC);

❑ to determine the effect of nutrients on biofilm activity in industrial water systems, and

❑ to investigate the development of cross resistance among different bactericides.

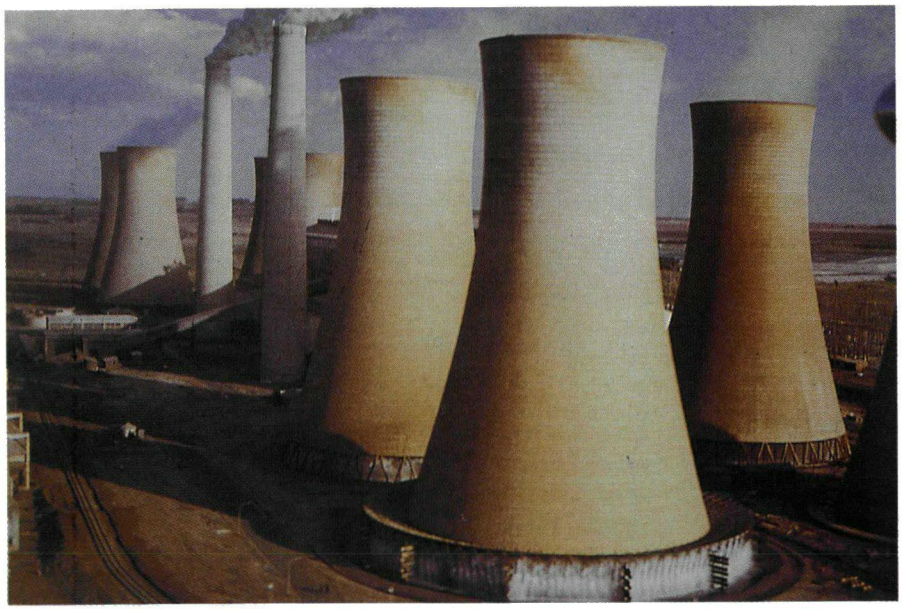
**RESULTS**

The various experiments, methods and results of this research conducted by the research team under the leadership of Prof Cloete, are described and discussed in detail in the comprehensive WRC project report. However, in summarising their main findings Prof Cloete says the results of the research carried out have far reaching implications for the control and treatment of biofouling in industrial water systems. This includes new monitoring methods, information regarding biocidal mechanisms of action and resistance, and information leading to better treatment programmes. The main results are summarised below.

**•Monitoring methods**

Aerobic bacteria in industrial water systems are best enumerated using R2A agar and incubating for 5 days at 30°C. Sulphate-reducing bacteria (SRB) are best enumerated using IS medium and it is recommended that this medium be used for SRB enumeration in water cooling systems. As water samples are dynamic, both the culturable count and the community structure change during storage, irrespective of temperature. Samples must be analysed as soon as possible after taking, in order to ensure a representative result.

Biocide concentrations in water systems can be determined by using the Sterikon bio-indicator system. An investigation into the commercialisation of this method is recommended. The Malthus system, using conductance measurements, can be used for enumerating sulphate reducing bacteria in pure culture, and also for biocide evaluations. Antisera prepared against surface antigens of sulphate-reducing bacteria (SRB) cultured in IS medium, were species specific and could not be used to identify SRB enriched from natural systems, since surface antigens are subject to environmental conditions.



*Biofouling commonly occurs in water cooling systems.*

**•Resistance to biocides**

A variety of bacteria dominant in industrial water systems do develop resistance to various water treatment biocides. In certain cases, resistance is concurrent with cross-resistance. Resistance to the biocides 2,2-methylenebis (4-chlorophenol), sodium dimethyl dithiocarbamate and isothiazolone increases gradually during exposure to sub-inhibitory concentrations. This is due to alterations in the outer membrane protein profiles. Resistance to tetradecyl-benzyl-dimethyl ammonium chloride develops after approximately one month of exposure to subinhibitory concentrations. Extracellular polysaccharides are not necessarily the cause of increased resistance of bacteria in biofilms. Attachment *per se* confers increased resistance to bacteria due to an as yet uncharacterised phenomenon. Bacteria do not develop resistance to the oxidising biocides, namely hypochlorous acid and hydrogen peroxide. This suggests that biofouling programmes should, where possible, always incorporate oxidising biocides as well as non-oxidising biocides.

**•New group**

Most of the sulphide-producing bacteria isolated using IS medium were found to be Gram-negative facultative anaerobes belonging to the genus *Shewanella*, with *Shewanella putrefaciens* being the most prevalent specie. *Shewanella putrefaciens* plays a most important role in microbially induced corrosion (MIC), mainly by way of cathodic depolarisation. More research regarding the characteristics and role of these organisms in MIC should be done.

**•Bacterial attachment**

The available carbon in water does not have an influence on the rate of bacterial attachment to surfaces. Attachments of bacteria has a marked influence on the structure and function of the cell.

The report emanating from this research, entitled **Optimisation of Biofouling Control in Industrial Water Systems** (WRC Report no 318/1/94) is available, free of charge, from the Water Research Commission, PO Box 824, Pretoria 0001. (Overseas price: US $30.)

# Investigating the Salt Load of the BREEDE RIVER

The Breede River catchment is one of South Africa's primary vine and deciduous fruit growing areas. The greater part of the irrigated grapevines and orchards, covering some 45 000 ha, is situated between Worcester and Bonnievale comprising the middle part of the Breede River Valley. Irrigation in the Valley dates back to the 18th century. Irrigation water is needed mostly from October to April, as the Valley lies in the winter rainfall region with a hot, dry summer climate.

Winter rainfall run-off from the catchment is stored in the Greater Brandvlei Dam and the Department of Water Affairs and Forestry (DWAF) is committed to supply water of a specified quality to the farming community along the Breede River, as far downstream as the Bonnievale agricultural area.

## SALINITY

Salinity levels in the Breede River rose sharply in the 1960s and 1970s. Investigations into the salinisation of the Breede River began when increasing amounts of water had to be released from the Greater Brandvlei Dam to freshen the water in the river.

## RESEARCH

The Water Research Commission (WRC) has, over the last two decades, been actively involved in the co-ordination and funding of research projects aimed at gaining a better understanding and the quantification of the salinisation processes in the Breede River. Research on the salinisation problems in the Middle Breede River Valley has investigated a large number of factors which could contribute to the salt load of the river. The same aspects have been looked at often, but in a different context, at different localities or times and by different researchers (as well as from different angles).

## GROUNDWATER

Groundwater contributions from geological formations adjacent to the Breede River has been identified as one of the factors which could affect the salinity of the Breede River.

In this region groundwater is mainly recharged in the mountains where the rainfall is up to eight times higher than in the valley. It flows mainly along faults, joints and fractures towards the Breede River. The aquifer is effluent. Water-level gradients change little during the year and groundwater flow towards the river is relatively constant.

Against this background the WRC funded the project entitled **Investigation into the contribution of groundwater to the salt load of the Breede River, using natural isotopes and chemical tracers**, undertaken by Professor Jurgen Kirchner of the Institute for Groundwater Studies, University of the Orange Free State.

## AIMS

The aims of this investigation were:

- ❑ to determine whether part of the salt load in the Breede River is derived from groundwater discharging from underlying formations and adjoining aquifers of the Nama Group, the Cape Supergroup and possibly the Karoo Sequence, by means of an investigation into the spatial distribution and concentration of natural isotopes and chemical tracers in aquifers beneath and along the Breede River, and
- ❑ to determine the applicability and feasibility of using chemical tracers for pollution and waterbalance studies.

## SAMPLES and DATA

A pilot study to ascertain whether identifi-

cation of different aquifers contributing to the run-off through *fingerprinting** of ground- and surface waters was possible, showed encouraging results.

Based on findings of the pilot project, and considering time constraints and funds available, it was decided that this investigation would be based on chemical analyses of approximately 20 surface water sites and some 55 groundwater sites, sampled at quarterly intervals. These sites were chosen for (i) their representativeness of the various groundwater sources, (ii) their geographical distribution over the area of investigation, and (iii) their chemical composition.

The samples were analysed for a wide range of macro- and micro-elements, as well as $^{2}H$ (hydrogen) and $^{18}O$ (oxygen) isotopes.

Strontium-ratio analyses, as suggested by Dr Walraven of the Council for Geoscience, showed consistent differences in the $^{87}Sr/^{86}Sr$ ratios of ground- and river water.

The researcher also reviewed relevant data of previous research and re-evaluated some of the earlier pump test data.

## RESULTS

### Isotopes

Contrary to the expectations raised by the findings of the pilot study, it was not possible to quantify the river recharge by groundwater by means of the $^{2}H$ and $^{18}O$ balance methods, because of the following reasons:

❑ The groundwater component in the river appears to be relatively small. A large error margin for other (flow) components in the system, such as (a) return flow and run-off volumes or (b) representative salinities of return flow and groundwater,

## * FINGERPRINTING

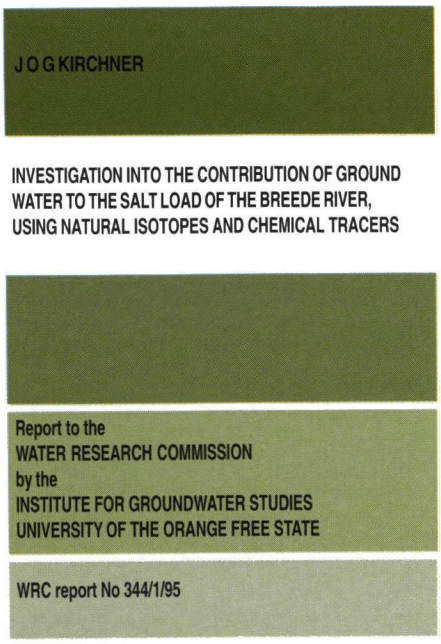
Fingerprinting allows the quantitative tracing of a single component in a system if the tracer is unique to this component. If we have components with discernable differences in the concentration of a certain tracer, then qualitative statements about the presence of certain components may be possible. If the number of different tracers with discernible differences and the number of independent measurements exceed the number of components, it may be possible to obtain (semi-)quantitative answers.

meant that groundwater inflow could not be calculated with an acceptable degree of confidence.

❑ Evapotranspiration affects the isotope ratios of return flow, and it proved impossible to obtain a representative isotope ratio of irrigation return flow. Inaccurate characterisation of such a major component, meant that $^{2}H$ and $^{18}O$ balancing could not be used to quantify run-off in the Breede River.

### Sr analyses

Contrary to $^{2}H$ and $^{18}O$, it was found that strontium isotopes are not influenced by evapotranspiration. Subsurface drainage from agricultural land (return flow) retained the same ratio as irrigation water. A small increase in the river water strontium ratio from the top to the bottom end of the irrigation scheme, could be explained by groundwater contributing approximately 6,7 per cent of the total strontium load at the bottom end. Because of different strontium concentrations found in groundwater from different geological formations, groundwater flow as a percentage of total flow could vary from three per cent (for Bokkeveld Shale) to 34 per cent (for Table Mountain Sandstone). Since Table Mountain Sandstone water has a TDS of only 17 mg//, it can be concluded that if the groundwater contribution originates from Table Mountain Sandstone, groundwater cannot contribute significantly to the salt load of the Breede River. Groundwater originating from Bokkeveld Shale would likewise be expected, because of its small contribution to flow, to make only a minor contribution to the salt load of the Breede River.




### Pumping tests

A re-evaluation of pumping test data from previous investigations seemed to confirm the conclusions drawn from the strontium ratio analyses. By using the flow values from the re-evaluated pumping tests and the water-level difference between boreholes and the river, a groundwater flow rate of ± 4 000 $m^3/d$ was calculated. This compared well with the 6 500 $m^3/d$ calculated from strontium isotope ratios for Bokkeveld shale.

The report entitled **Investigation into the contribution of groundwater to the salt load of the Breede River, using natural isotopes and chemical tracers** (WRC Report no 344/1/95) is available, free of charge, from the Water Research Commission, PO Box 824, Pretoria 0001. Foreign orders: US $35 per copy.

### Return flows

Maximum irrigation and irrigation return flows occur near the lower end of the study area; this is also the stretch of the Breede River where salinisation is increasing most rapidly. From the geological disposition, one would expect that the effect of in-flowing salty groundwater should be more evenly spread. This strengthens the conception that ground water of a high salt content does not enter the Breede River in appreciable amounts.

