



Effluent disposal to sea:

Dilution theories verified

Industry's pressure on the South African marine environment is growing rapidly. According to Dr JA Lusher, Department of Water Affairs, there are at present 61 marine pipelines along South Africa's coast disposing effluent into the sea. While the majority of these are small and discharge only sewage, the number of pipelines discharging industrial effluents is increasing. To cope with this increasing discharge, proper procedures must be adopted to ensure that pipelines are well designed and suitably located so as to eliminate or minimize any possible adverse effects.

Against this background the Water Research Commission last year negotiated a twelve month agreement with the National Research Institute for Oceanology (NRIO) of the CSIR to develop a guide for the marine disposal of effluents.

The Water Research Commission has been involved in sponsoring research into the disposal of municipal sludge to the marine environment since 1980.

Discharge of effluent to the ocean, says Mr John McGlashan, senior adviser, WRC, results in dilution, dispersion and purification of the effluent. The degree of dilution and dispersion, however, depends upon topographic and oceanographic conditions pertaining to the discharge site and will only be satisfactory if a properly designed system is used.

For the design of such a system

a thorough knowledge of the sea bed topography and oceanographic data such as wind, waves and current data are essential. The basic data, coupled with theoretical dilution predictions for various pipeline and diffuser configurations and various chemical, biological and health constraints will be used to produce a design or alternative designs for a particular discharge.

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Effluent to sea

(Front Cover) Photograph taken from an aeroplane at 900m showing the red dye plume as it reaches the surface, with the fishing vessel being positioned for sampling the highest concentration of dye. (Right) Plumes rising from the individual ports along the submarine pipe — identified by rhodamine-stained effluent reaching the surface as individual patches.

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One of the most important aspects of such a design is to ensure that under all oceanographic conditions an acceptable quality of sea water in terms of chemical, biological, bacteriological and physical criteria is ensured in designated areas of the sea, the sea bed or along the coastline.

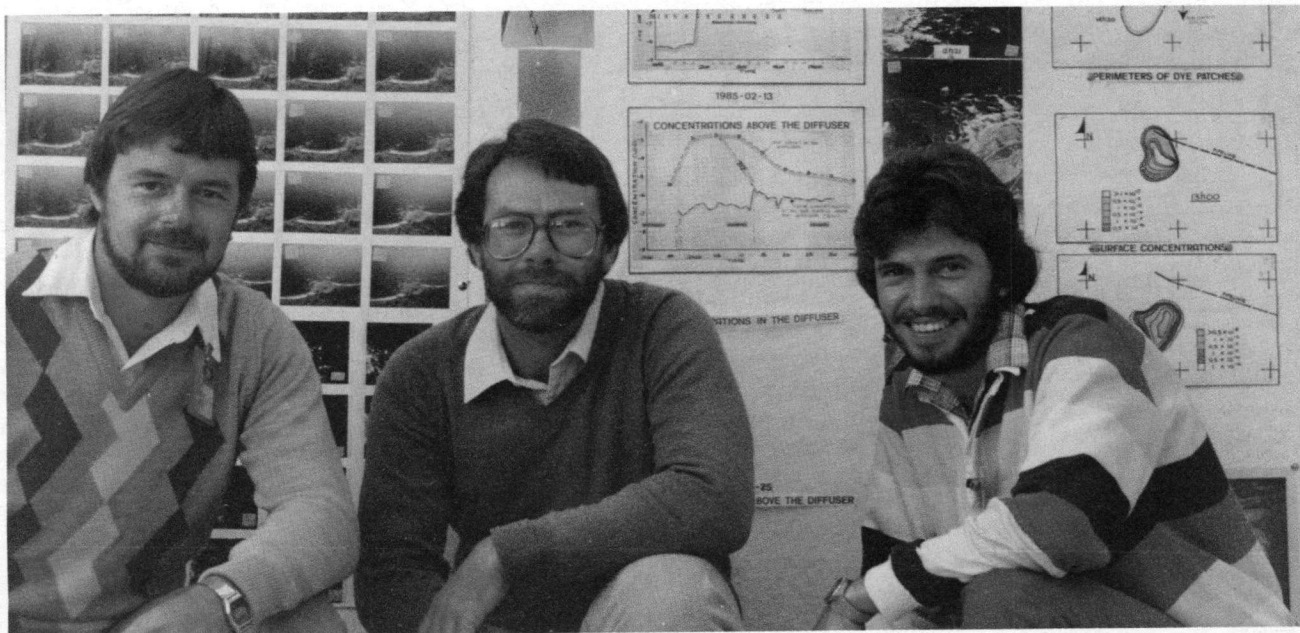
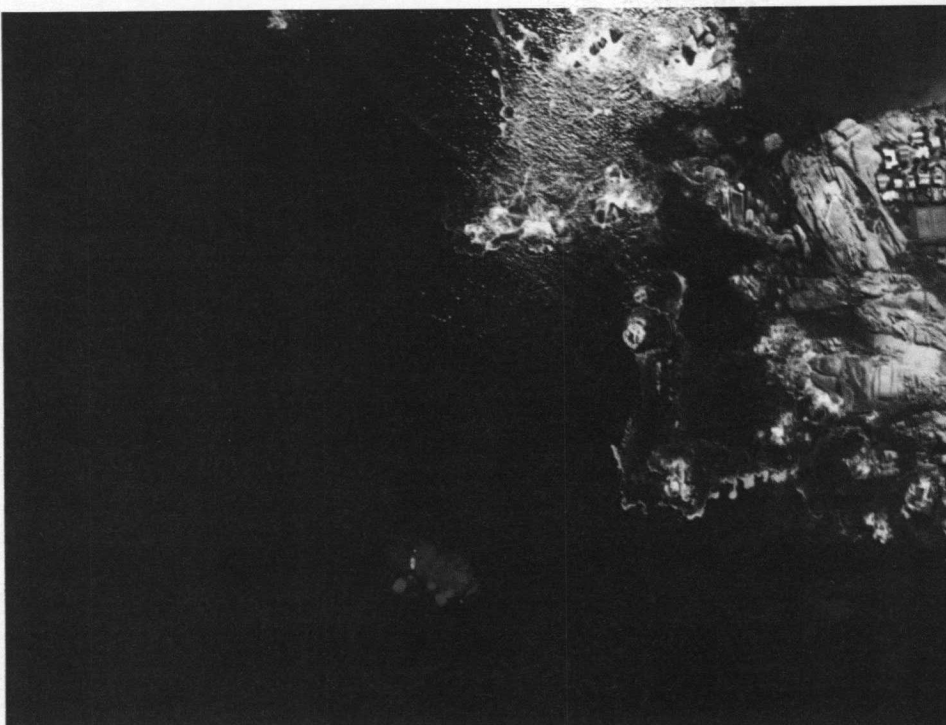
Mr McGlashan says, that at present, the only guide available in South Africa for the design of marine disposal systems is that published by the Natal Town and Regional Planning Commission in 1969 with the title *The Disposal of Effluents into the Sea off the Natal Coast*.

While this publication has served as a valuable and authoritative work in this field, he says there is a need for a new guide owing to the very sophisticated degree of specialisation reached in many of the areas involved and the substantial advances in mathematical modelling techniques and computerisation.

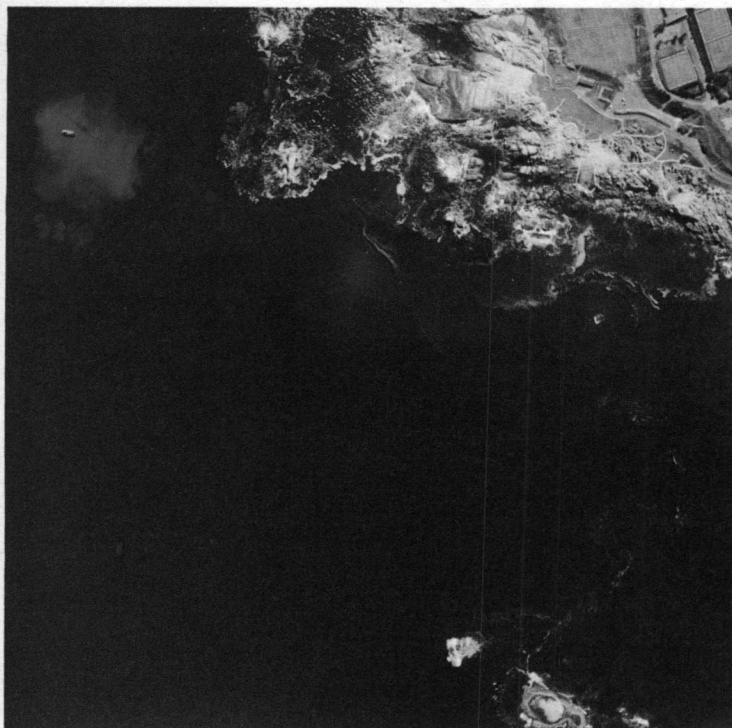
According to Mr Geoff Toms, head of the hydrodynamics and water quality division (coastal

engineering and hydraulics) at NRIO, the new guide will be in the form of a general guideline for practising engineers to assist them in deciding whether a submarine pipeline is a viable option or not, and if so, designing the pipeline and monitoring its performance afterwards.

He says the Water Research Commission's agreement with NRIO consists of two parts. The first part involves the verification of



Three of the members of the Hydrodynamics and Water Quality Division of NRIO who were responsible for planning and executing the field exercises. From left Messrs M van Niekerk, WAM Botes and JJ Buirski. Any one exercise involved up to 15 personnel.



theoretical predictions of effluent dilution when discharged to sea using a submarine pipeline and the second part the preparation of a number of chapters of the new guide. These chapters will deal with dilution calculations, initial data collection and surveys, diffuser design and hydraulics and structural considerations.

Mr Toms says that with respect to theories which predict dilution of effluents it is evident that while many theories have been derived, often supported by laboratory tests and sound computational models, the verification of these theories under full-scale operating conditions is lacking.

To test some of the dilution theories in the field NRIO has chosen a pipeline discharging macerated sewage to sea off Camps Bay near Cape Town.

Fluorescent Rhodamine B dye, which is used as a tracer, is injected for a short period into the effluent. This plug of dye, fully mixed with the effluent, is then pumped down the pipeline at the effluent flow velocity and arrives some time later at the diffusers, at the end of the pipe, where it is ejected through the ports into the sea. The effluent-dye mixture is then further diluted with seawater during its rise to the surface of the sea where the dye concentration is measured with a fluorometer.

This method, says Mr Toms, to release a slug of dye instead of a continuous stream of dye, allows the simulation of a "pulse" which avoids "old" dye coming into contact with "new" dye in the forming effluent field. Intense monitoring of the effluent field during the initial emergence of the dye provides data for the *initial dilution* estimates, while the subsequent monitoring of the 'patch' of dye, observing its growth, movement and concentrations with time provide data for *secondary dilution*.

The initial dilution of an effluent field is that dilution which occurs due to the mixing caused by the momentum of discharge and/or the buoyancy difference between the effluent and the surrounding sea water. At the end of the initial dilution stage, a field of effluent is formed either at the water surface or as a submerged field. Secondary dilution then takes place to further dilute the field by advection and dispersion, transporting effluent away from the outfall.

According to Mr Toms the main design philosophy for a pipeline is to design it according to a theory which does not take into account any currents in the sea.

"We talk about a stagnant water theory and also, for simplicity, about a uniform water column in which there is no density structure

(Top left) Thirty minutes after the first dye-stained effluent has reached the surface. The vessel drifts to the North along with the main dye patch, while water samples are being collected. Residual dye from inside the pipe is still being pushed out with each pumping cycle. (Top) Water samples are being taken for eventual analysis by a fluorometer.

which might impair the mixing of the effluent.

"This uniform stagnant water theory is purely a mathematical set of procedures in the form of graphs from which one can read off, certain information like the depth of discharge, the velocity of discharge and the diameter of the outlet. The velocity and the diameter as well as the density of the effluent compared to the density of sea water is all tied up into the Froude number.

"So if you have got the Froude number and the depth of discharge you can enter these figures on the graphs and come up with the surface dilution of the effluent."

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Dilution theories verified



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Normally a dilution of at least a hundred times is required by the licensing authorities.

Mr Toms says stagnant water conditions however, are very rare in the sea, and therefore there are other theories, moving water theories, which allow one to predict what would happen to the effluent if there is a current.

"If we do measurements on a certain day and there is a current, we can compare the results between the stagnant water theory

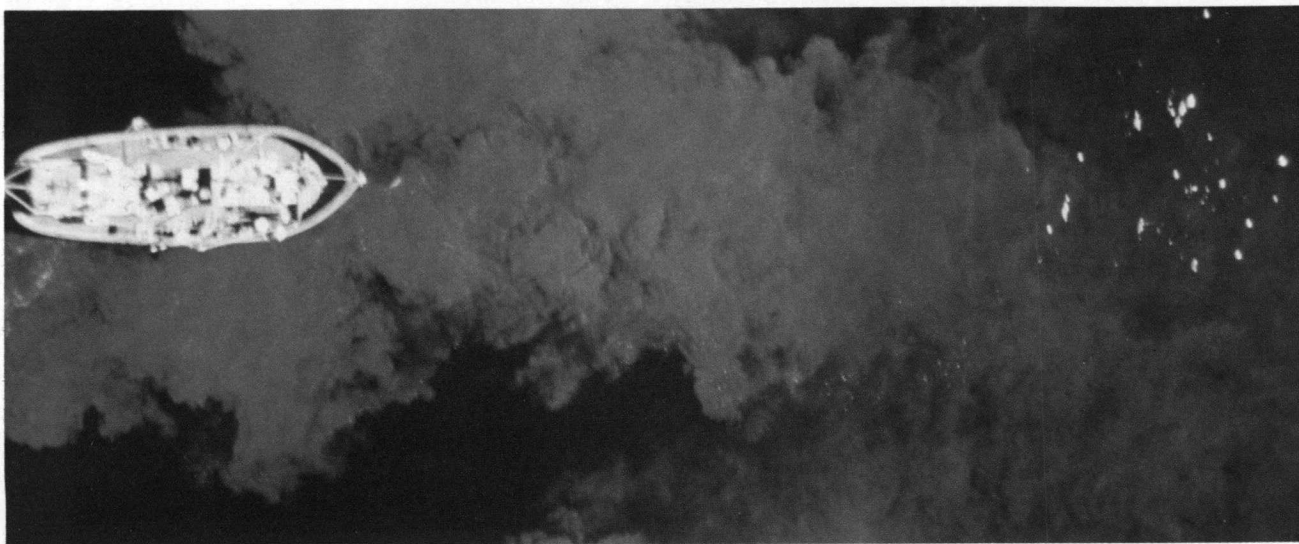
and the moving water theory and try and get a feel for how accurate it is," he says.

So far NRIO has done three verification exercises in the field. The measured initial dilution of the effluent-dye concentration was 750 times at the water surface above the diffuser, which compares favourably with the predicted range of dilutions from 440 to 1 320 times.

Mr Toms says the predicted dilution is very sensitive to the current strength and the degree of density structure in the sea water.

(Top) Mr J Buirski taking samples just as the first Rhodamine dye reaches the surface.

(Below) Vertical photography from 80m height by means of a remote-controlled camera suspended from a tethered hydrogen-filled weather balloon. The trajectory of the plume can be distinguished as it rises from the right to the left.



Novel RO technique tested for desalinating mine water

The quality of mine service water is often poor and saturated with calcium sulphate, creating problems of excessive scaling and corrosion of equipment operating on water underground.

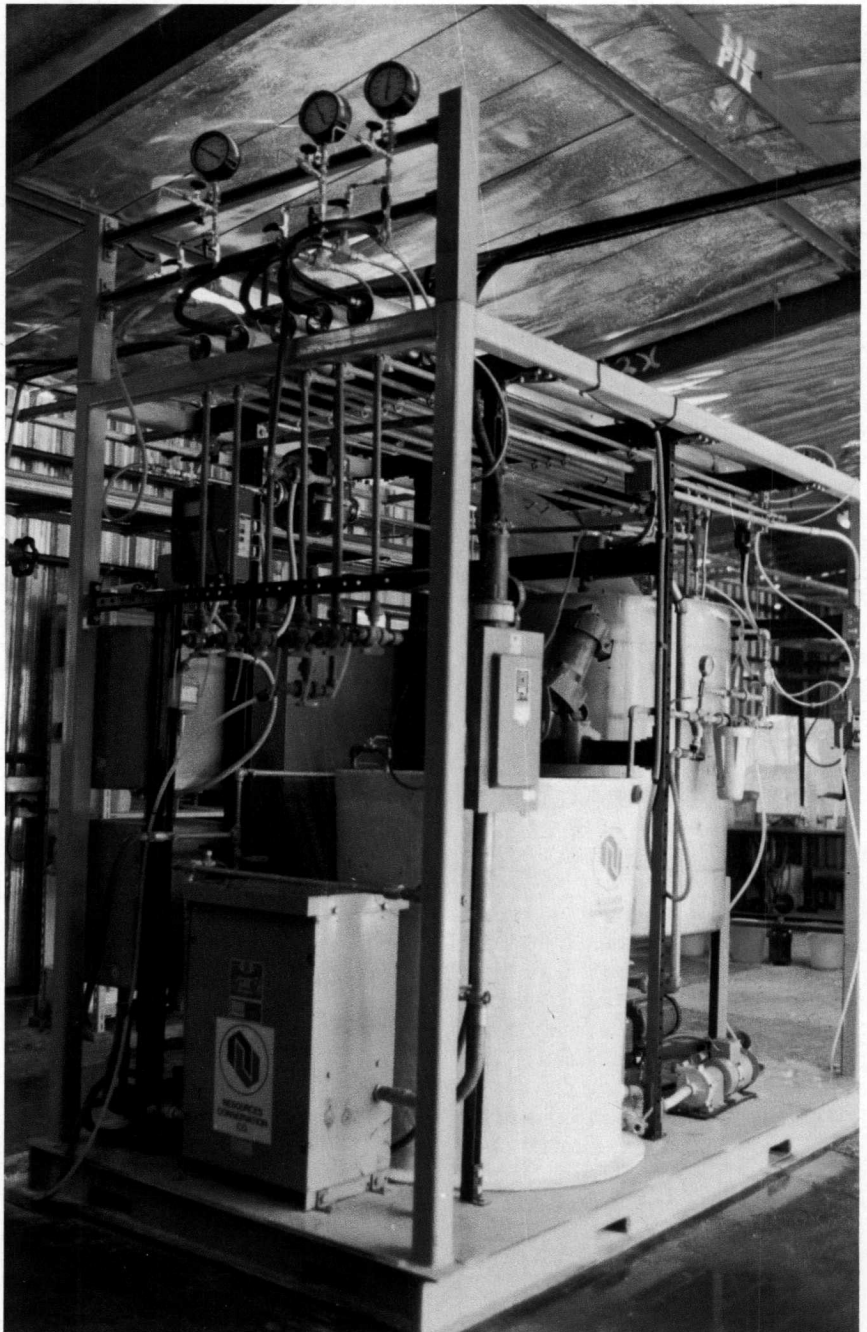
The current practice to improve the quality of this water is to add fresh tap, or fissure, water into the water reticulation circuits. However, tap water is becoming more expensive, and may be restricted in drought seasons, while fissure waters are diffuse and difficult to collect before contamination in mine workings.

An alternative approach to improve the water's quality is to desalinate the used mine service water and recycle it as make-up water. To achieve this a reliable and cost-effective desalination process is required. A number of desalination processes have been assessed by the Chamber of Mines but the high levels of calcium sulphate often present in mine waters make the use of conventional water treatment systems either extremely difficult or costly. One membrane process which showed great potential for this application, however, was seeded reverse osmosis.

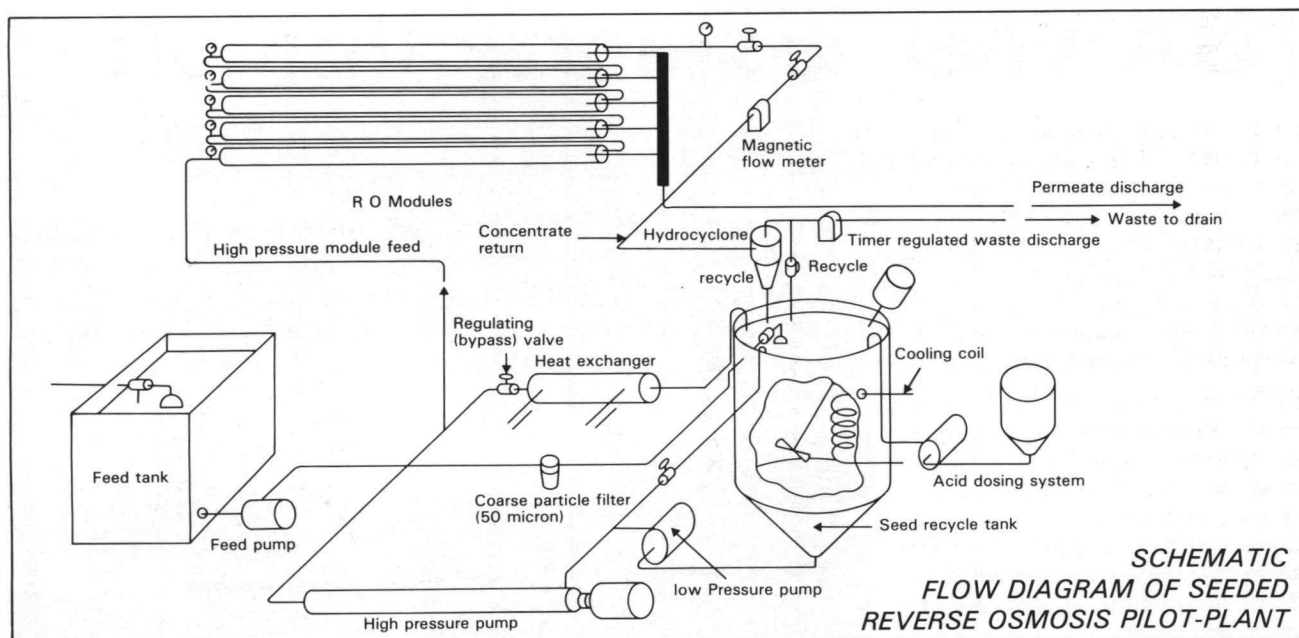
In the seeded reverse osmosis (SRO) process a slurry of "seed" crystals, principally composed of calcium sulphate, is incorporated into the feed water of a tubular reverse osmosis system. These seed crystals then serve as preferential sites for the growth of additional crystals of calcium sulphate, silica and other salts and prevent the formation of scale on the surface of the membrane. This seed material is added to the system at start-up. After the initial load is added no further outside source of seed material is required as the process is self-sustaining through the continuous crystallization of calcium sulphate.

