SA waterbulletin

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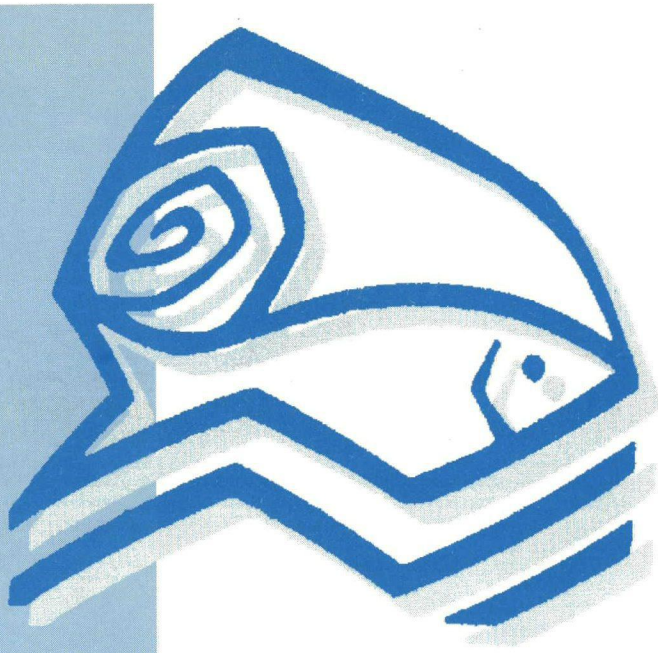
GROUNDWATER
WRC publishes assessment of nitrates in SA's groundwater

BESPROEIING
Navorsers evalueer besproeiingstelsels in die Breëvallei

WATER QUALITY
Impact of water quality variables on river ecosystems reviewed

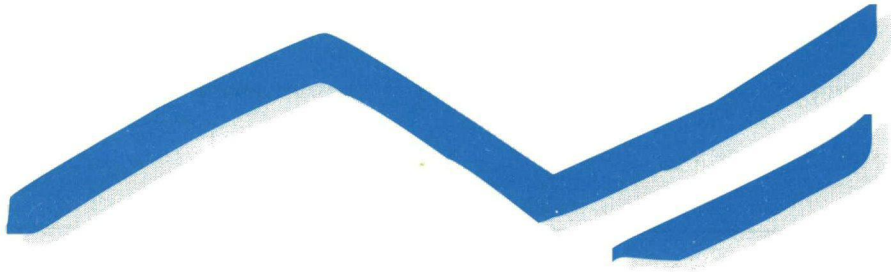


AQUACULTURE '94

The third congress of the Aquaculture Association of Southern Africa

21 – 23 SEPTEMBER 1994

Berg en Dal Rest Camp
Kruger National Park



The theme of the congress is "Towards 2000" and Mr Carlos Wurman, Director of Marine Resources in Chile has been invited as guest speaker. Mr Wurman has to a large extent been responsible for the meteoric development of aquaculture in Chile.

The conference will consist of invited contributions, 15 minute oral papers (with 5 minutes for discussion), poster presentations and workshops and panel discussions.

Enquiries: Mrs Suzette van Wyngaardt, Blyde River Aquaculture, P.O. Box 408, HOEDSPRUIT 1380. Tel. & Fax (01528) 35250. (Office hours 07:00 – 15:00)

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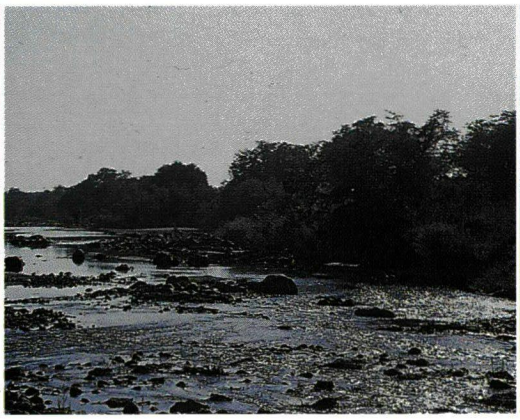

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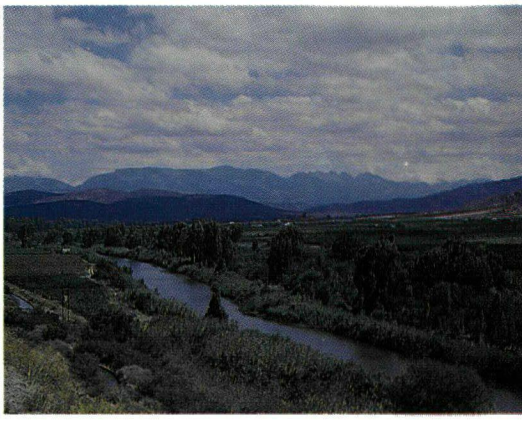

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Cover: Water scientists exploring the upper reaches of the Bergriver in the Franschhoek Mountains (Photo: Helene Joubert)

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Classifying rivers with the Aussies

A group of Australian water resource managers and researchers recently visited South Africa and shared their experience with their South African counterparts in a workshop on river classification and river health assessment, which was held at the University of Cape Town (UCT). The Australian delegation was led by Professor Barry Hart, Director of the Water Studies Centre at Monash University in Melbourne.

Some fifty South African water researchers and managers met with the Australians for the workshop week which proved an excellent opportunity to exchange ideas, renew aquaintances and forge new friendships.

The first two days were devoted to presentations on current classification and assessment work in both countries. The midweek Bergriver field trip was a pleasant break from the lecture hall and papers, availing the delegates of an opportunity to relax, mix and talk informally - all about rivers and research of course! This was followed by two days of small-group discussions, concentrating on specific problems such as the appropriate spatial scales for river classification. There was much discussion of the similarities between the two regions represented, but the differences in research and management approaches in these regions were also clearly noted. In the sphere of river and ecosystem health assessment the Australians were clearly ahead, while the South African researchers had the edge on the classification of rivers.

Dr Jay O'Keeffe (Insitute for Water Research, Rhodes University) in conversation with Dr Stuart Bunn (Centre for Catchment and In-stream Research, Griffith University)

Mr Bill Rowlston (Dept of Water Affairs) and Dr Robert Humphries (Western Australia Water Resources Council) having a discussion over a cup of tea.

LIASON

Discussions indicated that close liason regarding research, techniques and results will be of value to both groups of scientists. Considerable diversity in approaches along with new insights and ideas generated by the workshop contributed to the over-riding impression that there is much to be gained from collaborative research in future, with regard to both river ecology and management practices.

Prior to the workshop the Australian group spent two days in the Kruger National Park where they were briefed on the KNP Rivers Research Programme. On their way to Cape Town the group were also taken on an eye-opening tour of the hard-pressed Buffalo River catchment in the Eastern Cape. According to Prof Barry Hart, all of this river viewing gave the group a balanced idea of South African river types.

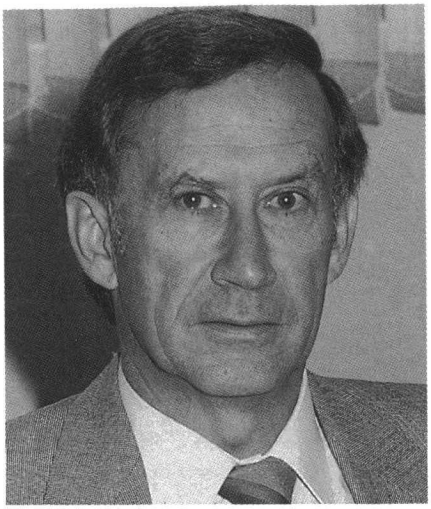
SA Waterbulletin espied Professor Angela Arthington amongst the Australian group at the workshop. She has previously visited South Africa in 1991 as a guest of the KNP Rivers Research Programme and a number of her initial recommendations to the Rivers Research Programme have been implemented since then. This visit afforded her the opportunity to assess development in the Rivers Research Programme since 1991.

Dr Caroline Palmer (Rhodes University) and Heather Mackay (Watertek, CSIR) talking to Don Blackmore (Chief Executive of the Murray-Darling Basin Commission).

Prof Barry Hart (Water Studies Centre, Monash University) and Dr Jenny Day (Freshwater Research Unit, UCT). In the background, left, is Prof Angela Arthington (Monash University) in conversation with two other researchers.

Dr Richard Norris (Water Research Centre, University of Canberra) speaking to Kate Snaddon (University of Cape Town). In the background other members of the Australian delegation are engaged in discussion.

Dr Pieterse groet



Dr MJ Pieterse

Dr Thys Pieterse het einde April na bykans agtien jaar diens by die Waternavorsingskommissie as adjunk-uitvoerende direkteur afgetree.

Dr Pieterse het in 1976 by die WNK aangesluit en was aanvanklik betrokke by inligting en tegnologie-oordrag. Hy sê die WNK se wetenskaplike tydskrif Water SA, waarvan hy lank redakteur was, asook die Suid Afrikaanse Waterinligtingsentrum (beter bekend as SAWIC) lê hom vandag nog na aan die hart.

As navorsingsbestuurder het hy betrokke geraak by projekte oor drinkwater en waterkwaliteit. Sy besondere belangstelling was drinkwatergehalte en gesondheidsaspekte rondom water, veral ten opsigte van die ontsmetting van drinkwater en die vorming van neweprodukte, soos trihalometane (THM's), tydens die ontsmettingsproses. Hy het ook in die besonder belang gestel in algtoksiene.

Dr Pieterse sê dat as hy terugkyk oor sy agtien jaar by die WNK, is dit veral die unieke opdrag en werkwyse van die WNK wat vir hom uitstaan. "Dit word oral, veral deur die buitelanders, as heel besonders beskou en hulle beny ons hierdie unieke opset".

Dr Pieterse sê dat hy, afgesien van die twee operasies wat hy binnekort moet ondergaan, voortaan graag meer rolbal wil speel en 'n klomp agterstallige leeswerk sal wil inhaal. Hy wil ook meer aandag gee aan sy fotografie as 'n stokperdjie asook tyd spandeer by sy plekkie by die see, "en my kleinkinders geniet".

Namens die WNK wens ons dr Pieterse 'n voorspoedige uitspantyd toe.

Dr Green promoted

Dr G Green

Dr George Green has been appointed as the new Deputy Executive Director at the WRC as of 1 May 1994, following the retirement of Dr Thys Pieterse.

Mnr Weideman tree wéér af

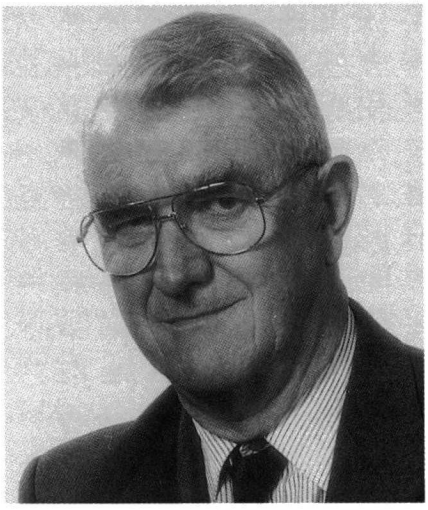
Mnr P Weideman

Mnr Piet Weideman het onlangs op die rype ouderdom van 75 jaar by die Waternavorsingskommissie as komitee-sekretaris afgetree. Sy eerste aftrede was in Julie 1973 toe hy in die Staatsdiens afgetree het, maar steeds op 'n kontrakbasis aangebly het. In Mei 1980 sluit hy by die WNK aan as komitee-sekretaris en die afgelope veertien jaar was sy ervaring en skerpsinningheid van groot waarde vir die WNK. Dit was nie sonder rede nie dat een van die WNK se navorsingsbestuurders, Dr Peter Reid dikwels na hom verwys het as "the wise one" .

Mnr Weideman was gewild vir sy fyn humorsin en sy haas onuitputbare repertoire stories en grappe. Met navraag oor sy toekomsplanne het hy skertsend, met 'n vonkel in die oog, gesê: dit sal hoofsaaklik gholf, rolbal en "drink" wees - uit lojaliteit teenoor die WNK "moet jy mos 'n vloeistofverbruiker wees!".

Namens die WNK wens ons mnr Weideman 'n aangename rustyd toe.

Pybus – New WISA President



Mr P Pybus

Mr Philip Pybus was recently elected as the new president of the Water Institute of Southern Africa (WISA). He succeeds Mr Schalk van der Merwe, who was president for the term 1992-94.

Philip Pybus graduated from Cambridge University with a degree in Civil Engineering. He also has a BSc (Hons) in Water Utilisation Engineering from the University of Pretoria. He has been in the consulting sector all of his working life, except for three years when he worked on water related schemes.

He is very well experienced in the design and construction of water and wastewater treatment plants having spent most of his working life on these in particular. However, his experience also covers the design and construction of dams, reservoirs, pipelines and pumpstations.

He has been an active member of WISA and its forerunner, the South African Branch of IWPC, for many years, having first been elected to the Council in 1978.

Preliminary assessment published on the severity of nitrate problems in South Africa's groundwater

The worldwide concern over rising nitrate levels in groundwater has been echoed in South Africa and the Water Research Commission consequently decided to fund a one-year investigation in order to make a preliminary assessment of the extent and severity of the problem in South Africa.

According to the final report emanating from the investigation the main objectives of the investigation were:

- To carry out a preliminary situation assessment concerning groundwater contamination in South Africa with respect to both the extent and severity of nitrate pollution using existing information;
- To identify the major contributors (polluters) qualitatively;
- To make an initial assessment of the possibilities to manage nitrate pollution caused by the major contributors (as gleaned from the literature); and
- To evaluate the need for further research.

The researcher, Dr G Tredoux of the Division of Water Technology at the CSIR in Stellenbosch, says groundwater plays a vital role as a water supply source in nearly two-thirds of South Africa, even though groundwater resources supply only fifteen per cent of the total water consumption of the country. In the semi-arid to arid regions of the country, groundwater is generally the sole source of water and more than 280 towns and settlements are at least in part dependent on groundwater. Despite these facts, little is known about groundwater quality and time related trends in particular. This holds true for all aspects of groundwater quality and especially for nitrate. To date the occurrence of nitrate in groundwater in Southern Africa and its health related impacts have only been studied on an *ad hoc* basis by researchers.

NITRATE IN GROUNDWATER

Nitrogen is one of the main biogeochemical elements and together with carbon, oxygen, sulphur and phosphorus, these elements in their biogeochemical cycles constitute the main life-supporting system for planet Earth. The occurrence of these elements and their compounds in water (including groundwater) thus also forms part of these natural cycles. Nevertheless, the presence of the nutrients nitrogen and phosphorus in water is generally considered to be a manifestation of pollution. In the case of groundwater, pollution is difficult to trace and the effects are not obvious. However, the deterioration is long-lasting and in cases where excessive nitrates occur, ingestion of the

water could be fatal for babies and livestock. The only possible beneficial aspect of the occurrence of nitrate in water is its immediate availability as a plant nutrient when the water is used for irrigation.

Exposure to high doses of nitrate is generally perceived to be associated with adverse health effects ranging from the 'hot dog headache' and methaemoglobinaemia to cancer and other effects. The occurrence of infant methaemoglobinaemia resulting from the consumption of water with high nitrate concentrations was first recognised clinically by Comly in 1945. The report says Hungary has the best statistics on the occurrence of methaemoglobinaemia as it has been a notifiable disease in that country since 1968. In contrast to infants, adults show no apparent effects from nitrate ingestion, at least in the short term.