## CONCLUSIONS

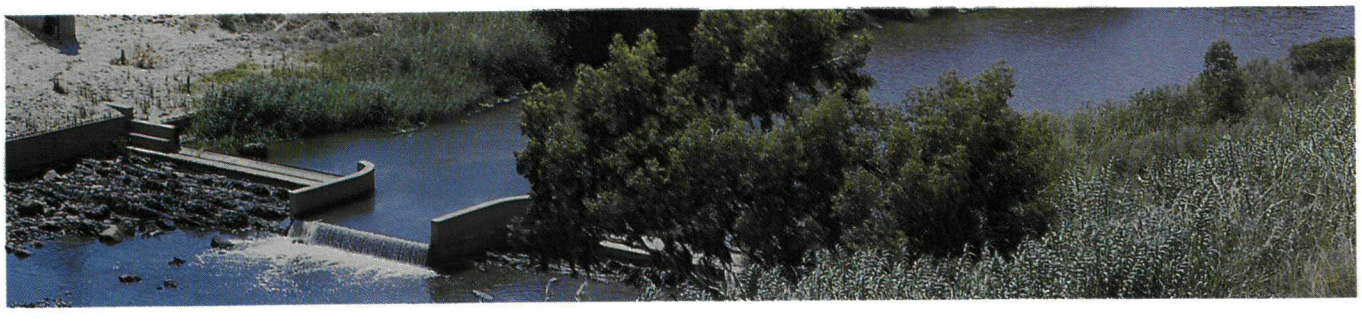
The researcher came to the following conclusions:

i) It is unlikely that groundwater inflow to the river is a major contributor to, or source of, the salinisation in the Breede River.

ii) Strontium isotope ratios can be very useful in salt and water balance studies, provided that the input waters are sufficiently different and are not submitted along their flow paths to the influence of strontium with different isotope ratios.

## NEW TECHNIQUE

The strontium isotope ratio method is a new technique with considerable potential. For the investigation of areas with similar problems, it seems superior to other approaches and should be further tested for its applicability.



# SURFACE WATER RESOURCES OF SOUTH AFRICA 1990


A series of reports which contain the results of a revised appraisal of the 1981 survey "Surface Water Resources of Southern Africa" are currently available from the Water Research Commission.

The aim of the revision, called the **WR90 Study**, was to update and improve the 1981 survey and also to provide a basis for a preliminary planning of water resources development. The survey will make available in a single set of documents valuable data and information for water resources planning and development.

WR90 assembles the 22 main drainage regions of South Africa under six groups which are dealt with in six corresponding volumes for each of which there is a report. The reports consist of three parts: a **user manual**, a **set of appendices** comprising data, information and analyses and a **book of maps**. A **CD ROM** containing a Readme File, all hydrometeorological data in the Appendices and GIS data (36E00 files) together with an updated version of ARC VIEW 2 is also available.

To order a set of the WR90 Study Reports, please complete the order form on the reverse side and send it to: The Librarian, Water Research Commission, PO Box 824, Pretoria. Tel: (012) 330-0340. Fax: (012) 331-2565.

# ORDER FORM: WR90

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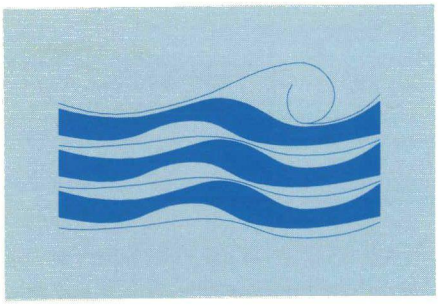

# Water literature in cyberspace :

## exploring sources of bibliographic information

The Internet is growing daily and the wealth of information available to professionals working in the water sector has increased dramatically. The principal strength of the Internet lies in the fact that digital information is fluid, and more amenable to adapt to individual purposes and perspectives than paper-based information sources. Access is virtually instantaneous and widespread nowadays.

A number of water utilities, water supply companies, research organisations, commercial concerns and government departments in the water field are creating a presence for themselves on the Internet. These sites are aimed at different user groups and end results. Water boards, utilities and local authorities make available information to educate and inform their customers. Research organisations and government departments publish project results and other related public information. Commercial companies use the Internet to advertise products and run business forums. Global accessibility to information on water has benefitted tremendously from this ever increasing number of information providers, as well as the continued improvement of Internet and communications technology. Searching and printing from bibliographic databases, reading and down loading extensive bibliographies onto disk, or even printing of full-text articles is now possible on various Internet sites.

In an effort to better serve the information needs of the water community of South Africa, SAWIC is continually exploring and testing new Internet sites to find useful and interesting information sources. Several of the sources identified by SAWIC are databases of water literature produced by water research organisations or government bodies, especially in North America. These databases can usually be accessed free of charge and most of them provide a user-friendly searching interface with on-screen help in selecting keywords, printing results or accessing the full text of the article, or even ordering the article from the publisher or library.

The World Wide Web, or simply "the Web", is the fastest growing Internet system and it is usually via the Web that users gain access to searchable bibliographic databases. It is simple to use and the documents found are displayed almost immediately on the screen and can be either down loaded or printed directly.

### Searchable Bibliographic databases

**• US National Institutes for Water Research**
gopher://gopher.uwin.siu.edu:4501/1niwr_pubs
The NIWR database covers the time period 1984-1995 for publications, mostly articles, conference papers and reports, produced by the state-linked US Water Resources Research Institutes. Two search formats are provided: browsing through an alphabetic listing or searching with keywords. This database still resides on a gopher system and abstracts of the documents are available.

**• United States Geological Survey, Water Resources Scientific Information Centre**
http://www.uwin.siu.edu/databases/wrsic/index.html
The complete WRSIC database on international water research (from 1967 to October 1993) can be searched using keywords and preselected years of publication. However, on-screen help is limited and users should be familiar with selecting keywords to obtain satisfactory results.

**• The University of Florida, Center for Aquatic Plants**
http://aquat1.ifas.ufl.edu/database.html
The Center for Aquatic Plants maintains the APIRS (Aquatic Plant Information Retrieval System). The bibliographic database has about 41 000 references on all aspects of aquatic (including wetland) plants, eg plant ecology, utilisation, physiology and control. The focus is mostly North American. Detailed instructions and examples are given to assist in searching the database with keywords

**• Purdue University, National Extension Water Quality Database**
http://hermes.ecn.purdue.edu:8001/server/water/water.html
The database is a product of the Purdue University - US Department of Agriculture Extension Services Water Quality Information Management Project. Publications are grouped in broad categories and subcategories. Electronic full text versions of only some of the publications are available from the site. Ordering details are supplied with each document.

### Bibliographies

**• Great Lakes Information Network**
http://www.great-lakes.net:2200/refdesk/biblio
The Great Lakes World Wide Web pages provide detailed information on the lake system and related issues. A number of bibliographies can be accessed from the site dealing with various aspects of the lake ecosystem, eg. the Ecosystem Management Bibliography from the Forestry Library of the University of Minnesota.

**• Waterwiser - Water Efficiency Clearing House**
http://www.waterwiser.org/biblio.html
This project of the American Water Works Association is aimed at providing information on water conservation technologies and programs. Bibliographies accessible through the site include : Conservation Planning, Effects of Conservation of Water Use, Xeriscaping and Water Efficient Landscaping, etc. Full citation information is provided.

### Library catalogues

**• University of California, Water Resources Center Archives**
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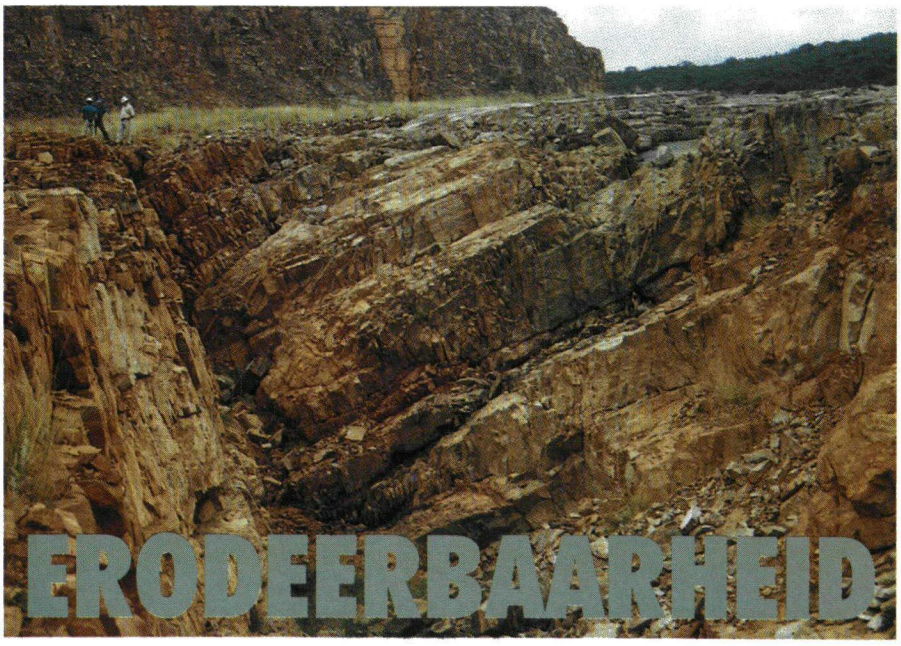



# van verskillende rotsformasies ondersoek

**Die Waternavorsingskommissie het 'n verslag vrygestel wat die resultate bevat van 'n ondersoek na die erodeerbaarheid van verskillende rotsformasies by damoorlope waar watervloeitoestande varieer. Die ondersoek is deur navorsers aan die Departement Geologie by die Universiteit van Pretoria uitgevoer.**

By 'n dam in 'n rivier moet voorsiening gemaak word vir die wegvoer van vloedwater. Gewoonlik word sulke water met behulp van 'n oorloop oor die damwal na 'n plonspoel of langs 'n natuurlike sloep of geboude kanaal na die rivier stroomaf van die damwal weggelei.

Een van die belangrikse aspekte wat die uitvoerbaarheid en koste, asook die veiligheid van damme beïnvloed, is die beskikbaarheid al dan nie van geskikte rots om in en stroomaf van die oorloop of afvoerkanaal weerstand te bied teen erosie. Indien daar twyfel oor die erosieweerstand van materiale bestaan, word die oorlope van belangrike damme gewoonlik met beton beklee. Korrek beklede oorlope bied goeie beskerming teen erosie, maar die verhoogde kapitaalkoste daaraan verbonde, kan die ekonomiese uitvoerbaarheid van veral kleiner damme nadelig beïnvloed.

Verskeie damme het al geswig as gevolg van verkeerd ontwerpte oorlope, oormatige erosie in onbeklede oorloopstrukture of deur oorlope met onvoldoende kapasiteit. Die energie wat vrygestel word as die water na die oorspronklike riviervlak terugkeer, kan groot vibrasies en ernstige erosie veroorsaak indien dit nie behoorlik gedemp of beheer word nie. Die volgende probleme kan ontstaan indien grootskaalse erosie in damoorlope plaasvind:

- Menslike lewens kan in gevaar gestel word deur skade aan of swigting van die dam.
- Eiendom kan beskadig of vernietig word.
- Groot koste moet aangegaan word om die skade te herstel.
- Ongerief en skade word veroorsaak as gevolg van die onderbreking van watervoorsiening.

Huidige metodes om die omvang van erosieskade in verskillende rotsformasies in onbeklede damoorlope en gebiede stroomaf daarvan te kan voorspel, is onbevredigend en veroorsaak dat daar dikwels onnodige koste aangegaan word deur goeie kwaliteit rots te beklee, terwyl in ander gevalle, ernstige skade deur erosie van onbeklede oorlope veroorsaak word.

Navorsing oor die erosie van grond- of grasbedekte onbeklede damoorlope is deur talle instansies gedoen. Tot op hede is daar egter nog nie 'n toets ontwerp waardeur die moontlikheid en omvang van erosie in verskillende rotsformasies volgens vasgestelde parameters geklassifiseer en geëvalueer kan word nie.