Tubular reverse osmosis systems are required for the SRO process as slurries of 3-10 per cent solids are circulated continuously in the system. Such concentrations of suspended solids would rapidly result in complete blockage of either spiral or hollow fibre configuration RO modules. These high concentrations of suspended solids are achieved through the use of hydrocyclone in the concentrate return stream. The fraction of the

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The (5 m³/day) reverse osmosis plant which was operated at the ERPM gold mine on the East Rand on mine service water pumped to the surface. The equipment was supplied by the American Resources Conservation Company.



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hydrocyclone-processed stream that is enriched with seed material is returned to the seed recycle tank and the seed depleted stream then becomes the waste. This recycle of seed, plus the fact that SRO systems operate at high water recovery, leads to high total suspended solids levels in an operating SRO system. The high recoveries can be achieved on waters saturated with calcium sulphate without producing excessively high osmotic pressures because the calcium sulphate content of the feedwater is precipitated in the seed slurry process.

To evaluate seeded reverse osmosis in desalinating a scaling-type mine water, the Water Research Commission initiated a collaborative study with the Chamber of mines Research Organisation and the American Resources Conservation Company (who developed and patented the SRO process, and supplied the equipment).

The Chamber evaluated a small 5 m³/day SRO pilot plant which was operated at the ERPM gold mine on the East Rand on mine service water pumped to the surface. The pilot plant was operated at high water recoveries (94-96 per cent) for a period of 5 000 hours and the results have been very promising.

In the pilot plant the mine water is fed into a holding tank and then

pumped, via a 50 micron cartridge filter, into the seed recycle tank. From the recirculation tank, the feed liquid is pressurized to about 4 MPa in a horizontal, multi-stage centrifugal pump and fed to the RO modules in series. As the water passes through the modules, permeate is extracted and the remaining solution becomes more concentrated. Salts then start to precipitate on the seed crystals when their solubilities are exceeded. Upon leaving the last module, pressure is reduced through throttling valves and the reject slurry enters a hydrocyclone. The hydrocyclone concentrates the solid seed material for recycle back to the recirculation sump and the overflow is blown down to waste as required for the desired recovery levels.

The only pretreatment which is undertaken before the mine water is fed to the SRO system is coarse (50 micron) particle filtration, to protect the pumps, pH control (pH 4-6) to protect the membranes, and chlorine addition to prevent biological growth.

RESULTS

- No evidence of either scaling or fouling of the RO membranes has been observed.
- The dissolved solids rejection of the modules decreased by some 5 per cent (from 98 per cent) with respect to the seed slurry

feed water and by 15 per cent (from 85 per cent) with respect to the incoming mine water, during the test programme. The product water quality correspondingly deteriorated from about 350 to 900 mg/l dissolved solids. This decline in performance is significant but not excessive and might well have been more satisfactory if optimum operating conditions had been maintained to minimise hydrolysis of the RO membranes.

- The product water flow from the plant was up to specification and an average permeate flux of about 650 l/m²/d (normalised to 2 750 kPa and 25°C) was being achieved after 5 000 hours. This flow rate corresponds to 1 100 litres per module per day.
- The unit has been operated successfully by unskilled personnel and the process has remained insensitive to variations in operational conditions.

Although the initial investigations have been very successful, further test work on a larger unit needs to be carried out to determine costs. Even so, the technical feasibility of the SRO process to desalinate mine service water has been demonstrated.

The research project was carried out under the leadership of Dr RC Harries, Engineering Materials Branch, Chamber of Mines.

SA voer waterinligting uit

'n Ooreenkoms tussen die Suid-Afrikaanse Inligtingsentrum vir Water en Pergamon Infoline ('n internasionale verspreider van gerekenariseerde inligting) in Engeland, het daartoe gelei dat inligting oor water wat in Suid-Afrika versamel word, binnekort wêreldwyd beskikbaar sal wees.

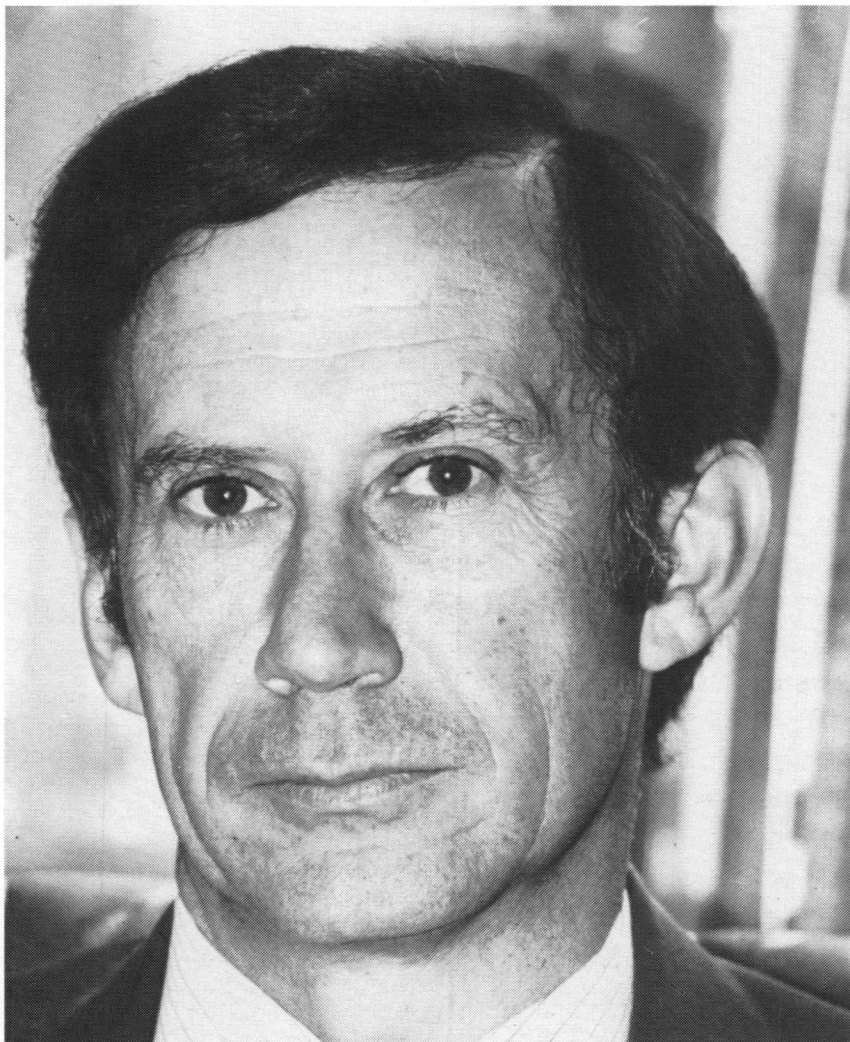
Dr Thys Pieterse, senior adviseur van die Waternavorsingskommissie, het verlede jaar die eerste aanvoorwerk vir die ooreenkoms gedoen toe hy tydens 'n buitelandse besoek, onder andere, die bemerking van die Suid-Afrikaanse inligtingsdiens, bekend as *Waterlit*, ondersoek het.

Kragtens die kontrak sal Pergamon Infoline beide 'n vaste minimum jaargeld asook tantieme aan die inligtingsentrum vir Water betaal vir die gebruik van *Waterlit*.

SAIW

Die Suid-Afrikaanse Inligtingsentrum vir Water (SAIW) wat deur die WNNR onder kontrak met die Waternavorsingskommissie bedryf word, het in 1976 begin om die gerekenariseerde bibliografiese databasis *Waterlit* te ontwikkel. Sedertdien het dié inligtingsdiens merkwaardig gegroei. Ongeveer 560 internasionale en plaaslike wetenskaplike en tegniese tydskrifte word op 'n gereelde grondslag vir insluiting in *Waterlit*, geïndekseer. Voorts word verslae, boeke, patente, tesisse en konferensie-mededelings in verband met water ook daarin opgeneem. Daar is reeds 105 000 items in hierdie omvattende databasis en meer as 1 200 items word elke maand bygevoeg. Die Suid-Afrikaanse Inligtingsentrum vir Water lewer ook retrospektiewe soektogte en SDI (selektiewe disseminasie van inligting)-dienste op *Waterlit* aan 'n groot getal en verskeidenheid van persone wat in die waterveld in Suid-Afrika betrokke is.

Dr Pieterse sê Pergamon Infoline het onlangs ook 'n kontrak met die Water Research Centre (WRC) in Brittanje gesluit waarvolgens hulle



Dr Thys Pieterse, senior adviseur, WNK.

toegang tot die WRC se waterdatabasis *Aqualine* met sy ongeveer 80 000 items verkry het.

"Verder is Pergamon met voorbereidings besig om 'n verdere waterdatabasis, naamlik *Selected Water Resources Abstracts* (SWRA) in hulle portefeulje op te neem. SWRA word deur die Water Resources Scientific Information Centre, US Department of Interior, geproduseer."

Pergamon Infoline sal dus 'n omvattende internasionale inligtingsdiens oor wateraangeleenthede kan aanbied. Alhoewel daar oorvleueling tussen hierdie databasisse bestaan, het elkeen ook sy unieke versameling van inligting.

Volgens mnr Morkel Steyn, bestuurder van die SAIW, is Pergamon reeds in besit van die

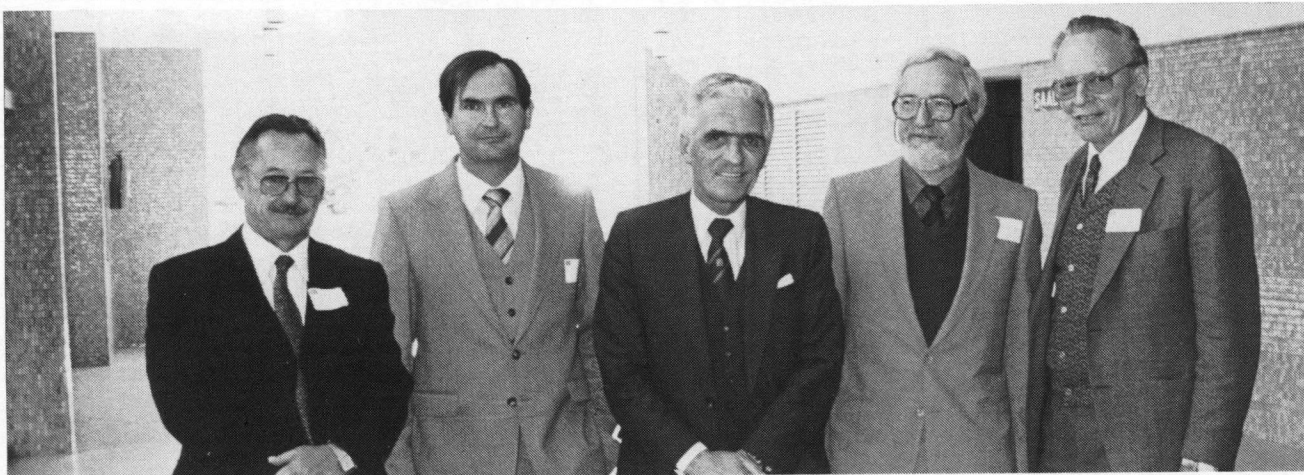
volledige band met *Waterlit*-data en behoort hulle dit binnekort te kan gebruik in hulle soektogte. Hy sien uit na goeie samewerking met die Britte, ook ten opsigte van gesamentlike bemerkingsaksies wat geloods sal word.

Kwaliteit

Dr Pieterse sê Suid-Afrika kan trots wees op die hoë kwaliteit van waternavorsing wat in die Republiek gedoen word en in baie opsigte wêreldwye erkenning geniet.

"Deur middel van hierdie nuwe ooreenkoms met Pergamon Infoline sal die navorsing- en ontwikkelingswerk in Suid-Afrika nog wyer bekend gestel word en verdere kontakte vir Suid-Afrikaanse waternavorsers opgebou word."

GROUNDWATER '85



(Top) From left: Dr PJ Smit (Geological Survey), Dr PJT Roberts (WRC), Mr GJ Kotze, Deputy Minister of Agricultural Economics and Water Affairs, Professor B th Verhagen (Wits) and Mr JR Vegter (Department of Water Affairs).

The biennial symposium of the Geological Society, this year titled **Ground Water '85**, was held from 1 to 4 July at the University of Pretoria.

The theme was resource assessment, management and conservation. Discussions centred on drought relief and rural water supply, ground water modelling, dolomite aquifers, isotope studies and ground water and contamination.

The symposium was opened by Mr GJ Kotze, the Deputy Minister of Agricultural Economics and of Water Affairs, and included a day visit to the West Rand Dolomite Area.



A sinkhole on the West Rand.

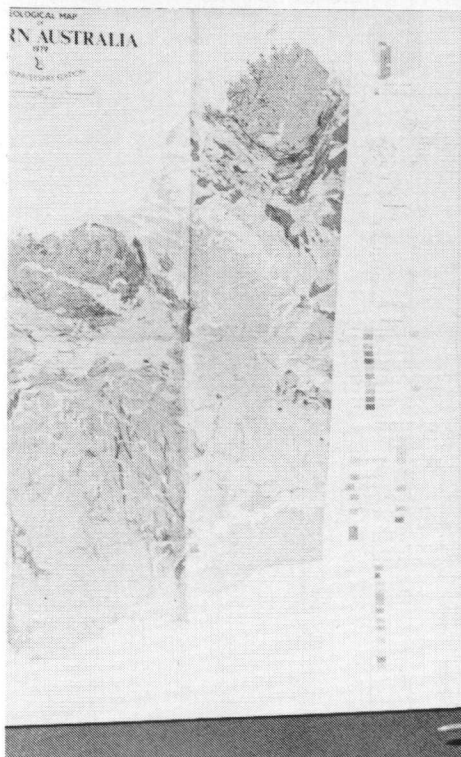
Mr FJ Sandilands (Technicon Witwatersrand), left, and Mr BF Lubbe (PPC, Lime Acres).



GROUNDWATER '85



(Top) Delegates at the Zuurbekom Pumping Station.



(Left) Mr TT Bestow (Geological Survey, Western Australia).
(Below) Delegates at borehole ZM30.



(Below) Professor D Sparks (UCT),
left, and Mr W van der Merwe
(Kanty McDonald).



(Below) From left: A Simmonds
(Goldfields), S Rosin (SRK) and
A Harley (SRK).



Institute of Water Pollution Control

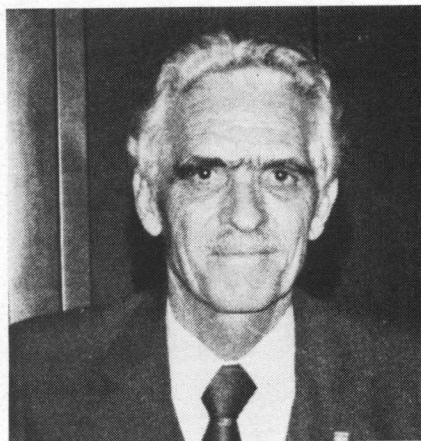


From left: Mr Brian Trim (City Engineer's Department Johannesburg), Mr John McGlashan (WRC), Mrs Margot Leathern (Westville), Mr Fred Kolbe (SS & O).



From left: Mr Johan Wagner (Rand Mines), Mr Hendrik Best (Department of Water Affairs), Mr Johan Vorster (Alberton Municipality).

All aspects of water pollution and its control were reviewed at the biennial conference of the South African Branch of the Institute of Water Pollution Control (IWPC) held in Durban earlier this year. Attending the conference were almost 350 scientists and engineers.



Mr GJ Kotze (Deputy Minister of Agricultural Economics and of Water Affairs).



Mr Piet Odendaal (Chairman of IWPC), left, and Mr John O'Neill (President of IWPC).

The conference was opened by the Deputy Minister of Agricultural Economics and of Water Affairs, Mr GJ Kotze, and addressed by the President of the Institute, Mr John O'Neill from England.

Other activities included the banquet, Civic reception and farewell party. Post-conference tours were organised to Durban's Northern Wastewater treatment plant and the Umgeni Water Board's Wiggins Water Works.



From left: Dr Thys Pieterse (WRC), Dr Danny Walmsley (CSIR), and Dr Dirk Grobler (CSIR).



From left: Dr Wiechers (WRC), Dr Dold (UCT), Mr and Mrs Palmer (Ninham Shand) and Mr King (Cape Town).

IWPC

Oozing promises of clean water . . .

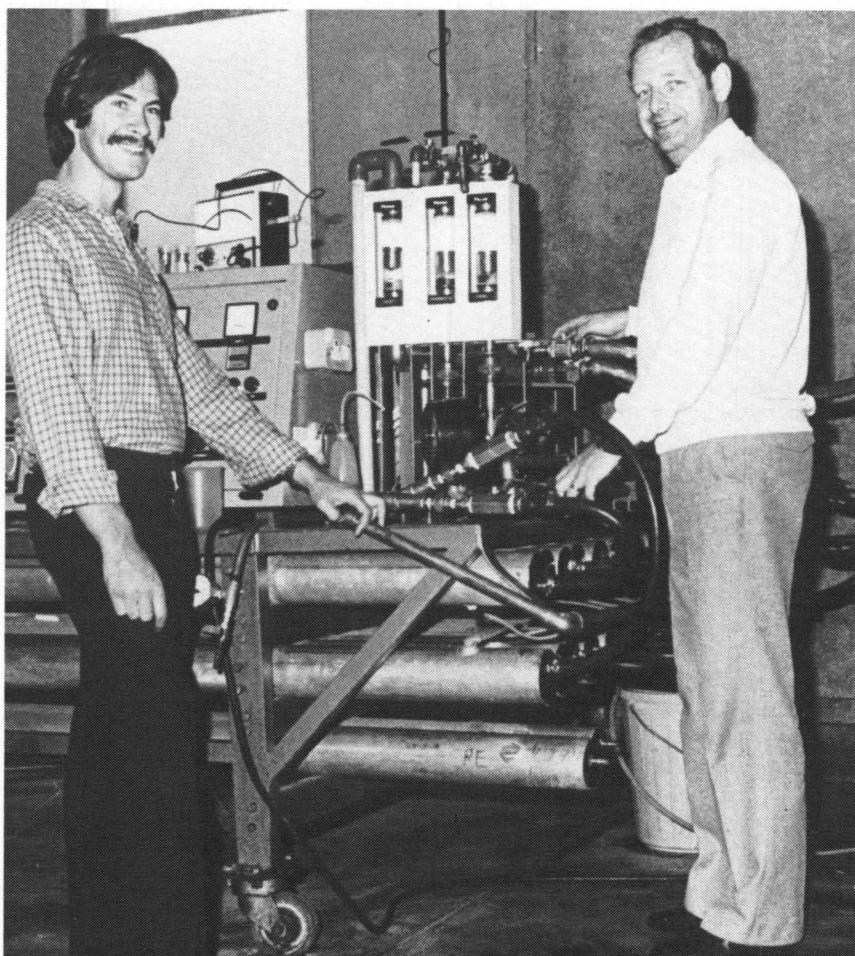
Port Elizabeth Municipality is investigating the reclamation of secondary sewage effluent by reverse osmosis at its Fishwater Flats Works. After almost two years of pilot studies the results are sufficiently encouraging for a larger prototype plant to be considered. Details of the results obtained during the first 10 000 hours of running were presented at the I.W.P.C. Conference in Durban in May this year ('Reclamation of secondary sewage effluent by reverse osmosis: a pilot plant study' by Vail J.W. and Barnard J.P.). One of the authors, Mr John Vail, answered these questions for *S.A. Waterbulletin* on behalf of the City Engineer, Port Elizabeth.

Why is Port Elizabeth interested in the reclamation of sewage effluents?

Mainly as a *supplementary* source of water.

Assessments of potential future water supplies for the Port Elizabeth Metropolitan Area include the possibility of using water reclaimed from sewage. The reason is not the lack of exploitable bulk resources but the belief that non-conventional sources of water could, with advantage, be integrated with the development of conventional surface water supplies. It is accepted that reclaimed water is unlikely to provide a base supply in the foreseeable future but, under certain circumstances, the use of reclaimed water, as a supplementary source, could prove to be a viable proposition, particularly in meeting peak demands or when existing sources are far from the point of use.

For these reasons the Fishwater Flats Works, which treats 90 per cent of the city's sewage and which came on stream in 1976, was designed with water reclamation in mind. The sewerage system supplying the works collects separately from the predominantly domestic and predominantly industrial areas of the town and this separation is maintained throughout the liquid purification process, so that tertiary treatment can be applied to an effluent which is mainly domestic in origin. At the present time tertiary treatment, in the form of rapid sand filtration and chlorination, is being applied to about 5 Ml/day of secondary effluent to produce a second class water which is used by several industries and on the sewage works itself. The tertiary facilities were



Mr John Slim (right) and Mr Chris Taylor, both of the City Engineer's Department, Port Elizabeth, with the Bakke reverse osmosis unit used in the pilot plant study.

designed for a maximum of 15 Ml/day but, so far, the demand for that amount of second class water has not emerged.

A further step in the development of water reclamation was taken in 1983 when a small reverse osmosis (RO) plant was commissioned at Fishwater Flats to

investigate the RO-method of purifying tertiary treated sewage effluent to potable water standards.

Why did you choose to treat the effluent by reverse osmosis and not, for instance, with one of the other well-proven techniques?

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IWPC

Clean water

(From page 11)

The dissolved solids content of the domestic secondary sewage effluent at the Fishwater Flats Works is already 600-1000 mg/l and averages 750 mg/l. The process developed at Daspoort, for instance, by itself, does not demineralise. A choice of RO was made for the demineralisation step and the question then arose as to what extent the organic matter could be removed by RO without unacceptable fouling of the membranes. The RO system manufactured by Bakke Industries Ltd in Paarl, a tubular membrane system with flow reversal, seemed to offer the most promise for membrane cleaning. It also featured a novel and inexpensive support module which to some extent offset the higher costs associated with tubular systems. Finally, the NIWR had already done some research on this particular system (see page 32) and we decided to follow suit.

Can you tell us something about the pilot plant and the feed used in the experiment?

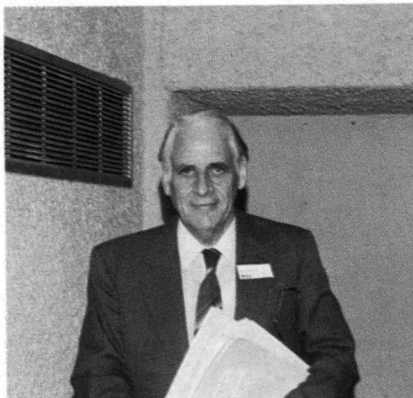
The 40 m³/day pilot plant is a single-pass, tubular system of cellulose acetate membranes arranged in a 2 × 16, non-tapered, module configuration with flow reversal every hour. One layer has sponge-balls, the other does not.