The World Health Organisation found no firm epidemiological evidence linking gastric cancer and drinking water containing more than 10 mg/ℓ of nitrate but according to them a link cannot be ruled out due to "the inadequacy of the data available".

Stock-losses due to nitrate poisoning have occurred in Namibia and in Bophuthatswana. In these cases, the nitrate concentration was usually several hundred milligrams per litre. It would seem, however, that detrimental effects particularly on dairy cows could occur at much lower concentrations.

NITROGEN CHEMISTRY

Nitrogen can exist in a range of oxidation states at ambient conditions which gives rise to a series of stable nitrogen compounds occurring in the environment. These include nitrogen gas, ammonia and nitrate. Nitrate itself has a low primary toxicity, but the partially reduced form nitrite which is produced by bacteria in the digestive tract is hazardous to infants and livestock.

Nitrogen is one of the main biogeochemical elements supporting life on Earth. The occurrence of nitrogen and its compounds in water and groundwater forms part of these cycles. Virtually all natural conversions between the various nitrogen compounds are dependent either on bacterial action or biochemical reactions in plants or animals.

Inter-laboratory studies have shown that even today many laboratories generate incorrect nitrate results. If not clearly specified, the way in which the concentration of nitrate is reported (e.g nitrate as N, nitrate as NO_3^- etc,) may also lead to erroneous interpretation.

NITROGEN IN THE SOIL

Nitrogen transfers between soil and vegetation constitute 95 per cent of the nitrogen flow and thus by far exceed other global nitrogen transfers. Only five per cent of the total flow is concerned with exchanges to and from the atmosphere and the hydrosphere.

Denitrification in the soil zone is crucial for maintaining a balance and to prevent nitrate accumulation in the subsurface. This is a natural process which depends on the action of denitrifying bacteria. It has been recorded in many instances in various types of aquifer and both under natural and polluted conditions. Confirmation of denitrification was obtained by means of gas analyses and isotopic ratios.

NITROGEN ISOTOPES

Nitrogen has two naturally occurring isotopes, one with atomic mass of 14 (^{14}N) and the other with atomic mass of 15 (^{15}N). Once the constants of isotopic fractionation are known, the natural systems can be studied by the analysis of isotopes. Diagrams are included which indicate the extent to which nitrate sources, i.e. from fertilisers, natural soil nitrification or animal and sewage waste can be distinguished.

CONCLUSIONS

The report says the hydrochemical data contained in the national groundwater data base of the Department of Water Affairs and Forestry provided an overview of nitrate occurrences in groundwater. The median nitrate concentration for the 18 827 groundwater sampling points was 4,5 mg/ℓ. However, 27 per cent of the sources exceeded 10 mg/ℓ, 15 per cent 20 mg/ℓ and 4,3 per cent 50 mg/ℓ. The higher nitrate levels (> 20 mg/ℓ, but mostly >50 mg/ℓ) occur largely in the following areas:

- in the Kalahari Beds in the Gordonia District adjacent to the Namibian border;
- in the Asbestos Hills Formation, Griquatown Group, in the vicinity of Prieska;
- on the Ghaap Plateau, south-west of Vryburg;
- in the Springbok Flats; and
- along the Crocodile River.

The first two occurrences are considered to be due to natural nitrate accumulation, while the last two are related to anthropogenic inputs or to natural phenomena or both.

IMPACTS

Groundwater nitrates have caused methaemoglobinaemia in infants in Southern Africa, sometimes with fatal consequences. Although individual cases are known, statistics are unavailable. The simultaneous occurrence of faecal pollution increases the risk for infants. An epidemiological study was carried out in an area with slightly elevated nitrate levels, but no studies have been undertaken in areas where the nitrate levels are high (i.e. approaching 50 mg/ℓ).

No conclusive evidence has been found linking gastric cancer and drinking-water containing 10 mg/ℓ or more nitrate. However, the report says, a link cannot be ruled out completely due to the inadequacy of the data available.

Livestock losses due to nitrate poisoning would appear to occur relatively frequently but only at relatively high (>100 mg/ℓ) nitrate concentrations. Sub-lethal concentrations, however, also affect animals detrimentally, particularly dairy cows.

The availability of nitrate on irrigation water, complying with salinity and other irrigation requirements, could be considered beneficial in certain instances.

ACCUMULATION

Under natural conditions the "internal" nitrogen cycle is virtually closed within the topsoil. However, environmental conditions exist under which natural leaching of nitrate from the soil zone takes place

and natural accumulation occurs in groundwater. Preconditions for accumulation relate to aspects of vegetation, rainfall, temperature, soil, geology and hydrology. This phenomenon has led to extensive areas in South Africa and adjacent territories having elevated nitrate concentrations in groundwater. Natural nitrate accumulations are also known from Chile, Australia and the USA.

ANTHROPOGENIC INPUTS

Surplus nitrogenous inputs to the soil, mostly derived from anthropogenic sources, result in increased transport of nitrate to groundwater. This is often manifested by isolated occurrences of elevated nitrate concentrations in boreholes near feedlots, kraals, pit latrines and other pollution sources.

Potential point sources of serious concern are sewage sludge (uncomposted) and effluent disposal to land, on-site sanitation and waste disposal by land filling. Some of these activities, such as landfilling, is controlled by the central government by means of a permitting system. However, on-site sanitation is widely practised without proper regard to the pollution potential. The risk involved has been proven in neighbouring territories and elsewhere, but local information is lacking.

Although conclusive scientific evidence is lacking for South Africa, it is considered highly probable that fertilizer and manure application to land constitutes the most widespread diffuse source of nitrate pollution as identified in other parts of the world. The highly variable rainfall worsen the situation in the case of fertilised dry land farming due to the associated unpredictable plant cover and fertiliser needs.

Nitrogen isotope studies have provided proof that cultivation of the soil leads to mineralisation of soil organic nitrogen followed by leaching and accumulation in the groundwater even without any artificial nitrogen inputs. The situation in the Springbok Flats is ascribed to this phenomenon.

TRENDS

The report says worldwide, groundwater nitrate concentrations brought about by anthropogenic activities are on the increase. This is in all probability also true for South Africa but longer term records are lacking. In the case of the Springbok Flats it was concluded that no general trend existed and that the high nitrate values are possibly largely due to a one-time nitrogen mobilisation. The modelling of nitrate transport to groundwater has been attempted in many countries with a reasonable degree of success. These models provide valuable insights into expected future trends in groundwater nitrate levels. In addition to long term (upward) trends in nitrate concentrations short term drastic changes in groundwater nitrate levels have been recorded. In Namibia stock losses are largely due to such sudden changes.

CONTROL MEASURES

Control measures for reducing nitrogenous inputs to the environment are essential for protecting groundwater resources. In view of the considerable delay (varying from years to decades) between the introduction of control measures and any decrease in groundwater nitrate levels it is a matter of extreme urgency to take action in this regard, the report says. Overseas experience provides valuable guide-lines for developing workable local measures.

INFORMATION PROGRAMME

Informing the public and particularly the farming community as well as farming related industries of the hazards of nitrate pollution is considered an important tool for voluntary reduction of nitrogenous inputs, both with respect to diffuse sources as well as the myriad of small point sources. The impacts of a variety of anthropogenic activities causing groundwater pollution is unknown and ignored by many local authorities, planners, developers and others.

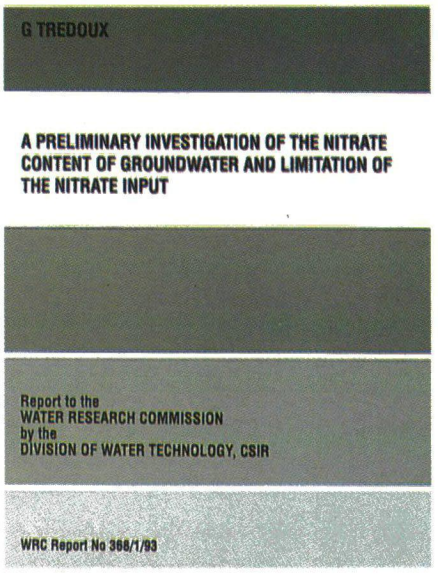
The compilation of guides, such as the one jointly published by the Water Research Commission and the Department of Agriculture for the handling of manure from animal feeding units, is considered to play a crucial role in environmental (and groundwater) protection.

DENITRIFICATION PROCESSES

In view of the fact that groundwater is already contaminated in many areas in South Africa denitrification for potable use and stockwatering will be needed in areas where no alternative supplies are available. A number of treatment processes are being used successfully for the removal of nitrate from drinking water, e.g. biological denitrification, ion exchange and partial desalination by ion exchange, electrodialysis or reverse osmosis. In virtually all cases the denitrification stage is followed by activated carbon adsorption to remove traces of organic compounds added to the water during treatment. This clearly has serious financial implications.

In the case of stockwatering the product water does not need to comply to the same high (aesthetical) standards and biological denitrification is economically feasible using molasses as organic substrate.

The report says *in situ* denitrification (aquifer restoration) is being investigated abroad and some degree of success has been achieved. Only when the technique is fully developed should it be adapted for this country.



Copies of this report "A preliminary investigation of the nitrate content of groundwater and limitation of the nitrate input" (WRC report 368/1/93) are available free of charge from the Water Research Commission, PO Box 824, Pretoria 0001. Overseas price: $20.

Membrane performance in SPARRO process investigated

The Slurry Precipitation and Recycle Reverse Osmosis (SPARRO) process has been demonstrated to be technically feasible for improving the quality of mine service water that contains high concentrations of dissolved calcium and sulphate ions, which is the case for the majority of gold mine service waters.

In a report to the Water Research Commission, two researchers, M Bailey-McEwan from the CSIR's Division of Mining Technology, and GJG Juby of the consulting engineers Stewart Scott Inc., summarise the results of an investigation carried out in the SPARRO pilot plant at the East Rand Proprietary Mines Ltd (ERPM). The investigation was aimed principally at identifying the reactions occurring within the seed reactor of the SPARRO plant. This was in an attempt to find the reasons for the unacceptably poor membrane performance that had been observed in previous work.

According to the report the limited test work suggests that the deteriorating membrane performance (which continued to occur) was caused rather by a combination of phenomena associated with the increasing concentration of dissolved and suspended solids as the feed slurry passed through successive rows of membrane modules. Radioactivity may be one such phenomenon. However, the work was insufficient to

positively and conclusively identify the cause of deteriorating membrane performance. Further work to so identify this cause and hence modify plant design to achieve acceptable membrane life, is essential if the SPARRO process is to be applied in full-scale plants to improve service water quality on mines.

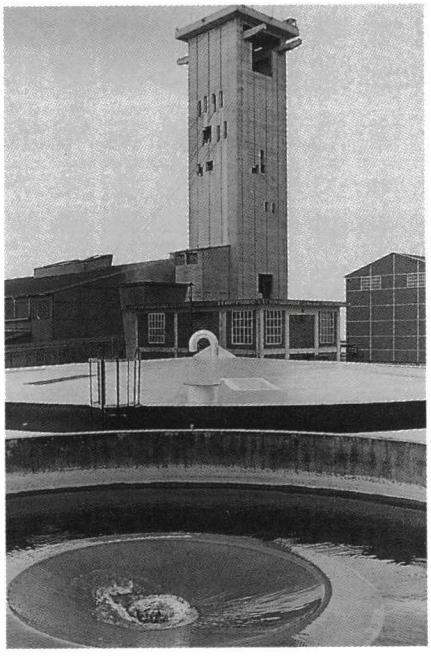
Copies of this report on "The Determination of the Reaction Kinetics in a SPARRO Seed Reactor" (WRC Report 461/1/93) are available free of charge from the Water Research Commission, PO Box 824, Pretoria 0001. Overseas price: $15.

In previous work during 1990 at the COMRO test site at East Rand Proprietary Mines Ltd, two pilot water-desalinating plants were operated in parallel on the same pretreated raw mine water. Both plants employed the seeded reverse osmosis principle. While not identical in capacity, their configuration differed in only one respect. In the first plant, known as the MLT plant, the raw mine water was fed into the seed reactor. In the second plant, known as the SPARRO plant, the raw mine water was instead fed into the slurry recycle stream, leaving the reactor and entering the modules of tubular membranes. The membranes in the MLT plant were able to maintain a stable flux rate at the design value. However, persistent membrane fouling, indicated by flux deteriorating to unacceptably low levels, occurred in the SPARRO plant.

The report says it was postulated that this fouling was inherently due to the difference in configuration between the two plants. Accordingly, the "contaminants" in the raw mine water causing this fouling in the SPARRO plant would not do so in the MLT plant, because the raw mine water was fed into the seed reactor. There, these "contaminants" would be encapsulated in growing seed crystals as the reject stream, also entering the reactor, desupersaturated.

The present study was undertaken to determine the reaction kinetics within the reactors and thereby ascertain the influence of these reactions upon observed membrane performance. The report says the above postulate would be verified by operating the SPARRO plant in the "MLT mode" (by changing the configuration accordingly) and then in the SPARRO mode under otherwise identical conditions.

Due to various delays, it was only possible to carry out limited test work. The SPARRO plant was converted to operate in the MLT mode and two experimental analyses of reaction kinetics were performed. The researchers say that upon reflection, their results pointed to a logical conclusion. This was that, in the MLT mode of operation, blending of the supersaturated reject stream with unsaturated raw mine water results in a mixture of lower supersaturation and consequently a far slower precipitation rate. Therefore, the likelihood that any "contaminants" in the raw mine water would be trapped within the matrices of growing crystals and be removed from suspension or solution is considered to be remote. Accordingly, there appears to be little merit in pursuing the study of reaction kinetics further, the researchers say.



In an attempt to limit water usage, the mining industry has increased the degree to which mine service water is recycled and re-used.