## RESULTATE

### Literatuurstudie

'n Omvattende literatuurstudie is onderneem en die belangrikste resultate kan soos volg opgesom word:

- Probleme met erosie by onbeklede damoorlope word wêreldwyd ondervind en verskeie instansies is besig met navorsing in die verband.
- Daar is metodes beskikbaar waarmee die erodeerbaarheid van kohesielose en sagte kohesiewe materiale onder verskillende vloeitoestande bepaal kan word. Toetse met hoëdrukwaterspuite word dikwels gebruik vir die evaluering van erodeerbaarheid.
- Empiriese formules vir die berekening van kolkgatdiepte by vryvaloorlope gee 'n redelike goeie korrelasie met waargenome toestande, maar bring nie die geotegniese eienskappe van die rotsformasie in berekening nie.
- Natuurlike rotsformasies bestaan uit 'n komplekse samestelling van rotsblokke en diskontinuïteite wat op baie verskillende maniere deur vloeiende water aangeval kan word. Alhoewel die meganisme van erosie en die tersaaklike rotsmassaparameters reeds ondersoek is, bestaan daar geen bevredigende metode om die graad en tempo van erosie van rotsformasies met die verwagte hidrouliese toestande waaraan dit blootgestel sal wees, te voorspel nie.
- Diskontinuïteite in 'n rotsformasie verteenwoordig gewoonlik die swakste materiaal wat eerste sal erodeer en

toegang aan water verleen om die rotsmassa binne te dring en rotsblokke te verwyder. Rotsmateriaal (rotsblokke in die rotsmassa) ondergaan geen of min verandering wanneer dit aan watervloei onderwerp word. Wanneer die sagter naatvulmateriaal rondom die rotsblokke egter uitgespoel word, kry waterdruk toegang tot die rotsmassa en word blokke uitgelig en weggevoer.

- Erosie kan plaasvind as gevolg van verwering, drukverligting, verwydering van kohesielose materiaal, afskuur van kohesiewe materiaal en beweging van blokke uit 'n gepakte rotsmassa. Die proses wat erosie veroorsaak, hang ook af van die hidrouliese toestande wat kan wissel van plaatvloei tot hoogs turbulente vloei of direkte impak van 'n waterstraal.
- As gevolg van die komplekse aard van rotsformasies, vind verskillende meganismes van erosie gelyktydig plaas. Die prosesse van erosie verander ook met tyd omdat materiaal wat verwyder word, nuwe geometriese en geologiese toestande blootstel.
- Verskeie navorsers het tot die gevolgtrekking gekom dat dit vanweë die komplekse interaksie tussen rotsformasies en hidrouliese parameters, nie moontlik is om 'n streng wetenskaplike metode vir die bepaling van erodeerbaarheid daar te stel nie.

**Modeltoetse**

Die navorsers sê 'n reeks modeltoetse is ook in 'n vloeikanaal uitgevoer om die meganisme van erosie op sagter materiale te bestudeer wat naatvulling in 'n rotsformasie naboots.

Verskillende sand-klei-, sand-klipslag-klei, sand-sement- en sand-kalkmengsels is gekompakteer en aan 'n verskeidenheid indeks- en skuifsterktetoetse onderwerp. Daarna is hierdie materiale alleen of in kombinasie met kleiteëls, in 'n vloeikanaal onder verskillende vloeitoestande aan erosie blootgestel.

Volgens die navorsers is die belangrikste resultate van die laboratoriumtoetse die redelike goeie verband wat verkry is tussen die klei-inhoud en kohesie van die monsters en die drumpelsnelheid en drumpeleenheidsdrywing waarby erosie begin plaasvind. Daar is ook 'n korrelasie tussen klei-inhoud en erosietempo wanneer die toetse uitgevoer word met vloeisnelhede wat hoër as die drumpelwaardes is.

Die waterspuittoetse wat op monsters in die laboratorium uitgevoer is, het nie 'n goeie korrelasie met kohesie of erodeerbaarheid getoon nie. Hoëdrukwaterspuittoetse wat in die veld uitgevoer is, het nie voldoende stroomdrywing voorsien om rotsblokke te beweeg nie. Hierdie soort toetse kan volgens die navorsers moontlik gebruik word om die relatiewe erosieweerstand van sagte naatvulmateriaal in 'n rotsformasie aan te dui.

**Erosieskade**

Die benadering van hierdie studie was om met behulp van 'n groot aantal gevallestudies van erosieskade by bestaande damoorlope, 'n geskikte korrelasie te probeer vind tussen geselekteerde parameters van die rotsmassa, die stroomvloei en die waargenome erosie.

Data van altesame 91 erosiepunte met verskillende rotsformasies, vloeitoestande en grade van erosie is van damoorlope in Suid-Afrika en die VSA verkry en verskeie kombinasies van parameters is met mekaar vergelyk ten einde die rotsmassaparameters wat die beste korrelasie bied, te kan identifiseer.

Die navorsers sê in die meeste gevalle was daar geen of baie swak korrelasie wanneer enkele of kombinasies van rotsmassaparameters gebruik is en die enigste duidelike onderskeid tussen die verskillende grade van erosie het voorgekom waar eenheidstroomdrywing teen die Kirsten-indeks gestip is. Hierdie grafiek is gebruik om 'n evaluasiekaart op te stel waarmee 'n voorspelling van die graad van erosie in 'n onbeklede oorloop gemaak kan word.

**Geotegniese ondersoeke**

Die navorsers sê geotegniese ondersoeke vir die evaluering van erodeerbaarheid behoort in drie stadia uitgevoer te word.

Gedurende die eerste stadium is die rots gewoonlik nie blootgestel nie en word van 'n diamantboorkern en waterdruktoetse in boorgate gebruik gemaak om die rotsparameters vir die berekening van 'n voorlopige Kirsten-indeks te verkry.

Tydens die konstruksiestadium word die rotsformasie blootgestel en kan al die parameters gemeet word om sodoende 'n meer betroubare Kirsten-indeks te kan bereken.

Elke keer nadat 'n vloed wat groter as die vorige een is oor die oorloop gevoer is, behoort die graad van erosie by geselekteerde punte gemeet te word ten einde die betroubaarheid van die evalueringskaart te toets en waar nodig te verbeter.

Die toepaslikheid van 'n aantal verskillende maatreëls vir voorsorg teen moontlike erosieskade en metodes om bestaande erosieskade te herstel word in die verslag bespreek. Die belangrikste hiervan is die demping van energie, volledige of gedeeltelike bekleding van erodeerbare materiale en die verwydering van onreëlmatighede of los materiaal uit die pad van die watervloei.

**EVALUERINGSKAART OPGESTEL**

Een van die hoogtepunte van hierdie navorsingsprojek wat deur die Waternavorsingskommissie gefinansier is, is die ontwikkeling van 'n rotsmassa-evalueringskaart. Die navorsers, A van Schalkwyk, JM Jordaan en N Dooge van die Universiteit van Pretoria, sê die kaart kan gebruik word om die graad van erosie in 'n onbeklede damoorloop te voorspel indien die eenheidstroomdrywing en die Kirsten-indeks, 'n rotsmassa-klassifikasiestelsel, bekend is.

Die evalueringskaart dek die volle spektrum van geologiese materiale: van 'n klei of totaal verweerde rots tot 'n rotsformasie wat bestaan uit 'n sterk rotsmateriaal met nate.

Die evalueringskaart is gebaseer op die waargenome gedrag van grond- en rotsformasies by 'n aantal damoorlope in Suid-Afrika en die VSA en sal nie noodwendig die gedrag van alle soorte natuurlike materiaal onder verskillende vloeitoestande akkuraat voorspel nie. Die rede is dat die meganisme van erosie van plek tot plek kan verskil en dat die veskillende parameters nie orals dieselfde rolle speel nie. Ander faktore wat bydra tot die gebrek aan betroubaarheid is die probleem om maksimum eenheidstroomdrywing by enige punt akkuraat te bepaal of te voorspel. Stroomdrywing kan lokaal varieer as gevolg van onreëlmatighede in die geometrie. Sulke onreëlmatighede ontstaan dikwels vanweë erosie en die uitwerking daarvan kan dus nie vooraf bepaal word nie.

Afskrifte van die verslag getiteld **Die erodeerbaarheid van verskillende rotsformasies onder variërende vloeitoestande** (WNK-verslag 302/1/95) is gratis verkrygbaar vanaf die Waternavorsingskommissie, Posbus 824, Pretoria 0001.

# Potential of bioremediation technology investigated

**The widespread problem of contamination of water and soils by organic chemicals is increasingly receiving attention due to its potential impact on public health and the environment. Researchers at the Division of Water Technology, CSIR, say in a report to the Water Research Commission that halogenated and hydrocarbons and organic aromatic compounds are mentioned most regularly as priority pollutants since many of these are toxic to a broad spectrum of organisms and man.**

The researchers, K Pearce, H Snyman, H van Heerden, H Greben and RA Oellermann, say that "to solve many of the environmental problems facing us today, innovative technologies, such as bioremediation for instance, are required".

Bioremediation is a biological treatment process involving the controlled use of microorganisms to break down hazardous organic chemicals into innocuous forms: degrading them aerobically to carbon dioxide and water, or anaerobically to carbon dioxide and methane. Nature has been using bioremediation to recycle organic compounds since time began. However, the innovation to harness this energy to degrade hazardous and recalcitrant hydrocarbons, in a confined and controlled environment, came relatively recently. Bioremediation offers a comparatively inexpensive, yet highly efficient, method of removing toxic chemicals from contaminated soils. It can be used exclusively or together with other physical and chemical treatment strategies.

The report says South Africa faces a number of environmental challenges, some of which can be directly addressed through harnessing the process of bioremediation. A comparatively low and highly variable rainfall, averaging about 502 mm per annum, as compared to a world average of 802 mm per annum makes South Africa a relatively arid country. It is thus important not only to develop water resources but also crucial to protect the quality of water. Although use of groundwater is currently limited, it is expected to increase in future and hence this valuable resource must also be protected. Contaminated soil in the vicinity of either surface or groundwater may have adverse impacts on the water quality.

In South Africa a growing industrial sector contributes to an increasing number of contaminated sites, requiring treatment. Currently, the report says, the most frequently utilised practice is to landfill contaminated soil. Not only is this a shortsighted option, since the availability of space in a hazardous waste landfill site is diminishing rapidly and suitable new sites are not easily found, but it is really a displacement of the problem. In contrast, bioremediation technology can provide a more environmentally friendly and cost effective solution to the problem. Opportunities for the bioremediation of contaminated soil are therefore increasing.

The researchers say bioremediation of contaminated soil is not unknown in South Africa, although it is not nearly as prevalent as in Europe and America where it is used extensively as a means of reducing the negative impact of pollution by undesirable solids, liquids and gases on the environment. They say bioremediation techniques are proving to be economic methods for the effective treatment of effluents and rehabilitation of polluted sites. Full scale bioremediation has had most application within the petrochemical industry.

The first documented use of bioremediation in South Africa was approximately 1980 when a refinery established an area to treat oily wastes through so called "landfarming". Since that time, various refineries have followed suit, as did the storage and handling sections of the oil industry.

To date a number of contaminated sites arising from industrial activities, service stations, vehicle accident spills, bulk storage facilities and railway sidings have been treated in South Africa using bioremediation.

**WRC**

To evaluate bioremediation technologies on a laboratory scale as an appropriate and viable technology, and to optimise treatment conditions and scale-up for pilot scale evaluations of bioremediation at contaminated sites, the Water Research Commission contracted the Division of Water Technology at the CSIR. The evaluations conducted by the researchers were to include soil systems simulation, slurry digestion and volatile organics biotower reactors. In each case biological treatment was to be applied employing selected microorganisms for specific pollutants. The model pollutants included mineral hydrocarbon oils, aromatic organics and aromatic halogenated organics. The economics of the technology were also to be evaluated and the process design criteria provided to successfully remediate contaminated soils.

A survey was to be undertaken to determine the nature and extent of contaminated sites in South Africa. The objective was to determine whether contaminated sites are an area for concern, what the most prevalent contaminants are, and to assess whether bioremediation is seen as an appropriate and viable technology. Needs within the bioremediation technol-

ogy arena in South Africa were also to be identified.

## RESULTS

At laboratory scale a number of aspects were investigated. These included the factors affecting the rate of bioremediation of phenol using batch reactors and the viability of slurry reactors to remediate phenol contaminated soil. A satisfactory analytical method of phenol extraction and determination was also developed for soil matrices.

High recoveries of phenol from soil adsorption studies indicated that minimal adsorption of phenol to soil surfaces occurs under the conditions used. Thus, any decrease in phenol concentration obtained in the laboratory studies could be attributed to degradation rather than adsorption. Some losses of pure phenol may have occurred due to volatilization.

The rate of phenol degradation was enhanced in batch reactors with the addition of nutrients. Where no nutrients were added, biosupplementation increased phenol breakdown.

Addition of nutrients and biosupplementation in the slurry reactors resulted in no significant advantages in the rate of phenol degradation. This may have been due to adequate nutrient concentrations and bacterial populations already existing in the soil.

The researchers say the result of the soil column experiment showed that some breakdown of phenol in contaminated seepage water occurred as it percolated through the soil. Anaerobic conditions decrease degradation rates. It was demonstrated that increased oxygen levels in the seepage water improved the rate of degradation.