The plant began operating on 17 August 1983. It is now in its 22nd month of operation and has completed more than 13 000 hours actual running time. Throughout this period the feed was the tertiary treated sewage effluent, described above, fed to the RO unit after storage in a roofed reservoir for about two days. The feed was further filtered by means of a 50 µm in-line cartridge filter on the RO unit but no other pre-treatment was used. No attempt has been made to protect the unit from the normal vagaries of a sewage treatment plant, such as occasional poor quality effluents, failures in chlorination equipment, power failures and so on. The feed has

always been that which would be obtained in practice.

Membrane fouling is always a problem with RO systems. What was your experience in this pilot plant study?

One of the main purposes of our pilot plant investigation is to measure flux decline caused by fouling, in a system that includes flow reversal and sponge-ball cleaning, and to test the effect of various wash solutions. The standard peak flux values, obtained immediately after each weekly wash and calculated at 20°C and 4 000 kPa, aver-



Mr John Vail.

aged 679 l/m²/d during the 300-2 000 hour period and 646 l/m²/d during the 9 000-10 000 hour period, a drop of only 4,9 per cent. This good result was only achieved with a high pH washing agent (which could affect salt rejection — see below) and steeper flux decline rates are being experienced with neutral washes, so the optimum washing agent still has to be determined. Nevertheless, the modest flux decline so far observed in this experiment is encouraging and gives a reasonable expectation of an acceptable working life for these membranes with this particular feed water. It is interesting to note that organic fouling appears to be controllable, even with pre-treatment that consists only of rapid sand filtration and chlorination, provided careful attention is paid to membrane washing. A steep drop in flux occurs in the first 300 hours, due to membrane compression, and is allowed for in the design of an RO plant.

What about membrane degradation?

Another major objective of the pilot plant investigations is to determine the rate of membrane degradation as a result of chemical or bacterial (enzyme) hydrolysis or other factors. Membrane degradation is best measured by salt rejection.

The overall salt rejection of the pilot plant (measured as conductivity) is monitored daily and remained close to an average of 89 per cent for over 9 000 hours. This result was confirmed by salt rejection surveys on individual modules at regular intervals. A gradual decline in salt rejection occurred after 9 000 hours but, with a change to a low pH (6,0) washing agent, it levelled off at about 10 500 hours and 85 per cent rejection, followed by a slight improvement. The loss of salt rejection may have been due to membrane hydrolysis, caused by prolonged use of a highly alkaline wash, and obviously we still have to find the optimum pH for the wash solutions. Four module failures have so far taken place due to defects in manufacture.

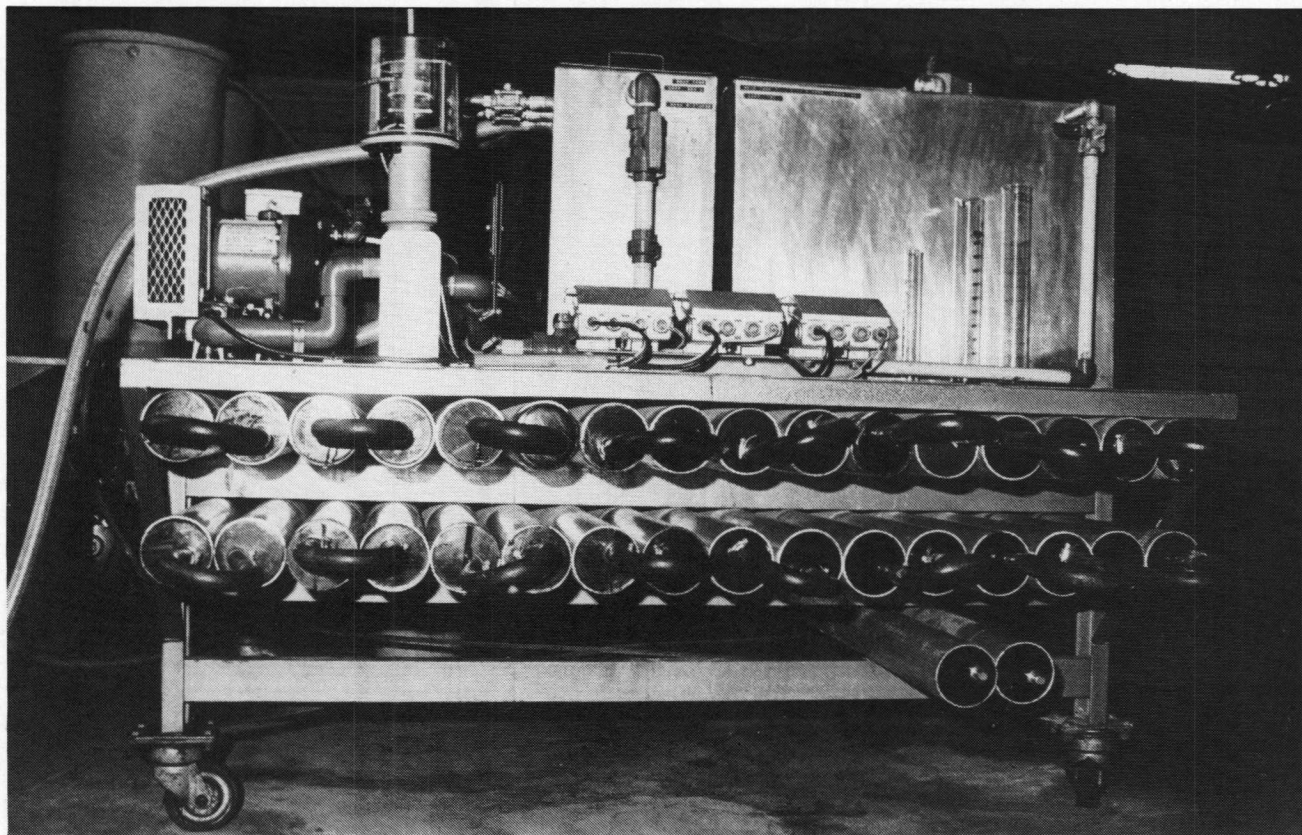
Is the quality of the water produced of a potable standard?

It was not one of the objectives of this experiment to make an exhaustive study of product water quality, but we determined most of the chemical constituents, other than the organic micro-pollutants. For those constituents which were determined, the product was of potable standard, except, perhaps, for ammonia and THM's. pH adjustment will also be necessary. Reduction of THM's will be linked to the optimum procedure for pre-RO disinfection, which will be investigated later. The clarity of the product is such that final disinfection will be simple and effective, once the ammonia levels have been reduced.

What are your plans for the future?

It is proposed to continue the pilot plant work for another year, mainly to continue observations on flux decline and membrane degradation, or other failures, but also to investigate longer periods between

IWPC



The 40 m³/day Bakke pilot plant used at the Fishwater Flats Works, Port Elizabeth, was a single-pass, tubular system of cellulose acetate membranes arranged in a 2 x 16, non-tapered module configuration with flow reversal every hour.

flow reversals (at present 1 hour), various washing agents, alternatives to chlorine as disinfectant, and product stabilisation (pH adjustment).

But you are also planning the construction of a larger reverse osmosis system at the Fishwater Flats Works?

Yes. Even if the results obtained from the pilot plant continue to be favourable, there are three main areas in which a pilot plant does

not provide sufficient information —

- large-scale operational problems including maintenance aspects,
- maintenance of potable water quality under full-scale operational conditions (quality control in a pilot plant is a relatively simple matter), and
- estimate of true operating costs (there is always some uncertainty in extrapolating these from a pilot plant study).

For these reasons, and because of a general lack of experience in South Africa in using RO for sewage effluent reclamation, it is considered that the next essential step in the development of this technology is the construction and operation of a larger plant. If we go for about 500 m³/day we should be able to obtain the information we want and, also, might find a useful outlet for the reclaimed water as boiler feed make-up.

Swedish awards for best innovations

In June 1986 the Swedish Inventors Association will be one hundred year old — the oldest in the world.

To celebrate this occasion four awards of about \$30 000 each will be presented by the King of Sweden to the best innovations made during the past ten years in the areas *Water, Industry, Forestry and Energy*. These target areas

were carefully selected in 1976 when the International Inventors Awards initiative was first announced.

The Nobel Prize model was chosen for the nomination procedure.

The nominations will involve several thousand organisations, research institutes and individuals around the world. Among these should be mentioned the United

Nations Development Programme, the UN Food and Agriculture Organisation, the United Nations Industrial Development Organisation, the World Bank and all Patent Offices in the world.

Enquiries:

Inventors Association,
PO Box 16020,
S-10321 Stockholm, Sweden

IWPC

Biothermal process economical

Biothermal stabilisation of sewage sludge is an attractive low-level technology and cost-effective process not only for developed areas but also for under-developed areas.

The National Institute for Water Research (NIWR), in collaboration with the Water Research Commission, is conducting research into biothermal stabilisation of mixtures of sewage sludge and filler material in terms of degree of stabilisation and pasteurisation achievable. Research also includes an investigation into cost aspects. The results to date were presented at the IWPC Conference in Durban by Mr JH Nell, Control Research Technician at the NIWR in Bellville.



A pile of sludge mixed with woodchips undergoing biothermal stabilisation during which temperatures in excess of 70°C are readily achieved. The aeration fan is seen in the foreground.

An increasing need for the disposal of sewage sludge on land has until now been hampered by the potential threat of the transfer of pathogens from sludge to man. Sludge can be pasteurised by composting, but this has not been possible in the past because of excessive moisture in dewatered sludge.

A process has been developed in the USA which uses wood chips in the biothermal stabilisation process

to absorb the excess moisture from dewatered sludges. This process has been evaluated under local conditions by the Cape Regional Laboratory of the NIWR.

In his presentation Mr Nell said that biothermal stabilisation offers significant advantages in eliminating pathogens. Addition of filler material not only solved the high moisture content problem, but also

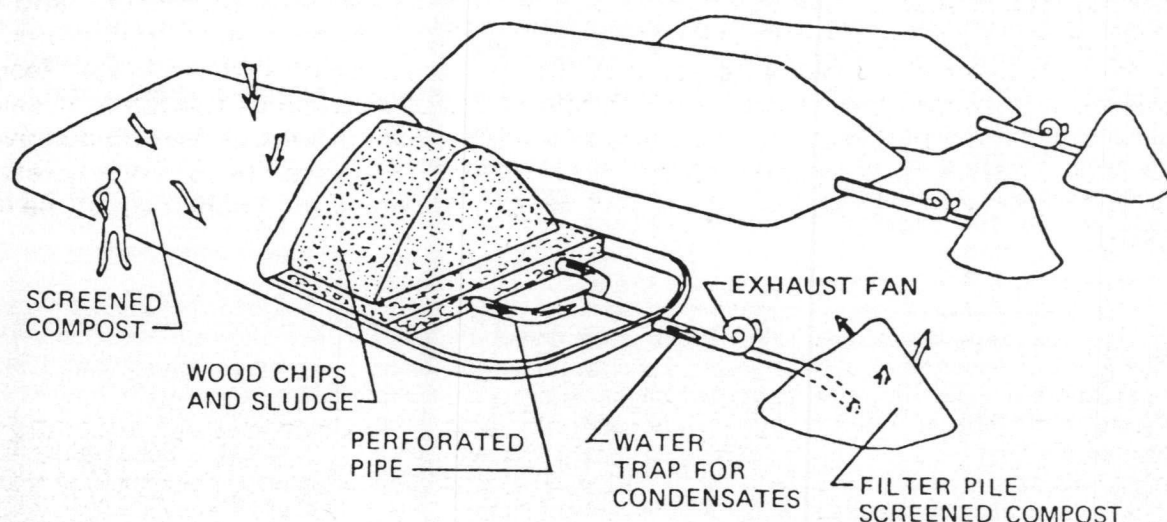
reduced costs by eliminating regular turning of windrows.

"It is believed that the biothermal stabilisation of sewage sludge is an attractive process not only for application in developed areas, but also in under-developed countries because of its cost-effectiveness and the relatively low level of technology required," Mr Nell said.

According to Mr Nell the results of the investigation showed with

IWPC

COMPOSTING WITH FORCED AERATION



Schematic diagram of forced aeration composting process (Photo: Manual for composting sewage sludge by the Beltsville aerated-pile method).

respect to dewatering of the sludge that:

- low polyelectrolyte dosages and even no polyelectrolyte addition to the feed of the centrifuge still produced an acceptable sludge cake in terms of moisture content although solids capture was reduced considerably;
- the percentage moisture in the sludge cake and solids capture when dewatering the sludge by filtering the sludge through a bed of wood chips compares favourably with results obtained when dewatering by centrifuge;
- the mixing of sludge produced by this non-mechanical dewatering with wood chips required less labour.

With respect to the biothermal stabilisation process Mr Nell said that:

- a sludge to wood chips ratio of 1:2 gave better results than a 1:1 ratio in terms of aeration requirements and heat generation;
- the composting mixture of sludge and wood chips is not fully stabilised after the initial 14 day aeration period. However, complete elimination of the four

individual microbiological indicator organisms tested, is obtained within the 14 day period;

- a 30 cm insulation layer of matured compost provided better results in terms of stabilisation and pasteurisation;
- an aeration rate of 4 m³ per ton of dry material gave optimum stabilisation and pasteurisation;
- a higher reduction in carbon content was obtained in the middle of the windrow than in the lower zone. A loss of nitrogen occurred during stabilisation with the rate of loss in the middle of the windrow being higher than in the lower section;
- faecal coliforms, *Salmonella*, Coliphage and viable *Ascaris* ova are completely eliminated in the middle and lower section of the windrow;
- no obnoxious odours could be detected outside the boundaries of the composting site. On the site the only malodour emanated from the freshly produced sludge cake, but was only limited to the vicinity of the dewatering section;

- there was a complete absence of runoff from the completed windrows. The runoff produced by the non-mechanical dewatering section was channelled away and presented no problems;
- during the maturation stage no further loss in nitrogen content occurred. A reduction in carbon content continued during this period resulting in adequate stabilisation;
- approximately 40 per cent total reduction in mass was obtained. The greatest part of this loss in mass was caused by the removal of moisture;
- the cost per ton of dry material processed will be less than that of domestic refuse composting. Compost produced from sewage sludge is also more valuable in terms of nutrient content and aesthetic appearance than domestic refuse compost or digested sludge. Other benefits include the absence of any landfill requirements and the elimination of costly anaerobic digesters and drying beds.

IWPC

Sugarcane flourishes on treated sludge

As a cost-effective alternative to disposal, the utilisation of treated sludge for agricultural purposes is becoming more and more important. According to Mr JS Easton, a chemist with the City Engineer's Department of Durban, R45 000 per annum can be saved on a 100 hectare sugarcane farm, if sludge instead of inorganic fertilizers were used.

Mr Easton is currently undertaking a long term investigation using single applications of anaerobically digested sludge for sugarcane cultivation. The sludge is taken from the Northern Waste Water Treatment Works near Durban.

Although the experiment will continue for a number of years, the results to date have shown rather spectacular differences in rate of growth, colour and size of the sugarcane plants growing in the sludge treated soil, compared to the plants growing in the soil with

inorganic fertilizers. "The differences were already noticed three weeks after planting and became progressively more obvious with time," Mr Easton said.

He continued: "The plants growing in the soils treated with filter press cake and with liquid digester sludge, were dark in colour and extra shoots or tillers appeared three weeks after planting. The green colour intensified with time and the tillers became as tall and thick as the original plant.

"In the case of plants which re-

ceived the usual levels of applied inorganic fertilizers, the colour of the leaves was normal but far less intense than the plants in the sludge treated soils," Mr Easton said.

The control soil after 11 months gave a cane yield of only 18 t per hectare compared to an average of 160 t per hectare for the sludge treated soil.

Another interesting observation included the difference between the tillers provided by the control plants and those being treated by



The sugarcane treated with fertilizers (left) at 11 months compared to the sugarcane treated with treated sludge (right) for the same period.

IWPC

sludge. No tillers were produced by the control plants after they had been harvested, while between 12 and 33 tillers per lysimeter were counted in the sludge treated trials.

Nematode damage to the roots of the plants in both the sludge treated and control soils was noticed five months after planting. "Use of the nematicide "Temik" had to be delayed however, until completion of the pathogen decay study, since the latter would have been affected by the treatment," Mr Easton said.

Mr Easton pointed out that it is difficult to compare experimental data with results in the field but added that throughout the investigation all the results obtained were compared with controls under identical conditions.

On a question about the possibility of farmers making use of sludge for agricultural purposes, Mr Easton said that it is not possible at this stage because of certain health restrictions.

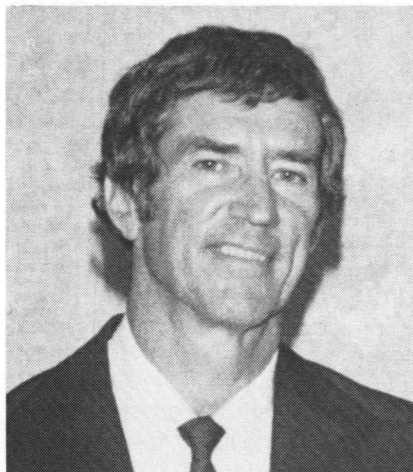
Heavy metals, complex organic compounds and pathogenic bacteria, viruses and helminth ova

can all present potential health hazards if not adequately controlled.

Pathogen tests

Dr MB Richter, Medical Health Officer of Durban, conducted certain pathogen decay tests on the sludge being used in the sugarcane investigation.

Based on these pathogen decay results and subject to certain built-in safeguards, including a contrac-



Mr Ian Easton.

tual undertaking, Dr Richter is of the opinion that sludge of this quality could justifiably and safely be used for sugarcane and certain other restricted purposes.

Dr Richter said that the sludge would be classified as a secondary sludge and use could thus be permitted for crops not eaten raw by humans e.g. sugarcane, fruit trees, flowers and vines (well mixed with soil), crops used as dry fodder for animals, plantations, tree and plant nurseries. It can also be used for development of parks and sports fields where there is limited contact with the ground such as golf, cricket, hockey and soccer fields.

According to Dr Richter there are other factors which require consideration as well to ensure adequate control of any potential health hazard. Amongst others they are soil type and its ability to filter out organisms, catchment areas of rivers and streams, dryness of the sludge, its safe transportation and prevention of spillage, exclusion of humans, livestock and other animals by adequate fencing, and adequate protection of handlers.

P-Standard now a fact of life

(a general summary)

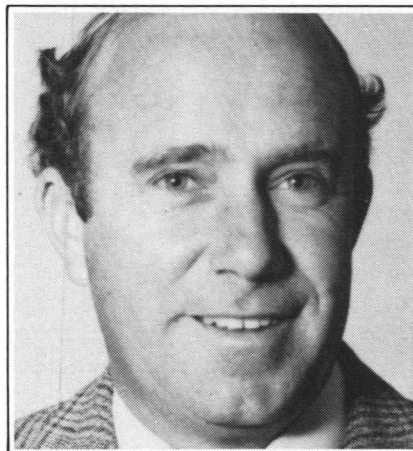
The implementation of the long expected effluent phosphate standard has arrived. It has been preceded by years of detailed scientific research and numerous debates on its pros and cons.

Mr HJ Best, Managing Engineer of Water Quality at the Department of Water Affairs, aptly summarised the standard when he said that it is now a fact of life. He spoke at the recent IWPC conference in Durban on water legislation and its implementation, and said that although exemptions from the standard will be given in certain cases, these would be withdrawn as soon as the technology to overcome specific problems is available.

"The Department requires compliance with the 1 mg/l phosphate standard for 95 per cent of the time and less than 4 mg/l for 100 per

cent of the time," Mr Best said.

At present local authorities have a choice between biological or chemical phosphate removal. The mechanisms for biological phosphate removal plants are still poorly understood and therefore plants



Speaker: Mr Harold Nichols.

will require chemical back-up during winter months and possibly in the summer months as well.

According to Mr Best it must be accepted that in the initial stage all biological phosphate removal plants will require chemical back-up.

The pilot plant at the Vereeniging Water Reclamation Works is an example of the capabilities of a combined biological-chemical plant which meets the high effluent standards.

A surprise finding at this plant was that the coagulation requirements for chemical flocculation and coagulation of the biological plant effluent were less than the stoichiometric dosage requirements for phosphate removal.

Various degrees of success have been achieved by small and large

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IWPC

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biological plants in different parts of South Africa, but there are still uncertainties and unknowns about the mechanisms operative in these processes. Clarification, for example, needs to be obtained on the precipitation of "metal phosphates" in biological sludges noticed at both the Umlaas and the Johannesburg Northern Works.

Researchers throughout the country are looking into various aspects of biological phosphate

removal such as generations of short chain organics, effluent characteristics, bacteria responsible for the process and the addition of iron acetate to improve phosphate removal.

A representative from Sasol indicated at the conference that they are investigating the use of iron acetate to improve biological phosphate removal. This chemical would have the advantage of not adding unwanted anions (such as chlorides and sulphates) except the acetate ion which is known to stimulate biological phosphate removal.

"Although today we cannot rely on biological phosphate removal to bring the phosphate in the final effluent down to the required low concentrations, I think that in five, or at the most ten, years time we will be able to design activated sludge plants for biological phosphate uptake which will remove phosphates as reliably as chemical phosphate removal plants," Mr P Vosloo, consultant for Geustyn, Forsyth en Joubert, said.

Disadvantages

The cost implications of chemical phosphate removal concern local authorities most. Concern was also expressed about the corrosive nature of the chemicals in

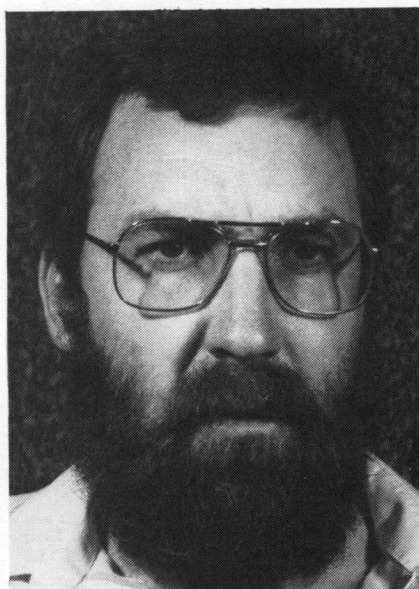


Speaker: Mr Hendrik Best.

use as well as the contribution of these chemicals to the salt load of our river systems.

In this respect calculations by the Department of Water Affairs have shown that the salts which will enter the Vaal Barrage by the year 2000 through chemical dosing of effluents, will constitute only two per cent of the total salt load into the system. In their calculations a growth rate of six per cent per annum in the amount of sewage sludge was assumed.