MODULES

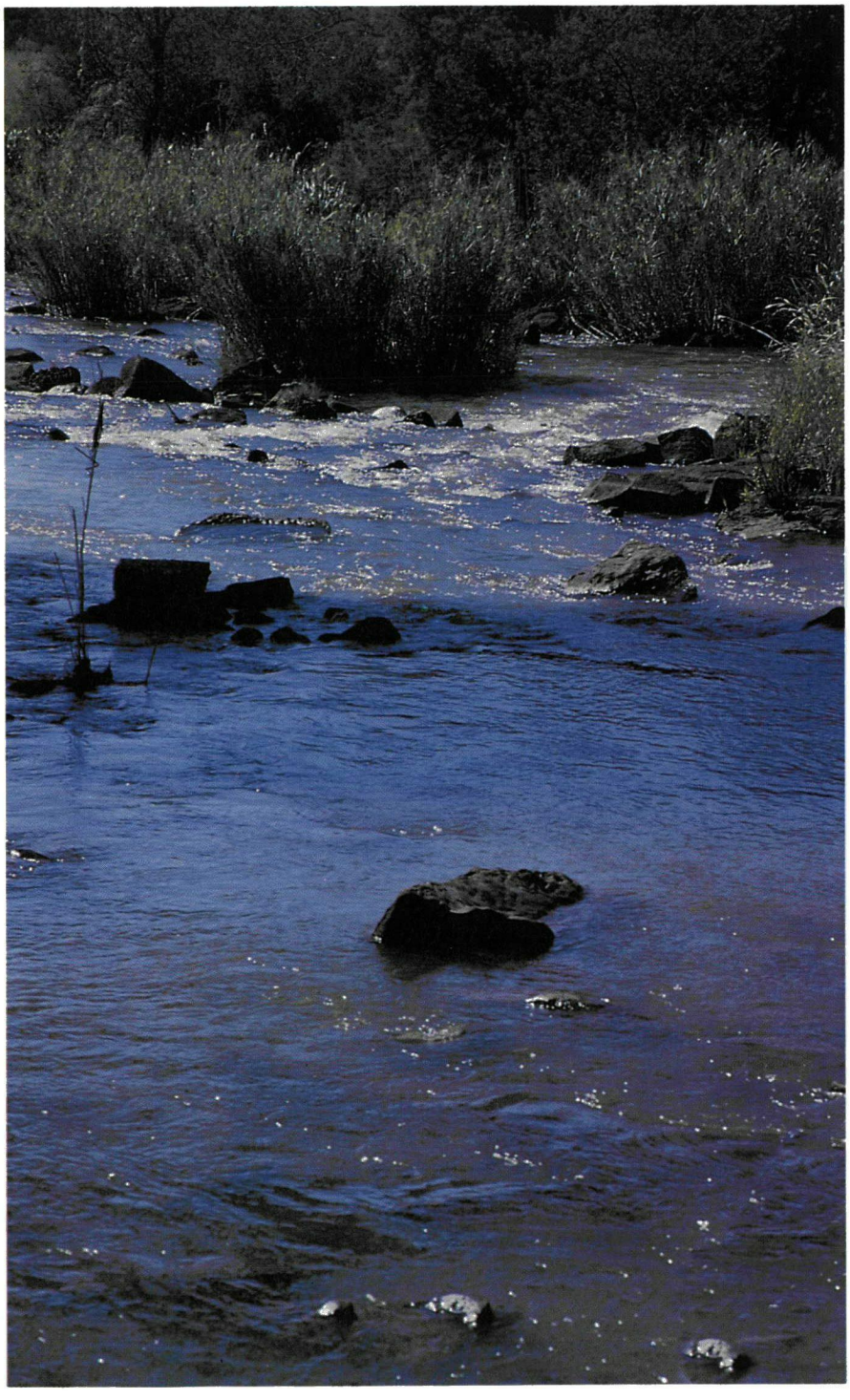
During operation of the SPARRO plant in the MLT mode, membrane performance was monitored through detailed surveys of 30 individual modules. Over 1 300 hours, the overall salt rejection decreased and flux increased gradually. Of more significance was that, of all three Banks, the modules in Bank 1 of the tapered module stack showed the best performance, while those in Bank 3 showed the worst performance. Although there was no time available to convert the plant back to the SPARRO mode, records of operation in the SPARRO mode during early 1992 showed similar membrane degradation. Therefore, this degradation does not appear to be due to mode of operation (plant configuration), but rather to a combination of phenomena associated with the increasing concentration of dissolved and suspended solids in the feed to successive rows of membrane modules.

The researchers say in the report that radioactivity may be one such phenomenon. Radionuclides appear to be almost totally rejected by the membranes, even when their overall salt rejection is poor. This is an encouraging finding, suggesting that SPARRO systems may find application in removal of radionuclides from chilled service water for drinking by workers underground.

The report concludes that the work done to date nevertheless remains insufficient to conclusively identify the causes of the various forms of unacceptable membrane performance that have been observed on the SPARRO plant in all tests since 1989.

"If the SPARRO process is to be applied in full-scale improvement of water quality on mines, further work is essential to identify these causes and modify plant design appropriately."

Researchers review the impact of water quality variables on South Africa's riverine ecosystems



The present and future quality of South Africa's fresh water resources is fundamentally important if the continued existence of both the resource, and the populations reliant on the resource, is to be ensured. This is the view of two researchers in the Freshwater Research Institute of the University of Cape Town, HF Dallas and JA Day, in a review report to the Water Research Commission on the effect of water quality variables on riverine ecosystems.

The researchers say that in recent years the Department of Water Affairs and Forestry has instituted a policy of pollution control by means of receiving water quality objectives.

"In essence, the water quality objectives (that is, the quality to be strived for) for any stretch of river will be determined by the needs of the users of the water in that stretch."

The Department recognizes five categories of user: the agricultural, industrial, domestic and recreational sectors, and the natural environment.

The researchers say that appropriate criteria and guidelines are available for most water quality variables for the first four of these categories. However, this is not true for the natural environment.

In an early attempt to develop expertise in this field, the Water Research Commission in 1991 began funding a three-year project entitled "The effects of Water Quality Variables on Riverine Ecosystems", carried out by the Freshwater Research Institute of the University of Cape Town.

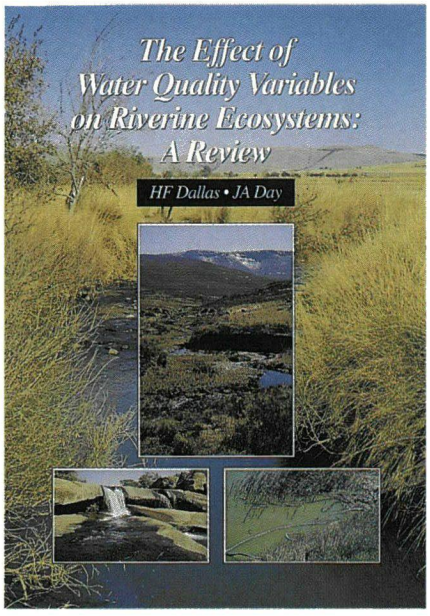
The main aims of this project are to produce a chemical classification of South African rivers, to collate and ana-

lyse available data, to develop methods for validation of interim guidelines and to synthesize the literature on the topic.

The review report now released by the Water Research Commission is the result of the last of these aims.

WATER QUALITY

In the review, the researchers say, water quality is taken to be the combined effect of the physical attributes and chemical constituents of a sample of water for a particular use. Functional riverine ecosystems usually support a variety of organisms within different trophic levels, such as primary producers, primary consumers and secondary consumers. Rivers are divided into zones which are distinct with respect to their physical, chemical and biological characteristics. In addition to zonal differences there are regional differences: for instance Natal rivers are very different from south-western Cape rivers. Regional differences arise as a result of difference in climate (temperature, mean annual precipitation, mean annual evaporation); geomorphology (gradient, erosion), geology and biota. These differences need to be considered when establishing guidelines for the protection of riverine ecosystems. Within each region or zone, community composition is determined by water quality, the type of habitat (biotope) available, the degree of water movement, temporal variability of the water and the historical distribution of species. Water quality variables potentially affecting riverine ecosystems may be physical (turbidity, suspensoids, temperature) or chemical (non-toxic: pH, TDS, salinity, conductivity, individual ions, nutrients, organic enrichment and dissolved oxygen; and toxic: biocides and trace metals). Each variable has an effect, either beneficial or detrimental, on aquatic organisms; and the overall effect when more than one variable is involved is dependent on whether they act synergistically or antagonistically. The effect of each variable on individual organisms is also influenced by the tolerance limits of the organism. In addition to individual variables, rivers are often the ultimate receivers of whole effluents which are essentially a combination of a number of water quality variables.



The assessment of water quality on aquatic biotas incorporates assessment of physical, chemical and biological attributes. Biotic indicators used to estimate the effects of reduced water quality on ecosystems and their biotas include attributes of individual species (e.g. growth rate, reproduction, etc.), biotic communities (e.g. species composition, biodiversity) and natural processes (e.g. rate of photosynthesis). At the individual level, research is mostly laboratory-based and the process employed is termed "toxicity testing". At the community level water quality effects are more complex and assessment includes utilisation of diversity indices, biotic indices, community comparison indices, functional feeding groups and reduced assemblages. Monitoring of water quality may involve the examination of chemical, physical or biological attributes. Each has its advantages and disadvantages in assessing overall water quality. The greatest difference between physical/chemical and biological attributes is that the former provides an instantaneous and often specific assessment at the time the sample is taken, whereas biological attributes integrate changes in water quality over time.

TEMPERATURE

The thermal characteristics of running water are dependent on various hydrological, climatic and structural features of the region, catchment area and river. Running waters in regions of seasonal climates exhibit daily and periodicity patterns, in addition to longitudinal changes along a river course. All organisms have a temperature or range of temperature at which optimal growth, reproduction and general fitness occur. Changing water temperature may expose the aquatic biota to potentially lethal or sublethal conditions. Anthropogenic causes of temperature changes in river systems include those resulting from thermal pollution, stream regulation or changes in riparian vegetation. The elevation of water temperatures affects oxygen solubility and may also increase the biotic toxicity of certain chemicals, both which result in increased stress on the associated organisms. Many life cycle characteristics of aquatic organisms are cued into temperature, i.e. temperature is the cue for migration, breeding, emergence, etc. Temperature changes affect metabolic processes and life cycle patterns by altering reproductive periods, rates of development and emergence times of aquatic organisms. Variation in temperature tolerance amongst the biota and regional and seasonal temperature differences, should be considered when establishing guidelines for the management of water temperature in rivers.

TURBIDITY

The immediate visual effect of a change in turbidity is a change in water clarity. An increase in turbidity or suspensoids affects light penetration, which may have far-reaching consequences for riverine biotas. The natural seasonal variations in rivers often include changes in turbidity, the extent of which is governed by the basic hydrology and geomorphology of the particular region. Erosion of land surfaces in catchment areas by wind and rain is a continuous and historically natural process. Land-use practices such as overgrazing, non-contour ploughing and removal of riparian vegetation accelarate this erosion, however, and result in increased quantities of suspensoids in associated rivers. Increases in turbidity can, and often do, result from other anthropogenic processes, such as release of domestic sewage, industrial discharge (including mining, dredging, pulp and paper manu-

facturing) and physical perturbations such as road, bridge and dam construction, road use and reservoir management. If turbidity increases resulting from human inputs are as infrequent as natural flooding is, they may well be handled by the stream community. Continuous high-level inputs, on the other hand, may have very serious consequences for the riverine biota. As light penetration is reduced, primary production decreases and food availability to organisms higher in the food chain is diminished. Suspensoids that settle out may smother and abrade riverine plants and animals. Community composition may change depending on which organisms are best able to cope with this alteration in habitat. Predator-prey interactions are affected by the impairment of visually hunting predators. Nutrients, trace metals, biocides and other toxins adsorb to suspensoids and are transported in this form. Few studies on turbidity effects have been conducted in South Africa, primarily because turbid rivers are fairly common in this country and are thus considered to be problematic.

pH & ALKALINITY

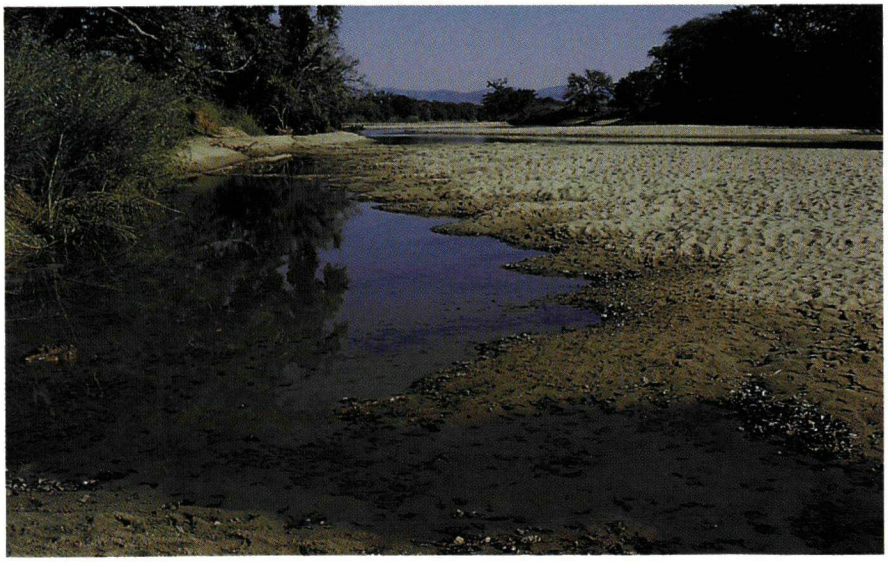
pH is largely determined by the concentration of hydrogen ions (H^+), and alkalinity by the concentrations of hydroxyl (OH^-), bicarbonate (HCO_3^-) and carbonate (CO_3^{2-}) ions in water. Addition of acid or alkali to a water body alters pH. Since pH is a log scale, a change of one unit means a ten-fold change in hydrogen ions. Further, in poorly buffered waters pH can change rapidly. The rate of change of pH is determined by the buffering capacity (e.g. by the carbonate-bicarbonate system) of the water. The pH of natural water is determined by geological and atmospheric influences. Most fresh waters are relatively well buffered and more or less neutral, with pH ranges around 6 - 8. pH determines the chemical species (and thus potential toxicity) in which numerous elements and molecules are found in the water. For instance, aluminium is mobilised following acidification. Changing the pH of water changes the concentration of both H^+ and OH^- ions, which affects the ionic and osmotic balance of aquatic organisms. Relatively small changes in pH are not normally lethal, although sublethal effects such as slow growth and reduced fecundity may occur due to increased physiological stress placed on the organism by increased energy requirements. Human induced acidification of rivers is normally the result from certain industrial effluents, mine drainage and acid precipitation. Alkaline pollution is less common, but may result from certain industrial effluents and anthropogenic eutrophication. The effects of altered pH on riverine biotas have been investigated via toxicity testing, artificial streams and field studies. These studies indicate that a change in pH from that normally encountered in unpolluted streams has severe effects upon the biota. The degree of severity of the effects is dependent on the extent of acidification or alkalinisation. Some streams are naturally far more acidic than others and their biotas are adapted to these conditions. It is recommended that guidelines be site-specific with regard to pH and alkalinity and that pH not be permitted to change by more than plus-minus one pH unit.

TDS

Material dissolved in water is commonly measured as total dissolved solids (TDS), as conductivity or as salinity. TDS represents the total quantity of dissolved material, organic and inorganic, ionized and un-ionized, in a water sample. Conductivity is a measure of the ability of a sample of water to conduct an electrical current. TDS and conductivity usually correlate closely for a particular type of water. Salinity refers to the saltiness of water. Natural TDS in rivers is determined by geological and atmospheric conditions. Anthropogenic activities such as industrial effluents, irrigation and water re-use lead to increases in TDS. Very little information is available of the tolerances of freshwater organisms to increased TDS. Generally it is the rate of change rather than the absolute change that is important. Juvenile stages are often more sensitive than adults and effects may be more pronounced in upper mountain streams where organisms are generally less tolerant of stress. Ions most commonly found in natural waters are the cations calcium, magnesium, sodium and potassium, and the anions bicarbonate, carbonate, chloride and sulphate. Their characteristics and importance with respect to aquatic systems are discussed in the report.

NURIENT ENRICHMENT

Various plant nutrients are required for normal plant growth and reproduction. It is nitrogen and phosphorus, however, that are most commonly implicated in excessive plant growth resulting from nutrient enrichment of aquatic systems. Most nutrients are not toxic (exceptions include nitrite and ammonia), even in high concentrations, but when present in aquatic systems in these high concentrations, they may have a significant impact on the structure and impact of



biotic communities. Climatic and catchment characteristics influence initial nutrient concentrations in rivers. Anthropogenic sources of nutrients may be of the point-source type (e.g. sewage treatment works, industry, intensive animal enterprises) or may be diffuse (e.g. agricultural surface runoff, fertiliser application), or urban runoff. On entering an aquatic system, phosphorus is dissolved in the water column or adsorbed onto soil and other particles. Nitrogen occurs abundantly in nature and is an essential constituent of many biochemical processes. In aquatic systems, nitrates are rapidly converted to organic nitrogen in plant cells. Nitrite is an intermediate in the conversion of ammonia to nitrate and is toxic to aquatic organisms. Un-ionized ammonia (NH_3) is also toxic to aquatic organisms and its toxicity increases as pH and temperature increase. Lethal and sublethal effects of nitrite and ammonia are tabulated in the report and current local and international standards of phosphorus, nitrogen, ammonium, ammonia, nitrate and nitrite are discussed.