### Landfarming

Petroleum contaminated field samples were used to demonstrate landfarming and investigate parameters affecting the rate of degradation. Parameters that were investigated in isolation and in conjunction with each other included addition of moisture, nutrients, oxygen (through turning the soil and by addition of hydrogen peroxide) and biosupplements. The pH of the soil was adjusted and maintained at 6 - 7. The effect of a commercial biosupplement was compared with that of a biosupplement cultivated from indigenous microorganisms in the soil. A comparative study showed that application of moisture, nutrients, air and a biosupplement resulted in the fastest rate of degradation of total petroleum hydrocarbons (TPHC). A decrease of 94 per cent from initial levels of 320 g/kg soil to 18 g/kg TPHC soil over a period of 10 weeks was achieved. A control enabled differentiation between a decrease in total petroleum hydrocarbons due to volatilization, chemical or photo-oxidation and biodegradation. Volatilization contributed largely to the initial reduction of TPHC. However, after the volatile fractions had been lost, the microorganisms then degraded the heavier fractions of the oil. There was no significant difference in the ultimate performance between the two biosupplements, although the indigenous biosupplement initially showed quicker degradation. This may have been due to an acclimatization period of the commercial microorganisms to the specific soil conditions.

Over a ten week period the application of moisture and oxygen resulted in increased rates of biodegradation when compared to a natural control, indicating these to be limiting factors in bioremediation. Both parameters affect the ability of microorganisms to grow and thrive. Moisture levels may also affect the mass transport and bioavailability of the contaminant to the microorganisms.

Measurement of subsequent growth of wheat seedlings in the soil after bioremediation was not indicative of successful remediation. Possible reasons include alteration of the soil structure and an unsuitable choice of indicator seedlings.

### Full scale bioremediation

Important factors impacting on the strategy and design of a full scale bioremediation project are highlighted and demonstrated with a case study in the report. Sufficient data to design the project is essential. Data requirements include the location and history of the site, its physical characteristics, the nature and extent of contamination and risks associated with the contamination. The researchers say it is important at the outset to establish closure goals, to help with the assessment and choice of a suitable clean up technology. A comprehensive design and costing should be undertaken for any full scale project. After installation, bioremediation must be maintained and controlled using a well designed sampling and monitoring programme. Analyses should be of a chemical and biological nature and should include determinations of contaminant levels, nutrient concentrations, pH and microbiological plate counts. Bioremediation is considered complete when target levels have been achieved. Rehabilitation of the bioremediation site (should treatment have occurred in situ), or of the excavated site, should follow.

A case study of an ongoing full scale bioremediation project, following the aforementioned strategy, is presented in the report. Bioremediation of the excavated contaminated soil containing high concentrations of weathered petroleum oils was performed on site using landfarming. Total petroleum levels were reduced from 7 400 - 23 000 mg TPHC/kg soil to 820 - 2 335 mg TPHC/kg soil over 168 days. Depressed moisture levels due to the low water retention capacity of the soil necessitated frequent application of water, which was essential to enhance the rate of degradation. Low moisture retention, a larger fraction of more recalcitrant and weathered petroleum, and less intensive treatment compared to the pilot scale, resulted in a slower TPHC degradation rate when compared to pilot scale investigations.

## CONCLUSIONS

The researchers concluded that bioremediation was a viable technology for the treatment of contaminated soils when used correctly. Slurry reactors, although effective, are not seen as an appropriate technique for widespread use in South Africa due to high initial capital requirements. Landfarming, on the other hand, is feasible, requiring no technologically advanced infrastructure.

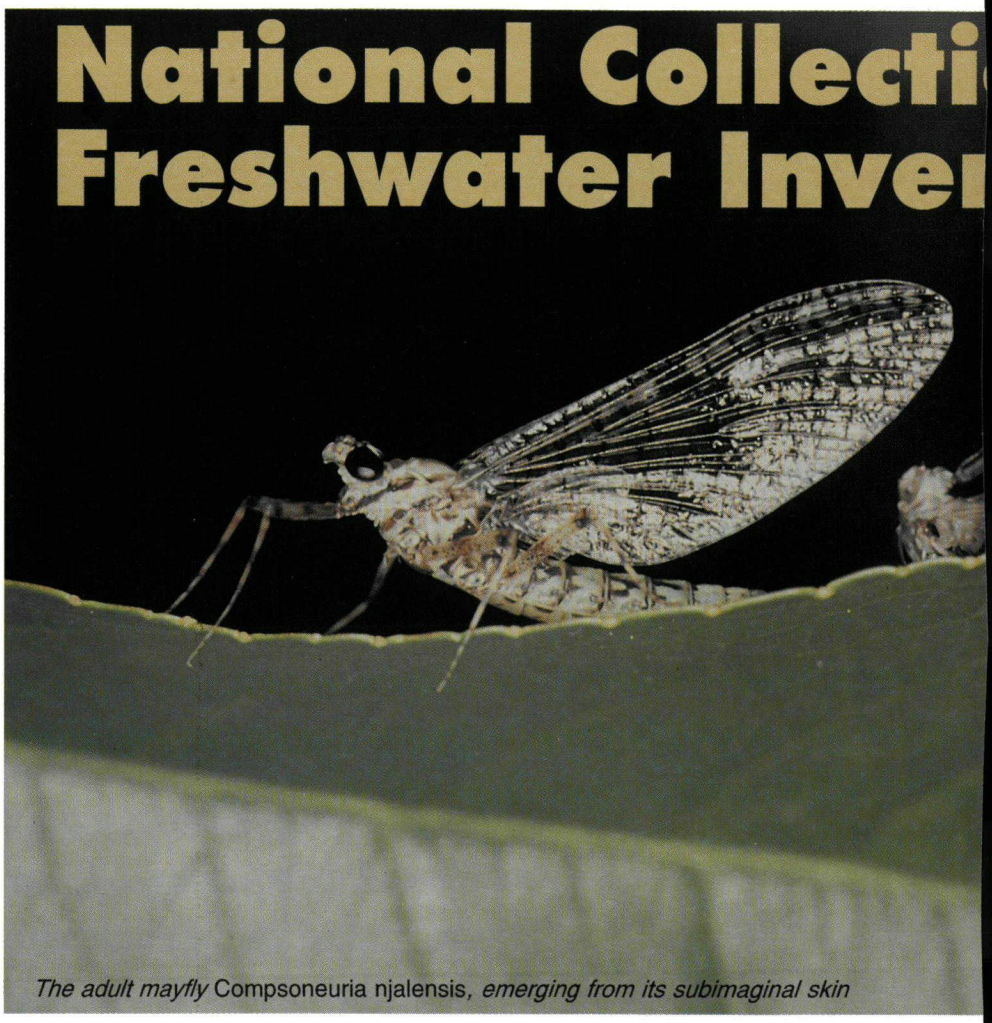
Parameters influencing the rate of biodegradation include moisture, oxygen, pH, nutrients and microorganism strains and population levels.

The researchers say it is unrealistic to expect pilot scale degradation rates under full scale conditions, due to less intensive treatment, different conditions and weathering of contaminants.

Copies of the final report summarising the research results, entitled **Bioremediation technology for the treatment of contaminated soil in South Africa** (WRC Report 543/1/95), are available free of charge from the Water Research Commission, PO Box 824, Pretoria 0001. (Overseas price: US$ 15.)

# FURTHER APPLICATIONS OF THE ALBANY

Macroinvertebrates are an essential functional component of freshwater ecosystems. Communities of this diverse group of organisms are found in almost all aquatic biotopes which are able to support life. In addition to being an important food source for other aquatic animals such as fish, they are responsible for the removal and recycling of nutrients, as well as biologically filtering and purifying the water they live in. The presence or absence of sensitive species or, conversly, the proliferation of pollution tolerant species offers some insight into the overall state of health of a particular aquatic environment. As a result, the monitoring of aquatic invertebrates is becoming increasingly recognised as an invaluable tool for water quality assessment.




*The adult mayfly* Compsoneuria njalensis, *emerging from its subimaginal skin*

The Albany Museum's National Collection of Freshwater Invertebrates is a comprehensive collection with coverage of all the major river systems in southern Africa (Table 1). The recent computerisation of the catalogued information associated with the specimens held in the collection has made this database of baseline biological information more accessible. Coupled with recent advances in communication technology such as the Internet, this wealth of information is now readily available to contribute towards the effective management of our aquatic resources.

Each accession within the handwritten catalogues has its own corresponding computerised record containing the following information: a unique catalogue number, the collector, date, locality (collecting site, grid reference, waterbody, river system, province, country) habitat or biotope, sample type and taxonomic information (order, family, sub-family, genus and species) as well as additional information on the number of specimens, life-cycle stage (larva, pupa or adult), name of identifier and whether or not the specimens are out on loan.

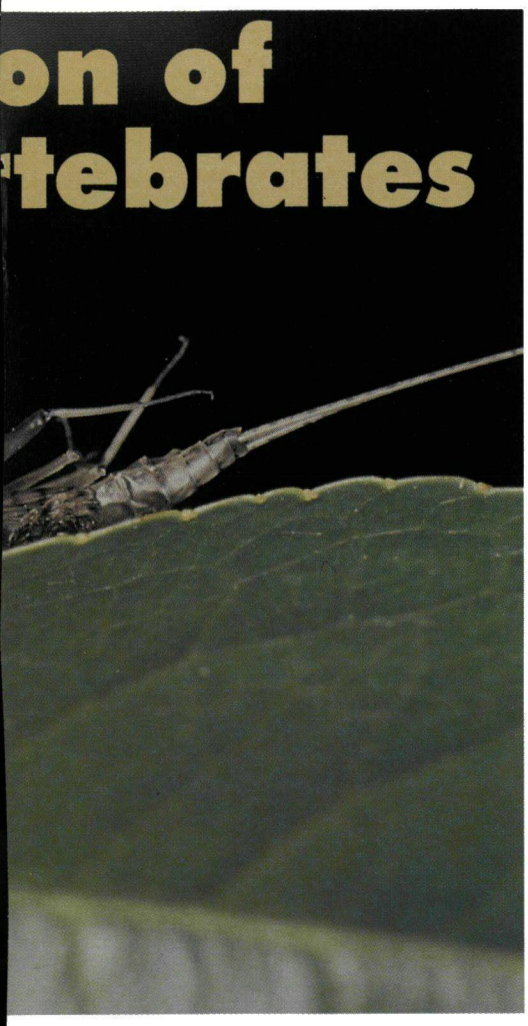
In addition to the traditional uses of museum collections such as taxonomic, evolutionary, ecological and life history studies (Table 2), several other applications have evolved from the computerisation process. Information required by researchers or monitoring organisations may be sorted or extracted within any field in the computerised catalogue, thereby allowing a wide variety of reports to be generated. Such reports may take the form of inventories of invertebrates found in any particular river system or a list of distribution records of a particular species within a number of river systems. Information in the other fields may be used to refine the output of the report, for example only specimens collected in the marginal-vegetation biotope. Such data can provide new insights into ecologically important factors such as species-associations, habitat preferences and trends in life-history styles.

Records of baseline biological information serve as useful reference points for organisations involved in Environmental Impact Assessments (EIA's) or long-term Integrated Environmental Management (IEM) programmes. Such historical data are invaluable in assessing, for example, the in-stream-flow requirements of aquatic communities of a particular waterbody or stretch of river (see Table 3 for further applications). Also, long-term changes in macroinvertebrate species compositions reflecting the severity of a particular development or alteration to the flow regime of a river may only be assessed where such comparative historical baseline information is available (Cambray & de Moor, 1988).

The National Collection of Freshwater Invertebrates and its associated computerised database is unique in that it contains biological information which in many in-

# MUSEUM'S

**S.J. Mangold & F.C. de Moor**
**Albany Museum, Somerset Street, Grahamstown 6140**




stances is pertinent to developing a picture of the "before and after" effects of such alterations (O'Keeffe & de Moor, 1988). By interfacing the National Collection of Freshwater Invertebrate database with other databases of faunal, floral, physical and climatogical information, a holistic environmental picture may be built, giving a broad ecological view of a particular river or site.

Geographical Information System (GIS) applications are yet further developments made possible by the computerisation process. Using the latitude and longitude co-ordinates in the grid reference field of the electronic database, the known distribution of a selected species or faunal assemblage may be plotted on a digitized map of South Africa using a GIS programme such as GRASS. By interfacing the distributional records with available physical databases for South Africa, a plot of species distribution may be obtained with respect to altitude, temperature or mean annual rainfall.