Speaking on chemical phosphate removal from municipal waste waters Dr HNS Wiechers, Senior Adviser at the WRC, stressed the need for optimising the chemical phosphate precipitation process in order to minimise its disadvantages.



Speaker: Dr Dirk Grobler.

First aquaculture workshop

A workshop on water quality maintenance in aquaculture is to be held as a joint undertaking of the Aquaculture Research Programme of the CSIR, the Department of Ichthyology and Fisheries Science, Rhodes University and the JLB Smith Institute of Ichthyology.

The practice of aquaculture is based on the assumption that proper management of systems, by optimal input of high quality water and feed, can provide higher yields than is possible in unmanaged natural systems. Maintenance of good water quality is obviously, therefore, a prerequisite for success.

Although aquaculture is by no

means new to South Africa, it has a rather weak scientific foundation. Most of the knowledge is based on "off the shelf" technology from other countries. It is the fundamental aim of this workshop, and hopefully others in the future, to establish sound culture criteria based on, and determined by, local environmental conditions.

Other aims of this first aquaculture workshop will be to:

- define water quality in terms of aquaculture (freshwater and marine);
- assess our present knowledge of water quality maintenance in aquacultural systems;

- define the effects of poor water quality on culture organisms during various life history stages; and
- formulate a document appraising our current knowledge of water quality maintenance and define, more clearly, specific problem areas which need to be investigated.

Such a document will lead to a greater understanding of the underlying principles of water quality management and to more goal-orientated research.

The workshop will be held from 26-27 September 1985 at the JLB Smith Institute in Grahamstown.



The highly eutrophied waters of the Hartbeespoort Dam.

Eutrophication research:

Hartbeespoort Dam report finalised

A final report containing the results of three years' eutrophication research done on Hartbeespoort Dam by the National Institute for Water Research (NIWR) of the CSIR will soon be available.

The research programme, which cost more than a million Rand, was jointly financed by the NIWR, the CSIR's Cooperative Scientific Programme and the Water Research Commission.

According to Dr Herman Wiechers, Senior Adviser of the Water Research Commission, the overall aim of the programme was to achieve an understanding of the functioning of the Hartbeespoort Dam ecosystem in order to generate the necessary information required to manage the biota and productivity of the ecosystem so that the undesirable consequences of extremely high nutrient loads can be ameliorated.

The study resulted in the compilation of an extensive data base on hypertrophic Hartbeespoort Dam comprising physical, chemical and biological data. It quantifies problem aspects related to hypertrophy, ie the prolific growth of toxic algae, floating mats (hyper-

scum) of decaying and stinking algae and anaerobic waters with large concentrations of reduced compounds, eg hydrogen sulphide, ammonia and dissolved iron.

The data collected was used to construct an ecosystem model for the Hartbeespoort Dam system. This model, as well as other empirical models, was used to predict the probable outcome of a number of impoundment management options.

The study identified significant nutrient losses, as large as 50 per cent, between the points of discharge by local authorities and industries, and the point where the river enters the dam. The mechanisms by which such losses occur were not investigated since this

study was limited to the impoundment, but may include adsorption onto sediments, chemical precipitation and biological conversion to plant material, as well as losses by water abstraction from the river. This phenomenon can possibly be capitalized on by the technique of pre-impoundment (small dams in the catchment area).

In the light of these findings, predictions indicated that the Hartbeespoort Dam would remain highly eutrophic even after the introduction of the 1 mg/l (as P) effluent phosphate standard. An effluent standard of 0,5 mg/l was predicted to be necessary to effect a significant change in the trophic status of the impoundment.

(To page 20)

WATER SA tien jaar oud

Water SA, 'n Suid-Afrikaanse wetenskaplike tydskrif wat uitsluitlik oor water handel, vier vanjaar sy tiende verjaarsdag. Die eerste uitgawe is in April 1975 deur die Waternavorsingskommissie gepubliseer en sedertdien verskyn die blad elke drie maande.

SA Waterbulletin het onlangs met dr Thys Pieterse, senior adviseur van die Waternavorsingskommissie en redakteur van die tydskrif, 'n onderhoud gevoer oor die ontstaan, die doelstellings en die bedryf van **Water SA**.

— *Waar het die gedagte aan 'n wetenskaplike tydskrif oor water ontstaan?*

Dr Pieterse: *Water SA* het onder die leiding van dr GJ Stander, vorige voorsitter en hoof-uitvoerende beamppte van die Waternavorsingskommissie, tot stand gekom. By hom was daar geen twyfel nie dat waternavorsing op sigself geen bydrae kan maak tot die sinvolle beplanning van 'n land se waterhuishouding nie, tensy die navorsingsresultate so wyd as moontlik bekend gestel word en die toepassing van die resultate bevorder word.

Die daarstelling van *Water SA* is as 'n betekenisvolle stap in dié rigting gesien, veral aangesien daar destyds geen ander multidissiplinêre wetenskaplike tydskrif in

Suid-Afrika was wat uitsluitlik op water gerig was nie.

— *Wat is die doel om navorsingsresultate op verskillende gebiede in die waterveld sáám in een blad te publiseer?*

Dr Pieterse: Die tydskrif dek 'n wye spektrum van aktiwiteite en het ten doel die publisering van oorspronklike werk in alle vertakings van die waterwetenskap, — tegnologie en -ingenieurswese. Dié multidissiplinêre inslag word ontleen aan die besef dat die waterwetenskap nie in kompartemente afgesluit kan word nie en dat kruisbestuwing tussen dissiplines noodsaaklik is.

— *Is die bydraes wat u ontvang meestal van Suid-Afrikaanse navorsers?*

Dr Pieterse: Die oorgrote meerderheid van die artikels is van plaaslike navorsers, maar heelwat oorsese navorsers van 'n verskeidenheid lande soos die VSA, Nederland, Thailand, ens het reeds in *Water SA* gepubliseer — 'n tendens wat moontlik in die toekoms kan toeneem.

— *Hoe gaan u te werk om die bydraes te beoordeel?*

Dr Pieterse: Elke artikel wat vir publisering in *Water SA* aangebied word, word normaalweg na twee beoordelaars verwys en, indien nodig, kan verdere beoordelaars betrek word. Die keuse van beoordelaars en die kommunikasie met hulle vind tans op 'n persoonlike grondslag plaas. Die kom-

Hartbeespoort Dam report finalised

(From page 19)

Aeration/destratification was identified as an in-dam management technique which holds potential.

Experimentation with this technique was attempted in the mid-seventies — unfortunately, with little success due to the short duration of the test and a variety of practical problems. The current investigation was a "desk-study" with no in-dam experimentation being undertaken. A thorough literature search was made and using this information and the data from Hartbeespoort Dam, the possible biological and chemical consequences of aeration/destratification were assessed. It was predicted that the application of this technique may result in the change of the dominant algal species from a toxic blue-green to

non-toxic green algae. Mixing of the cold bottom water with the warm surface waters may also result in a lowering of the water temperature with a concomitant decrease in water evaporation rate. However, it may also result in a number of undesirable consequences, for example the proliferation of filter clogging algae. Pilot or full-scale experimentation will be necessary to establish the true potential of this technique as an in-dam method for dealing with eutrophied waters.

The study showed that the fish community in Hartbeespoort Dam is being exploited by anglers close to its maximum sustainable yield (about 525 t/a). Consequently, a commercial fishery would adversely affect recreational fishing and is, therefore, not recommended.

The researchers estimated that approximately 3 600 tons (wet mass) of *Microcystis* could be

harvested per year. However, this particular algae is toxic to cattle and sheep, and possibly man, as well as being deficient in certain essential amino-acids and is, therefore, of little practical use. If the conditions in the dam could be changed to result in a more palatable algae, this will have definite advantages for its protein production potential. Unfortunately, the factors controlling algal type are not yet sufficiently well understood to make practical control in the dam a feasible undertaking.

According to Dr Wiechers a variety of bio-manipulation strategies to ameliorate the consequences of eutrophication were considered, but none appeared to hold much promise as viable eutrophication management techniques.

Copies of the final report will be available from: Foundation for Research Development, CSIR, PO Box 395, Pretoria 0001.



As blyk van waardering vir die leidende rol wat dr GJ Stander, voormalige voorsitter van die WNK, in die totstandkoming van die wetenskaplike tydskrif *Water SA* gespeel het, is 'n spesiale stel *Water SA* — volumes van die afgelope tien jaar aan hom oorhandig. Die oorhandiging het plaasgevind in 'n Pretoria-verpleeginrigting waar dr Stander aangesterk het na 'n operasie. Van links: dr JP Kriel, huidige voorsitter van die WNK, dr Stander en dr MJ Pieterse, senior adviseur, WNK, en redakteur van die tydskrif.

mentare van die beoordelaars dra grootliks daartoe by om te help in die finale beoordeling en redigering van 'n artikel.

Uitstekende samewerking word van beoordelaars verkry en die beoordelingstelsel is in 'n groot mate daarvoor verantwoordelik dat *Water SA* 'n hoë standaard kan handhaaf.

— *Hoeveel artikels is reeds gepubliseer?*

Dr Pieterse: Tot en met die April 1985-uitgawe het daar 287 artikels in *Water SA* verskyn uit 'n totaal van 359 wat vir publiserings aangebied is. Met ander woorde ongeveer 80 persent van die artikels wat aangebied is, is uiteindelik gepubliseer.

— *Waar word Water SA orals gelees?*

Dr Pieterse: *Water SA* het tans ongeveer 2 500 intekenare waarvan nagenoeg 900 in die buiteland is. Dit geniet wêreldwye dekking in dié sin dat meer as 20 internasionale uittrekseldienste opsommings van die artikels wat in *Water SA* verskyn, versprei en bekend stel. So byvoorbeeld word opsommings van *Water SA*-artikels tot in Russies deur 'n uittrekseldiens in Rusland versprei.

— *Enige nuwe planne vir die toekoms?*

Dr Pieterse: Ja daar is nuwe planne — ek wil op hierdie stadium egter net na een verwys en wel ten opsigte van die beoordelingstelsel. 'n Posing sal aangewend word om 'n sogenaamde "gerekenariseerde bestuurstelsel" in dié verband te ontwikkel. Alle medewerkers sal volgens 'n wetenskaplike klassifi-

seringstelsel in groepe van kundigheid en belangstellingsvelde ingedeel word en hulle samewerking sal dan binne die bepaalde groepe gevra word.

Graag wil ek dan ook van die geleentheid gebruik maak om my opregte waardering te betuig aan alle outeurs vir hulle bydraes en alle beoordelaars wat so gewillig saamwerk in die onbaatsugtige taak om die artikels te beoordeel.

М. Вахрамеева
6 Д103. Заметка о связи между годовым количеством осадков и показателями годовичных колец у деревьев в одном из районов Южной Африки. А note on the relationship between annual rainfall and tree-ring indices for one in South Africa. Zucchini W., Hiemstra L. A. V. «Water S. A.», 1983, 9, № 4, 153—154 (англ.)

В горах Сидарберг к С. от Кейптауна на высоте 1330 м над ур. моря было обследовано дерево 376-летнего возраста с целью установить связь между характером годовых колец и кол-вом осадков, которые здесь являются лимитирующим фактором. Проанализированы данные по осадкам за последние 78 лет. Все материалы статистически обработаны. Коэф. корреляции между двумя указанными параметрами 0,474. Он недостаточно высок, чтобы можно было с удовлетворительной точностью использовать годовичные кольца для характеристики выпадающих осадков в прошлом или прогнозировать их на будущее. Библ. 2. М. В.

'n Voorbeeld van die opsommings wat die Russiese Akademie vir Wetenskap in Russies versprei van artikels wat in *Water SA* gepubliseer word.

Sanciahs news/nuus

NEWS FROM THE SOUTH AFRICAN NATIONAL COMMITTEE FOR THE INTERNATIONAL ASSOCIATION OF HYDROLOGICAL SCIENCES

NUUS VAN DIE SUID-AFRIKAANSE NASIONALE KOMITEE VIR DIE INTERNASIONALE GENOOTSKAP VAN HIDROLOGIESE WETENSKAPPE

Individual membership of IAHS

Progress is being made with the registration of some South African hydrologists as individual members of the IAHS. Article 12 of the by-laws of IAHS states that "National Committees should draw up lists of hydrologists in their countries who are willing and qualified to participate actively in the work of the Association. Such lists should be forwarded to the Secretary General who should compile a list of members of IAHS from them."

In terms of Article 12, the South African National Committee drew up a register of South African hydrologists which was lodged with the Secretary General. The Secretary General was requested to select hydrologists from the register for individual memberships of IAHS according to the membership requirements of the Association. It was subsequently decided by the IAHS that the selection of individual members should be done by the National Committees and the following guidelines were published in the IAHS yearbook for 1983-1987

"The Association has had individual members since 1983. The membership consists of hydrologists named by National Committees of the member countries from amongst those hydrologists with established reputations who have played, or who are playing, a substantial part in IAHS activities. Consequently, individual hydrologists seeking membership of the Association should approach their National Committees to have their names registered as candidates for membership. There is no membership fee. The Secretary General will publish a list of members of the

Association from the names forwarded to him by National Committees."

Since the criteria for qualification are still open to a wide range of interpretations, the Secretary General was approached to get some idea of the number of names that he was expecting from the S.A. National Committee and to discuss our proposal for selection criteria with him. He confirmed that some countries had registered less than 10 hydrologists while others had registered more than 300. He indicated that he was expecting at least 50 names from South Africa based on contributions by South Africans in the past at international symposia. He also indicated that he fully supported our decision to set a minimum requirement of a four year degree.

SANCIAHS has nominated 64 South African hydrologists for individual membership of IAHS and the list of names will be displayed at the Hydrological Symposium to be held in Pietermaritzburg during the period 16 to 18 September 1985. Applications for registration as an individual member of IAHS will be considered by SANCIAHS each year and should be sent to the chairman of SANCIAHS (Water Research Commission, PO Box 824, Pretoria, 0001). Hydrologist's applying for individual membership must

- have an established reputation as a hydrologist
- have at least a four year degree
- be prepared to contribute to IAHS symposia and working groups or have participated in IAHS activities in the past, and
- be supported in their application by at least two members of SANCIAHS.

Applications for individual membership of IAHS should not be confused with application for registration as a hydrologist with SANCIAHS which involves being incorporated into the register of S.A. Hydrologists. This register forms the basis of communication with the local hydrological community and was used in drawing up the initial list of individual members of IAHS.

Technical terms and Antarctic slang

A brief comment on the Dictionary of meteorology and hydrology

by: Dr Peter JT Roberts

The dictionary is designed as an aid to persons using Afrikaans as a medium of communication in the fields of meteorology and hydrology and I should imagine it will also be of value to editors of bulletins, journals and annual reports who need to translate contributions by various authors. The Preface to the dictionary makes it clear that it is not the last word on the subject but "at most it represents a step towards the eventual stabilisation of and the introduction of norms into Afrikaans technical language in these fields". In this the dictionary succeeds most admirably and the authors deserve due praise.

The translation of scientific reports from English to Afrikaans often presents problems especially when editors are faced with sentences like 'cloud scale forcing is being modelled at various scales



Mr JJH Booysen, Chief Director of the Department of National Education, recently officially presented copies of the new Dictionary of meteorology and hydrology to members of the Department of Transport, the Department of Water Affairs and the National Terminology Services. Pictured are from left: Mr FC Symington, Chief Terminologist, Department of National Education and Mr Booysen.

of motion with lumped parameter deterministic models . . .'. Dictionaries are of little assistance in such cases and the problem is compounded by the fact that scientists in any particular discipline appear to be unable to standardise terminology. For example, the word "deterministic" is given two very different meanings in hydrological literature and the reader is left to guess what an author means when he uses the term. The word 'lumped' has spatial connotations for hydrological modellers but temporal connotations for limnological modellers and so on. However, if most people were to record words and phrases that present problems and contact the authors of the dictionary, it would not be long before nearly all commonly used terms would be catered for and only new terms would be left to the inventive skills of writers and translators.

On reading through the English-Afrikaans section there were several English terms which, rightly or wrongly, tended to set the teeth on edge, such as, across wind (instead of cross wind), earth-synchronous (instead of geosynchronous), flowage resistance (in-

stead of flow resistance) and hot belt (instead of heat belt). There were also terms such as influent stream (verloorstroom), effluent stream (wenstroom) and outbreak of air (inval van lug) which left me facing the wrong way! The first time that I used the dictionary was to find an Afrikaans word for 'cooling tower blow down'. The only word offered was 'omwaaï' which is most appropriate for the four Johannesburg cooling towers but not for most others.

Strange terms

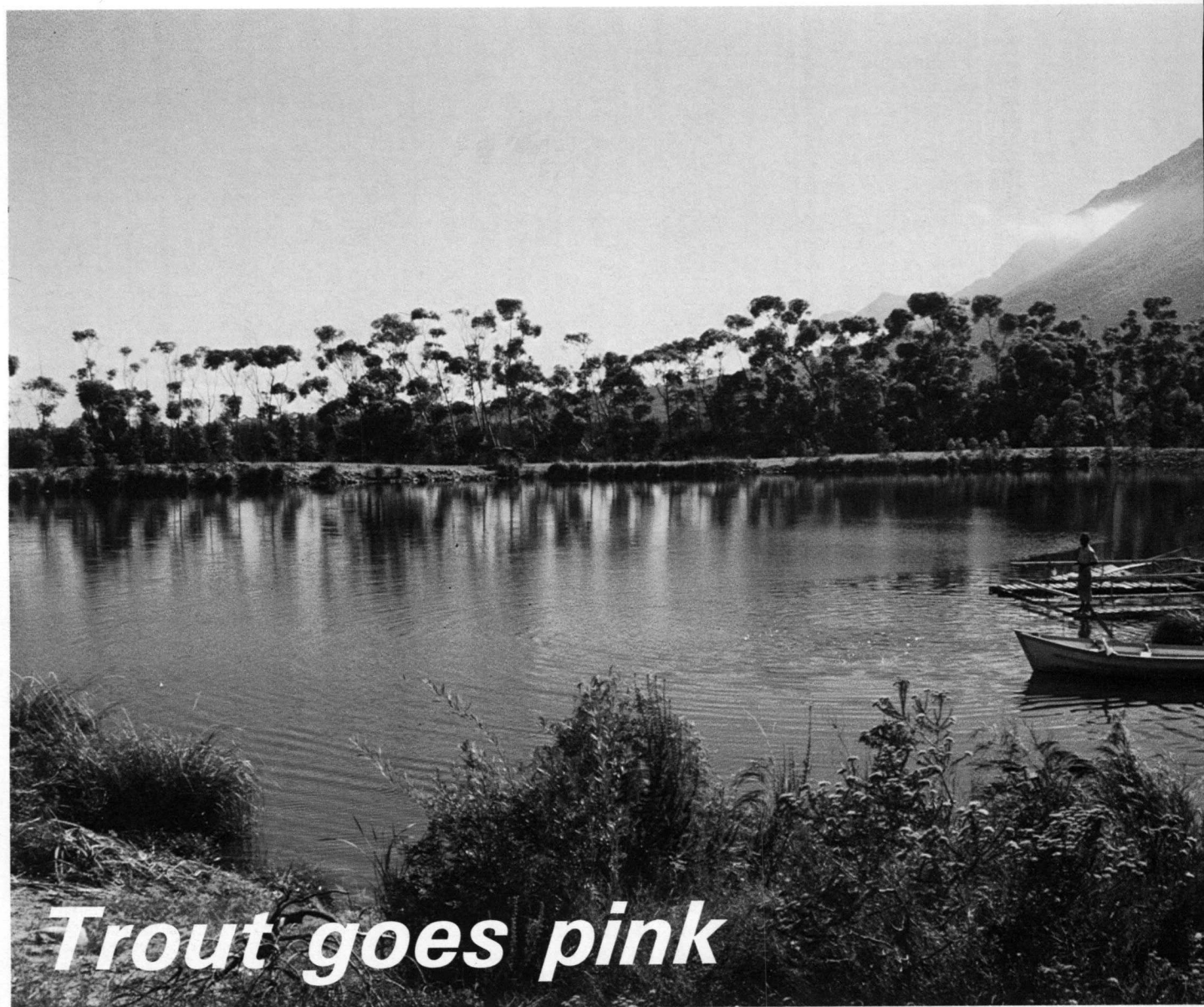
The number of strange English terms that I found in the dictionary left me contemplating the evident gaps in my education. The Editor of the dictionary mentioned in the introduction that many of the terms are relatively unknown to South Africans and since the dictionary is not a defining dictionary but one that merely give the equivalent Afrikaans terms, the meaning of many of them will remain a mystery. The only way to make sense of some of them is to string them together in the hope that they will create a collective picture as follows:

It was one of those **dog days**

with **milky, sloppy weather** and a **green sun** filtering through the **mizzle** and the **smaze**. A group of hydrologists sat in a **paraselenic circle** on **bummocks** beneath a **raintree** enjoying an **isopycnic** with pancake and lolly ice. They watched as **negative fossil raindrops** made **isocer-aunic** patterns on the **indifferent limpid waters** of the **meromictic lake**. However, the weather soon became **guti** with **isallobaric winds** and an **emissary sky** and they realised that they would soon be in a **sferic fix** if they did not depart hastily for the **thief zone** in their **hydrochory**!

The word 'bummock' (ysknol) is one that I find difficult to accept.

When I was at University, a ridge or pile of ice in an icefield was referred to as a hummock (in polite circles at least) and I initially suspected that the word bummock is Antarctic slang. However, I eventually found a dictionary that contains the word 'bummock' and apparently it is a "brewing of ale for a feast". Now that is a subject that most hydrologists and meteorologists find very interesting!



June 1985 might just be what fish lovers and especially trout fanatics have been waiting for. Salmon trout has been marketed in South Africa after careful research and experimental trials. According to Mr SSR Pittard, Director of Atlantic Salmon Trout Farms, the name salmon trout comes from the pinkish colour of the trout which it acquires after being raised on a special diet in seawater. The seawater changes the texture, quality and colour of the salmon trout

Before salmon trout finds its way to the plate of the fish connoisseur, it basically goes through three stages.

During the first stage, the hatching stage, trout eggs are imported from America and then hatched and reared at the Fisantekraal Trout Hatchery to an average mass of between 150 and 250 g. From here they are sold live to Atlantic Salmon Trout Fish Farms.

During the second stage at the

De Hoek Estate at 24 Rivers the fish are grown to optimum size in ponds. At Paternoster the fish are rounded off in seawater which constitutes the third and final stage in the breeding of salmon trout.

When *SA Waterbulletin* visited the Fisantekraal Hatchery on the farm Elandspad in Du Toitskloof, part of it was still under construction.