ORGANIC ENRICHMENT

Organic enrichment is probably the most common and best documented type of pollution occurring in rivers. The main sources are effluents from domestic sewage, food processing plants, animal feedlots and abattoirs. Organic discharges (also referred to as oxygen-demanding wastes) generally deplete or reduce the concentration of dissolved oxygen in the receiving water body as a result of aerobic decomposition of the waste by micro-organisms. Increases in turbidity (and hence reduced light penetration)), suspended solids (and hence substrate modification) and nutrients (nitrogen, phosphorus and hence increased potential for plant growth) often accompany oxygen depletion. Combined these factors significantly affect riverine biotas in receiving waters and enrichment of a water body with organic material almost always results in a decrease in richness and diversity and an alteration in composition of biotic communities. Traditionally, the saprobien system of zones has been used for describing these effects. Indicator species and communities have been established for severely, moderately and mildly impacted zones. The particular species found are partially dependent on the ecoregion and river zone in which enrichment occurs.

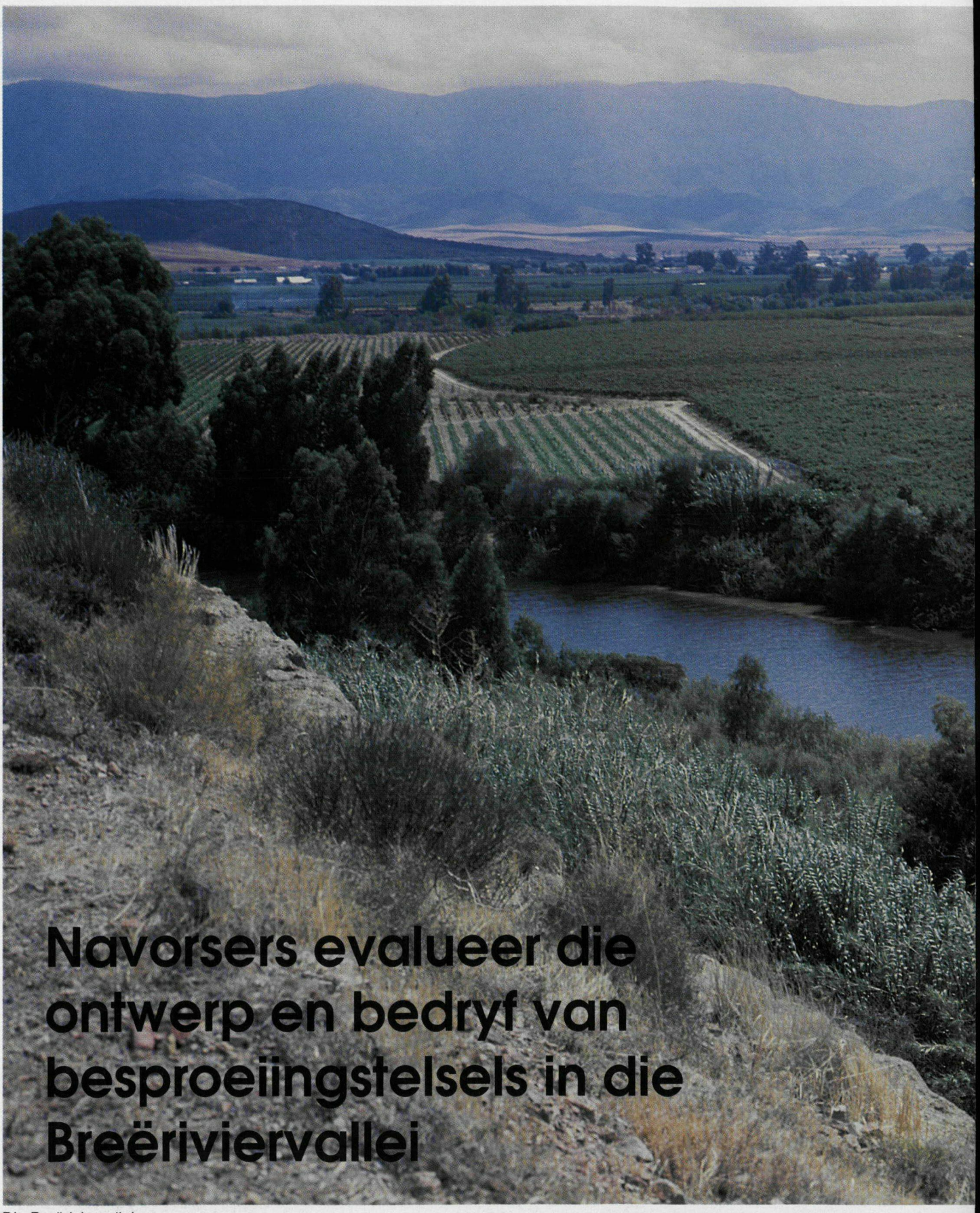
DISSOLVED OXYGEN

Dissolved oxygen is probably one of the most important determinands of the "well-being" of an aquatic organism. Various factors modify the concentration of dissolved oxygen in water, including the rate of reaeration from the atmosphere (dependent on turbulence, oxygen deficit and pressure); temperature; salinity; respiration by all organisms and photosynthesis by plants; organic enrichment (biological oxygen demand) and chemical oxygen demand. The extent to which an organism is affected by dissolved oxygen concentrations is determined by its dependence on water as a medium. Fish are particularly susceptible, as are larvae of stoneflies, caddisflies and mayflies, which respire with gills or by direct cuticular exchange. Low concentrations of dissolved oxygen may cause various sublethal effects such as changes in behaviour, blood chemistry, growth rate and food intake, as well as lethal effects. The importance of natural diurnal fluctuations in dissolved oxygen should be noted when establishing water quality guidelines.

BIOCIDES

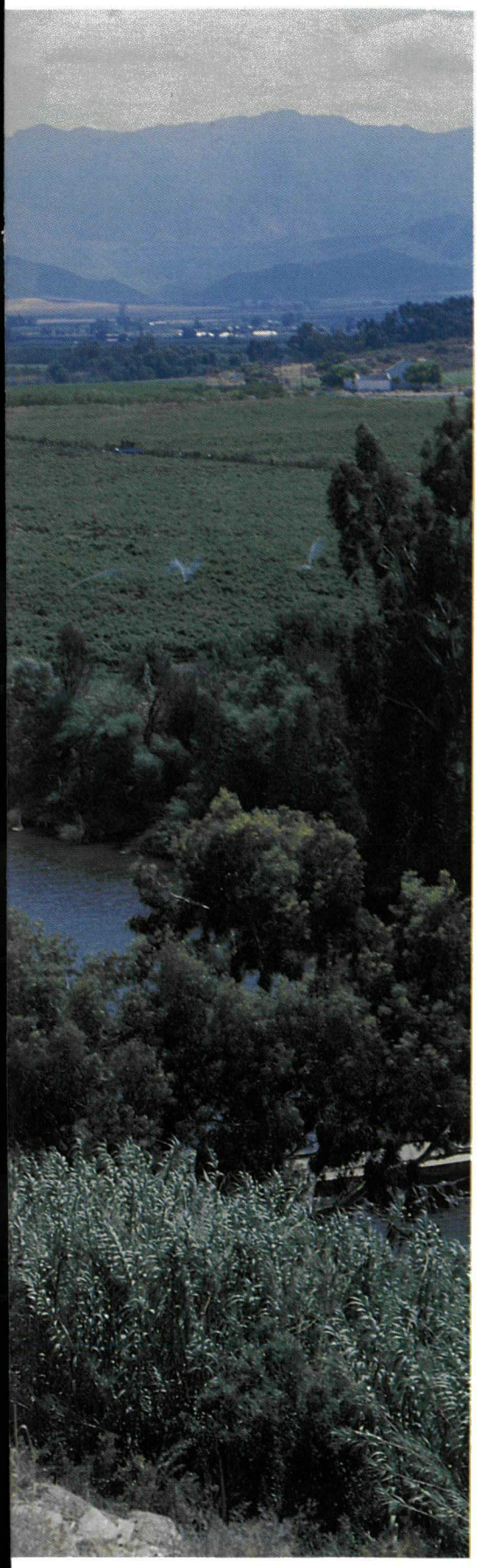
Biocides have been and are being used in the control of pests, usually associated with agricultural crops and vector-borne diseases. The most commonly used biocides are herbicides, fungicides and insecticides. Potential sources of biocides in aquatic systems include direct application (pest control) industrial effluents, sewage, leaching and runoff from soil and deposition of aerosols and particulates. Studies have concentrated on biocide residues in the biotic and physical environment, bioaccumulation, determination of tolerance (acute and chronic) limits of aquatic organisms and the effects of biocides on whole communities. The nature, modes of action and toxicity of biocides vary considerably. Generally, organochlorine insecticides (e.g. DDT, dieldrin) are the most hazardous with respect to the natural environment. Their use has subsequently been banned in many countries. These biocides are persistent in the environment and bioconcentrate in organisms and thus through food chains. Methods for biocide detection and quantification are complex and expensive. Analyses are complicated by the small quantities of biocides found in water and the variety of breakdown products, with variable toxic properties, of most biocides.

Copies of this report entitled "The Effects of Water Quality Variables on Riverine Ecosystems: A Review" (TT 61/93) are available free of charge from the Water Research Commission, PO Box 824, Pretoria 0001. Overseas price: $30.



Navorsers evalueer die ontwerp en bedryf van besproeiingstelsels in die Breërivierallei

Die Breërivierallei.



'n Studie wat deur die Waternavorsingskommissie gefinansier is, toon dat die ontwerp van besproeiingstelsels in die Breëriviervallei in Wes-Kaapland, oor die algemeen van 'n hoë standaard is.

Sommige boere in die vallei slaag ook daarin om besproeiing so te skeduleer dat beide potensiële dreinering en watertekorte, soos deur die plant ondervind, tot 'n klein persentasie van die toegediende besproeiingswater beperk word.

Die studie is uitgevoer deur die raadgewende ingenieursfirma Murray, Biesenbach & Badenhorst.

In 'n verslag aan die Waternavorsingskommissie waarin die belangrikste bevindinge van die studie opgesom word, sê die skrywers dat die grootste enkele verbetering in die waargenome standaard van besproeiingskedulering in die Breëriviervallei teweeggebring sal word deur 'n verbetering van die boere se besproeiingsbestuurvernuf.

"Die meerderheid besproeiers benut nie die potensiaal van hul besproeiingstelsels ten volle nie en dit word bereken dat potensiële dreineringsverliese oor die algemeen hoog is. Hierdie feit word gewyt aan 'n lae vlak van teoretiese kennis ten opsigte van besproeiingskedulering, onbewustheid van die nadelige gevolge van oorbesproeiing en 'n gebrek aan maatreëls om boere tot beter skedulering aan te spoor."

Die verslag sê indien hierdie aspekte aangespreek sou kon word, bestaan die potensiaal om die dreinering en daaropvolgende versouting van die Breërivier te wyte aan besproeiingsterugvloei aansienlik te verminder.

Afskrifte van die verslag getiteld "Evaluasie van die ontwerp en bedryf van besproeiingstelsels in die Breëriviervallei met die oog op die beheer van potensiële dreineringsverliese" is gratis op aanvraag beskikbaar vanaf die Waternavorsingskommissie, Posbus 824, Pretoria 0001. Dit bestaan uit twee dele, naamlik, Volume 1: Tegniese Verslag (WNK verslag nr 256/1/93) en Volume 2: Bylaes (WNK verslag nr 256/2/93).

Gedurende die tydperk Januarie 1986 tot November 1987 was 'n navorsingspan betrokke by 'n loodsstudieprojek in die Breëriviervallei genaamd "A pilot study of the irrigated areas served by the Breede River (Robertson) Irrigation Canal" (WNK verslag nr 184/1/89).

Die studie het betrekking gehad op die beweging van water en sout deur 'n tipiese besproeiingsdistrik, maar het nie genoegsame antwoorde verskaf aangaande die vlak van besproeiingsbestuur nie. Hierdie onsekerheid het aanleiding gegee tot die formulering van 'n opvolgprojek om te kyk na besproeiingsverliese en die daarmee gepaardgaande versouting van die Breërivier.

DOELSTELLINGS

Die doelstellings van die opvolgprojek is as volg geformuleer:

Ten einde vas te stel wat die moontlikheid is om versouting in die Breërivier te beheer deur besproeiing doeltreffend te skeduleer en sodoende dreineringsverliese te verlaag, sal

- so kwantitatief moontlik op mesoskaal (besproeiingslandgrondslag) bepaal word hoeveel dreinering onder 'n verteenwoordigende monster van die besproeiingstelsels wat in die Breëriviervallei gebruik word, in die praktyk plaasvind;

- bepaal word watter rol die gehalte van besproeiingsontwerp en korrekte stelselkeuse in die potensiële vermoë van die boer speel om toediening van besproeiingswater te beheer en eweredig oor 'n besproeide land te versprei en sodoende die hoeveelheid dreinering te beheer;

- die doeltreffendheid en vlak waarop watertoedienings geskeduleer word, met die norm, daargestel deur die Departement van Landbou en Watervoorsiening vir die verskillende besproeiingstelsels, vergelyk word. Die invloed wat die vlak van bestuur op ondoeltreffende waterbenutting en ongewenste oor- of onderbesproeiing het, sal dus vasgestel kan word;

- knelpunte in huidige besproeiingsbestuur en ontwerpprosedures

geïdentifiseer word en voorstelle gedoen word oor hoe dit in die praktyk aangepas kan word sodat waterbenutting verbeter en dreinering meer doeltreffend beheer kan word.

PROJEK

Die studie is deur die Robertson-kantoor van Murray, Biesenbach & Badenhorst onderneem en het vanaf Mei 1988 tot Desember 1991 geduur.

Aan die hand van inligting wat bekom is tydens die aanvanklike loodsstudie-projek is 'n verteenwoordigende groep proefpersele gekies. Hierdie persele is soos volg saamgestel:

Verwys na Tabel A.

Elke perseel is bestudeer en die volgende inligting is vir elk gedokumenteer:

- ❑ Topografie
- ❑ Gewas en plantspasiëring
- ❑ Besproeiingstelseluitleg
- ❑ Grondtipe en grense van verskillende grondeenhede
- ❑ Grondsoutinhoud-ontledings wat op drie tydstippe, naamlik Junie 1989, September 1989 en April 1990 gedoen is.

Die hidrouliese ontwerp van elke besproeiingstelsel is met behulp van IDES-rekenaarprogramme geëvalueer. Hierdie evaluering het ingesluit 'n vasstelling stelselleweringseenvormigheid van die geïnstalleerde stelsel teen teoretiese inlaatdrukke, sowel as gemete inlaatdrukke. 'n Herontwerp van die stelsels is ook met behulp van die IDES-program gedoen om die kapitale koste van die geïnstalleerde stelsel na te gaan.

Drie mini-weerstasies, elk saamgestel uit 'n Klas A-verdampingspan en 'n reënmeter, is opgerig. Die studiegebied is opgedeel sodat proefpersele in drie tipiese gebiede met verteenwoordigende weerkundige inligting bedien kon word.