A further GIS application is that of modelling species distribution. This technique strives to identify areas in the country which have a similar suite of environmental conditions to those found within a particular species' known distributional range (ie. additional regions which would be theoretically suitable for habitation by that species). In order to do this, point lat./long. co-ordinates are required for all localities where the species to be modelled was collected. By interfacing these co-ordinates with electronic databases of physical parameters such as rainfall, temperature and elevation, a range of values for each of the above parameters is developed for the known distribution of the species.

In addition to localities where that species was found, localities which have been sampled in a similar fashion, but did not yield the species are required. This data set of localities with contrasting environmental conditions, required for compara-

**Table 3. Applications of the National Collection of Freshwater Invertebrates:**

1.Integrated Environmental Management and Environmental Impact Assessments
2.Geographical Information Systems applications
3.Water quality management and monitoring (e.g. SASS4 verification)
4.Bioindicator species
5.Nature Conservation
6.Education

**Table 1. Specifications of the National Collection of Freshwater Invertebrates:**

**Size:**
Approximately 1,5 million specimens collected over the past 100 years.
**Coverage:**
Mostly southern Africa + some Afrotropical coverage
**Types of surveys represented:**
* Commissioned surveys of particular catchments
* Long-term monitoring surveys
* General and specialized *ad-hoc* surveys.
**Total Number of Catalogues:** 86
**Time span covered by individual catalogues:**
* 5 catalogues over 20 years
* 7 catalogues between 10 and 20 years
* 10 catalogues between 5 and 10 years
* 64 catalogues less than 5 years
**Computerised Catalogues:**
48 (at present)
**Number of computerised accessions:**
Approximately 70 000 records in DBase III Plus

**Table 2.**
**Uses of the National Collection of Freshwater Invertebrates (after Cambray et al, 1987):**

1.Historical record of past biodiversity
2.Biodiversity inventories
3.Taxonomy & systematics
4.Evolutionary studies
5.Biogeography studies
6.Ecological studies
7.Ecomorphology
8.Life-history studies

tive purposes, is a necessary ingredient for the development of the model. The two data sets of physical values (corresponding to presence and absence of that species respectively) are then subjected to a statistical analysis in order to ascertain which of the physical parameters significantly limit the distribution of the species.

Once these parameters have been identified, a search through the original databases of physical parameters is conducted to ascertain where in the country a similar range and combination of values prevail. Upon the completion of this process, a model of the known and predicted distribution of the species can be plotted. However, it must be borne in mind that modelling species distribution using GIS is a **predictive modelling technique** which is unable to take into account natural dispersion barriers and other paleogeographic factors.

*The Antelope Park Spruit, a stream in the North East Cape*

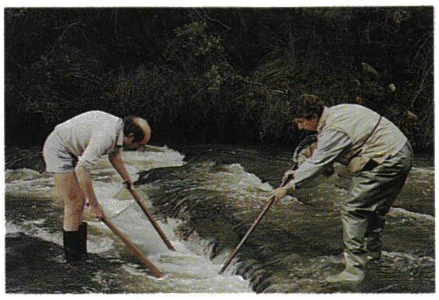
Benefits stemming from this type of GIS research for water quality management are manifold, including the identification of key environmental variables or a combination of these governing the distribution of macroinvertebrates; predicting macroinvertebrate community changes in response to environmental manipulation; the identification of areas which are vulnerable to invasion by aliens or areas of important conservation status.

Other applications of the National Collection of Freshwater Invertebrates and its associated expertise include the verification of macroinvertebrate identifications on behalf of monitoring organisations, particularly those using the South African Scoring System (SASS4). This biomonitoring technique, developed as a method of rapid assessment of water quality, relies on the designation of a particular score to each family present in a composite macroinvertebrate sample. The score assigned to each family varies according to tolerance or susceptibility to pollution and whether or not the family is associated with a disturbed aquatic ecosystem. For this reason, cognisance is also taken of the number of air breather families present and the total score contributed by them. By totalling the number of families as well as the scores assigned to them, a cumulative score is obtained as well as an average score per taxon (ASPT) for each site. In this manner, the SASS technique is able to give a comparable reflection of water quality, both over time and between sites or different rivers (Moore & McMillan, 1992).

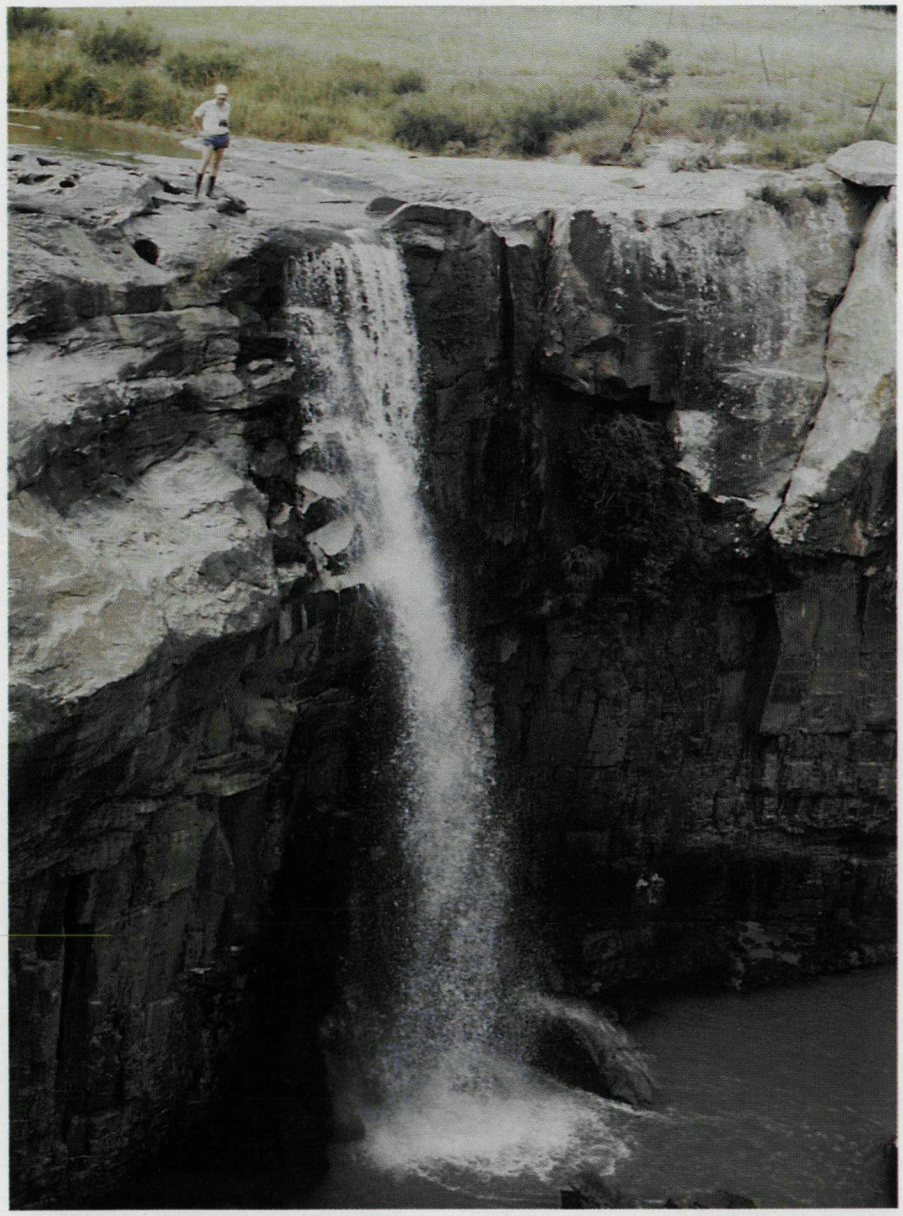
However, one of the major stumbling blocks of this technique is that a fair amount of knowledge and experience of invertebrate taxonomy is required in order to identify the taxa confidently to family level. Inaccurate identifications could result in a distorted score or biotic index, thereby seriously jeopardising the reliability of this technique as a tool for rapid water quality assessment. By sending voucher specimens to the Department of Freshwater Invertebrates on a regular basis, identifications can be confirmed at a generic or specific level and additional information regarding any particular species (e.g. bioindicator status and tolerance ranges, whether or not the species is a pest in other areas or is vector of a disease) can be relayed back to the monitoring organisation. In addition, as more knowledge is gained about the ecological requirements of important indicator species, this information could be used to further refine and develop the SASS technique.

*Close up of the bottled collection of vialed specimens*

The National Collection can serve as a repository and reference hub for all organisations which rely on accurate macroinvertebrate identifications for water quality assessment. As greater use is made of this resource, it is anticipated that more qualified manpower will be required to identify and curate the increased volume of material flowing into the department. This positive indirect spinoff of creating more jobs in the field of freshwater biology will ultimately be of benefit to water research and management



*Collecting specimens with a kick-screen on the Buffelspoort Spruit, Mpumalanga*



countrywide.

The Department of Freshwater Invertebrates at the Albany Museum is at present in a position to assist aquatic resource managers and development planners in making informed decisions based on sound verifiable biological information. This approach would assist in preventing inadvertent alterations in water quality or flow regimes, which may result in the proliferation of pest species like the blackfly *Simulium chutteri* (*sensu* O'Keeffe & de Moor, 1988). Management based on these principles will go a long way to ensure that we utilize our aquatic resources optimally without unnecessarily compromising the environment. Afterall, the environment is not only a user, but is the primary provider of high quality water.

**ACKNOWLEDGEMENTS**

Dr Anthony Palmer of the Agricultural Research Council is acknowledged for his assistance with the GIS component of this work. Special thanks must go to Dr Jim Cambray of the Albany Museum for photographing the computer images. Ms Helen James, Mr Wouter Holleman and Ms Irene de Moor are thanked for proofreading various drafts of this manuscript. This work was funded by the Water Research Commission.

***LEFT:*** *Waterfall on the Nqanculu River, North East Cape*
***BELOW LEFT:*** *Larva of the micro-caddisfly* Oxyethira *sp. in its transportable case*

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# Assessing effluent discharge impacts

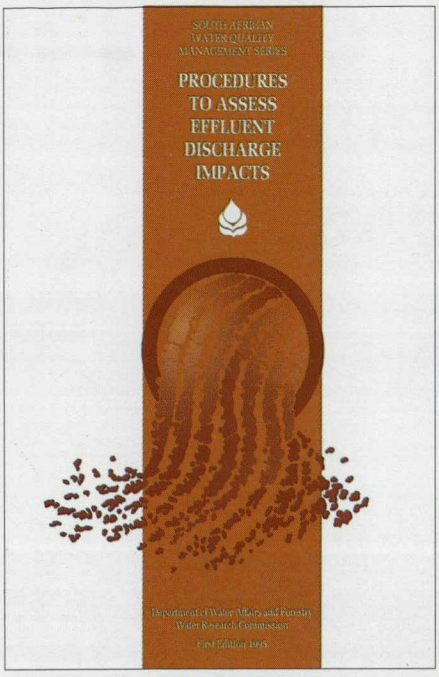
## - new manual of practice published

The South African Water Act makes it mandatory that effluents must be treated to acceptable standards and returned to the water course from which the water was originally obtained. The Department of Water Affairs and Forestry has been implementing these requirements stipulated in the Water Act since the early 1950s through a uniform effluent standards approach. However, continued deterioration of water quality in some parts of South Africa has lead the Department to adopt a more comprehensive approach towards controlling the impacts of effluents on the quality of the receiving water bodies. One of the key concepts embodied in this approach is that the capacity of water bodies to assimilate waste is a limited national resource which must be managed in a sustainable way.

Since the Department published its comprehensive approach to effluent control in 1991, it became obvious that the necessary management tools and information to support its implementation had to be developed. Because the receiving water quality objectives approach takes many factors into account there was the danger that its application in practice could lack consistency. The need to formalise the assessment of the impact of effluent discharge on the receiving water bodies, prompted the Water Research Commission and the Department to jointly initiate a project which culminated in the production of a manual of practice, which is relevant to South African conditions.

In this manual, entitled "Procedures to assess effluent discharge impacts", the procedures are described which must be followed to assess the impacts of effluent discharges on the quality, and therefore the fitness for use, of the receiving water bodies. These assessments will be used to decide whether or not an application to discharge an effluent will be granted or

*The effluent discharge investigation is one of the water quality management tools the DWAF uses for management of point source effluent. It obtains and records specific information about an effluent discharge and its impact on the receiving water and the water users.*




not, and, if it is granted, what the requirements should be that the discharger must comply to. It therefore forms one of the corner stones of the Department's current approach to the management of effluent discharges.