Already completed were the hatchery and the fingerling rearing

units. The latter consist of eight porta pools, each with a volume of 8 000 litres, in open sided sheds. In these tanks the fingerlings are grown to about 20 g in size.

Still under construction were the fingerling growing units as well as three or four earthen ponds.

According to Mr Mike Kruger, Manager of Fisantekraal Trout Hatchery, Elandspad, and more specifically the Kraalstroom river area, presents one of the most favour-



One of the ponds for salmon trout at the De Hoek Estate at 24 Rivers.



Mr SSR Pittard, Director of Atlantic Salmon Trout Farms, left, and Mr P Lourens, Manager of Atlantic Salmon Trout Farms, at Paternoster where the salmon trout are reared in saltwater before being marketed.

able sites in the Western Cape for trout farming. The quality as well as the quantity of water available are excellent. The healthy population of rainbow trout in the Kraalstroom is a good indication of the ideal water this location has for trout farming.

"We have a number of advantages inherent in our water supply and site," Mr Kruger says. "Basically we have three separate water sources and all the water is gravity fed into the tanks so that no permanent pumping is necessary."

The hatchery receives its water from three sources: the Du Toit stream, Kraalstroom and two underground spring water sources.

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Salmon trout are stocked at different sizes in porta pools at 24 Rivers before being taken to Paternoster.

Pink Trout

(From page 25)

Mr Kruger says that the springs play an important role in the hatchery. This water source enables them to hatch trout eggs throughout the year. The water temperature during the year is a maximum of 14,5°C and a minimum of 11°C. Trout eggs can only be hatched in water with a temperature of less than 16°C.

He also points out that these springs have clear water even during the most severe storms. The water reticulation system has therefore been designed to incorporate these springs into the main water supply and pipeline systems of the rearing tanks.

Fish stocks are regulated according to the available water flow. The total fish stock in summer would be ± 30 t.

According to Mr Kruger the survival rate during the hatching period is ± 90 per cent, for the 5 g fish ± 85 per cent and eventually for the 250 g fish ± 75 per cent.

"The fish are fed on a balanced diet containing the necessary proteins, fats, carbohydrates, vitamins and minerals.

"Once in full production we will import 100 000 trout eggs every second month from the USA which means a total annual production of about 40 t," Mr Kruger says.

Before the fish are taken to Paternoster they are stocked according to different sizes in growing ponds at 24 Rivers. Water is diverted from 24 Rivers for the fish production and as in the case of the hatchery, the water quality is excellent.

The trout are then taken to Paternoster to remain in seawater for two to four months.

Once in full production an estimated annual yield of 250 t salmon trout (about 20 t per month) is envisaged, according to Mr Pittard.

He says before the trout are weighed and sorted out, they are disinfected against bacteria by ultraviolet light. They are then packed and sold fresh or smoked.

On the packaging and selling of



Top: Mr Pittard. Above: A true delight — smoked salmon trout.

salmon trout Mr Pittard says fresh trout are packed into five kg boxes.

A few more options are available as regards the smoked variety. The connoisseur may choose either

smoked fillet, or sliced sides which are vacuum packed with a layer of plastic between each slice, or sliced smoked salmon (not in sides) packed in 85 g and 350 g catering packs.

OUTO-ANALISERING VAN SULFAAT EN ALKALINITEIT ONDERSOEK

Navorsing oor die outo-analysing van sulfaat en alkaliniteit in water is voltooi.

Volgens dr WHJ Hattingh, senior adviseur van die Waternavorsingskommissie was die doel van dié studie wat oor negentien maande gestrek het:

- om die akkuraatheid van die bepaling van die alkaliniteit van water te probeer verbeter om sodoende die kation/anioonbalans wat gebruik word om die betroubaarheid van die chemiese ontleding van water te meet, te verhoog.
- om die spoed van die bepaling van sulfaat in water te probeer versnel deur die oordrag van monsters te beperk of uit te skakel.

Dr Hattingh sê hierdie twee aspekte is deeglik ondersoek en die volgende resultate is behaal:

- Die bestaande indikatoromslagmetode is verbeter en die spoed van bepaling kan vanaf die normale 30 monsters per uur na 120 monsters per uur opgestoot word. Om die probleme wat met kleur en troebelheid ondervind word te oorkom, is 'n enkel-punttitrasiesisteem ontwikkel. Laasgenoemde metode kan ook teen 120 monsters per uur benut word en is baie betroubaarder as eersgenoemde metode. Steurings soos kleur, troebelheid en chemiese indikator-steurings is uitgeskakel.



Dr JF van Staden, Departement Chemie, Universiteit van Pretoria.

- Die bepaling van sulfaat berus op die presipitasie van sulfaat as bariumsulfaat, gevolg deur die nefelometriese bepaling van die konsentrasie van die bariumsulfaatsuspensie. Hierdie suspensie het egter die nadeel dat dit aanpak in die vloeisel waar die ligmetings gemaak word en op hierdie wyse word 'n 'geheue' opgebou. Wanneer 'n monster met 'n lae sulfaatkonsentrasie volg op 'n monster met 'n hoë

sulfaatkonsentrasie dan veroorsaak hierdie geheue dat die lae monster se waarde kunsmatig hoër gelees word. Hierdie oordrag van geheue is dus 'n wesenlike probleem in sulfaatanalises. Probleme met hierdie tipe steuring is tot 'n groot mate opgelos deur 'n voorklepfiltrasiestelsel te ontwikkel. 'n Verdere handmetode, wat op die gebruik van 'n loodioonselektiewe elektrode berus, is ook ontwikkel om daardie monsters wat op geen ander manier ontleed kan word nie, te ontleed. Hierdie laasgenoemde metode is 'n handmetode maar lewer tog 'n uitweg vir die klein aantal monsters wat nie met die geoutomatiseerde metode bepaal kan word nie.

Die navorsingswerk is gedoen deur dr JF van Staden van die Departement Chemie, Universiteit van Pretoria.

Graskarp bewys sy nut in damme

Die graskarp wat uit Sjina en Oos-Rusland afkomstig is, het die afgelope paar jaar in Nederland getoon dat hy suksesvol gebruik kan word om damme, kanale en waterweë skoon te hou.

Volgens 'n brosjure *Graskarper en het waterplantenbeheer*, uitgegee deur die graskarp-studie-

groep van die Nasionale Raad vir Landboukundige Navorsing in Wageningen, het volskaalse eksperimente getoon dat die graskarp beter in staat is om waterplante in toom te hou as die chemiese en meganiese metodes wat tans gebruik word.

Waterkapasiteite van gronde:

FINALE VERSLAG VRYGESTEL

'n Finale verslag getiteld *The development of profile available water capacity models* is deur die Waternavorsingskommissie vrygestel. Die verslag bevat die eindresultate van 'n navorsingsprojek wat professor MC Laker en mnr LCC Boedt van die Departement Grondkunde, Universiteit van Fort Hare, met finansiële steun van die WNK, oor die waterhouvermoë van verskillende gronde gedoen het.

Die vernaamste doelstellings van die projek was

- om die profielbeskikbare waterkapasiteit vir 'n gekose reeks van grond/gewaskombinasies (mielies, koring, katoen en erte) in sekere besproeiingsgebiede (die Ciskei en by die Vaalharts en Loskopbesproeiingskemas) te bepaal.
- om hierdie data wat verkry is te gebruik vir die ontwikkeling van 'n model waarmee die profielbeskikbare waterkapasiteit onder ander toestande voorspel kan word.
- om die ontwikkelde model te gebruik vir die opstelling van tabelle vir besproeiingskedulering, en
- om die doeltreffendheid van watergebruik, soos bepaal deur konvensionele metodes met die nuwe benadering van profielbeskikbare waterkapasiteit te vergelyk.

Volgens mnr David van der Merwe, hoofadviseur van die Waternavorsingskommissie was dié projek 'n voortsetting van 'n vorige projek getiteld: *Navorsing oor die grondfaktore wat 'n invloed het op die optimale benutting van besproeiingswater in die swart state*.

"Die plantbeskikbare waterkapasiteit van 'n grondprofiel is 'n begrip wat in die vorige projek ontwikkel is in 'n poging om 'n wetenskaplik meer aanvaarbare kriterium vir die water wat vir 'n plant in 'n grondprofiel beskikbaar is, daar te stel."



Mnr Van der Merwe sê vir die mees doeltreffende benutting van besproeiingswater moet dit op optimum intervalle toegedien word.

"'n Mens kan aanvaar dat met elke toediening 'n betekenisvolle hoeveelheid verlore gaan, bv. verdamping vanuit die boonste grondlae. Sulke verliese kan verminder word deur die intervalle tussen besproeiings te verleng. Sou die grond egter toegelaat word om na te lae voginhoude uit te droog tussen besproeiings, word die gewas benadeel en die opbrengs daal. Onder sulke omstandighede sal die watergebruiksdoeltreffendheid m.a.w. opbrengs per eenheid water toegedien, ook daal. Die optimum besproeiingsinterval is dus die maksimum interval wat toegelaat kan word sonder om die gewas te benadeel."

Hy sê die profielbeskikbare waterkapasiteit van 'n grond is die hoeveelheid water wat 'n grondprofiel aan 'n spesifieke gewas

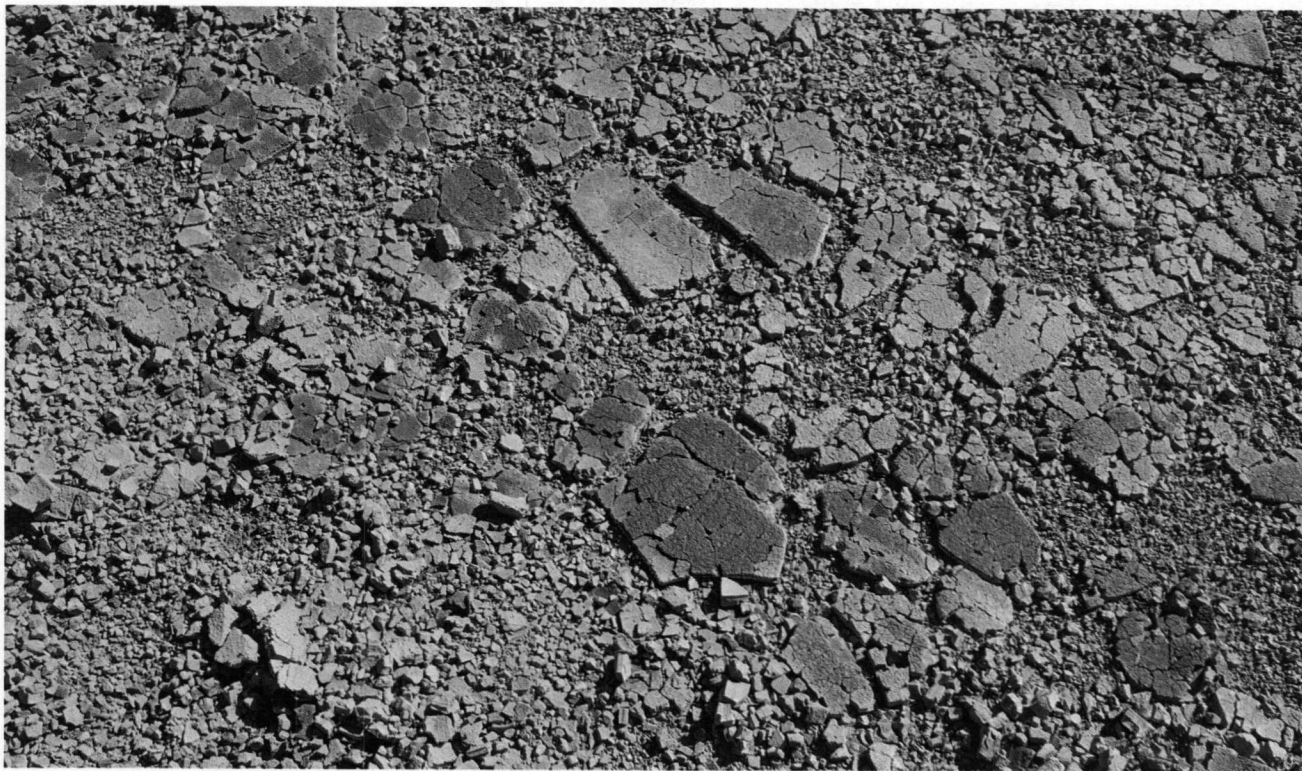
beskikbaar kan stel. Dit hang af van die potensiële worteldiepte van die gewas, die intensiteit van wortelontwikkeling op elke diepte, die waterhou- en -geleidingseenskappe van die grondprofiel en die mate van vogstremming wat die gewas kan verdra voordat opbrengs betekenisvol benadeel word.

Besproeiingskeduleringsproewe waarin van die profielbeskikbare waterkapasiteitsbegrip gebruik gemaak is, het getoon dat dié begrip wel die potensiaal het om as 'n betroubare basis vir skedulering te dien. Besproeiingsintervalle is deur hierdie benadering verleng waardeur die seisoenswatergebruik verlaag is, maar watergebruiksdoeltreffendheid is egter nie tot dieselfde mate verbeter nie.

Navrae oor die finale verslag kan gerig word aan: Die Voorsitter, Waternavorsingskommissie, Posbus 824, Pretoria 0001.

The final report on a research project relating to drought occurrences has been made available. The project was carried out by the Department of Civil Engineering of the University of Stellenbosch with financial aid by the Water Research Commission.

Models for drought assessment



The main object of the study, which consists of three reports, was to develop the methodology to assess drought risk in a manner that is universally applicable and suitable for implementation on a large scale.

According to Professor Walter Zucchini, professor in the Department of Mathematical Statistics at the University of Cape Town and one of the project researchers, it was not possible to develop a universal definition for drought. Because drought is both area and user specific it manifests itself in many different ways. A family of drought indices was therefore developed to meet the requirements of a variety of users.

In the *first report* a daily rainfall model representing the whole of South Africa is presented. The model was developed to fit 2 550 rainfall records. By means of this model the properties of any rainfall-based drought index at any of these stations are simple to obtain. The report provides parameters for

each of the stations as well as examples of application together with detailed algorithms needed to implement the model.

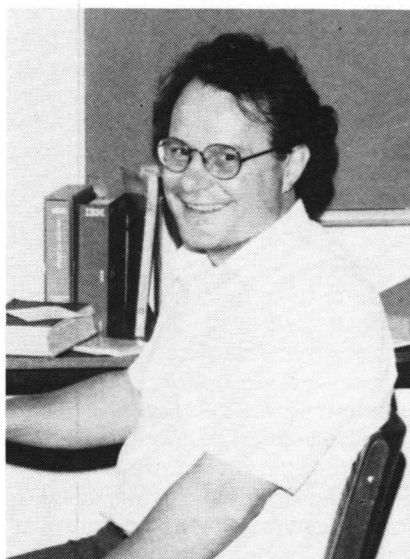
"One of the problems which had to be solved was to work out methods to fill the gaps in the data. This proved to be very expensive and we decided to modify our

models to accommodate these gaps," Professor Zucchini says.

The average length per station of data utilised was 54 years. Professor Zucchini says that for some stations data covering only ten years were available. The longest period is about 120 years which belongs to a station in Cape Town.

According to Professor Zucchini the model does not provide one with all the exact answers, but gives a clear indication of the statistical chances of drought occurrences.

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Professor Walter Zucchini (UCT), one of the project leaders.

Drought

(From page 29)

The *second report* deals with streamflow and the methodology for assessing the risk of deficiencies in streamflow. The purpose of this is to enable water resources managers to address pertinent questions regarding release strategies from reservoirs in times of drought. The theory is illustrated using a number of examples. Relevant estimates for 67 annual reservoir inflow records are given.

A *third report* deals firstly with the problem of augmenting hydrological records by using related records. This is especially of interest to civil engineers and hydrologists. Secondly it discusses new methods of estimating the missing values in rainfall records.

On the subject of future research objectives in this field, the report suggests that a set of comprehensive computer packages be

prepared for the convenient implementation of the methods developed in this project.

It also suggests that models be developed which simultaneously describe all the important climatic variables associated with drought. In this regard special reference needs to be made to not only rainfall as was done in this project, but also to temperature, solar radiation, humidity and wind speed.

A final recommendation is that more detailed research be carried out on the spatial aspects of drought.

The reports can be obtained on request from:

*The Head
Department of Civil Engineering
University of Stellenbosch
STELLENBOSCH
7600*

or

*The Librarian
Water Research Commission
PO Box 824
PRETORIA
0001*

New Publication

According to *Europe Environment* a new publication on water management policies has just been published.

The book is entitled "Policies for Integrated Water Management", and is in English, French and Russian.

In one volume the book provides the:

- Declaration of Policy on Prevention and Control of Water Pollution, including Transboundary Pollution (1980);
- Declaration of Policy on the Rational Use of Water (1984); and
- Decision on International Cooperation on Shared Water Resources (1982).

For more information contact the ECE/UN Information Unit, Palais des Nations, CH - 1211 Geneva, 10, Switzerland.

Irrigation development objectives in perspective

In dealing with various objectives of irrigation development at the recent irrigation workshop, Dr Simon Brand of the Development Bank of Southern Africa, drew attention to the importance of an economic perspective in all stages of irrigation development.

He said that such a perspective recognises that there are generally more objectives, for example social, political and economical objectives, than can be totally achieved with the limited resources available. Irrigation development and project design based only on a single objective such as efficient water use, or on one set of objectives such as economic objectives, can result in bad decisions and unintended consequences.

Dr Brand pointed out that such an economic perspective should also recognise the interactions between these objectives. Research into these trade-offs and linkages can contribute towards more ra-

tional decision-making on the allocation of resources to irrigation development. Such research should be encouraged.

From loan applications for irrigation development received by the Development Bank of Southern Africa, and from its preliminary evaluation of some existing projects, it appears that frequently stated economic, social and other objectives mentioned could ultimately amount to no more than lip service unless trade-offs between objectives are properly understood and projects are designed accordingly.

Economic objectives deal with, amongst others, the optimum utilisation of scarce resources, production of agricultural surpluses over and above subsistence needs and stabilisation of agricultural production. Social objectives will include factors such as the alleviation of poverty and the improvement of living conditions of par-

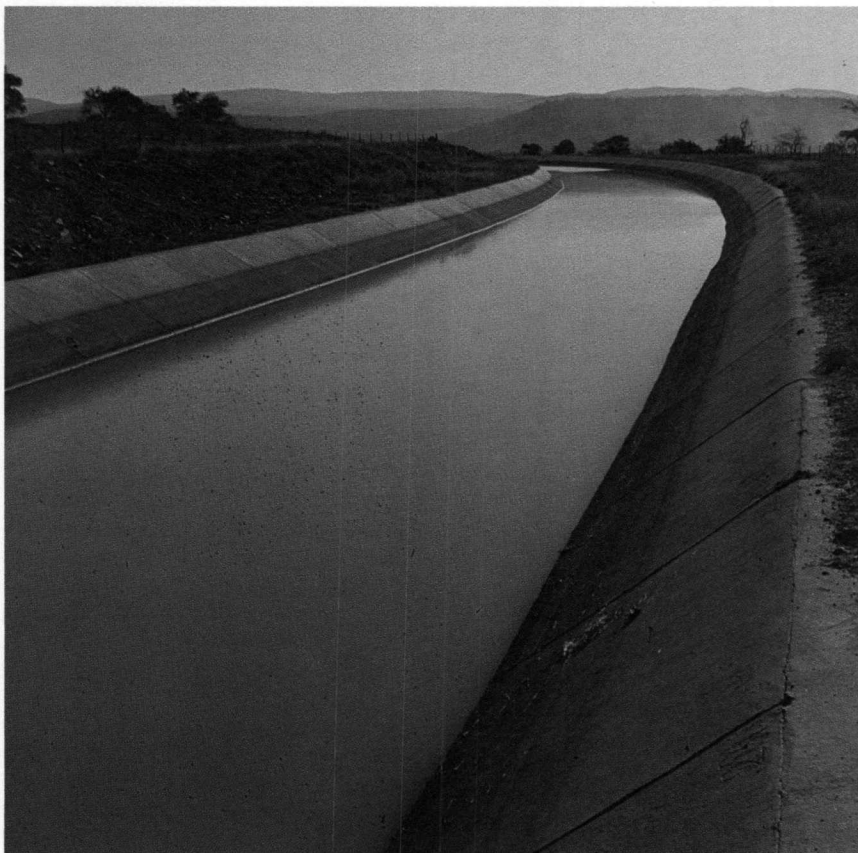
ticular groups, and the rehabilitation of certain groups who have suffered from adverse developments such as drought, war or economic adversity.

Dr Brand drew attention to projects where stated aims had not been realised because of a failure to appreciate the trade-offs between objectives and to design accordingly.

He mentioned cases where sophisticated, large-scale and centrally-managed designs had been adopted for reasons of water-use efficiency as well as to serve certain political objectives such as the creation of highly visible 'signs of progress'.

However, because of inefficiencies that arose in the overall operation of the projects, the only objectives that were ultimately served were those of politically motivated ostentation, while the projects ran at huge losses.

Dr Brand also focussed on the



An irrigation canal on the Makatini Flats.

comparison between the evolution of irrigation objectives in respect of White farmers in South Africa, and those applying in respect of irrigation development in the National States.

"In earlier times, the emphasis in policy documents relating to irriga-

tion development for White farmers rested strongly on social objectives like rehabilitation and the relief of poverty, and on conservation of resources," he said.

Dr Brand said although the emphasis shifted in later years towards optimal utilisation of

resources as the most important objective for irrigation development, these economic criteria are, however, still somewhat tempered by social considerations. According to the 1984 White Paper on Water Tariff Policy the tariff levied on irrigation water, although it must at least cover the current operating costs of the scheme, must be held at a cost the farmer can afford.

"Essential as the clear articulation of irrigation development objectives is for a successful irrigation development policy, merely to state such objectives is not sufficient to ensure the success of individual projects. For that, the design of projects must be appropriate as well," Dr Brand said.

"Because all resources, not only particular ones, are scarce," he concluded, "it is important that the economic perspective be brought strongly to bear in the identification, design and implementation of all irrigation development, wherever in Southern Africa it may be."

Committee for nutrient removal restructured

The Institute of Water Pollution Control has now had a Working Committee for Nutrient Removal for many years. In the light of the imminent implementation of the effluent phosphate standard, the terms of reference of this committee were recently revised in order to better serve members and their particular needs at this important time. The following objectives have been set:

- Document, collect, discuss and disseminate information

on all aspects of nutrient removal.

- Act as a communication channel between local authorities, industries, consultants, etc and the Department of Water Affairs.
- Assist with demonstration and training sessions.