Elke proefperseel is met 'n BERMAD-watermeter toegerus sodat alle besproeiingswater wat op 'n perseel toegedien is, gemeet kon word.

Gewas/Besproeiing-Kombinasie	Getal Persele	Totale Oppervlak (ha)	Getal boere Verteenwoordig
Wingerd/drup	12	26.47	10
Wingerd/mikro	10	15,07	5
Wingerd/sprinkel	5	17,06	2
Wingerd/vloed	1	2,56	1
Akkerbou/sprinkel	8	22,07	7
TOTAAL	36	83,29	13

Tabel A: Keuse van proefpersele

	Gewasfaktore											
Gewas	Jan	Feb	Mrt	Apr	Mei	Jun	Jul	Aug	Sep	Okt	Nov	Des
Wingerd/Drup	0,31	0,34	0,32	0,13	0,13	0,13	0,13	0,13	0,13	0,13	0,27	0,32
/Mikro	0,51	0,49	0,53	0,20	0,20	0,20	0,20	0,20	0,20	0,29	0,46	0,48
/Sprinkel	0,47	0,53	0,52	0,20	0,20	0,20	0,20	0,20	0,20	0,30	0,44	0,50
/Vloed	0,52	0,52	0,45	0,20	0,20	0,20	0,20	0,20	0,20	0,28	0,36	0,38
Lusern/Sprinkel	0,80	0,80	0,80	0,70	0,60	0,50	0,50	0,50	0,60	0,70	0,80	0,80

Tabel B: Gewasfaktore gebruik in die berekening van netto gewaswaterbehoefte.

Stelseltipe	Gemiddelde CU waardes vir	
	Geïnstalleerde stelsel by ontwerpdruk	Geïnstalleerde stelsel by gemete druk
Drup	99,0	98,7
Mikro	97,9	98,0
Sprinkel	98,5	98,7

Tabel D: Eenvormigheid van toediening (CU) soos bereken vir die geïnstalleerde stelsels

Gewas/Besproeiing-kombinasie	Gemete besproeiing	Potensiële dreineringsdiepte		Benuttings doeltreffendheid
	(mm)	(mm)	(% van bespr.)	(%)
Wingerd/Drup	435	181	41,6	56,8
Wingerd/Mikro	665	260	39,1	66,5
Wingerd/Sprinkel	699	313	44,8	67,8
Wingerd/Vloed	507	371	73,2	64,1
Akkerbou/Sprinkel	852	117	13,7	106,8

Tabel E: Waargenome besproeiingsprestasie soos bereken vir twaalf maande periode.

Vir die tydperk 14 April 1989 tot 29 April 1990 is daaglikse reënval- en verdampingsmetings aangeteken. 'n Rekord van daaglikse lesings van alle watermeters is ook saamgestel en dit verskaf 'n weergawe van die totale besproeiingstoediening wat plaasgevind het.

'n Verfyning van die gewone metode om evapotranspirasie met behulp van verdampingsyfers en gewasfaktore te bepaal, is ondersoek met die oog op moontlike toepassing daarvan in hierdie studie. Voldoende verwysingsfaktore kon egter nie verkry word nie en die poging is laat vaar. Verdere navorsing is egter beslis wenslik, aldus die verslag.

'n Grondwaterbalans wat gegrond is op gewasfaktore, wat deur die Navorsingsinstituut vir Wynkunde en Wingerdbou op Stellenbosch verskaf is, en die waargenome Klas A-panverdampingsyfers, is vir elke perseel opgestel. Die resultate van die grondwaterbalanse is met behulp van vyf stelle tensiometers asook die waargenome wisseling in grondsoutinhoud kwalitatief getoets.

Die resultate van die grondwaterbalansberekenings is aan die deelnemende boere voorgelê. Hierna is 'n onderhoud met elke boer gevoer. waartydens die resultate bespreek en teen die boer se eie ondervindings en waarnemings getoets is. Terselfdertyd is met behulp van 'n vraelys gepoog om elke individu se kennis van besproeiingskedulering te toets ten einde vas te stel wat die tipiese boer se kennisvlak is.

Dit moet beklemtoon word dat die grondwaterbalans en gevolglik ook die berekende potensiële dreineringsverlies, beïnvloed word deur die spesifieke gewasfaktore en teoretiese stelseldoeltreffendhede wat in die berekenings gebruik word. Die toepaslike waardes soos aanbeveel vir gebruik in hierdie studie, word in Tabel B en C getoon.

Stelsel	Toedieningsdoeltreffendheid (%)
Drup	90
Mikro	85
Sprinkel	80
Vloed	70

Tabel C: Teoretiese stelseldoeltreffenheid gebruikom brutobesproeiingsbehoefte te bereken.

RESULTATE

- Daar is bevind dat die standaard van besproeiingsontwerp op die vlak van individuele persele inderdaad baie hoog is. As maatstaf hiervan dien die berekende hoë eenvormigheid van toediening (CU) soos aangedui in Tabel D.

Daar is wel 'n wisseling waargeneem in die bedryfsdrukke van die besproeiingstelsels. Hierdie wisseling kan waarskynlik aan die eienskappe en vermoëns van toevoernetwerke toegeskryf word, maar die ontleding van toevoernetwerke het buite die bestek van hierdie studie geval.

Die gevolgtrekking word dus gemaak dat die standaard van besproeiingstelselontwerp nie die boer se vermoë om die toediening van besproeiingswater en die hoeveelheid dreinering te beheer, benadeel nie. Die waargenome hoë standaard van ontwerp dra dus eerder by tot die moontlikheid om dreineringsverliese te beperk.

- Oorbesproeiing met gepaardgaande hoë potensiële dreineringsdieptes is waargeneem. Terselfdertyd is lae gemiddelde vlakke van waterbenuttingsdoeltreffendheid bereken. Vir die studietydperk is gemiddelde waardes van gemete besproeiing (na toelating vir stelselverliese), dreineringsdiepte en waterbenuttingsdoeltreffendheid (besproeiingsbehoefte as persentasie van gemete besproeiing, effektiewe reënval en toeganklike grondwater) vir die vyf gewas/besproeiingskombinasies bereken, soos aangedui in Tabel E.

Weens die wyse waarop dit bereken is, word 'n hoë (selfs hoër as 100%) waterbenuttingsdoeltreffendheid verkry wanneer "tekort"-besproeiing beoefen word. Dit verklaar die hoë waterbenuttingsdoeltreffendheid wat vir sprinkelbesproeiing van akkerbougewasse bereken is. Hierdie doeltreffendheid gaan egter gepaard met die ontstaan van aansienlike watertekorte.

Dit is duidelik dat daar heelwat ruimte vir verbetering in die gemiddelde waterbenuttingsdoeltreffendheid bestaan. Dat verhoogde doeltreffendheid prakties haalbaar is, word gedemonstreer deur die hoë waardes wat deur individuele besproeiers met die getoetste besproeiingstelsels behaal is. Die navorsingsverslag sê dat drupbesproeiing, gevolg deur mikrobesproeiing, die laagste potensiële dreineringsdiepte vertoon het, ten spyte van sy lae benuttingsdoeltreffendheid. Dit is 'n belangrike feit uit die oogpunt van potensiële versouting van die Breërivier weens oormatige diep perkolasie van besproeiingswater.

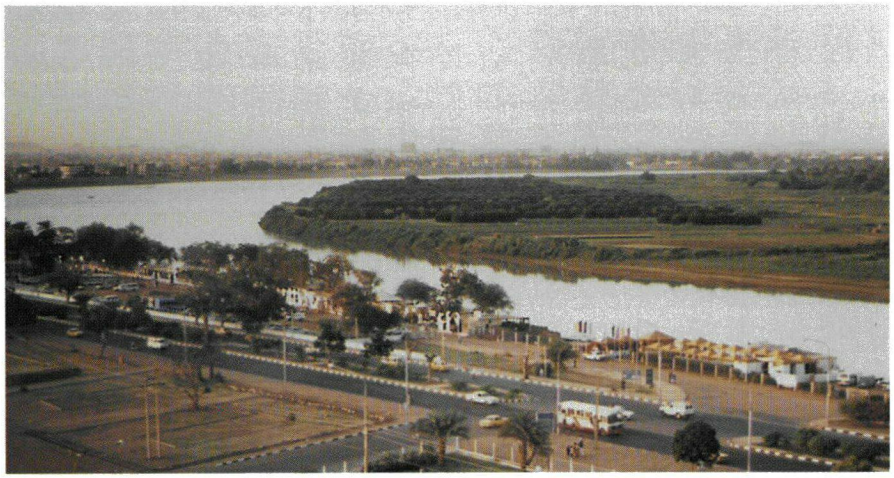
- Die navorsingsverslag sê dat uit die gesprekke wat met deelnemende boere gevoer is, is dit baie duidelik dat die boere grootliks staatmaak op hulle eie ondervinding by enige besluite rondom besproeiingskedulering. Die deelnemende boere het egter geblyk 'n lae vlak van kennis van teoretiese besproeiingskedulering asook die gevolge van oorbesproeiing te hê. Dit het ook baie duidelik na vore gekom dat slegs ekonomiese en finansiële oorwegings die boere sal aanspoor om enige nuwe rigting ten opsigte van besproeiingskedulering in te slaan.

- Die grootste enkele verbetering in die waargenome standaard van besproeiingskedulering sal teweeggebring word deur die verbetering van die besproeiingsbestuurvernuf van die boere in die Breëriviervallei.

- Uit die resultate van die grondwaterbalansberekenings, blyk dit dat met die huidige standaard van besproeiingskedulering daar groot potensiële dreineringsverliese by feitlik alle besproeiingspersele in die Breëriviervallei voorkom. Dit is dan ook logies om te verwag dat hierdie dreineringsvolumes wel as terugvloei in die Breërivier sal beland en sodoende reeds bydra tot die versoutingsprobleem.

South Africans present papers at Nile conference

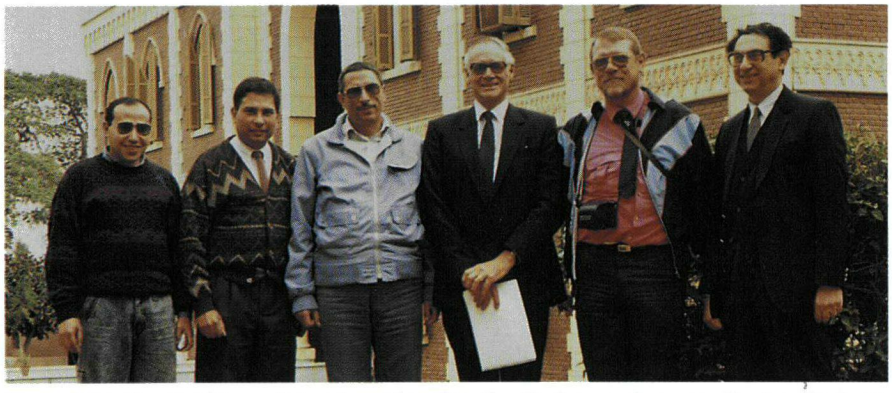
During February this year the African Nile countries held two conferences in Khartoum, Sudan. The first conference called "Nile 2002" dealt with the socio-economic development of the Nile basin as a resource to the ten countries sharing the river, while the second conference, held immediately after the first, was concerned with sustained utilisation and technical development of water resources in Africa.



The confluence of the Blue Nile (foreground) with the White Nile (flowing from left to right in the background).

Three South Africans, Professor D Stephenson (University of the Witwatersrand), Mr C Benadé (Cape Nature Conservation) and Dr J Jordaan (Department of Water Affairs and Forestry) were invited by the organisers, the Ministry of Irrigation and Water Supply of the Sudan, to attend the conferences.

According to Dr Jordaan the invitation "emphasised the high regard South African expertise is already enjoying so shortly after Sudan has begun to establish trade relations with its southern colleague on the African continent".



Two of the South African delegates attending the Sudan conference, Dr Jan Jordaan (holding documents) and Mr C Benadé (with camera), pictured with their Egyptian hosts: Hydraulics and Sediment Reseach Institute research personnel and Professor Elassiouti of the Cairo University (far right).

He said they found the reception extremely hospitable and their papers were received with much interest. Professor Stephenson presented a soil-erosion and sediment hydrodynamic numeric modelling technique. Mr Benadé discussed the management of ecological problems resulting from the regulation of the Orange River and Dr Jordaan gave an overview of South African water augmentation procedures, particularly trans-catchment water transfer schemes.

The South Africans were also able to participate in study visits to the vast Roseires and Sennar Dams' irrigation project in the area between the White and the Blue Nile. Earlier they had toured the Nile Delta and visited the Hydraulics and Sediment Research Institute situated at the Delta Barrage, near Cairo, as well as the very impressive Irrigation Museum close-by.

Dr Jordaan said the main conclusions of the Sudan conference could be summarised as follows:

- ❑ To encourage more participative development of water resources between basin sharing countries in Africa; and
- ❑ To promote a more grass-roots level involvement with maintaining water projects by the users.

"Awareness of environmental concerns was brought home as an absolute necessity and something to be adhered to by developing nations in tune with what is now considered standard procedure in developed regions," he said.

One of the highlights of the conference was the formal constitution of the Southern Region of the African Division of the International Association for Hydraulic Research. It was also proposed and accepted that a future conference, possibly in 1996, should be held in South Africa.

Dr Jordaan said the Sudan conference was attended by more than 120 delegates and some 45 papers were presented. The sessions were divided into hydraulics, efficient use of water resources and systems analysis and hydrology. The South Africans also chaired and co-chaired some of the sessions.

They all three agreed that Sudan as an emerging African nation (and other similar countries) could benefit from closer co-operation with the Southern African subcontinent and likewise that "we in Southern Africa could derive valuable know-how from their experience in large scale irrigation projects on large rivers such as the Nile".

FRIEND PROJECT GETS ON STREAM

At a Steering Committee meeting held in Dar es Salaam on 16-18 February 1994 the official participation of South Africa in the southern African FRIEND project has been ratified. SANCIAHS played an important facilitating role in achieving this milestone on the road to greater involvement of South African hydrologists in our continent's affairs.

The southern African initiative involves 11 countries: Tanzania, Zambia, Malawi, Zimbabwe, Swaziland, Botswana, Lesotho, Namibia, South Africa and hopefully Angola and Mozambique will actively join. The project developed from the European FRIEND project which was carried out from 1986 to 1989 in its first phase and continuous in its second phase.

The objectives of the project are briefly as follows:

I Establishment of data bases

(a) Master register of all southern African streamflow gauging stations.

(b) Database of daily streamflows for approx. 1000 catchments from 10 countries in HYDATA format.

(c) ARC/INFO coverage of spatial characteristics (soils, hydrogeology, climate, vegetation & landuse)

(d) Catchment characteristics values for approx. 1000 gauged catchments.

II Development of software packages

(a) Data archiving and processing of hydrological data.

(b) Flood frequency analysis.

(c) Low flow frequency and duration analysis.

(d) Rainfall - Runoff modelling.

III Research activities

(a) Spatial and temporal variability of mean annual runoff by water balance and remote sensing techniques.

(b) Spatial and temporal variability of low flow statistics at the southern African scale.

(c) Spatial and temporal variability of flood statistics at the southern African scale.

(d) Assessment of the applicability of different rainfall-runoff models to catchments in the region for simulating daily and monthly streamflow time-series.

IV Development of design procedures

(a) Procedure for the estimation of mean annual runoff at gauged and ungauged locations for water resources assessment and transnational transfer.