The publication is primarily aimed at all those who have to dispose of effluents and are therefore required to comply with the requirements of the Water Act, and to the water quality practitioners in the Department and provincial and local authorities. However, because it documents in some detail current water quality management policies and practices in South Africa it should also be a useful source of information for academic and research institutions, non-government organisations and members of civil society who are concerned about water quality.

Copies of the manual **Procedures to assess effluent discharge impacts** (WRC Report TT 64/94) are available free of charge from the Water Research Commission, PO Box 824, Pretoria 0001. (Overseas price: $40,00).

# REQUEST FOR INFORMATION

## Vegetation and groundwater

**The CSIR, on behalf of the Water Research Commission, is doing a survey of the ways in which vegetation and ground water interact in South Africa. If you have any information on, or experience of, one of the following topics, our project team would like to hear from you.**

**The maximum depth at which plant roots have been discovered in boreholes or excavations;**
- where did this occur?
- what type of plant was involved?
- what was the material in which the roots were found (soil, sandstone, granite etc).

**Situations where vegetation died as a result of a falling water table (caused, for example, by pumping of groundwater or the reduction in recharge);**
- where did this occur?
- in what year?
- what was the depth of the water table before and after the deaths?
- what type of plants were affected?

**Situations where the groundwater level rose or fell as a result of changes in land use or vegetation, for instance, afforestation, clearing for crops, bush clearing, or initiation of irrigation.**
- where did this occur?
- in what year?
- describe the vegetation and land use change, and the change in groundwater level.

We are keen to hear from you even if you feel the information you have is vague. By gathering all the bits and pieces of information together we hope that larger pictures may begin to develop.

**Please write, fax, phone or e-mail your information to:**

Dr Dave Scott
Environmentek, CSIR
PO Box 320
Stellenbosch
7599

Tel: 021 - 889 1122
Fax: 021 - 889 1130
E-mail: GWVeg@csir.co.za

# HYDROLOGY TO THE RESCUE OF OUR RESOURCE BASE

**_Water resource base_ is one of the new buzz words that is being used and, as with the term Integrated Catchment Management, we probably have a number of widely divergent views on what is meant by this term.**

In some documents it is clearly spelt out that the aquatic environment, or even rivers only, is to be seen as our water resource base. This view, however, does not tally with our understanding of the hydrological cycle. If you don't look after the land you loose the rivers. Therefore, I would like to advocate a far more holistic view, namely that the land surface of a catchment is the resource base. The condition of the land is actually a sure sign of how well that catchment is functioning. The condition of our rivers and wetlands is also an excellent indicator of the well-being of the resource base. What is sadly lacking at present is a commonly understood and accepted picture of the present state of our resource base.

Over the past fifty years "the National Veld Trust has relentlessly attempted to promote the conservation of South Africa's natural resources for the benefit of present and future generations... the Trust has largely focused on creating awareness for environmental protection among all sectors of society. It has taken the stance that unless the alarming rate of degradation is curbed, future development and social upliftment in South Africa will be in jeopardy. One of the first actions ever undertaken by the Trust was to formulate draft legislation which led to the proclamation of the first Soil Conservation Act (45/1946)", writes A L Terre Blanche, Chairman of the National Veld Trust in his Foreword to the recent discussion document of the Trust, **Towards a National Policy and Strategy for Natural Resource Conservation and Management in South Africa** (July 1994).

The proverbial tons of topsoil "exported" to the oceans have obviously not made us to care more for the land. Thirst will do the trick, I am convinced. Eroded land can still function in some of the aspects for which land is usually used; you can still see it (degraded though), build on it, walk on it, you can even plough it and plant trees, but when a river runs dry ... the water is gone! And if you pump the groundwater into the atmosphere it is also gone forever. We can now probably call upon water, to elevate care for our land above the mere lip service that the majority of the people have paid to soil conservation.

The 1994 discussion document of the National Veld Trust is intended to support the RDP and to meet the needs of a new South Africa with a revised policy reform as indicated therein. It represents "a first step in bringing about an improvement in natural resource conservation and management throughout the country... and is intended to stimulate thought and action ... in both the public and private domains. No time or effort should be spared in bringing about change in land management at the "grass roots" level. ... and to establish a new resource conservation ethic in South Africa".

The land surface is the foremost contact and collecting surface of rain on our earth and the flow regime of our rivers is determined to a very large extent right there and then. It is not true that groundwater bodies need to be recharged before rivers will start to run (and dams to fill up). There is a continuous process of water flow separation near or at the land surface that has to be managed.

Our modern measurements do not reflect the dramatic change which has taken place in our waters since the 1860s. Unfortunately the fate of our perennial rivers, wetlands and springs can only be deduced from folklore.

However, in the same discussion document Dr Derek Scotney writes: "Many factors could mitigate against the adoption of a new conservation ethic and care will be needed to prevent the demise of past achievements". Therefore, let us use our hydrological knowledge together with the rapidly rising public interest in water to help save the land, our *water resource **base***.

**Hugo Maaren**
**Secretary, SANCIAHS.**

## SOUTH AFRICAN HYDROLOGY HOME PAGE

The Water Research Commission obtained some financial support from UNESCO to initiate a home page in the World Wide Web with regard to hydrology and Water Resources in Southern Africa. We see this as the start of an informal level of co-operation amongst water scientists and practitioners in Southern Africa.

The policy regarding the use of "HYDROLIB-SA" will be modified as the page develops. Users are therefore encouraged to contribute to this policy development. "HYDROLIB-SA" is intended as an electronic repository of water resources and hydrology-related data and information. The information and data should be useful and promote the sharing of resources and knowledge amongst the SADC countries, starting with the scientific community. The ultimate control of this library is to be vested in the site owner (at this stage the WRC through the Computer Centre for Water Research (CCWR)). However, the wishes of regular users of the library will be taken into account very strongly. Users or potential users are therefore encouraged to let the CCWR or WRC know of their data and information needs. All relevant submissions will be included as far as possible.

The Web page is accessible under:
*http://www.ccwr.ac.za/hydro*
or start surfing from:
*http://www.ccwr.ac.za/wrc*

**New Name Needed**

We would welcome any ideas to give the hydrology home page a more appropriate and better sounding name!

# SURFACE WATER RESOURCES OF SOUTH AFRICA 1990


A series of reports which contain the results of a revised appraisal of the 1981 survey "Surface Water Resources of Southern Africa" are currently available from the Water Research Commission.

The aim of the revision, called the **WR90 Study**, was to update and improve the 1981 survey and also to provide a basis for a preliminary planning of water resources development. The survey will make available in a single set of documents valuable data and information for water resources planning and development.

WR90 assembles the 22 main drainage regions of South Africa under six groups which are dealt with in six corresponding volumes for each of which there is a report. The reports consist of three parts: a **user manual**, a **set of appendices** comprising data, information and analyses and a **book of maps**. A **CD ROM** containing a Readme File, all hydrometeorological data in the Appendices and GIS data (36E00 files) together with an updated version of ARC VIEW 2 is also available.

To order a set of the WR90 Study Reports, please complete the order form on the reverse side and send it to: The Librarian, Water Research Commission, PO Box 824, Pretoria. Tel: (012) 330-0340. Fax: (012) 331-2565.

# Researchers study novel approach to sludge dewatering

M SMOLLEN
A KAFAAR

DEVELOPMENT OF ELECTRO-OSMOTIC SLUDGE DEWATERING TECHNOLOGY

Report to the
WATER RESEARCH COMMISSION
by the
DIVISION OF WATER TECHNOLOGY, CSIR

WRC Report No 427/1/95

**The problems associated with sludge dewatering are widely appreciated and the search for improved dewatering techniques is being pursued worldwide, with new approaches and associated equipment regularly appearing on the market.**

Recognising the importance of sludge handling and utilisation technologies, the Water Research Commission entered into a two year contract with the CSIR Division of Water Technology (WATERTEK) to investigate electroosmotic sludge dewatering which presents a novel approach in South Africa. The researchers at WATERTEK who carried out the investigation, M Smollen and A Kafaar, say the research project had four objectives:

- A literature review on the role of sludge liquid structure in sludge dewatering;
- A laboratory investigation of electro-osmotic dewatering and sludge behaviour when subjected to electroosmotic process;
- A study of sludge dewatering using partly built (one stage) electroosmotic filter-belt scale model; and
- An investigation of sludge dewatering using the two stage electroosmotic filter-belt scale model.

## CONCLUSIONS

The literature review, which was undertaken as the first stage of the investigation, highlighted an important aspect of sludge behaviour and that is that the physical and chemical phenomena, which occur in the interface of the electric double layer, are indicative of the importance of the individual liquids fixed in the sludge particle. A better understanding of the distribution of water and of the forces that bind water within the sludge may lead to better dewatering performance. Inefficiency of mechanical dewatering in removing liquids held within the electric double layer (minute capillary structures), can be overcome by dewatering **sludge** enhanced by electroosmosis.

From laboratory experimental results it was concluded that electroosmotic dewatering has the ability to remove the liquid which is difficult to remove with conventional methods.

A scale model of a filter belt device, in combination with electroosmotic dewatering was developed and partly built. It was found that the experimental results support the preceding laboratory results. It seems that electroosmosis can be particularly effective in the dewatering of biological or chemical gelatinous and fine particle sludges too difficult for mechanical dewatering

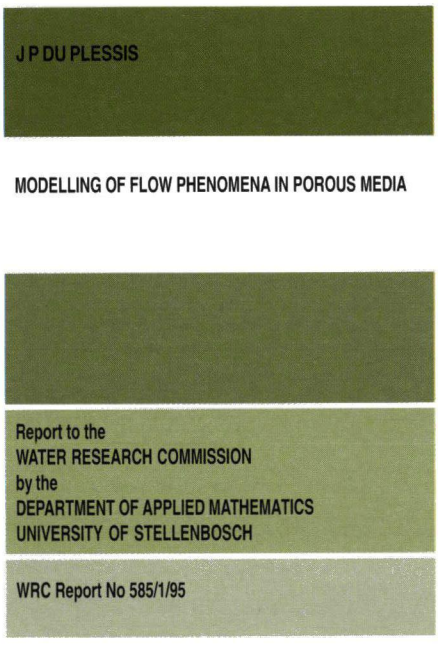
A significant advantage of electroosmosis can be observed when applied in filtration processes. Blinding of the filter media, which is recognised as a major drawback of filtration, is markedly reduced by electro-osmosis.

The researchers conclude that the findings of the investigation are sufficient to justify the investment in a prototype pilot-plant which, upon incorporation of structural and mechanical improvements, can be optimised for factory production and sales as a proven unit.

Copies of the report summarising the research results titled **Development of electro-osmotic sludge dewatering technology** (WRC Report 427/1/95) are available free of charge from the Water Research Commission, PO Box 824, Pretoria 0001. (Overseas price: US$ 15).

# Modelling water movement through porous structures

**Any analysis of water research activities will invariably show that a major part of such activities concerns flow through porous media, says Professor JP du Plessis from the Department of Applied Mathematics, University of Stellenbosch, in a report to the Water Research Commission. The report emanates from a two-year research project financed by the Water Research Commission on the mathematical prediction methods of water movement through porous structures.**




Professor Du Plessis says standard filtration using sand beds and technically more advanced practices utilising membrane systems are but two examples of applied technology making use of flow through porous media. Naturally occurring phenomena such as water seepage through sandstone and other rock formations are governed by the same physical principles and the mathematical modelling is therefore similar. Runoff from precipitation, irrigation and spraying of farmlands also cause water movement through porous soils and the monitoring of concurrent pesticide concentration redistribution has become a problem of considerable importance.

Field research activities on these phenomena form an important aspect of many projects launched by the Water Research Commission. Managerial action on findings require extensive qualification and quantification of results and the better the modelling framework on which such elaboration takes place the better the chances are for any predictive judgement to be optimal under practical circumstances.

Professor Du Plessis says more often than not so called "mathematical models" consists of curve-fitting by linear regression techniques and the qualification of the result is measured against the tightness of the fit for the particular set of data. The produced "mathematical model" is then an equation of some kind with some numerical coefficients of which the physical bearing is mostly unknown. In this research project the emphasis is focused on the physical origin of the type of curve against which the data is tested and the prime goal is therefore to use the physics involved to prescribe the curve being used. In this manner the coefficients are quite often reduced and, since the knowledge is available about the physical origin of the particular curve, the remaining coefficients are bounded by physical constraints. The experimental and numerical data are then only used to fine-trim these coefficients and much less experimental work is normally needed. Since physical length parameters of the particular case are explicitly used in the modelling, the problem of scaling is eliminated and laboratory-scale results apply directly to field-scale phenomena.