The committee will meet twice per year at the CSIR in Pretoria. These meetings are open to all interested persons who feel they can contribute to the attainment of the above objectives. The next meeting will be held on 25 September 1985. Please contact the Committee Chairman:

Dr HNS Wiechers
c/o The Water Research Commission
PO Box 824
PRETORIA 0001
(Tel: (012) 28-5461)
should you wish to attend.

Osborn receives Aussie award

During the 1985 International Convention of the Australian Water and Wastewater Association, Mr Dave Osborn of the Johannesburg City Health Department Laboratories was awarded the Association's Dr Michael Flynn Award for the best paper presented at the conference.

Attending the Melbourne conference were 479 delegates from 13 countries. A total of 73 papers were presented. Apart from Mr Osborn South Africa was also represented by Messrs A Gerber and P Williams (NIWR); L James (Rand Water Board); and R Phelines (Umgeni Water Board).

Reclaiming sewage effluent:

Membranes make the difference

The direct application of reverse osmosis for reclaiming high quality water from secondary sewage effluent has recently been receiving serious attention in South Africa. Apart from the work Port Elizabeth Municipality is doing at its Fishwater Flats Works (see page 11) the National Institute for Water Research (NIWR) of the CSIR also recently concluded a series of pilot-scale tests, sponsored with the partial financial support of the Water Research Commission, to demonstrate the technical and economical feasibility of reverse osmosis (RO) for the reclamation of water from sewage effluents.

Reverse osmosis not only reduces the dissolved inorganic content of the feed water by 90 per cent or more, but the process effectively removes suspended and colloidal matter and most of the organic residuals that are not adequately treated by conventional sewage treatment processes. In addition, micro-organisms such as bacteria and viruses are almost totally rejected and the psychological factor of having a physical membrane barrier between the sewage derived feed water and the reclaimed product water is seen by many to enhance its acceptability to potential consumers.

One of the objectives of the 15 month research project was to develop a pretreatment process that would consistently produce RO feed water of acceptable quality with respect to its membrane fouling characteristics.

A pilot-scale pretreatment system capable of handling 40 l/min was designed and constructed. The system comprised chemical dosing, automatic pH control, coagulation/flocculation in a three-stage paddle flocculator, dissolved air flotation (DAF), chlorination and multi-media pressure filtration (MMF). Each of the unit processes was then evaluated individually to obtain good operational parameters.

Two extended test runs were carried out with the complete pretreatment system before it was used to provide feed water for the reverse osmosis units. During these runs the pretreated water consistently had a modified fouling index below 2 s/l² with good organic removal as indicated by the significant reduction in ultra-violet absorbance values.



Mr Allan Hon of National Institute for Water Research in Bellville pictured with the Bakke reverse osmosis pilot plant used in the research project.

The pretreatment process was then used on a continuous basis for 4 600 hours to provide feed water for the reverse osmosis units. Few mechanical problems occurred, and the process proved to be easy to control. The FeCl₃ dosage (as Fe) average 26 mg/l during the first 2 800 hours, but this was then increased to 30 mg/l to cope with variations in the feed water quality. A coagulation pH of 5,5 was

maintained in the test. The dissolved air flotation process gave excellent results at an average of 12 per cent recycle through the saturator, which was maintained at a pressure of between 350 and 380 kPa. This introduced about 8,5 mg air per litre of flow through the dissolved air flotation unit, which provided sufficient clarification so as not to overload the multi-media filter. The average turbidity of the

dissolved air flotation plant effluent before filtration was only 0,5 NTU.

The multi-media filter was operated at a design rate of 9,8 m/h and gave filter runs averaging 24 to 30 hours.

The pretreated water produced generally had a modified fouling index of well below 2 s/l², its ultra-violet absorbance at 275 nm was reduced by about 50 per cent and the total organic carbon (TOC) by 37 per cent on average. The average turbidity was only 0,15 NTU.

Reverse osmosis

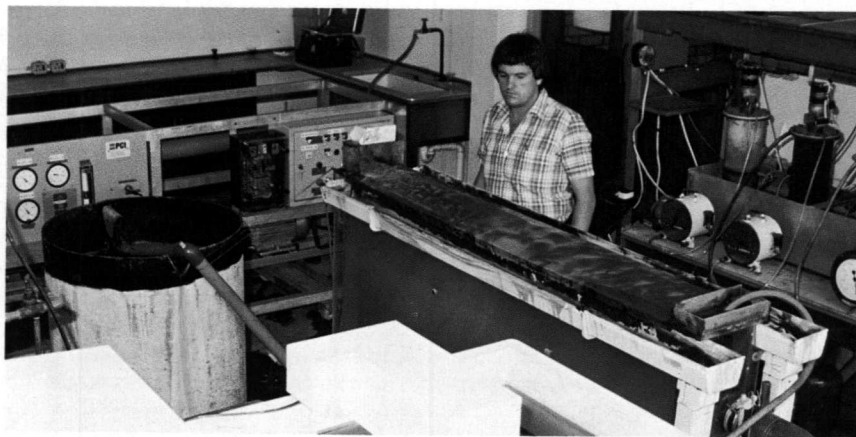
Two reverse osmosis units were used for the test evaluation. The main test unit was fitted with a Bakke Industries module array comprising 30 tubular modules in a taper flow configuration and fitted with flow reversal and sponge ball cleaning facilities. The modules were equipped with cellulose diacetate membranes having a nominal salt (NaCl) rejection of 90 per cent.

This unit had an output of 30 m³/d at 75 per cent recovery and operating at a module inlet pressure of up to 4 000 kPa.

The other reverse osmosis unit was fitted with a single Paterson Candy International (PCI) tubular module equipped with ZF99 thin film composite (TFC) membranes. Flow reversal and sponge ball cleaning facilities were also provided for this unit. At 4 000 kPa inlet pressure the PCI module had a design output of 1,4 to 3 m³/d, and a NaCl rejection of 98 to 99,5 per cent.

The feed to the PCI unit was a mixture of reject from the Bakke reverse osmosis unit and product from the pretreatment plant, in approximately a 1:1 ratio. This was done because of a shortage of pretreated water and also as it was not previously intended to compare the performance of the Bakke and PCI units, but rather to gain an insight into the fouling rates and response to cleaning procedures of the thin film composite membranes.

The performance of the cellulose acetate reverse osmosis membranes which had been provided by Bakke Industries, followed the expected pattern with a gradual decrease in output during the first



The NIWR laboratory in Bellville. The white apparatus in front is the flocculator.

approximately 2 100 hours, after which, however, a very noticeable increase in salt passage and abnormal increase in permeate (product) flux became apparent, particularly in the middle and last stages of the system.

This tendency persisted until the end of the pilot studies and it was apparent that the cellulose acetate membranes had suffered serious deterioration. Despite strenuous efforts to find the cause of the membrane failure this was not accomplished and a further project to elucidate the problem has been recommended.

The PCI reverse osmosis unit operated for a total of 3 787 hours and initially, a rapid flux decline was evident, which was apparently aggravated by the use of the wrong cleaning solutions (i.e. Biotex and citric acid).

The suppliers subsequently recommended alternative cleaning methods.

From 2 500 hours onwards, however, the position was reversed and the flux increased slightly after each cleaning cycle, until at 3 850 hours, it was higher than the initial starting flux.

Salt Passage

The salt passage had been extremely low during the first 3 800 hours, increasing at a mean rate of 0,002 per cent per day, i.e. from 0,8 per cent at start-up to 1,2 per cent after 3 800 hours. From this point onwards, a more rapid increase was evident, but it was still below 2 per cent at the end of the pilot studies and within the manufacturer's specifications.

Lack of funds precluded con-

tinuation of the project at this time, but recommendations for further work have been made.

Quality of the reclaimed water

The quality of the reclaimed water produced was excellent in most respects. The inorganic salts were reduced to very low levels, the only exception being the oxidized nitrogen ions, which were not effectively rejected by the cellulose acetate membranes. Composite membranes are known to reject nitrates more effectively.

The residual organic substances present in the reverse osmosis feed water and represented by total organic carbon, chemical oxygen demand and ultra-violet absorbance are effectively removed to very low levels. However, the total organo-halogen precursors (TOHP), which are present in microgram concentrations, were apparently not rejected to any marked extent by either the CA nor the ZF99 composite membranes during the pilot plant studies. These results were disappointing, but in subsequent special tests using untreated secondary sewage effluent as feed to the PCI unit (composite membranes), good reductions (~90 per cent) of trihalomethane precursors (THMP) were obtained, while the trihalomethanes (THM) themselves were poorly rejected (~8 per cent).

The overall performance of the reclamation process train with regard to the removal of microbiological organisms was excellent. No viruses were detected in the product water at any time and on-

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Membranes

(From page 33)

ly on one occasion was a positive coliform count obtained on the reverse osmosis permeate.

On a full-scale application, additional disinfection would be used as a final step in the water treatment process, but it is in any case reassuring to know that the membrane process itself eliminates virtually all micro-organisms.

Ames mutagenicity tests performed on the untreated secondary effluent and on the permeate from the PCI reverse osmosis unit produced very promising results. It was reported that the quality of the permeate was superior to Pretoria's normal tap water in this respect. These tests were not performed on the pretreated effluent or on the permeate from the Bakke reverse osmosis unit because of the presence of chlorine in these waters.

Provided that the nitrate levels in the secondary effluent are low, and that the use of chlorine is eliminated or controlled to restrict the formation of potentially dangerous trihalomethanes, the product water from the reverse osmosis reclamation process would be suitable for unrestricted re-use.

Costs

The total cost of reclaiming water on a 10 Ml/d basis, using pretreatment and tubular reverse osmosis with CA membranes, has been estimated to be 74c/m³, the pretreatment cost contributing 9c/m³ to this figure. This is based on a membrane service life of three years which has, however, still to be demonstrated for a plant of this type fitted with cellulose acetate membranes. At this stage no attempt has been made to determine the reclamation costs using composite membranes, but this is likely to be significantly higher because of higher initial costs.

Mr HA de Villiers
Mr GR Botha
Mr AT Hon
National Institute for Water Research
CSIR

NATSURV-opname by

Die Waternavorsingskommissie se nasionale opname van nywerheids- en afvalwater (Natsurv) is tans in volle swang. 'n Besoekdag is onlangs by die Applepiser (fruitree)-fabriek aan die Oosrand gehou om aan die loods-komitee van dié projek, asook lede van die Waternavorsingskommissie en besoedelingsbeheerbeamptes van die Departement van Waterwese praktiese te demonstreer hoe 'n tipiese Natsurv-opname by 'n fabriek uitgevoer word.

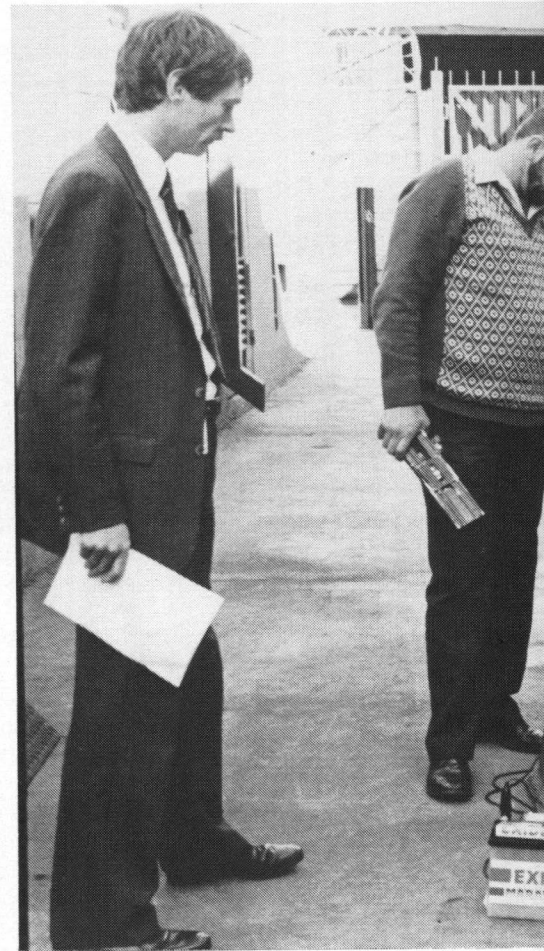
Die Natsurv-opname is aan die einde van verlede jaar deur die Waternavorsingskommissie en die Departement van stapel laat loop om optimale waterverbruik in die nywerheid te probeer bewerkstellig.

Tydens die demonstrasie het die klem veral geval op die kontroliering van grootmaatwatermeters se akkuraatheid. Kalibreerapparaat, spesiaal ingevoer uit Japan, is hiervoor gebruik. Apparate wat die vloei van fabrieksuitvloeiels meet en monsters daarvan neem, is ook gedemonstreer.

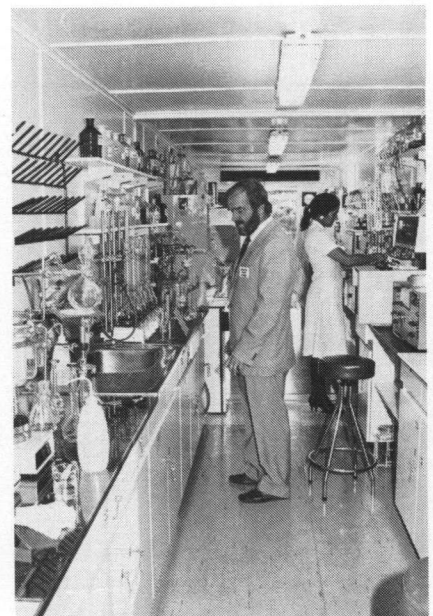
In Wynberg, by die hoofkantoor van die firma wat vir die Natsurv-opname verantwoordelik is, Binnie en Vennote, kon besoekers die verskuifbare laboratorium en die rekenaarfasieliteit waar die data verwerk word, besigtig.

Die laboratorium wat spesiaal in twee skeepshouers ingerig is en maklik vervoer kan word, word gebruik vir die ontleding van uitvloeielsmonsters. Alle data wat met die opname ingesamel word, word uiteindelik in 'n gerekenariseerde databasis geberg waar dit beskikbaar sal wees vir toekomstige navorsingsprojekte asook vir die Departement van Waterwese om hulle te help met hul monitoringsverpligtinge.

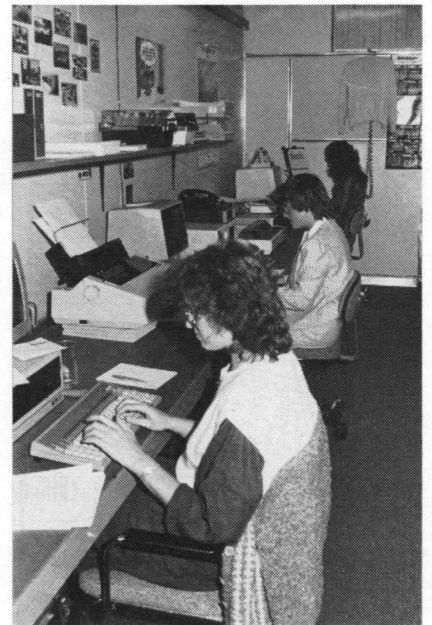
Fabriek wat besoek word, ontvang 'n drukstuk van die inligting wat deur die Natsurv-span op die perseel ingewin is. Hierdie inligting kan 'n fabriek help om, indien nodig, sy water- en uitvloeielsbestuur teen 'n minimum koste tot eie voordeel te verbeter.



(Onder) Des en Nadine Hayes van Binnie en Vennote, wat in beheer is van die spesiale verskuifbare laboratorium.



Oosrand fabriek gedemonstreer



(Bo links) Besoekers besig met 'n besigtigingstoer deur die fabriek. (Bo) Die dataverwerkingsafdeling by Binnie en Vennote. (Links onder) 'n Deel van die toerusting wat gedemonstreer is. (Onder) Mnr P Skivington (tweede van links) Binnie & Vennote, verduidelik aan dr OO Hart, WNK, dr CF Garbers, president, WNNR, en mnr RO Morris, Departement van Waterwese, hoe van die inligting ingesamel word.



Ugly Fishling a Swan

When describing the sharptooth catfish, one would not exactly refer to it as the face of the eighties. But its Hollywoodlike scientific name, *Clarias gariepinus*, is only a slight indication that there are more qualities and possibilities about this fish species than are dreamt of in many a philosophy. At the Department of Ichthyology and Fisheries Science at Rhodes University in Grahamstown the potential of the sharptooth catfish has been realised for a number of years and thorough research has already been done and is currently being undertaken on the aquaculture of catfish.

According to Dr Tom Hecht, Head of the Department of Ichthyology and Fisheries Science, the catfish was artificially spawned for the first time in 1979 with a success rate of about 20 per cent. Although this was not very high it nevertheless was an indication that it could be done. By the summer of 1980 spawning techniques were improved and work then began on the large scale rearing of larvae.

"In any fish culture the rearing of larvae is the most important facet of the culture. If you cannot produce fingerlings it does not really matter how good your spawning techniques are. We have therefore done a great deal of work on nutri-

tional and environmental problems encountered in the rearing of the catfish," Dr Hecht says.

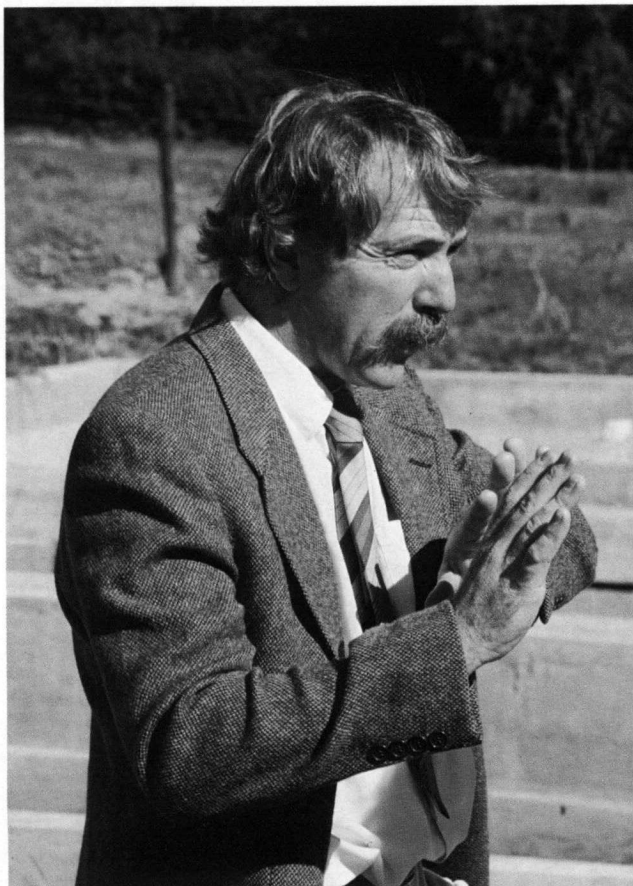
One of the highlights is the artificial dry feed diet for hatchery rearing of the sharptooth catfish which was developed by Dr Hecht and Mr Wynand Uys, a Research Officer with the Department.

In contrast to natural food, artificial food can be quality controlled and sterilised during manufacture and it can also be produced on a large scale and be easily distributed to ensure regular supplies. Natural live food cannot be sterilised and therefore the risk of introducing disease or parasites into the hatchery is high.

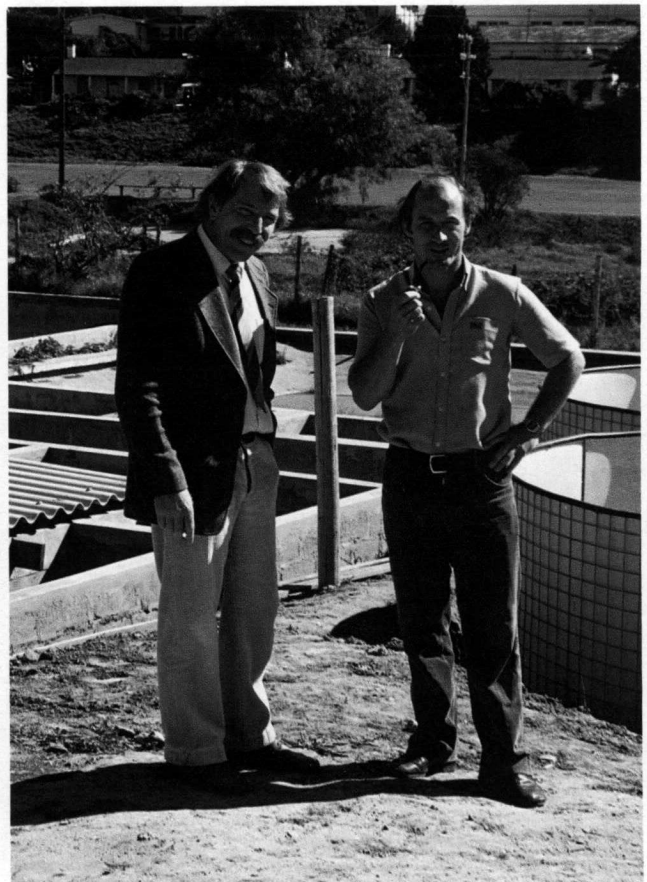
The growth rate eventually obtained with the artificial diet proved to be better than that obtained with natural food organisms. The established feed is suitable for use in commercial hatcheries and can also be utilised as a standardised and proven food source for further research on the rearing of sharptooth catfish larvae.

Dr Hecht points out that it is possible with this diet to spawn the fish and bring 80 per cent of the larvae up to fingerling stage. This is a high success rate for any kind of aquaculture.

At the moment some of the research is aimed at determining the nutritional requirements of the



Dr Tom Hecht.



Dr Hecht (left) and Mr Martin Davies.

sharp-tooth catfish in its different stages of development.

According to Dr Hecht the difference in the enzyme make-up in the gut of fingerlings and the premarket fish (± 600 g) indicates that the fish requires different food during various size stages.

"There are several other problems we encountered along the way," Dr Hecht says. "One of the main problems was differential growth which results in cannibalism. It was found that a combination of temperature and light periods were the cause of this problem.

"We found if the fish are kept alternately for periods of 18 hours light and six hours dark at a temperature of 27°C , it results in near equal growth with cannibalism being reduced to a very large extent."

Catfish Hybrid

For the past two years Dr Hecht has also been involved in work being done on a fish farm near Masebucu in the Southern part of Zambia where he cross-bred a Vundu male (an enormous catfish), with a sharp-tooth catfish female. The growth rate of this hybrid is up to 52 per cent faster than that of the sharp-tooth catfish.

Dr Hecht and his students are currently trying to establish whether the hybrid is sterile or not, before growing it in areas where the local catfish is not indigenous. If the fish does turn out to be sterile greater attention will be paid to it in future.