(b) Procedure for the estimation of low flow statistics at gauged and ungauged locations for water resources assessment, transnational transfer, water rights management, discharge management, dam feasibility studies.

(c) Procedure for the estimation of the design flood at gauged and ungauged locations for bridge, culvert and spillway applications.

(d) Initial guidelines on the application of time series models to ungauged locations, specifically model parameter quantification, for water resources assessment transnational transfers, water rights management, discharge management, more detailed dam/reservoir design, impacts of land-use change, catchment management.

V Dissemination of information

(a) Distribution of final report.

(b) Southern African FRIEND conference, subject to hosting agreement and financial resources (including conference proceedings).

(c) Scientific publications in internationally refereed scientific journals.

(d) Formal training programmes in data processing (incl. HYDATA), low flow analysis, flood analysis and model applications.

The target number of gauging stations for each country is as follows:

Botswana	20
Lesotho	30
Malawi	100
Mozambique	100
Namibia	40
South Africa	300
Swaziland	20
Tanzania	125
Zambia	125
Zimbabwe	125

(although these specific numbers are in no way binding)

The next meeting of the Steering Committee for the southern African FRIEND project is scheduled to be held in September 1995 in Grahamstown to coincide or link up with our next Hydrological Symposium. Any hydrologist who wants to use the opportunity to communicate with countries involved in this project should please contact Prof Denis Hughes at the Institute for Water Research, Rhodes University or me at the Water Research Commission.

Hugo Maaren

NEW RELEASE FROM NISC

Waterlit on CD

WATER RESOURCES ABSTRACTS 2
1970 – present, semi-annual updates

The Waterlit information database compiled by the South African Water Information Centre in South Africa is now avaialable on a single Compact Disk. You may use it in comfort of your own office.

Take advantage of this opportunity:

- Relevance to South Africa
- WATERLIT Records include South African holding libraries for easy access to the sources
- Free trial for one month with no obligation to buy
- Purchase entitles you to the Education database ERIC free
- One stop searching of these databases:

WATERLIT	221 000 Citations
AQUAREF	86 000 Citations
DELFT HYDRO	64 600 Citations

- Competitive price R 2755.00 ($ exchange at 3.5)
- In stock and available contract:

Margaret Crampton
JLB Smith Institute of Ichthyology Library
Pte Bag 1015, Grahamstown 6140, South Africa
Tel: 0461 27124 Fax 0461 22403 Internet: FISHLIT @ru.ac.za

THE NEWEST VERSION OF WATERLIT AVAILABLE

The latest version of the WATERLIT CD-ROM has just been released. Called NISC Water Resources Abstracts II, this combines WATERLIT with two other international water databases on one disc, at a very reasonable price.

When the WATERLIT database was started in 1974, it was not envisaged that users would eventually be carrying out literature searches on the database for themselves. At that stage and until two years ago anyone requiring information would approach the scientists at the South African Water Information Centre, who had been specifically trained in database searching, to undertake the search on their behalf.

New developments to the CSIR computer system resulted in InfoAccess. InfoAccess, with its graded levels of searching, enabled users to search CSIR databases and other local databases, including WATERLIT, from their own desks using a personal computer linked to a modem.

The next step was the introduction of the Worldnet Gateway which affords access to 1000 international as well as local databases. The range of databases is very wide and this wealth of information is available to subscribers from the convenience of their own offices. An added advantage is that no matter how many different databases are accessed, only one account is received and this can be paid in South African currency, removing the need to make arrangements for foreign exchange.

CD-ROM

Many users find it even more convenient to have the whole database conveniently available at all times. WATERLIT on CD-ROM is the ideal product in this case. The SilverPlatter version of WATERLIT contains more than 222 000 references on one CD-ROM disc, which can be accessed using a CD-ROM reader attached to a personal computer.

SilverPlatter uses the same software for their very extensive range of CD-ROM databases, which makes it easy for users to use several different databases. Update discs are issued every three months.

In addition to the South African users, the SilverPlatter WATERLIT is already being used in 15 different countries including the USA, Australia, Mexico, Egypt and France. In South Africa several large organisations have installed network versions of the database, which permit up to 25 users to search the database concurrently on local area networks.

DATABASES

The new Version of WATERLIT on CD-ROM has been produced by the National Information Services Corporation (NISC) in the USA and is called Water Resources Abstracts II. One CD-ROM disc contains three of the world's pre-eminent water resources databases: WATERLIT, Canada's AQUAREF, and the Netherlands' DELFT HYDRO. Any or all of the databases can be searched quickly and easily and the combination of the three databases provides really good cover of all aspects of water. The price of this CD-ROM is very competitive and it is updated twice a year.

WATERLIT (1975 - present), compiled by the South African Water Information Centre, provides over 220 000 citations on both industrial and environmental aspects of water, wastewater and sanitation. Coverage of water in arid lands is particularly strong. Topics include water supply and quality, hydrology, potable water, pollution control, treatment, aquifers, groundwater, rivers, drought evaporation, modelling, sedimentation, dams, legislation, metering and analytical techniques. More than 12 000 records are added each year, drawn from reports, conference proceedings and more than 760 local and international journals.

AQUAREF (1970 - present) focuses on North American water resources and related environmental topics. The file is updated every six months with records from the Inland Waters Directorate of Environment Canada. Coverage includes the publications of Environment Canada as well as those of numerous government agencies, universities, research establishments, conference proceedings and over 200 journals.

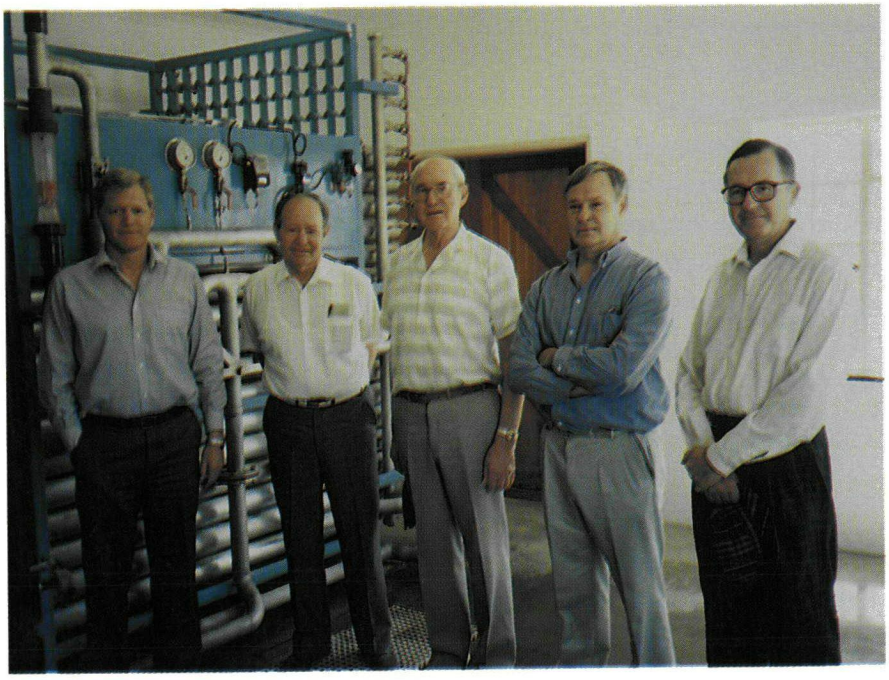
DELFT HYDRO (1977 - 1987), compiled by the Delft Hydraulics Laboratory of the Netherlands, provides international coverage of water and related scientific literature, with a special emphasis on engineering and related technical disciplines. DELFT's citations and abstracts cover technical reports, conference proceedings, books, theses, publication from water-related institutions and over 600 periodicals. DELFT HYDRO contributes a total of 64 800 records.

Good news for CD-ROM users is that the price of CD-ROM drives is dropping. The newest drives do not require that a card be installed in the PC, which means that the drive can easily be moved to another computer when necessary. Music lovers will be pleased to hear that the drive can also be used to play music CDs.

ENQUIRIES

Anyone interested in having either of the CDs on trial for a month may contact Angela Rethman at the South African Water Information Centre, P.O. Box 395, PRETORIA, 0001. Telephone (012) 841-2048. Fax (012) 86-2869. Internet address: sawic@csir.co.za.

Kommissie kyk na membraantegnologie



Lede van die Waternavorsingskommissie (WNK) het einde verlede jaar besoek afgelê by die Instituut vir Polimeerwetenskap aan die Universiteit van Stellenbosch, waar die WNK reeds verskeie jare navorsing oor membraantegnologie steun.

Die vervaardiging en kommersialisering van membraanstelsels by die Paarlse firma Membratek, is ook deur WNK-lede besigtig, asook 'n tru-osmose aanleg wat deur Membratek op die Wes-kaaplandse dorp Bitterfontein opgerig is. Die aanleg word gebruik om brak grondwater vir menslike gebruik te ontsout.

Op die foto verskyn van links: Mnr VJ Bath, Uitvoerende Hoof: Randwaterraad, dr WL van Wyk, voormalige Adjunk-direkteur-generaal: Departement van Mineraal- en Energiesake, mnr DH Marx, Voorsitter van die Magalies Waterraad, mnr PE Odendaal, Uitvoerende Direkteur: Waternavorsingskommissie en Professor PD Tyson, Vise-rektor: Universiteit van die Witwatersrand.

Vyf nuwe waterskemas aangepak

Die Minister van Omgewingsake en van Waterwese, mnr JA van Wyk, het aangekondig dat die Departement van Waterwese en Bosbou vyf nuwe waterskemas gaan aanpak. Die doel van die nuwe skemas is om water vir primêre gebruik aan sowat 1,25 miljoen mense in landelike gebiede te voorsien en waterverskaffing vir landboudoeleindes te stabiliseer.

Die eerste skema is die beoogde Nondweni-stuwal. Die terrein vir hierdie stuwal is in die Letabarivier, omtrent ses kilometer stroomop van die samevloeiing van die Molototsi- en die Groot Letabarivier, geleë. Die stuwal sal water wat uit die Fanie Bothadam losgelaat word laer af in die Letabarivier beter reguleer. Die beraamde koste van die projek beloop meer as R7,26 miljoen en dit sal na verwagting in 1995 voltooi wees.

Die tweede skema is die Ulundi-stuwal in die Wit-Mfolozirivier in die omgewing van Ulundi in KwaZulu. Die doel van die stuwal is die bestendiging van watervoorsiening aan Ulundi vanuit die Wit-Mfolozirivier, met ondersteuning van die Klipfonteindam, ongeveer 141 km stroomop naby Vryheid. Hierdie skema sal na raming by voltooiing in 1995, R6 miljoen kos.

'n Derde skema is die aanvulling van die Mhlatuzerivier deur die Middeldrift-oordragskema. Hierdie skema sal in die Tugelarivier in KwaZulu, ongeveer 18 km noord-oos van Kranskop, geleë wees. Dit word in drie fases ontwikkel en die koste sal by voltooiing in 2012 na raming R335 miljoen beloop.

Die vierde skema wat mnr Van Wyk aangekondig het, is 'n watervoorsieningskema tussen die Olifants- en die Steelpoortrivier. Die doel van die skema is om aanvullende water vir primêre gebruik aan die Nebo Plato naby Groblersdal in Lebowa te verskaf, aangesien die huidige watervoorsieningskema reeds teen volle kapasiteit bedryf word. Hierdie skema sal in 1997 voltooi word en sal na beraming R52 miljoen kos.

Die vyfde skema is die aanvulling van watervoorsiening aan KwaNdebele, hoofsaaklik vir primêre gebruik. Hierdie skema wat die uitbreiding van suiweringswerke sowel as die bou van pompstasies en pypleidings behels, sal in 1996 voltooi wees en na raming sowat R17 miljoen kos.

River revived

A Witbank river is set to once again teem with aquatic life decades after "dying" as a result of pollution from mined-out properties in the area.

The river, the Brugspruit, is a tributary of the Klipspruit, which forms part of the Olifants River catchment system.

According to Andre van Niekerk of environmental consultants, Wates, Meiring & Barnard, a project designed to clean up acidic run-off from old coal mines adjacent to the Brugspruit represents the first stage of a broader water quality management plan for the Klipspruit system. It will involve the planning, design, construction and commissioning of systems to intercept, collect and treat acidic drainage water from coal mines which ceased operations prior to the promulgation of the Water Act of 1956.

The treated water will be fed into the Brugspruit.

"The water will be treated to a standard high enough to ensure that it can sustain aquatic life and also meet the agricultural and drinking water needs of communities along the river's route," he said.

Artificial food developed for perlemoen

Leather tanning and aquaculture would appear to have nothing in common, but an algae produced in tannery effluent is proving invaluable to ichthyologists researching the culture of perlemoen (abalone) at Rhodes University, Grahamstown.

Mr Peter Britz, a lecturer in the Department of Ichthyology and Fisheries Science recently returned from a conference on perlemoen farming in Hobart, Tasmania, where he presented his findings on the development of an artificial feed for perlemoen. He has been researching the development of a suitable formulated food for perlemoen for the past few years.

Perlemoen is a very slow feeder. This means that any formulated food manufactured would have to remain stable in water and not dissolve quickly. Mr Britz has used a mixture of conventional animal feed with starch and a species of algae called *spirulina* which significantly boosts perlemoen growth rates. This algae is being experimentally cultured in tannery waste water by biotechnologists at Rhodes and is used in diets for perlemoen and fish by the Department of Ichthyology and Fisheries Science. The perlemoen food is manufactured in a flat pellet-form, similar to lasagna, which lasts in water for up to four days with minimal leaching.

Some farmers feed seaweed (their natural food in the wild) to perlemoen in captivity. However, harvesting of seaweed can be a problem when the sea is rough. In some countries it is also opposed by environmentalists.

"Formulated feeds are much more convenient and reliable and produce faster perlemoen growth," Mr Britz said.

A workshop on the use of formulated feeds was held at the conference as most countries regard formulated feeds as necessary for part or all of the perlemoen growth cycle. The dangers of relying on a single species of seaweed to feed perlemoen were highlighted after the conference in a visit to a perlemoen farm which had experienced mass mortality of perlemoen because the seaweed they were using was deficient in certain essential nutrients.

This does not occur with formulated feeds, which are nutritionally complete. Having developed a commercially viable feed, perlemoen research is now focused on the design of tanks for the mass rearing of perlemoen on formulated feeds. This includes researching ways to reduce costs in the farming process.

New Zealand and Japan have produced some feeds, but these are expensive and the one produced in South Africa is comparatively cheaper than the other feeds in the market.

Project

Sea Plant Products of Hermanus, a company which processes wild harvested perlemoen, have undertaken this research project with Rhodes in the hope that they will be able to farm perlemoen in the future and expand their share in the perlemoen market.

This would also help to conserve the perlemoen in the wild.

Cultured perlemoen can be sold at a smaller size and younger age than those caught in the wild, because they reach marketable size in three years. Due to the interest shown in the feed by perlemoen farmers from other countries, Sea Plant Products is considering marketing the feed internationally. Samples have been sent to Australia, New Zealand, China, Mexico and the USA for evaluation.

Mrs Hermien White of the Ichthyology Department has also developed a system of anaesthetizing perlemoen to remove them from rocks or other surfaces.

"In the past they were pried off the surface with a blunt object. This damaged the perlemoen because they have no coagulant in their bodies and they bleed to death. By anaesthetizing them it is possible to get a much higher price for them because they are not damaged, " Mr Britz said.