## CONTRIBUTIONS

The report presents a unified theory by which the same physical and mathematical principles are used to obtain momentum and tracer transport equations for an almost unlimited range of practically possible porosity and microstructural length scales. The analytical predictive results are shown to be accurate over a porosity range varying from 5 per cent, in the case of granular sandstones, to 98 per cent for foams. Length scales of experimentally verified results vary between a few micrometres for sandstones and several millimetres in the case of packed beds.

Careful analysis of computer simulation of average flow fields has provided insight into the influence of external boundary conditions applied and several suggestive remarks are put forward to improve correlation of numerical results with experimental observation.

Copies of the report entitled **Modelling of flow phenomena in porous media** (WRC Report 585/1/95) are obtainable free of charge from the Water Research Commission, PO Box 824, Pretoria 0001.
(Overseas price: US $15).

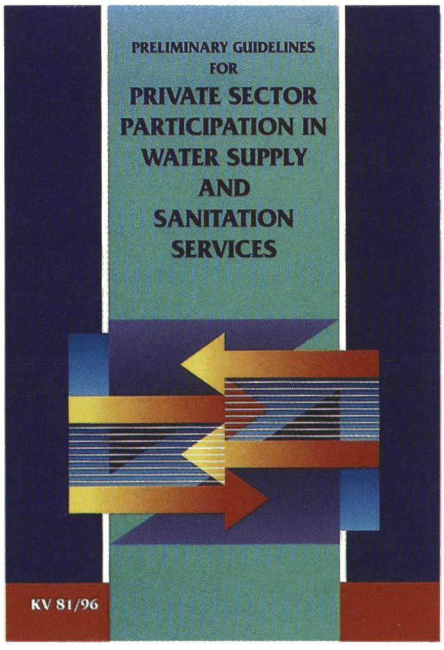
# Guidelines published for private sector participation in water supply and sanitation services

In the White Paper on Water Supply and Sanitation Policy the essential role that could be played by the private sector in the delivery of water and sanitation services was recognised. The publication of this Water Research Commission document is intended to promote the establishment of partnerships between the private and public sector in order to exploit all available resources to the benefit of the country.

The document is not intended to present detailed guidelines of various aspects of private sector engagement but is aimed at highlighting the issues that are pertinent when considering the engagement of the private sector in the supply of basic and essential services. The emphasis of this document is on partnerships. The privatisation of the water sector in the sense of the outright sale of public assets is not envisaged.

There are a range of services available from the private sector. The service most suitable to the needs of the community being served by the local authority should be selected after a proper study of the objectives that are to be achieved as a result of introducing private sector participation into water supply and sanitation. A clear articulation and understanding of the objectives is vital to achieve the best interactions and results from private sector participation.

While it can be shown that the private sector can provide an efficient and cost effective service, enhanced delivery and improved service must be measured against predetermined performance standards. Furthermore, the private sector must be engaged in a manner that will meet the aims of the local authority and provide a sustainable operation in which the user of the service can benefit from the provision of an improved and more cost effective service.




*The Water Research Commission recently published a document titled* ***Preliminary guidelines for private sector participation in water supply and sanitation services*** *(WRC Report KV 81/96). The purpose of the document, prepared by Consultant Philip Pybus under the direction of a project steering committee, is to alert the institutions that are currently responsible for the delivery of water and sanitation services to the variety of services available from the private sector, as well as the options that are available to them for the improvement and upgrading of these services.*

It is the purpose of these preliminary guidelines to ensure that the issues involved in such engagement are fully understood and that any ensuing decisions will benefit all the parties involved.

Private sector participation does not mean the privatisation or sale of public assets, but implies rather a mutually beneficial partnership of public and private sectors to ensure that consumers ultimately get the best service possible within the means available. The form of such a partnership, and the nature of the contracts that may be entered into, may range from the straightforward rendering of a specific service right through to a long term engagement involving not only the complete management and operation of the system but also the financing or refurbishment or extensions as well. The exact arrangements will depend on local circumstances, the needs of the people being served, and the particular needs of the agency responsible for water supply and sanitation services.

Copies of the publication **Preliminary guidelines for private sector participation in water supply and sanitation services** (WRC Report KV 81/96) are available free of charge from the Water Research Commission, PO Box 824, Pretoria 0001. (Overseas price: US$ 20).

REPORT REVIEWS

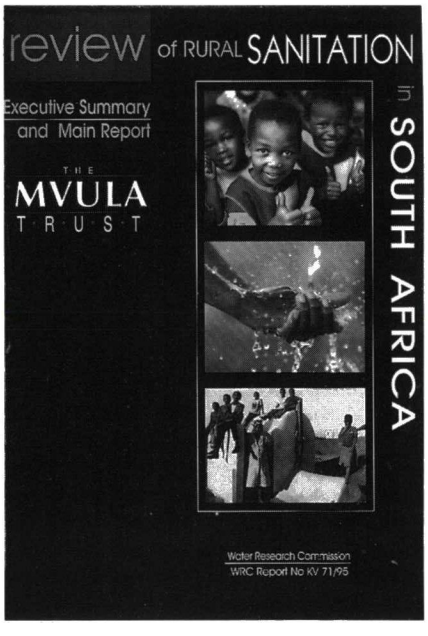
# RURAL SANITATION in South Africa

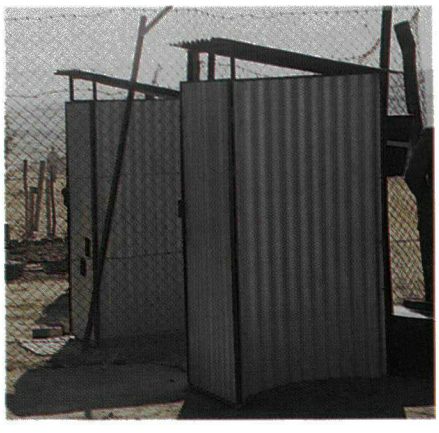
A report summarising an extensive study carried out for Mvula Trust and the Water Research Commission (WRC) to review the current situation with regard to sanitation in rural areas in South Africa can be obtained from the WRC in Pretoria.

The report, compiled by the Palmer Development Group in association with Makhetha Development Consultants, says that in order to address the problem of rural sanitation in South Africa, a "new approach is needed" because "until recently there has been an almost complete failure of public policy, backed up with the necessary resources". While the first steps have been taken in the field of policy making (such as the recently released White Paper of the Department of Water Affairs, titled **Water Supply and Sanitation policy**, Nov 1994) the report says "much needs to be done to enhance policies, prepare strategies and move on urgently to the implementation of projects on the ground, working together with the people who are in need of improved services".

It has been the intention of this research project to contribute to the development of policy and strategy through undertaking a review of rural sanitation in South Africa and putting forward proposals for improving the situation.

The findings of the research are comprehensively reported on in this review publication. The executive summary draws out the key findings and puts forward a recommended approach and programme of action for initiating and developing a national rural sanitation programme.



Copies of the publication entitled **Review of rural sanitation in South Africa** (WRC Report KV 71/95) are available free of charge from the Water Research Commission, PO Box 824, Pretoria 0001.
(Overseas price: US$25).

# SA WATERKALENDER

## 1996

The Water Research Commission is placing this calendar 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.

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**OKTOBER 1996**

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**NOVEMBER1996**

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**DECEMBER1996**

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## 1997

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

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

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

**Gids:**

- ○ Een SA Watergeleentheid vir hierdie dae.
- ❑ 'n Tweede SA Watergeleentheid gereël vir dié datums.
- × 'n Derde SA Watergeleentheid gereël vir dié datums.

Sien Konferensie- en Simposiumbladsy vir aangeduide geleenthede.

**JANUARY 1997**

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**FEBRUARY1997**

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**MARCH 1997**

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**APRIL 1997**

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**MAY 1997**

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**JUNE 1997**

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**JULY 1997**

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**AUGUST 1997**

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**SEPTEMBER1997**

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**OCTOBER 1997**

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**NOVEMBER1997**

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**DECEMBER1997**

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## SOUTHERN AFRICA

## 1996

### WATER AFRICA
JULY 9 - 12
An exhibition and conference called Water Africa 96 will be held at the Ghana International Trade Fair Centre in Accra.
Enquiries: Zia Howeson. Tel (011) 792-9807 Fax: (011) 791-0571.

### WATER ENGINEERING
JULY 18 - 19
The young water, environmental and geotechnical engineers' festival will be held at the Rob Roy Hotel, Botha's Hill, Natal.
Enquiries: Lesley Stephenson, Conference Secretary, PO Box 327, WITS. Tel: (011) 716-5091 Fax: (011) 339-7935.

### AQUATIC SYSTEMS
JULY 15 - 19
A conference on aquatic systems will be held at the Elephant Hills Hotel, Victoria Falls, Zimbabwe.
Enquiries: Ms Lesley Stephenson, PO Box 327, WITS 2050. Tel: (011) 716-5091 Fax: (011) 339-7835. E-mail: Stephenson @ egoli.min.wits.ac.za

### HYDRAULIC RESEARCH
AUGUST 5 - 7
The International Association for Hydraulic Research - African Division's biennial congress with the theme "From flood to drought" will take place at Sun City.
Enquiries: Miss Genevieve Stephenson, Conference Office, PO Box 327, WITS 2050. Tel (011) 716-5091 Fax (011) 339-7835.

### WATER MICROBIOLOGY
AUGUST 13 - 16
An introductory course in water microbiology will be held at the Division of Water Environment and Forestry Technology, CSIR, Pretoria. (Please note: Similar courses will take place on 12 - 15 November 1996 and 11 - 14 February 1997).
Enquiries: Mr Gerrit Idema. Tel: (012) 841 4638 Fax: (012) 841 4785.

### AFRIWATER '96
SEPTEMBER 2 - 5
The AFRIWATER Conference and Exhibition will be held at the Gallagher Estate in Midrand.
Enquiries: Nigel Walker Tel: (011) 886-3734 Fax: (011) 789 6497. International code: (+27 11).

### MEMBRANES
SEPTEMBER 9 - 11
A seminar on hygienic water re-use and reclamation using membrane techniques will be held in Windhoek, Namibia.
Enquiries: Ed Jacobs, Institute of Polymer Science, University of Stellenbosch, Private Bag X1, Matieland 7602. Tel: (021) 808-3178 Fax: (021) 808-4967 E-mail: epj@maties.sun.ac.za

### WATERSUIWERING
SEPTEMBER 16 - 20
'n Kortkursus in die bedryf van watersuiweringsaanlegte sal by die Universiteit van Pretoria aangebied word.
Navrae: Professor WA Pretorius, Departement Chemiese Ingenieurswese, Afdeling Waterbenutting, Universiteit van Pretoria 0001. Tel: (012) 420-3566.

### MINE WATER
SEPTEMBER 19
A one-day symposium on **Radioactivity in Mine Water** will be held by the Water Institute of Southern Africa at Randfontein Estates Sports Club.
Enquiries: Andrew McLaren, Gold Fields. Tel: (011) 639-2181 Fax: (011) 834-6770 or Dave Dorling Tel: (011) 414-1606 Fax: (011) 414-0953.

### PC-ACRU
SEPTEMBER 26 - 27
A two-day course on the Agrohydrological modelling system will take place at the Department of Agricultural Engineering of the University of Natal. To enrol see advertisement in this Bulletin.

### FIDIC '96
SEPTEMBER 29 - OCTOBER 2
The FIDIC annual conference will be held in Cape Town. Theme: **The role of the consulting engineering industry in developing countries**.
Enquiries: Conference Organisers, PO Box 44503, Claremont 7735. Fax: (021) 762 8606.

### ENVIRONMENTAL MANAGEMENT
OCTOBER 7 - 8
The 2nd Environmental Management, Technology and Development Conference will be held at the Indaba Conference Centre, Fourways, Gauteng.
Enquiries: Lesley Stephenson, Conference Secretary, PO Box 327, WITS 2050. Tel: (011) 716-5091. Fax: (011) 339-7835.

### FILTRATION SYSTEMS
OCTOBER 15 - 16
A short course on the **Design of declining rate filtration systems** will be held at the Rand Afrikaans University (RAU) in Johannesburg.
Enquiries: Professor Johannes Haarhof. Tel: (011) 489-2148 Fax: (011) 489-2466. E-mail: JH@ing1.rau.ac.za

### WATERBEHANDELING
OKTOBER 21 - 23
'n Kortkursus oor die behandeling van nywerheids- en verkoelingswater sal by die Universiteit van Pretoria aangebied word.
Navrae: Professor WA Pretorius, Departement Chemiese Ingenieurswese, Afdeling Waterbenutting, Universiteit van Pretoria 0001. Tel: (012) 420-3566.