The hybrids are stocked at various densities. Initially it was stocked at 20 000 per hectare, but currently stocking densities have been increased up to 200 000 per hectare. Until now no decline in the condition of the fish with regard to its length and mass relationship has been detected.

Dr Hecht is of the opinion that the maximum stocking level has not been reached yet. "We will increase the stocking density of the fish to a stage where we find that the increased density affects the condition of the fish," Dr Hecht says.

Because of a continuous flow of water through the ponds, diseases do not occur at these densities.

Some of the production ponds in Zambia are even up to six hectares in size.

Recirculation system

A unique part of the research and development at Grahamstown is the closed recirculation system under construction which has been designed by Mr Martin Davies, a Senior Technical Officer with the Department. Although this system is not the first of its kind in the

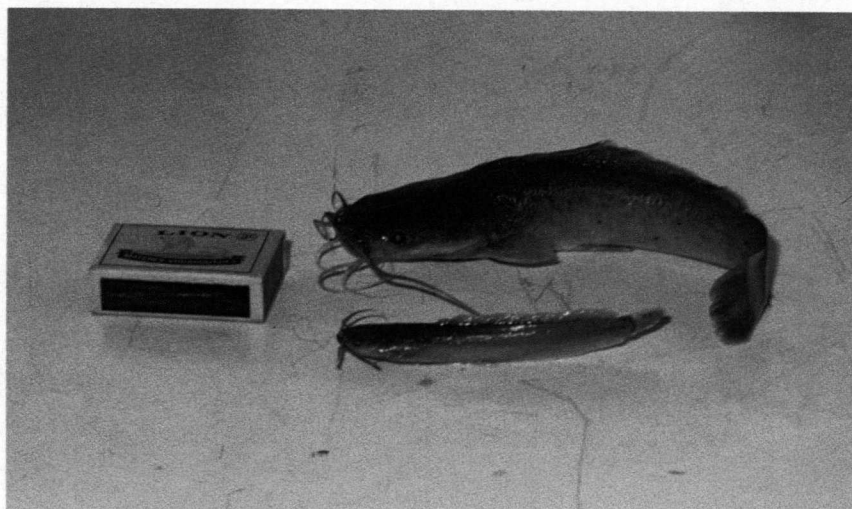
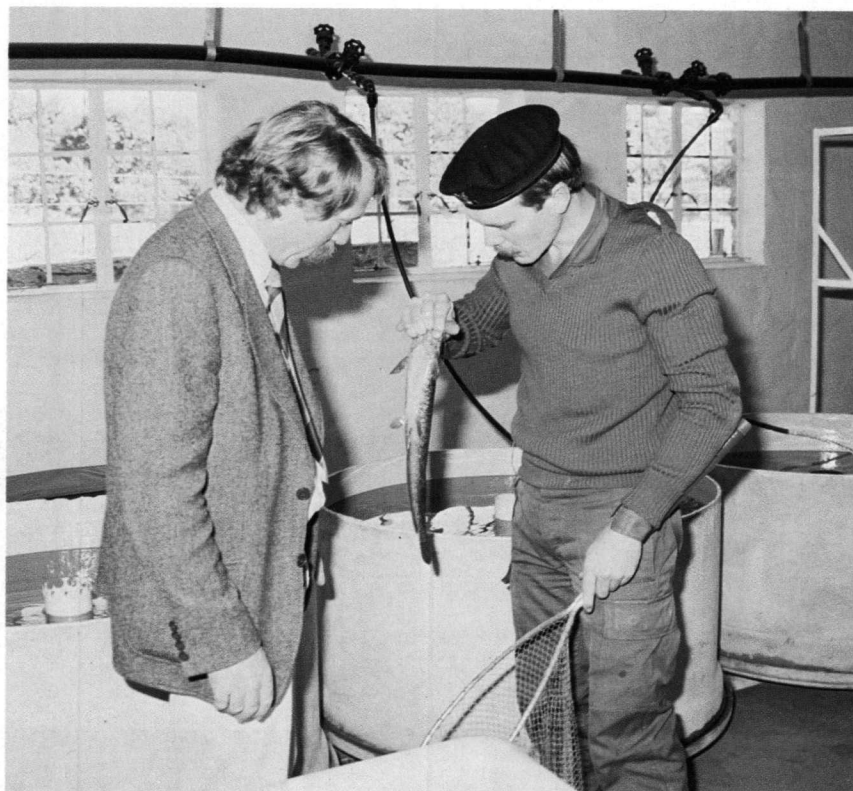
world, certain novel ideas have been introduced.

According to Dr Hecht the system will basically function as a type of purification system. After the fish in the ponds have eaten, the water will be pumped into a long channel.

Eventually the channel will be stocked with catfish which will eat the left-over food. Faecal matter will be taken through this channel

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(Below) Dr Hecht and Mr Wynand Uys (right). (Bottom) The size of the hybrid is considerably larger than that of the sharp-tooth catfish 60 days after hatching.



Ugly fishling a swan

(From page 37)

to sludge activation to be broken up.

"If one does not have sludge activation in a closed recirculation system, the biological filters become clogged and the water is not filtered equally through the filter resulting in insufficient filtration and purification," Dr Hecht says.

The next stage after sludge activation is sludge settlement whereafter the water is biologically filtered.

In the final stage, before water is pumped back to the fish, water will be gravity fed into the re-conditioning reservoir with aquatic macrophytes for final nitrate removal.

Dr Hecht feels that this type of recirculation system will not only enable them to research the rearing of larvae to market size under controlled conditions, but also to lecture effectively to post-graduates on the processes involved in the aquaculture of fish.

Market Potential

Apart from two independent studies, the market potential for any type of catfish has not really been tested in South Africa.

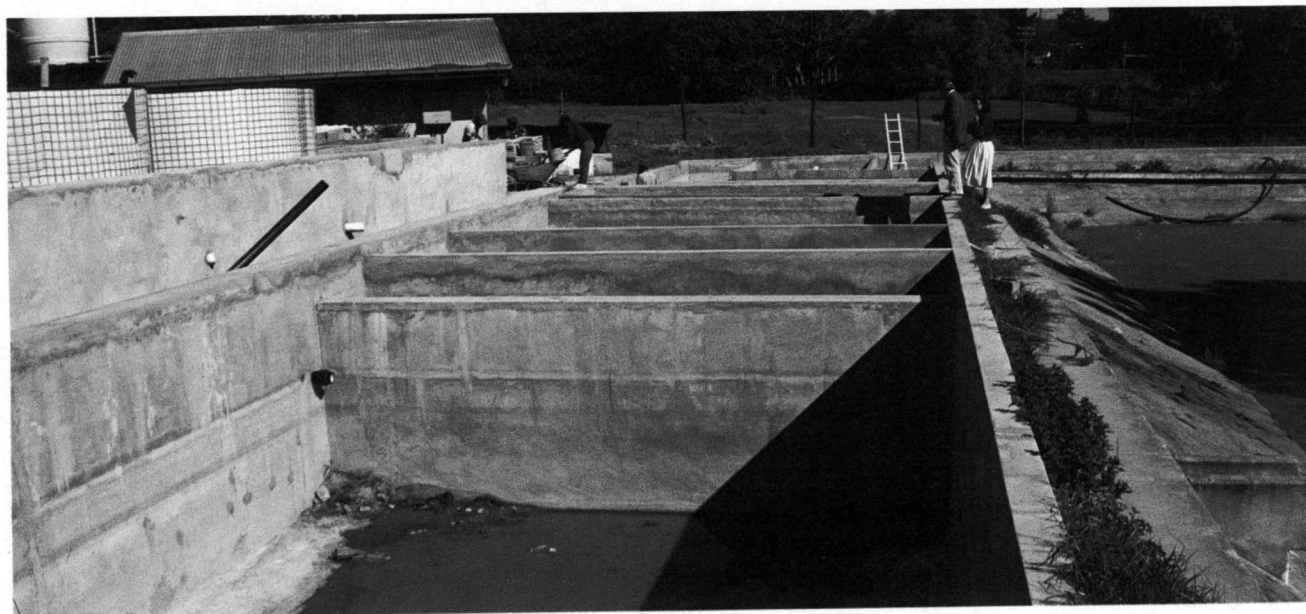
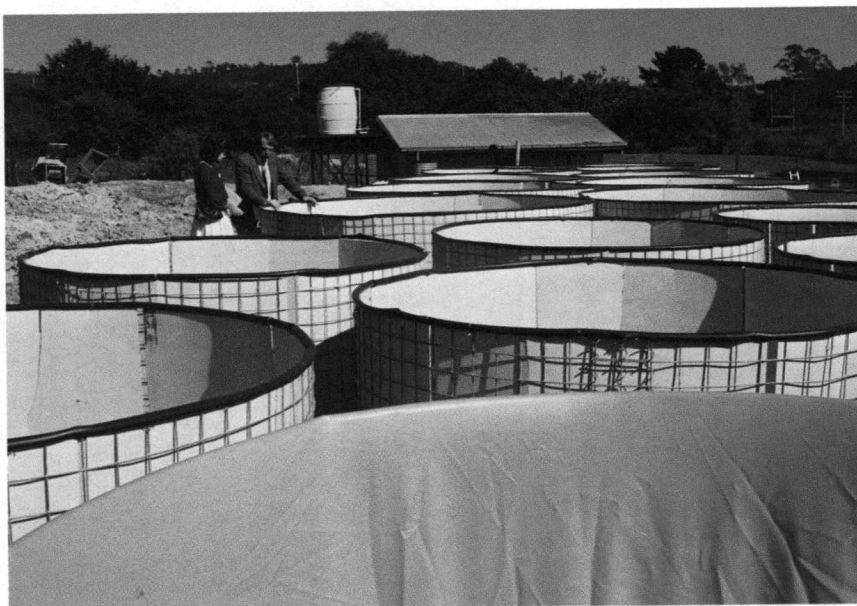
Dr Hecht feels that in areas where the fish is indigenous it will be accepted, but as far as the European market is concerned the catfish should be processed, skinned and cut into fillets, or canned and smoked. The hybrids are, for example, being exported to a famous hotelgroup in London in a processed form.

If not for the South African market, the catfish can be marketed in certain countries where it is very popular. It is a favourite dish in many African countries and in the northern parts of Southern Africa.

Dr Hecht says other projects include the development of a least cost feed for trout in the hatchery. The feed formulation used in South Africa is actually developed for the Northern Hemisphere where they farm with trout at temperatures below 15°C. In South Africa temperatures are 15°C and more and therefore the dietary requirements at these higher temperatures need to be looked into.

A final project is research in the hatchery on the physical and chemical requirements for catfish and tilapia larvae and fry.

(Below) Both pictures show the recirculation system still under construction. The official opening of the system will be at the aquaculture workshop in September (see separate article on page 18).



Groenlig vir Kendaluitleg

Navorsing wat gedoen is op modelle van Grootvleikragstasie en die beplande Kendalkragstasie het getoon dat by 'n uitleg van hierdie tipe droëverkoelingsstelsel slegs 'n geringe mate van warmlughersirkulasie plaasvind.

Die navorsing is gedoen deur die Afdeling Lugmeganika van die Navorsingsinstituut vir Meganiese Ingenieurswese van die WNNR onder kontrak met die WNK.

Volgens dr WJ van der Elst, hoof van Lugmeganika, was die doel van die navorsing om deur nuwe navorsingsmetodes die mate van hersirkulasie van warm lug tussen droëkoelingsringe onder verskillende windtoestande vas te stel.

Weens die groot hoeveelhede water wat vir kragopwekking met natverkoeling gebruik word en die beperkte beskikbaarheid van water op die Oos-Transvaalse steenkoolvelde, is EVKOM tans besig om 'n nuwe generasie droogverkoelde kragstasies te beplan en op te rig. Die stasies is by verre die grootste wat nog gebou is en omdat droëverkoeling minder effektief is as natverkoeling is dit noodsaaklik om enige negatiewe effekte op droëverkoeling, soos warmlughersirkulasie, tot die absolute minimum te beperk.

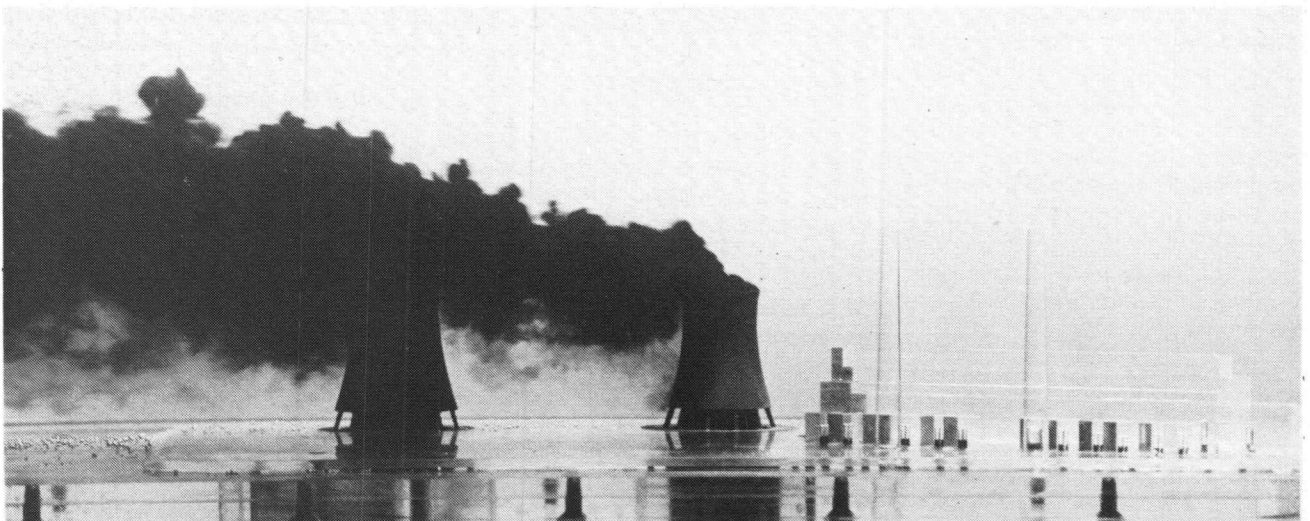
Dr van der Elst sê die navorsing is gedoen met die oog op die uitleg van die nuwe Kendalkragstasie.

Hy sê verder dat toetse aan-

(Na bladsy 41)



Mnr H Esterhuyse, senior navorsingstegnikus by die Instituut vir Meganiese Ingenieurswese (WNNR) en mnr E Wilhelm, Hoofwetenskaplike, Afdeling Lugmeganika (WNNR) by die watertunnel wat vir die navorsingsprojek gebruik is.



'n Model van die Grootvleikragstasie. Die kleurstof is slegs vir visuele effek gebruik en nie vir kwantitatiewe metings nie.



Aquatic biologists meet

Summary of the Limnological Society Congress, University of Cape Town, 1-5 July 1985

The 1985 Congress of the Limnological Society of Southern Africa was held from the 1st to the 5th of July at the University of Cape Town, better known for its marine biological than for its fast-growing limnological interests. There has always been a tendency for marine biologists and limnologists (freshwater scientists) to go their own ways because the ecosystems seem at first glance to be so very different and their communities of organisms so distinctive. This is reflected in the fact that it is nine years since South African aquatic scientists of all persuasions have held a joint meeting. But recent years have shown tremendous advances in our understanding of basic ecological processes concerned with the origins, utilisation and partitioning of resources in aquatic systems, so the Local Organizing Committee of the 1985 Congress decided that the time was ripe for a joint meeting of marine and freshwater biologists.

We wanted to examine to what extent some of these processes are common to marine, estuarine and freshwater ecosystems. Thus we chose the theme *Nutrients and detritus: pathways and problems in aquatic ecosystems*. On the first day, invited speakers reviewed the

processes of decomposition in freshwater ecosystems (Dr Richard Robarts, National Institute for Water Research, CSIR), in estuarine ecosystems (Dr Mike Schleyer, Oceanographic Research Institute) and in marine ecosystems (Dr Mike Lucas, Marine Biological Research Institute, UCT). Keynote papers on the second day examined nutrient cycling in African lake ecosystems (Dr Jeff Thornton, NIWR, CSIR) and in marine ecosystems (Dr Piers Chapman, Sea Fisheries Research Institute). These papers will be published as a Special Issue of the *Journal of the Limnological Society of Southern Africa* later in the year.

Plenary session

After some discussion in plenary session, the participants concluded that the basic processes of decomposition are essentially the same in marine, estuarine and freshwater ecosystems. Differences that do occur are due to environmental variables (such as temperature, turbulence, redox potential, pH, nutrient levels, the nature of the detritus and dissolved organic compounds available and the types of microbes, as well as the physical nature of the interfaces between the organisms and their substrata) rather than to fun-

damental differences in the biotic functioning of marine and freshwater systems.

It was soon evident in the discussion on nutrient cycling that this process, too, is extremely similar in freshwater, estuarine and marine ecosystems. Interest became focussed instead on the relative importance of biotic and abiotic factors in controlling the rates of cycling of nutrients, essentially nitrogen and phosphorus. It was concluded that a good deal is known about the gross cycling of these two nutrients in both marine and freshwater ecosystems but that research is needed on rates of flux in different ecosystems and the degree of importance of various types of organisms in nutrient cycling. In particular, we need to know more about the behaviour of phosphorus.

Several other papers also addressed the question of ecological processes while yet others concentrated on a variety of topics ranging from introduced seaweeds to the life-history patterns of fish. In view of the mixed audience of marine, estuarine and freshwater biologists, the final session was devoted to a series of papers reviewing some of the major aquatic programmes recently con-

(To page 47)

KENDAL

(Van bladsy 39)

vanklik in 'n windtonnel uitgevoer is, maar daar gevind is dat die klein hoeveelheid hersirkulasie tussen die model koeltorings beter gemeet kan word in 'n watertonnel.

"Ons het die metode so akkuraat gevind dat hersirkulasie van minder as 'n half persent van die warm lug nog akkuraat gemeet kan word" sê hy.

Hierna is hersirkulasietoetse gedoen op 'n model van die beoogde Kendalkragstasie. 'n Model van die kragstasie se geboue en ses koeltorings is op 'n skaal van 1:2 500 gebou vir die eksperimente in die watertonnel.

Oor die nabootsing van warmlugvloei sê dr van der Elst: "Omdat

warm lug minder dig is as koue lug moes ons die uitlaatpluime van die koeltorings naboots met 'n oplossing wat minder dig is as water. Hiervoor het ons 'n alkohol-wateroplossing gebruik en kiniensulfaat bygevoeg wat ons baie akkuraat kan meet en sodoende kon ons bepaal wat die persentasie warm lug van die pluim was wat by die ander koeltorings ingesui is. 'n Kleurstof is in die mengsel gebruik vir die visuele effek daarvan en nie vir kwantitatiewe metings nie."

Hy sê verder dat hoewel hersirkulasie wel plaasvind, dit nogtans baie min is. Selfs teen 'n windspeed van 15 ms⁻¹ sal slegs sowat 0,2 persent hersirkulasie plaasvind volgens hulle modeltoetse.

Dr van der Elst sê uit die navorsing blyk dit dat hersirkulasie nie 'n belangrike oorweging is by die ontwerp van 'n droogverkoelde kragstasie soos Kendal nie.

Nuwe WNK projekte

Watergehalte: Die departemente Gemeenskapsgesondheid en Dierkunde van die Universiteit van Kaapstad is besig met 'n tweejaar navorsingsprogram om te bepaal watter uitwerking chemiese besoedelstowwe in kos en water op die mens se gesondheid het. Die projek wat R18 400 beloop, staan onder leiding van mnr HO Fourie, 'n toksikoloog van die Departement van Gesondheid.

Grondwater: Die Instituut vir Grondwaterstudies by die Universiteit van die Oranje-Vrystaat, gaan die grondwaterkwaliteit in die Atlantisakwifer, naby Kaapstad, modelleer.

Die werk wat drie jaar sal duur en R654 000 sal kos, is daarop gemik om inligting te bekom oor die meganismes wat die besoedeling van grondwater beheer.

Die projekteleiers is professor FDI Hodgson en professor J Botha.

Watersverspreidingsstelsels: 'n Navorsingsprojek vir die ontwikkeling van 'n rekenaarprogram om watervloei in verspreidingskanale te simuleer ten einde operasionele waterverliese te verminder, sal deur die Randse Afrikaanse Universiteit se Fakulteit Ingenieurswese uitgevoer word. Die projek ten bedrae van R137 000 strek oor 'n periode van twee en 'n half jaar. Die projekteleier is professor GW Annandale.

Eutrofikasie: Die Departement van Waterwese sal in samewerking met die Nasionale Navorsingsinstituut van die WNNR navorsing doen oor die ontwikkeling van bestuursmodelle vir eutrofikasiebeheer. Die driejaar projek sal R268 000 beloop en onder leiding staan van dr DC Grobler van die NIWN en mnr N Rossouw van die Hidrologiese Navorsingsinstituut.

Waterbesparing: 'n Ondersoek na die waterverbruik en moontlike waterbesparing in woonstelle word ten bedrae van R39 600 deur die Nasionale Bounavorsingsinstituut van die WNNR uitgevoer. Die projek sal negentien maande duur, en die projekteleier is mnr GJ Malan.

DICTIONARY OF WATER CHEMISTRY

(German, English, French)

by FK von Ammon

This book provides a survey of the vocabulary used in the fields of water chemistry. It also includes technical terms related to physico-chemical, geological and biological matters. The dictionary lists these terms in the three major European languages English, German and French. It consists of three sections, each of which provides the equivalents of a given term in the other two languages. Thus, the book is a valuable tool for all who are involved in the collection, treatment, distribution or removal of

water and wastewater. It facilitates the use of foreign-language reference works or literature. It helps to simplify discussion and communications about international regulations and the standardization of methods monitoring quality.

The dictionary is published by VCH Verlagsgesellschaft, PO Box 1260/1280, D-6940 Weinheim, Federal Republic of Germany. Price US \$59,50 pp 203. ISBN 3-527-25956-2

IAWPRC Rio Conference

TIME RUNNING OUT FOR AUTHORS

Authors who wish to submit papers or posters for the 13th biennial conference of the International Association on Water Pollution Research and Control (IAWPRC), Rio de Janeiro, 17-22 August 1986, have little time left to do so. The D-date for air mailing is 31 October 1985.

Full papers or abstracts (in the case of posters), typed on the special IAWPRC laysheets, should be submitted together with six copies. The mailing ad-

dress is:

Mr A Milburn
1 Queen Anne's Gate
LONDON SW1H 9BT
England

Copies of the "First Announcement and Call for Papers" are available from Mr Phil Coombs, Secretary of the SA National Committee for IAWPRC, c/o NIWR, PO Box 395, Pretoria 0001

Effects of the atmosphere on dry-cooling systems studied

A detailed study on the effects of atmospheric conditions on the performance of a dry cooled system produced some significant results. The study was carried out by the WRC and ESCOM. The study formed part of the WRC's and ESCOM's research programme on the optimization of dry cooling as a measure to effect water savings in the power generating industry.