HRI name change

The Hydrological Research Institute (HRI) of the Department of Water Affairs and Forestry at the Roodeplaat Dam outside Pretoria has changed its name to the Institute for Water Quality Studies.

The name change arises from the fact that since its inception in October 1972, the emphasis of studies carried out by the Institute has shifted from hydrological research to an assessment of water quality and aquatic ecosystem health. The new name has been applicable since 22 March 1994, World Water Day.

Model analyses water uses

A hydrologic model to help analyse the effects of allocating water for consumptive and instream uses has been developed by the Montana Department of Natural Resources and Conservation in the USA.

Water Newsletter (160893) reports that the model, created to study the Missouri River basin, computes monthly streamflows, reservoir operations, hydropower production, irrigation and municipal water uses. Results were used to assess potential impacts to water quantity and distribution, water quality, water rights, wildlife and recreation. The model proved to be an important tool and simulation results formed the hydrologic basis of the environmental impact statement for reallocations. For more information, please contact Larry S. Dolan, MT Dept of Natural Resources and Conservation, 1520 E. Sixth Ave., Helena, MT 59620. USA.

Bromate removed from drinking water

Methods to remove bromate, a harmful compound, from drinking water have been developed by environmental engineers at the University of Colorado, USA.

According to Water Newsletter (300993) tiny amounts of bromate found in drinking water are the result of the ozonization process used by newer water treatment facilities to disinfect and oxidize water. Harmless bromine ions in groundwater react with the ozone that is bubbled through water to form bromate. The addition of ferrous iron to the treated water converts bromate to benign bromide.

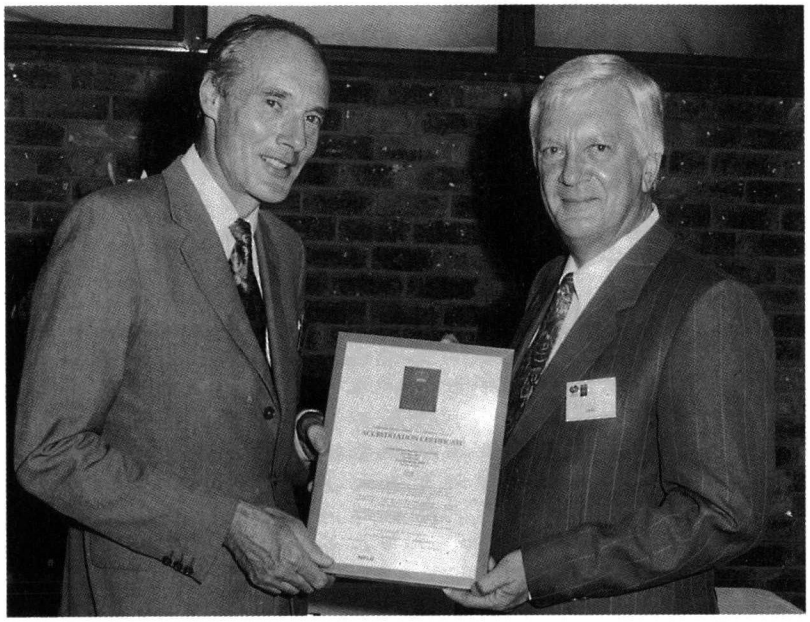
SABS labs accredited with NAMAS

Five SABS laboratories have added to their credentials by obtaining international accreditation. Mr John Doble, the British Consul-General presented certificates of accreditation by the National Measurement Accreditation Service (NAMAS) of the UK to the President of the SABS, Dr Jean du Plessis, at a function held in Pretoria.

The five laboratories have been accredited to international standards for the competent performance of tests. This is the first time ever that any South African laboratory has earned NAMAS accreditation.

The laboratories are the Pesticide Residue laboratory managed by Mr Awie Viljoen as well as four water testing laboratories situated in Pretoria, Durban, Port Elizabeth and Cape Town that are under the management of Mr Mike McNerney.

A spokesman for the SABS said that there was a growing awareness in industry of the need for reliable analytical data and that third party accreditation based on compliance to quality management standards was the most reliable means of ensuring that the client receives valid data.



Dr John Doble (left), the British Consul-General, presenting the Certificates of Accreditation to Dr Jean du Plessis, President of SABS.

"It has been estimated that approximately 30 per cent of analytical data produced worldwide is unreliable. Considering the expense of analytical services and the dependence that is placed on analytical data, it would be wise for industry to ensure that the data it uses is fit-for-purpose," he said.

Grondwater in Natal gekarteer

Die Departement van Waterwese en Bosbou het in samewerking met die Waternavorsingskommissie en ander belanghebbende partye begin om die grondwaterbronne van Natal op 'n 1:500 000 skaal te karteer.

Dit maak deel uit van 'n projek wat daarop gemik is om die grondwaterbronne van die hele land voor die einde van die eeu op kaarte vas te lê. Die kaarte sal inligting bevat oor die voorkoms, die ontwikkelingspotensiaal en die gehalte van die grondwaterbronne in 'n maklik verstaanbare vorm.

Die projek in Natal sal sowat 18 maande duur en nagenoeg R2,8 miljoen kos.

Satellietbeelding word op groot skaal gebruik om belangrike geologiese kenmerke en strukturele terreine uit te ken wat op die voorkoms van grondwater kan dui. Daarbenewens word die Departement se geografiese inligtingstelsel (GIS) ook grootliks gebruik om die kaartsamestellingsproses te outomatiseer.

PAM stops topsoil erosion

Polyacrylamide (PAM), a common wastewater cleaning compound, can also control the erosion of topsoil for farmers using furrow irrigation, says Water Newsletter (161293). This application has been tested over the past three years by the Soil and Water Management Research Unit of the American Agricultural Research Service in Kimberly, Idaho.

Isaac Shainberg, a researcher with the Israeli Institute of Soil and Water in Bet Dagan, first explored the ability of Polyacrylamide to reduce soil compaction and crust formation by rain. He later contacted the Kimberly researchers about using the compound for furrow erosion.

PAM has been used primarily at municipal wastewater treatment facilities. However, new data indicated that the type and density of the polymer's electrical charge play a role in PAM's ability to control erosion. By somehow increasing the cohesiveness of soil particles at the surface of a field, the PAM appears to make soil more resistant to the highly erosive forces exerted by water flowing over it.

PAM crystals added to irrigation water have practically halted erosion in treated fields. Just 10 ppm added to water during the first hour of an irrigation can reduce erosion by 70 - 99 per cent and each treatment is estimated to cost farmers about R8 - R12 per ha in the USA.

Furrows cause farmers difficulties because the fine sediment that erodes from the head of a furrow often settles out toward the middle and end of a furrow, forming a tight, nearly waterproof seal on the surface of the soil. By mid-season, water infiltration in a furrow is reduced to just 1 or 2 mm per hour. If farmers could prevent furrow erosion, the depositional crust would not form and that could translate into 20 per cent larger harvests, the publication says.

PETRO process saves Swakopmund money

The implementation of a novel pre-treatment solution has enabled the Swakopmund Municipality in Namibia to increase the capacity of its waste water purification works by more than 60 per cent, while at the same time avoiding the need to undertake costly repairs to critical elements of its existing plant.

Originally designed for a dry weather flow of 4,3 Mℓ/day, the municipality's old and new treatment works had reached the stage where it often operated to full hydraulic capacity. Overloads due to bottlenecks in pipelines regularly occurred during peak flows causing overflows of individual unit operations resulting in poor quality effluent.

In addition the plant was subjected to major seasonal fluctuations in terms of flows and organic loads. The daily peak flows were attributed to the various pump stations operating simultaneously causing sudden surges. Furthermore, the corrosive environment resulted in certain areas requiring urgent attention. These included the need for concrete repairs to primary sedimentation tanks, the existing inlet works and the digesters.

Solution

After closely examining and investigating the problems, the consulting team of VKE Namibia and Wates, Meiring and Barnard arrived at a solution that not only increased the plant's hydraulic capacity to 7 Ml/day but also dispensed with the need to undertake major repairs to the water works.

At the heart of the solution implemented was a decision to install a new lined earthen aerobic/anaerobic pond reactor to pre-treat the raw sewage and simultaneously balance the flow to the biofilters by providing a controlled overflow facility at the outlet of the pond. Known as the PETRO system, this process makes maximum use of anaerobic bio-degradation in biological filters.

Incoming raw sewage enters the bottom of the pond and flows through an anaerobic sludge blanket-type reactor. This process has reduced the incoming organic load at Swakopmund by more than 60 per cent as a result of its high efficiency. It is also designed to achieve primary sedimentation, sludge digestion and storage and, importantly, the balancing of flows.

As the sludge in the pond is stabilised it is drawn directly onto a drying bed.

The PETRO process contrasts with the previously employed configuration whereby the raw sewage gravitated through primary sedimentation tanks before reaching the biological filters. Sludge produced in the primary sedimentation tanks was pumped to the anaerobic digesters for stabilisation and disposal to sludge drying beds.

The use of the PETRO process therefore eliminated the need to undertake any repairs to the inlet works, primary sedimentation tanks and digesters.

In order to suppress anaerobic pond odours, the consultants decided that oxidation pond effluent, which contains algae, should be recycled to the surface of the anaerobic pond. This ensures that the top layer is aerobic thus minimising obnoxious odour emissions. The existing sludge pump station is being utilised for pumping algaerich water and humus sludge to the anaerobic pond.

With the PETRO process contributing to a stabilised flow, the biofilter towers operate on a 24-hour basis instead of 14 hours. This results in more efficient utilisation of the towers and better effluent quality.

After the biological filtration stage, the effluent at Swakopmund flows through existing humus tanks before reaching the chlorination tanks where disinfection takes place. A fraction of the final effluent from the humus tanks is diverted to an oxidation pond from where the algae-rich water is recycled to the aerobic/anaerobic pond reactor.

The new plant in operation is designed for an ultimate capacity of 7 Mℓ/day and a peak flow of 400 ℓ/second. The organic load capacity is 4 200 kg COD/day as opposed to 2 580 kg COD/day with the previous plant. When equated to people this represents an increase in capacity from about 25 800 to 42 000.

The cost of the entire project was R2,5 million, which was less than half the amount that would have been expended in undertaking a conventional expansion of the plant to achieve the equivalent capacity.

Permanent water schemes replace drought relief measures

Water delivery by tanker to drought-stricken rural areas has been stopped by the Port Natal-Ebhodwe Joint Services Board (JSB) after the recent rains, and plans are underway to replace this costly system with more permanent ways of supplying potable water to remote communities.

According to chairman Charles van Eck, the JSB spent over R6 million during an 18 month period delivering water to rural people who were totally without water. At the height of the drought they were transporting 9 million litres of water per week.

"This was an interim drought relief measure, but now that the rains have fallen, we can look at more permanent and cost-effective methods of ensuring that remote areas have water," he said.

These include spring protection, sinking boreholes and installing water tanks linked to gutters at rural schools and community halls.

"We will also consider reinstating the tanker service temporarily to supply water to communities where there is no natural source of supply," Mr van Eck said.

The new measures follow a helicopter survey of the whole JSB area, during which JSB officials landed at selected locations and met community representatives.

In addition to these new measures, the JSB has spent over R100 million on over 40 more complex water projects. An example is a R419 000 self-help water scheme recently completed at Kwanyuswa in the Ndwedwe district which supplies water to 2 000 people through yard taps at individual homesteads. A larger R6,4 million project at Ximba in the JSB's western area will supply water to 40 000 tribal people when complete.

SA WATERKALENDER

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.

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

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

Adres:
Die Redakteur
Posbus 824
0001 Pretoria
Tel: (012) 330-0340
Faks: (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 Konferensies- en Simposiumbladsy vir aangeduide geleenthede.

1994

APRIL 1994

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SOUTHERN AFRICA 1994

DAM DESIGN

JUNE 3

A one day seminar on earth dam design will be held at the Stellenbosch University Seminar Centre, Stellenbosch. The seminar is organised by the South African Institution of Civil Engineers Continuing Education, Western Cape Branch.
Enquiries: Mr Kobus du Plessis, tel (021) 400 2991 or Mr Doug Austin, tel (021) 400 2455. Fax (021) 4197096 (Attention Mr JA du Plessis). The postal address is City Council of Cape Town, City Engineers' Department, Drainage and Sewerage, PO Box 1694, Cape Town 8000.
Closing date: 20 May 1994.

WATER TECHNOLOGY

JUNE 6 - 9

The 1994 international African water technology exhibition and conference, Afriwater, will be held at the National Exhibition Centre, Johannesburg.
Enquiries: Natalie Sanders, McNaughton Victor CC, PO Box 31368, Braamfontein 2017. Tel (011) 643-4824/8 Fax (011) 642-9860.

SASAQS

JULY 13 - 15

The annual conference of the Southern African Society of Aquatic Scientists will be held at the SAB Institute for Coastal Research at the University of Port Elizabeth.
Enquiries: Dr Eileen E Campbell, Congress Secretariat, Botany Department, University of Port Elizabeth, PO Box 1600. Port Elizabeth 6000. Tel (041) 504-2329. Fax (041) 53-2317.

WATER ENGINEERING

JULY 14 - 15

A symposium entitled "50 years of water engineering in South Africa (a tribute to Prof Des Midgley)" will be held at the University of the Witwatersrand, Johannesburg.
Enquiries: Ms C Bernard, c/o Dr SJ van Vuuren, BKS Inc, PO Box 3173, Pretoria 0001. Tel (012) 209911 Fax (012) 20 9220.

CORROSION CONTROL

AUGUST 29 - 31

The sixth international corrosion conference entitled "Cost effective corrosion control into the 21st century" will be held at the Elangeni Hotel in Durban.
Enquiries: SA Corrosion Institute, PO Box 77, WITS 2050. Tel (011) 802-5145 Fax: (011) 804-3484.

AQUACULTURE

SEPTEMBER 21 -23

The third congress of the Aquaculture Association of Southern Africa entitled Aqua-culture '94, will be held at Berg en Dal Rest Camp, Kruger National Park.
Enquiries: Mrs Suzette van Wyngaardt, Blyde River Aquaculture, PO Box 408, Hoedspruit 1380. Tel & Fax: 01528- 35250. E-mailaddress: ihth@hippo.ru.-ac.-za.

WASTECON '94

SEPTEMBER 27 - 29

A conference on waste management will be held in Somerset West, Western Cape.
Enquiries: WASTECON '94, PO Box 1303, Cape Town 8000. Tel (021) 400 2423 Fax (021) 25 3848.

ENVIRONMENTAL MANAGEMENT

OCTOBER 18 - 21

The 2nd Southern African international conference on environmental management will be held at Victoria Falls in Zimbabwe.
Enquiries: SAICEM 2 Secretariat, c/o PO Box BW 294, Borrowdale, Harare, Zimbabwe. Tel (263) 4 739 822. Fax (263) 4739 820.

ICOLD

NOVEMBER 1 - 5

The 62nd executive meeting of ICOLD will be held at the Elangeni Hotel in Durban.
Enquiries: Mrs Ginny Eslick, ICOLD 1994 Organising Committee, PO Stamford Hill, 4025 Durban. Tel (031) 233 494 Fax (031) 232 405.

MEMBRANE TECHNOLOGY

NOVEMBER 2 - 3

The first WISA Membrane Technology Division workshop and seminar on the preparation, performance and practice of permselective membranes will be held at Van Stadens River Mouth resort, East Cape.
Enquiries: Dr Ed Jacobs (Secretary), Insitute for Polymer Science, University of Stellenbosch, Stellenbosch. Tel (021-808 3172).