### WATER TREATMENT
OCTOBER 21 - 23
A seminar and workshop on the **Treatment of coloured water for potable use** will be held in Mossel Bay.
Enquiries: Mr CD Swartz, PO Box 745, Mossel Bay 6500. Tel: (0444) 911242 Fax: (0444) 7960.

### ISIAME '96
NOVEMBER 4 - 8
An international symposium on industrial applications of the Mössbauer effect will be held in Johannesburg.
Enquiries: Prof Herman Pollak (Chairman), Mössbauer Laboratory, Department of Physics, University of the Witwatersrand, Private Bag 3, Johannesburg 2050. Tel: (011) 716-4053 Fax: (011) 339-8262. E-mail: 005KLKS@WITSVM A. WITS.AC.ZA

## SOUTHERN AFRICA

## 1997

### METEOROLOGY
APRIL 7 - 11
The 5th international conference on southern hemisphere meteorology and oceanography will be held at the University of Pretoria.
Enquiries: Conference Planners: Amie Wissing. Tel and Fax: (012) 46-0170.

## OVERSEAS

## 1997

### GROUNDWATER
APRIL 7 - 11
An international conference and course on **Analytic based modeling of groundwater flow** will take place in Nunspeet, the Netherlands.
Enquiries: The Conference Secretariat, MOORGA, Buerweg 51, 1861 CH Bergen, the Netherlands. Tel: +31 7258-99062 Fax: +31 7258 99040

### RAINWATER
APRIL 21 - 25
The 8th international conference on **rainwater catchment systems** will be held in Tehran, Iran.
Enquiries: Mr J Ghoddousi, PO Box 13445-1136, Tehran, IR Iran. Tel: +98 21 6418335 Fax: +98 21 6407214 E-mail: RAIN@NEDA.NET.IR

### WATER SYSTEMS
MAY 25 - 28
An IWSA and IAWQ specialised conference on **the Upgrading of water and wastewater systems** will be held in Kalmar, Sweden. Call for papers. **Abstract submission: 1 September 1996.**
Enquiries: Dr Ulf Lidman, Dept of Natural Sciences, University of Kalmar, Box 905, S 391 29 Kalmar, Sweden. Tel: (46) 480-446235 Fax: 480-446262

### ENVIRONMENTAL RESTORATION
JULY 7 - 9
The first international conference on environmental restoration will be held in Ljubljana, Slovenia. Conference themes: river, soil and groundwater contamination, pesticides/PCB/oil pollution, disposal of domestic waste/industrial waste/construction industry wastes and hazardous waste management. **Call for papers.** Deadline for submission of abstracts: **15 September 1996**.
Enquiries: Dr Milenko Ros, Slovenian Water Pollution Control Association, Hajdrihova 19, PO Box 3430, SLO-1001 Ljubljana, Slovevnia. Tel: +386 61 1760237 Fax: +386 61 125 9244 E-mail: milenko.ros@ki.si

### ACTIVATED SLUDGE
JULY 21 - 23
The second international conference on **Microorganisms in activated sludge and biofilm processes** will be held at Berkeley in California, USA. Call for papers. Deadline for receipt of extended abstracts: **August 15 1996**.
Enquiries: Professor David Jenkins, Microorganisms Conference, Department of Civil & Environmental Engineering, University of California at Berkeley, Berkeley CA 94720-1710, USA. Tel/Fax: 510 527-0672. E-mail: jenkins@ce.berkeley.edu

### LARREN '97
AUGUST 25 - 28
An international conference on land reclamation and rehabilitation will be held in Penang, Malaysia. **Call for papers**. Deadline for receipt of abstracts: 15 June 1996.
Enquiries: Larren '97, School of Civil Engineering, Universiti Sains Malaysia, Perak Branch Campus, 31750 Tronoh, Perak, Malaysia. Tel: 605-3676901 ext 5412. Fax: 605-3677440.

### IWRA
SEPTEMBER 1 - 6
The 9th world water congress of the International Water Resources Association (IWRA) will take place in Montreal, Canada. Theme: **Water resources outlook for the 21st century - Conflicts & Opportunities**.
Enquiries: Aly M Shady, Canadian International Development Agency, 200 Promenade du Portage, Hull, Quebec, Canada K1A 0G4. Tel: +1 (819) 994-4098 Fax: +1 (819) 953-3348 E-mail: aly-shady@ACDI-CIDA.GC.CA

### LANDFILL
OCTOBER 13 - 17
The sixth International Landfill Symposium will be held in Cagliari, Sardinia, Italy.
Enquiries: Ms Anne Farmer, CISA - Environmental Sanitary Engineering Centre, Via Marengo 34 - 09123 Cagliari (Italy). Tel: +39-70-271652. Fax: +39-70-271371. E-mail: cossur@vaxca3.unica.it

### WEFTEC '97
OCTOBER 18 - 22
The American Water Environment Federation's 70th annual conference and exposition will be held in Chicago, Illinois USA. **Call for papers: Deadline: 16 December 1996.**
Enquiries: WEFTEC '97 Program, 601 Wythe Street, Alexandria, Virginia 22314 1994 USA. Tel: 1-703-684-2452 Fax: 1-703-684-2471.

## OVERSEAS

## 1996

### STORM DRAINAGE
SEPTEMBER 9 - 13
The 7th international conference on urban storm drainage will be held in Hannover, Germany.
Enquiries: Prof F Sieker: Institüt für Wasserwirtschaft, Universität Hannover, Appelstrasse 9a, D-3000 Hannover 1, Germany. Tel: +49-511-7623567 Fax: +49-511-762-3456

### MONITORING TAILOR MADE
SEPTEMBER 9 - 12
The second international workshop on information strategies in water management will be held in Nunspeet, the Netherlands.
Enquiries: Workshop Secretariat, Buerweg 51, 1861 CH Bergen, the Netherlands. Tel: +31 72 5899062 Fax: +31 72 5899040.

### IRRIGATION
SEPTEMBER 15 - 22
The 16th International Congress on Irrigation and Drainage will be held in Cairo, Egypt.
Enquiries: The Organising Committee, Drainage Research Institute, National Water Research Centre, Delta Barrage, PO Box 13621/5, Cairo, Egypt. Tel: (202) 21 89 383 or (202) 21 88 941 Fax: (202) 21 89 153.

### BIOCHEMICAL ENGINEERING
SEPTEMBER 19 - 21
The first European symposium on Biochemical Engineering Science will be held at the Dublin City University in Ireland.
Enquiries: Drs Patricia Osseweijer, Kluyver Laboratory, Julianalaan 67, 2628 BC Delft, the Netherlands. Tel: +31-15-2785140. Fax: +31-15-2782355.
E-mail: P.Osseweijer@stm.tudelft.nl

*First Announcement*

DIVISION OF WATER, ENVIRONMENT AND FORESTRY TECHNOLOGY CSIR
WATER RESEARCH COMMISSION
WISA WATER CARE DIVISION

# *Seminar and Workshop on*
# TREATMENT OF COLOURED WATER FOR POTABLE USE
## *21-23 October 1996*
## *Mossel Bay*

## PREAMBLE

Organic colour in surface water supplies is found worldwide and constitutes a sizeable portion of the total water sources being treated for potable use. Unlike with most of the turbid surface waters, many problems are experienced with the treatment of coloured water. Amongst the more serious problems are the high chemical dosages required for colour removal, difficulty in controlling dosages because of variability of raw water quality, high aluminium residuals in the final water, the formation of disinfection by-products when these waters are chlorinated, the production of large volumes of sludge with poor dewatering characteristics, and corrosion and aggression of the storage systems and distribution network. There is a need for information on the design, operation and control of colour removal treatment plants, and for transferring this information successfully to the end-user.

The object of this workshop is to bring scientists, engineers, plant owners, managers and operating personnel together to provide an overview of the treatment of coloured water and of research that has been done in this field, and to provide plant managers and operators the opportunity to discuss the problems experienced at their plants, in order to address these in the form of guideline documents and identification of research needs. The workshop thus includes a strategic session to develop a strategy for further research on the treatment of coloured water for potable use.

## FORMAT OF THE WORKSHOP

On the first morning of the workshop (Session I) recognized scientists and engineers have been invited to provide an overview of the treatment of coloured water: origin, occurrence and nature of organically coloured water: reasons for treating coloured water; treatment options; design considerations; recent developments; and guidelines for design and operation of treatment plants.

In the afternoon of the first day (Session II) a number of plant managers and/or operators will provide short overviews of their treatment plants and problems that are experienced, with the view of stimulating discussion and generalising and prioritising problem areas.

On the second morning (Session III) a strategic session will be held which will be facilitated by the Water Research Commission. During the structured session priority areas to be addressed will be discussed, based on the needs expressed by the delegates and speakers, both in the current session and during the previous two sessions. A strategy for further research on the treatment of coloured water for potable use will be developed which will be made available to all concerned subsequent to the workshop.

In the afternoon of day two (Session IV) two full-scale treatment plants, treating water with some of the highest colour levels in the world, will be visited.

## PROGRAMME OUTLINE

**Monday 21 October 1996**
16:00 - 19:00 Registration and Meet and Greet

**Tuesday 22 October 1996**
07:30-08:30 Registration

**SESSION I**
08:30 - 13:00 Presentations by invited speakers
13:00 - 14:00 Lunch

**SESSION II**
14:00 - 17:00 Presentations by plant managers and operators
Evening Social Function

**Wednesday 23 October 1996**
**SESSION III**
08:30 - 10:30 Strategic planning session/identification of research needs

**SESSION IV**
11:30 - 12:30 Visit Kleinbrak Water Treatment Works, Mossel Bay
12:30 - 13:30 Lunch at Kleinbrak
14:30 - 16:00 Visit George Water Treatment Works

## WORKSHOP ATTENDANCE

A reduced fee for attendance of the workshop will be applicable for plant operators and for organisations registering 3 or more of their personnel for the workshop.

Participants will be responsible for their own travel and subsistence costs. Block bookings at hotels and guest houses have been made. Registration fees cover the meet and greet function, teas, coffee, 2 lunches, social function, excursions and workshop documentation.

The venue can accommodate 100 persons.

Further information on the workshop can be obtained from:

**CD Swartz**
**PO Box 745**
**6500 MOSSEL BAY**

Tel: (0444) 911242
Fax: (0444) 7960

# DECLINING RATE FILTRATION

## a short practical design course

WHEN: October 15 & 16, 1996
VENUE: Department of Civil Engineering, RAU

**BACKGROUND INFORMATION**

Declining rate filtration is finding increasing application in the water treatment field as an alternative to traditional constant rate filtration, due to its inherent robustness and simplicity. This is especially true for regions like South America, where access to and maintenance of sophisticated instrumentation and hardware are more difficult. In the last decade, however, it is being applied in countries like the USA, thanks to the solid theoretical framework that has been developed. Declining rate filtration was introduced in South Africa when two new filtration plants were commissioned in 1995 - a small plant at Cullinan and a large plant at Faure.

In order to make this technology accessible to the broader South African engineering community, this design course will be presented over two days at the Rand Afrikaans University. The main presenter of the course will be the internationally renowned filtration expert, Professor John L. Cleasby from Iowa State University in the USA, who was a primary force over the last two decades to establish the principles of design and analysis for declining rate filtration. He will be assisted by Professor Johannes Haarhoff of the Water Research Group at RAU.

The course is primarily presented for the hydraulic and process designers of water treatment plants, but will also prove indispensable to engineering managers at water boards and municipalities who ultimately have to be part of the decision whether declining rate filtration should be adopted in a particular situation or not. An important part of the course will be devoted to practical design examples and assignments which attendees will work through (by hand and with computer based design tools) and a technical background is therefore required. The course will be supplemented with discussions on the relative advantages and disadvantages of declining rate filtration from a process, as well as a practical viewpoint, and a thorough review of the Faure and Cullinan case studies.

**Enquiries about course content**

Professor Johannes Haarhoff. Tel: (011) 489-2148; Fax: (011) 489-2466; E-mail: jh@ing1.rau.ac.za
Internet: http://gandalf/~water/home.htm

**Enquiries about enrolment**

Mrs Zelna van Aswegen. Tel: (011) 489-2599; Faks: (011) 489-2466; E-mail: zva@ing1.rau.ac.za

**Enrolment**

Due to the hands-on nature of the course, participation will be limited to the first 30 applicants.

**Cost**

The total cost is R1 600, which includes comprehensive documentation, design software, computer use, meals and refreshments.