ICOLD

NOVEMBER 6 - 11

The 18th ICOLD congress will be held at the Durban Exhibition and Conference Centre.
Enquiries: Mrs Ginny Eslick, ICOLD 1994 Organising Committee, PO Stamford Hill, 4025 Durban. Tel (031) 233 494 Fax (031) 232 405.

ANALYTICA '94

DECEMBER

The second national symposium on analytical science will be held early in December 1994 in the Western Cape. Theme: "Toward the Welfare of Man and his Environment".
Enquiries: Dr IM Moodie, ANALYTICA '94, c/o PO Box 19070, Tygerberg 7505. Fax (021) 932-4575.

1995

GROUNDWATER

APRIL 3 - 7

The Centennial Conference of the Geological Society of South Africa will be held in Johannesburg.
Enquiries: Tel & Fax (012) 47 3398.

RIVER MANAGEMENT

MAY 14 - 19 1995

The IAWQ conference on river basin management will be held in the Kruger National Park.
Enquiries: Dr Ben van Vliet, Watertech, CSIR. Tel (012) 841-2237 Fax (012) 841-4785.

HYDROLOGY

SEPTEMBER 4 - 6

The 7th national southern African hydrological symposium will be held in Grahamstown.
Enquiries: Prof Denis Hughes, Institute for Water Research, Rhodes University, Grahamstown 6140. Tel (0461) 24014 Fax (0461) 25049. E-mail: Denis @ iwr.ru.ac.za.

IWSA

SEPTEMBER 9 - 15

The 20th biennial congress and exhibition of IWSA will be held in Durban.
Enquiries: Mrs Ginny Eslick, Congress International, 18 Rapson Road, Morningside, Durban 4001. Tel (031) 233 494. Fax (031) 232 405.

OVERSEAS 1994

DAM SAFETY

JUNE 6 - 17

An international dam safety, operation and maintenance seminar and study tour will be held in Denver, Colorado, USA.
Enquiries: American Water Foundation, PO Box 480632, Denver CO 80248-0632. USA. Tel (303) 628-5516. Fax: (303) 628-5469.

GROUNDWATER

JUNE 13 - 16

An international conference on future groundwater resources at risk will be held in Helsinki, Finland.
Enquiries: Ms Tuulikki Suokko, FGR 94, National Board of Waters and the Environment, PO Box 250, SF-00101 Helsinki, Finland. Fax: +358 0 4028 345.

WINERY WASTEWATERS

JUNE 20 - 24

An international specialised conference on winery wastewaters will be held in Narbonne, France.
Enquiries: Dr Rene Moletta, INRA, Boulevard du General De Gaulle, 11100 Narbonne, France. Fax: (33) 68 32 89 10.

ACTIVATED SLUDGE

JUNE 20 - 24

A short course entitled "Activated sludge process control" will be held at the Colorado State University.
Enquiries: Thomas Sanders, Environmental Engineering, Dept of Civil Engineering, Colorado State University, Fort Collins, CO 80523. Fax: (303) 491 7727. (303) 491 5448.

ENVIRONMENTAL PROTECTION

JUNE 27 - JULY 1

A short course entitled "Water resources development and environmental protection: problems, issues and solutions" will be held at the Colorado State University.
Enquiries: Thomas Sanders, Environmental Engineering, Dept of Civil Engineering, Colorado State University, Fort Collins, CO 80523. Fax (303) 491 7727. Tel (303) 491 5448.

IAWQ

JULY 24 - 30 1994

The 17th biennial conference and exhibition of the International Association on Water Quality (formerly the IAWPRC) will be held in Budapest, Hungary.
Enquiries: IAWQ, 1 Queen Anne's Gate, London SW1H 9BT England. Tel: +44 (0) 71-222 3848. Fax: +44 (0) 71-233 1197.

AFRICAN FISHERIES

AUGUST 1 - 5

The first African fisheries congress will be held in Nairobi, Kenya.
Enquiries: Professor S Dadzie, Department of Zoology, University of Nairobi, PO Box 30197, Nairobi, Kenya.

WATER MANAGEMENT

AUGUST 9 - 13

The fourth Stockholm water symposium with the theme "Integrated land and water management - challenges and opportunities" will be held in Stockholm, Sweden.
Enquiries: The Symposium Secretariat, Stockholm Water Symposium 1994, Stockholm Water Company, S-10636 Stockholm, Sweden. Tel +46 8736 2021. Fax +46 8736 2022.

MEMBRANES

AUGUST 29 - SEPTEMBER 2

The 7th international symposium on synthetic membranes in science and industry will be held in Tübingen, Germany.
Enquiries: DECHEMA e.V. Exhibitions and Congresses, Theodor-Heuss-Allee 25, PO Box 150104, D-6000 Frankfurt am Main 15. Tel (069) 7564-241/242/243 Fax (069) 75 64-201.

MUNICIPAL WATER

AUGUST 31 - SEPTEMBER 2

The 13th national conference on municipal and rural water supply will be held in Poznan, Poland.
Enquiries: Conference Secretariat, Polish Association of Sanitary Engineers & Technicians, ul. Wieniawskiego 5/9, 61-712 Poznan, Poland. Tel (48) 61 536 805 (285). Fax (48) 61 536 490.

RIVER BASIN

SEPTEMBER 13 - 16

An international conference on Integrated River Basin Development will be held in the UK.
Enquiries: Ms Jacqueline Watts, HR Wallingford Ltd, Wallingford, Oxfordshire OX10 8BA, UK. Tel +44-491-(8)-35381 Fax +44-491-(8)-26703.

MINE WATER

SEPTEMBER 19 - 24

The 5th international mine water congress will be held in Nottingham, UK. Theme: Mine water and the environment.
Enquiries: The Secretary, IMWA Conference, c/o Department of Mineral Resources Engineering, University of Nottingham, University Park, Nottingham NG7 2RD, United Kingdom. Tel (0602) 514076 Fax (0602) 678494.

ENVIRONMENTAL CONTAMINATION

SEPTEMBER 20 - 23

The second international symposium and exhibition on environmental contamination in Central and Eastern Europe will be held in Budapest, Hungary.
Enquiries: Roy C. Herndon, Symposium Co-Chairman, Florida State University/CHAERSE, 2035 East Paul Dirac Drive, 226 HMB, Tallahassee, Florida 32310-3700, USA Tel (904) 644-5524
Fax (904) 574-6704. E-Mail: buda94@chaerse.fsu.edu

IRRIGATION

SEPTEMBER 20 - 24

An international conference on irrigation management transfer will be held at Wuhan University in Wuhan, China.
Enquiries: Dr Sam H Johnson, PO Box 2075, Colombo1, Sri Lanka. Fax: 94-1-866854. Tel 94-1-867404. E-mail: IIMI 157:CGII29.

PARASITES & WATER

SEPTEMBER 26 - 28

A conference on Protozoan Parasites and Water will be held at the University of York, UK
Enquiries: IFAB Communications, Institute of Applied Biology, University of York, York YO1 5DD. Tel 44 (0)904 432940. Fax 44 (0)904 432917.

NUTRIENT REMOVAL

OCTOBER 4 - 6

The second Australian conference on biological nutrient removal from wastewater will be held in Albury, NSW, Australia.
Enquiries: AWWA - BNR2 Secretariat, Albury - Wodonga Convention Bureau, PO Box 323, Albury, NSW, Australia 2640.
Attention: Mr WGC Raper. Fax (intl) 613 542 2386. Tel (intl) 613 542 2387.

FISH ASIA '94

OCTOBER 26 - 29

The second Asian aquaculture and fisheries exhibition and conference will be held at the World Trade Centre in Singapore.
Enquiries: ITP Services Pte Ltd., 2 Jurong East St 21#05-19/22 IMM Building, Singapore 2260. Fax +65 296 5384.

SOIL SCIENCE

NOVEMBER 13 - 18

The annual meeting of the Soil Science Society of America will be held in Seattle, Washington, USA.
Enquiries: SSSA, 667 South Segoe Road, Madison, WI 53711-1086. Tel 608-273-8080. Fax 608-273-2021.

ANAEROBIC PROCESSES

NOVEMBER 23 - 25

An international meeting on "Anaerobic processes for bioenergy and environment" will be held in Copenhagen, Denmark.
Enquiries: Mia Clausen, Department of Environmental Engineering, Technical University of Denmark, Building 115, DK-2800 Lyngby, Denmark. Tel +45 45 399308. Fax +45 45 932850.

DESALINATION

DECEMBER 1 - 2

An international conference on desalination and water reuse will be held at Murdoch University, Perth, Western Australia.
Enquiries: Dr K Mathew, Remote Area Developments Group, Institute for Environmental Science, Murdoch University, Murdoch WA 6150, Western Australia. Tel: 61-9-332 2896 Fax: 61-9-310 4997.

OVERSEAS

1995

AWWA

APRIL 2 - 6

The Australian Water and Wastewater Association's 16th Federal Convention will be held in the Convention Centre at Darling Harbour, Sydney, Australia.
Enquiries: The Secretariat, PO Box 388, Artarmon, NSW 2064, Australia. Tel +61 2 413 1288. Fax +61 2 413 1047.

MICRO-IRRIGATION

APRIL 2 - 6

An international micro-irrigation congress entitled "Micro-irrigation for a changing world: conserving resources; preserving the environment" will be held in Orlando, Florida, USA.
Enquiries: Allen Samajstria, University of Florida, Agr. Eng. Department, Gainesville FL 32611, USA. Tel (904) 392-9295. Fax (904) 392-4092.

WATER TREATMENT

MAY 15 - 17

An IWSA specialised conference on advanced water treatment and integrated water system management into the 21st century will be held in Osaka, Japan.
Enquiries: Water Osaka '95, c/o Osaka Municipal Water Works Bureau, 6-28 Minami-ogimachi, Kita-ku, Osaka 530, Japan. Tel 06 (363) 7301. Fax 06 (363) 7362.

AFRICAN WATER CONFERENCE & EXHIBITION

6 - 9 JUNE 1994

NATIONAL EXHIBITION CENTRE
JOHANNESBURG

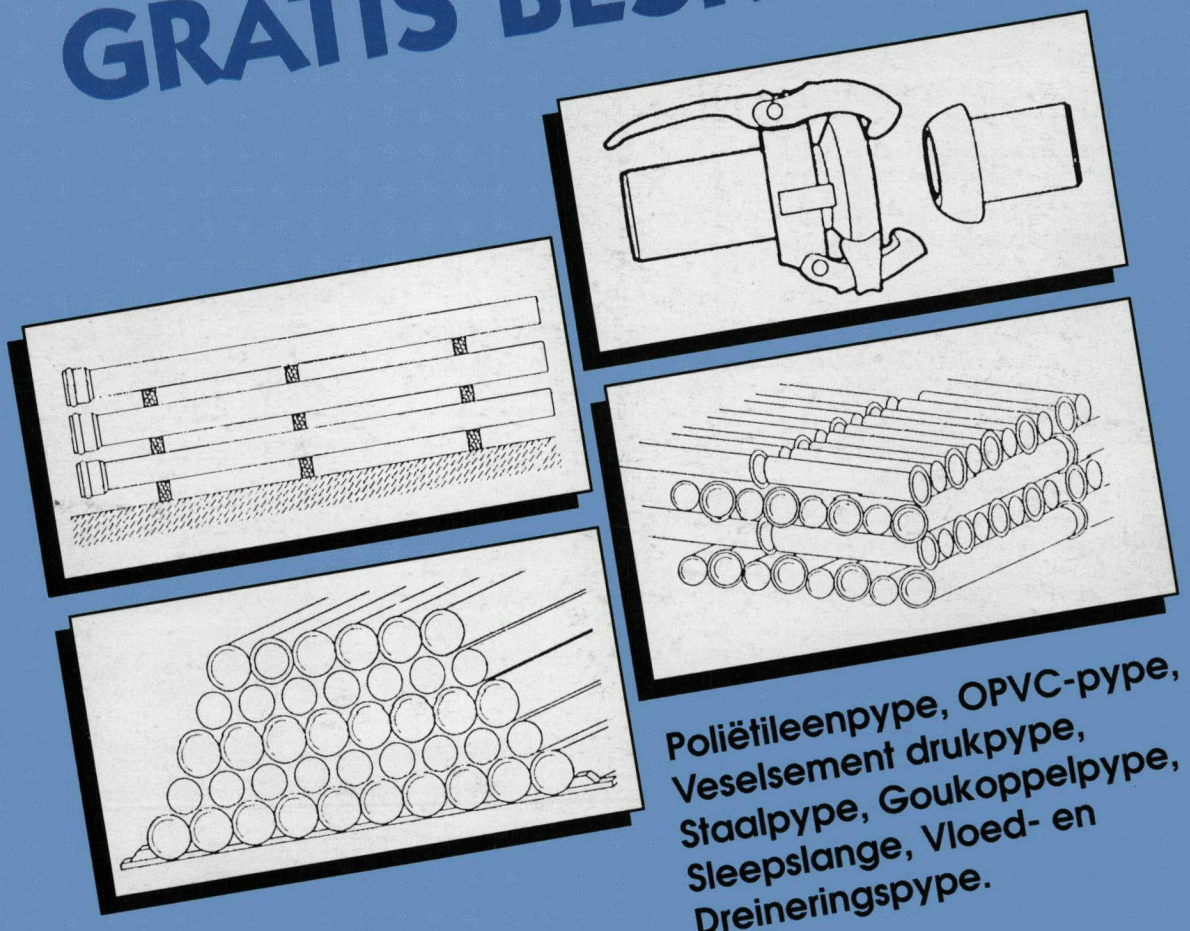
PROGRAMME

Venue	Organising Association	Topic
Monday 6 June		
Hall 1	Mine Water Technical Division, WISA	Mine Water Management
Hall 2	Institute of Waste Management	A workshop on the "Minimum requirements for handling waste", as published by the Department of Water Affairs and Forestry.
Hall 3	Membrane Technology Technical Division, WISA	Electro-Membrane Processes
Tuesday 7 June		
Hall 1	Southern African Industrial Water Association	Industrial water treatment workshop
Hall 2	Sludge Management Technical Division, WISA	Sewage sludge management in the context of current legalisation
Hall 3	Water Scientists Technical Division, WISA	The role of scientists in water purification.
Wednesday 8 June		
Hall 1	Pipeline Interest Group of southern African Corrosion Institute	Practical rehabilitation of pipelines
Hall 2	Nutrient Removal Technical Division, WISA	Appropriate operating technologies for African conditions
Hall 3	South African Chemical Institue.	Chemistry and water quality
Thursday 9 June		
Hall 1	Water Distribution Technical Division, WISA	Water supply and rapid urbanisation
Hall 2	Southern African Society of Aquatic Scientists	South African riverine water quality: management and current research
Hall 3	To be confirmed	

Prof Chris Buckley of the University of Natal will also be organising three computer modelling courses based on his Water Research Commission projects during the conference period. This will be held at a different venue. The three courses are: Chemical speciation; Modelling of reverse osmosis; Modelling of the residence time distribution. For further information please fax your details to Prof Buckley at 031 260 1118.

For more conference details, please contact:
Sally Keeling, Focus Conferences, PO Box 31368, Braamfontein 2017.
Tel (011) 643 4824/8 Fax (011) 642 6011.

PYPHANDLEIDING
GRATIS BESKIKBAAR



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Sleepslange, Vloed- en
Dreineringspype.

- Watter pyp en grootte om te gebruik
- Waar en wanneer om pype te gebruik
- Hoe om die verskillende pype te gebruik

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