According to Mr Frik Schutte, senior adviser, WRC, the siting of coal-fired power stations is, to a very large extent, dictated by the availability of sufficient supplies of coal for steam generation and of water for cooling purposes.

During the early 1970s it became apparent that due to restrictions in the availability of water on the Eastern Transvaal Highveld where the coal fields are situated it would become imperative for ESCOM to consider using dry cooling as an alternative to wet cooling at an early stage.

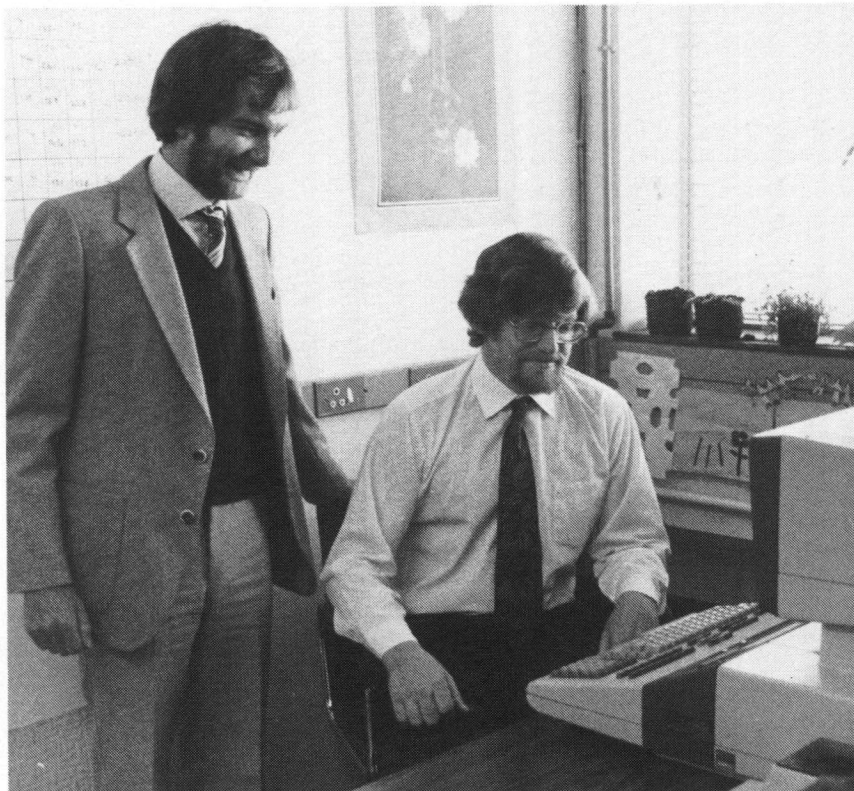
In coal-fired power stations, the largest volume of water is used for the condensation of the turbine exhaust steam; a substantial volume of this water is lost during subsequent recooling in evaporative cooling towers. Two alternative water cooling systems can be employed either independently or in conjunction for recooling of the circulating water, viz. wet and dry cooling systems.

Wet cooling systems

In wet cooling systems, the cooling water which is heated up during condensation of the exhaust steam is recoolled in open evaporative systems. The water is distributed in the form of small droplets in an open hyperbolic tower, comes into contact with the rising air column in the tower, evaporation takes place and hence also cooling. The loss of water by evaporative cooling is estimated at 1,5 — 1,8 l/kWh.

Dry cooling systems

In dry cooling systems, the cooling takes place in air-cooled heat exchangers in which there is no direct contact between air and water and, therefore, no loss by evaporation. In the system employed by



The researchers: Dr AD Surridge (right) and Mr D Hayton, both of the Atmospheric Sciences Division of the CSIR.

ESCOM at Grootvlei Power Station, the heat exchanger elements are installed in banks in the base of the same type of hyperbolic tower as used for wet cooling systems. The emission of heat from the heat exchangers induces a natural draught through the cooling tower which, as a consequence of the temperature difference between the water in the heat exchangers and the air draught, effects cooling of the circulating cooling water.

There are two ways of effecting non-evaporative cooling at power stations, viz. direct and indirect systems. In direct dry cooling systems (Matimba Power Station in Ellisras), the exhaust steam from the turbine is condensed directly in a mechanical draught air cooled

heat exchanger, while in indirect dry cooling systems, such as at Grootvlei, water used to condense the exhaust steam is then recoolled in the air cooled heat exchanger.

In considering the use of alternative cooling systems, it is important to point out that the thermal efficiency of a steam turbine plant (i.e. kg coal/kWh) is directly related to the degree of cooling that can be achieved in condensing the exhaust steam. For a given steam and cooling water flow rate lower cooling water temperatures result in lower turbine back pressures and, therefore, better efficiencies. Since lower cooling water temperatures can be achieved through evaporative cooling than by air cooling it follows that dry cooling will result

in higher coal consumption for the same electric power production.

It is therefore clear that any additional negative effects on the performance of dry cooling systems should be eliminated as far as possible.

Experience at the full scale dry cooled system at the Grootvlei Power Stations indicated that cooling performance could vary considerably from design figures and that the two most important phenomena suspected to adversely affect dry cooling performance are:

- Inversions in atmospheric temperature gradients resulting in a reduced draught and reduced air movement over the cooling elements and thus a rise in the tower approach temperature. These inverted gradients are well known phenomena on the Transvaal Highveld and usually occur during the colder months of the year, developing during the late afternoon and disappearing in the morning.
- Wind velocities exceeding 2,5 m/s are suspected to reduce tower performance in the same way as inversions, i.e. by reduced draught.

In order to study the effect of these phenomena on dry cooling tower performance and to minimize the effects a joint research project between WRC, ESCOM and the CSIR was developed.

The study was a joint undertaking by the Atmospheric Sciences Division of the CSIR who studied the atmospheric phenomena and ESCOM who monitored and studied the cooling performance of the Grootvlei dry cooled unit.

The study of atmospheric effects concentrated on the temperature and wind fields around the number six natural draught dry cooled tower at the Grootvlei power station.

The nature of the investigations required the acquisition of vast amounts of data. As appropriate instrumentation was not readily commercially available, considerable effort was spent on the development of suitable apparatus. The results were the construction of ideal instruments for a research oriented programme, which have

proven their capabilities in the field. The only planned instrumentation not developed was the Doppler acoustic sounder. The first instrumentation was installed during March 1981, and the final instruments were installed during March 1983.

Grootvlei

The following is a summary of some of the results obtained by the CSIR on wind and temperature fields around the Grootvlei six dry cooled tower:

- 100 m mast — Cooling Tower Interaction. A 100 m instrumented mast was erected by ESCOM to measure ambient wind and temperature profiles. However, it has been found that at wind speeds of about 4 m.s⁻¹, the cooling tower can affect the wind direction measured on the 100 m mast.
- Recirculation Inside Cooling Tower six. Zero-lift balloons released inside the cooling tower revealed considerable recirculation of air above the heat exchanger plane. From an energy viewpoint, it is considered that this recirculation will not adversely affect the cooling tower performance. However, should the recirculation take place through the heat exchangers, then adverse effects may occur.
- Inlet Air Velocity Profile. An average of seven months of data showed that the radial air speed profile at the inlet was an almost constant inward wind up to a height of 8 m, above which there was a slight increase, and then at the top there was a slight outflow.

This outward air flow was concluded to be the effect of local turbulence rather than continuous outflow of warm air from the tower.

- The air flow at the exit of the cooling tower shows a turbulent nature, and inflows can occur with periods of the order of ten minutes.
- Wind Field Near Cooling Tower Inlet. Observations have revealed a complex wind structure just outside the cooling tower inlet. The expected simple

downward and radial convergence of air into the tower was not always present. Some results were consistent with small scale recirculation of air just outside the top of the cooling tower inlet.

- Temperature profiles measured just inside the cooling tower six inlet indicate that at least about 50 per cent of the nocturnal temperature inversion magnitude was being entrained into the cooling tower. The result of this effect is that the coolant air temperature is higher than previously anticipated, to the detriment of the cooling system efficiency.
- Cooling Tower/Inversion Interaction. It was postulated by FK Moore of Cornell University, New York, that the excess drop in cooling tower performance under nocturnal stable conditions could be explained by the vertical transport of elevated warm air down into the cooling tower. He did not, however, consider the effect this would have on the stable boundary layer. It now appears that the cooling tower significantly affects the nocturnal temperature inversion, with a result that the isotherms may become distorted and fall in height as they approach the cooling tower.
- Gusts of warm air descend into the cooling tower inlet. These gusts have periods of the order of two hours.
- The variances of temperatures were measured on four masts located around the cooling tower, about 12 m from the inlet. The variance about the expected nocturnal temperature decrease is larger than expected, and larger than the daytime equivalents. Moreover, the temperature variances at 12 m above ground level was greater than those measured at 1.2 m and 24 m.
- Smoke tracer experiments indicated similar patterns to the isotherms near the cooling tower inlet.

Dr AD Surridge
Mr D Hayton
 Atmospheric Sciences Division
 CSIR

TOERUSTING

Ten einde 'n inligtingsdiens aan ons lesers te lewer, verwelkom die redakteur bydraes vir publikasie (beperk tot ongeveer 300 woorde en een of twee foto's en diagramme) deur vervaardigers en verspreiders van nuwe toerusting en prosesse wat met die bevordering van water-aangeleenthede verband hou.

Sulke bydraes word egter ontvang of gepubliseer met dien verstande dat: (1) die betrokke vervaardiger of verspreider wat die bydrae lewer, verantwoordelik bly vir die inligting of menings daarin vervat en vir aansprake ten opsigte van daardie toerusting en prosesse; en (2) publikasie daarvan nie impliseer dat die redakteur of die uitgewer of die Waternavorsingskommissie die inhoud van so 'n bydrae aanbeveel of daarmee in ooreenstemming is nie.

Lesers wat meer inligting verlang, word versoek om direk met die vervaardigers of verspreiders in verbinding te tree.



SA Waterbulletin
PO Box/Posbus 824
Pretoria 0001

EQUIPMENT

As an information service to our readers, the editor welcomes for publication contributions (limited to approximately 300 words and one or two photographs and diagrams) by manufacturers and distributors of new equipment and processes related to the promotion of water affairs.

Any such contribution is, however, received or published on the understanding that: (1) the relevant manufacturer or distributor submitting the contribution is responsible for the information or opinions expressed in it and the claims made therein for that equipment or those processes; and (2) its publication does not imply that the editor or publisher or the Water Research Commission underwrites or is in agreement with the contents of such contribution.

Readers who require further information are requested to contact the manufacturer or distributor direct.

MAJOR ADVANCE IN INDUSTRIAL FILTER TECHNOLOGY

A major advance in industrial filter technology is claimed by Pall, UK, represented in South Africa by Deomed (Pty) Ltd, in the development of the Profile filter element.

To provide longer, more economical service life, the element has a built in prefiltration outer section for particles larger than the rated size. The pore size in this section varies continuously, up to about 40 µm or more, from that of the inner absolute rated section.

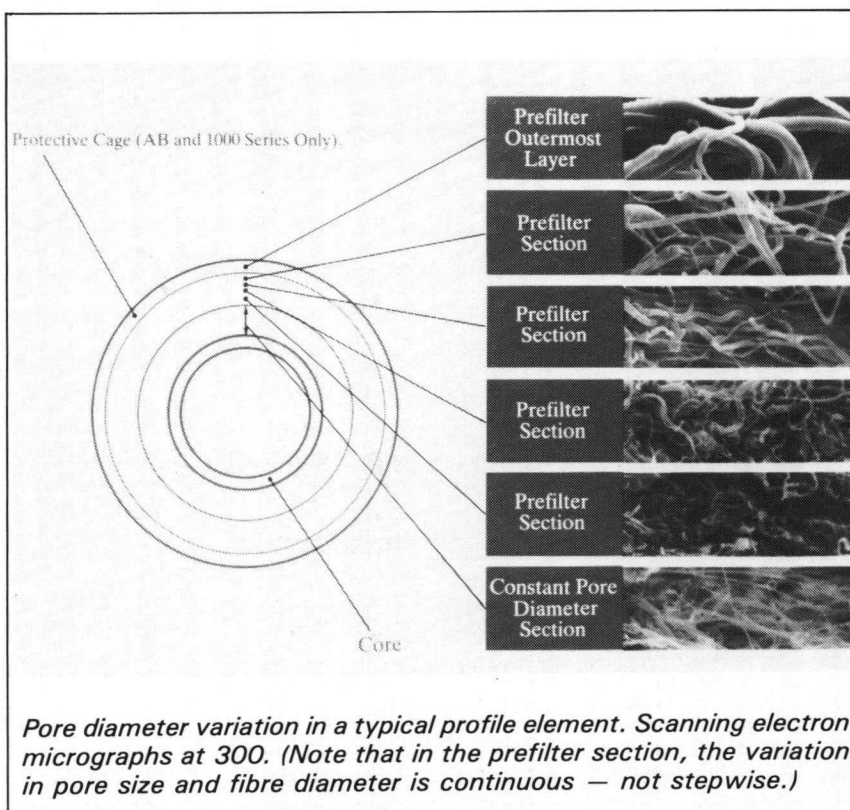
Throughout the inner section of the Profile filter the pore size is constant and it is this section which provides reliable absolute rated filtration.

The continuity of the variable pore section with its wide range of pore sizes and its depth combine to provide long life in service. In conventional filters fibre diameter is the same throughout, variation of pore size being accomplished by varying the packing density. Elements of the new Profile filter achieve different pore sizes by varying the fibre diameter but maintaining uniform density. Pore sizes vary over a range as much as 40 to 1.

Another important feature of the element based on a long established principle, is that 5 µm diameter fibres are used for a 10 µm rating giving a superior filter when compared with the 30 to 40 µm diameter of cellulose fibres for the same rating. The thinner fibres give five or more times as many pores resulting in better removal rating and longer life.

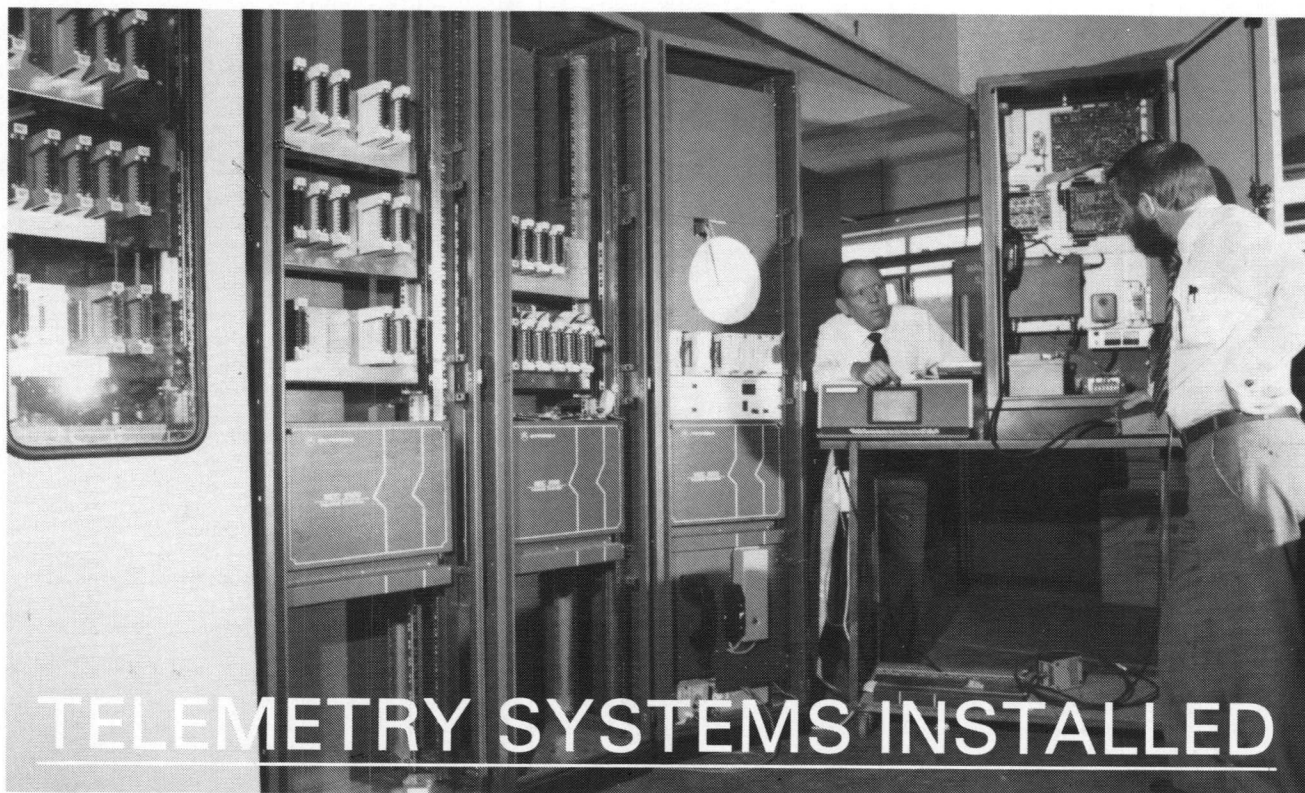
The finest grade of element achieves a removal rating of 0,5 µm, providing a typical efficiency of 99,99 per cent when tested using a 0,3 µm bacterium.

Constructed entirely of polypropylene, the



Profile filters have numerous applications in many industries, including petrochemical, water treatment, plastics, printing, paints and resins, beverages, pharmaceuticals, gases and cosmetics. The absence of binders and surfactants gives the filters compatibility with a wide range of fluids.

Enquiries:
Deomed (Pty) Ltd
PO Box 32299
BRAAMFONTEIN
2017
Tel: 833-1300



TELEMETRY SYSTEMS INSTALLED

The Communications Division of Motorola SA have just completed the first of 14 individual telemetry systems for installations of the Department of Water Affairs throughout South Africa.

The contract, worth just under R1m was awarded at the end of last year, and should be completed by mid-1986. All the engineering design work, and final assembly will be undertaken in South Africa.

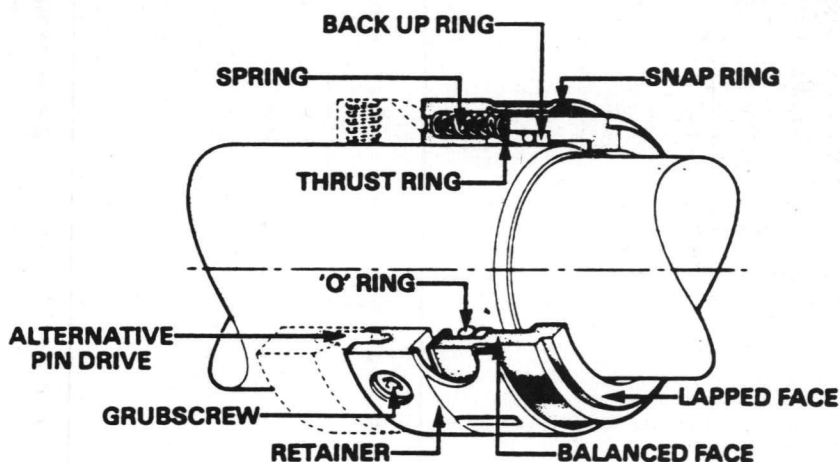
Each of the 14 systems will consist of a number of outstations, mostly at reservoirs, and one base station usually situated in the Department of Water Affairs, HQ for a particular area. The biggest system will be at Ndebele, with nine outstations linked by repeater to one base station. The Motorola equipment will consist of standard INTRAC radio data-link units, to transfer such essential information as reservoir level, flow rates, valve status, etc as well as alarm signals. Information will be displayed on LEDS, with hard-copy back-up on chart recorders.

The most northern system will be at Duiwelskloof, near Tzaneen, the most eastern at Nahoon near East London, the most western at No 12 Vaal Gamagara, just beyond Kimberley, and the furthest one south at Saldanha Bay. All the outstations will be unmanned.

Although each of the 14 systems will operate autonomously, Motorola have provided the facility for a total link-up if required in the future so that monitoring and control of all the reservoirs could be from one central point, possibly Standerton. This would also be achieved by means of the standard Motorola INTRAC system.

Enquiries:

Communications Division
Motorola SA (Pty) Ltd
PO Box 39586
BRAMLEY
2018



MECHANICAL SEALING

Increasing waterflood injection pressures, often greater than 20,4 MPA to cope with deeper reservoirs, have in turn placed greater demands on mechanical seals.

Where standard seals are unsuitable, Crane Packing (Pty) Ltd of Springs has produced a series of special types such as its Type 10 series (PTFE bellows) and Type 15 (metal welded bellows).

However, the company also provides a standard range of multi-spring O ring seals which can be easily converted into wedge ring seals, so giving greater flexibility, by simply exchanging the O and wedge rings and changing the faces.

Such a mechanical seal is the Type 8B1, which can form the basis for most process and industrial rotating shaft sealing re-

quirements, particularly in arduous operating conditions where high speeds and high pressures are encountered.

In addition, the effect of abrasives in the sealed liquid are minimised by a wide face design, positive drive and a retainer design which encourages flushing of all seal unit components by the pumped liquid. Design is such that the heavy face will resist distortion from high pressures.

Enquiries:

Crane Packing (Pty) Ltd
PO Box 890
SPRINGS
1560
Tel: 818-2031

EXPOXY

3576

Until recently butterfly valves used in the chemical and petrochemical industry were made exclusively from metal, or composites of metal and other materials.

The UK company Felton Fluid Handling, manufacturers of high-quality butterfly valves, invested in research and development in order to find out the possibilities to replace metal by a plastic, for cost and quality reasons. A number of different plastics of the thermosetting type were tested.

Important requirements for a plastic to be used in a butterfly valve are high mechanical strength, the possibility to make dense moulded thick section parts, chemical resistance and, for use in drinking water systems, it should have no effect on the quality of the water.

To achieve high mechanical strength in a plastic, long glass fibres are conventionally used. It transpired, however, that with long glass fibre reinforced moulding compounds it is not possible to obtain the required mechanical strength and the density necessary to avoid porosity in this thick-walled application.

The application and requirements were discussed with the moulding compound manufacturer Synres-Almoco B.V. After some time the R & D department of that company succeeded in developing a high physical strength product without the use of long glass fibre as a reinforcing agent: EPOXY 3576.

This is a material that is easy to mould without the presence of porosity, voids and cracks, even in thick sections, with high strength and low water vapour permeability and which can stand high pressures.

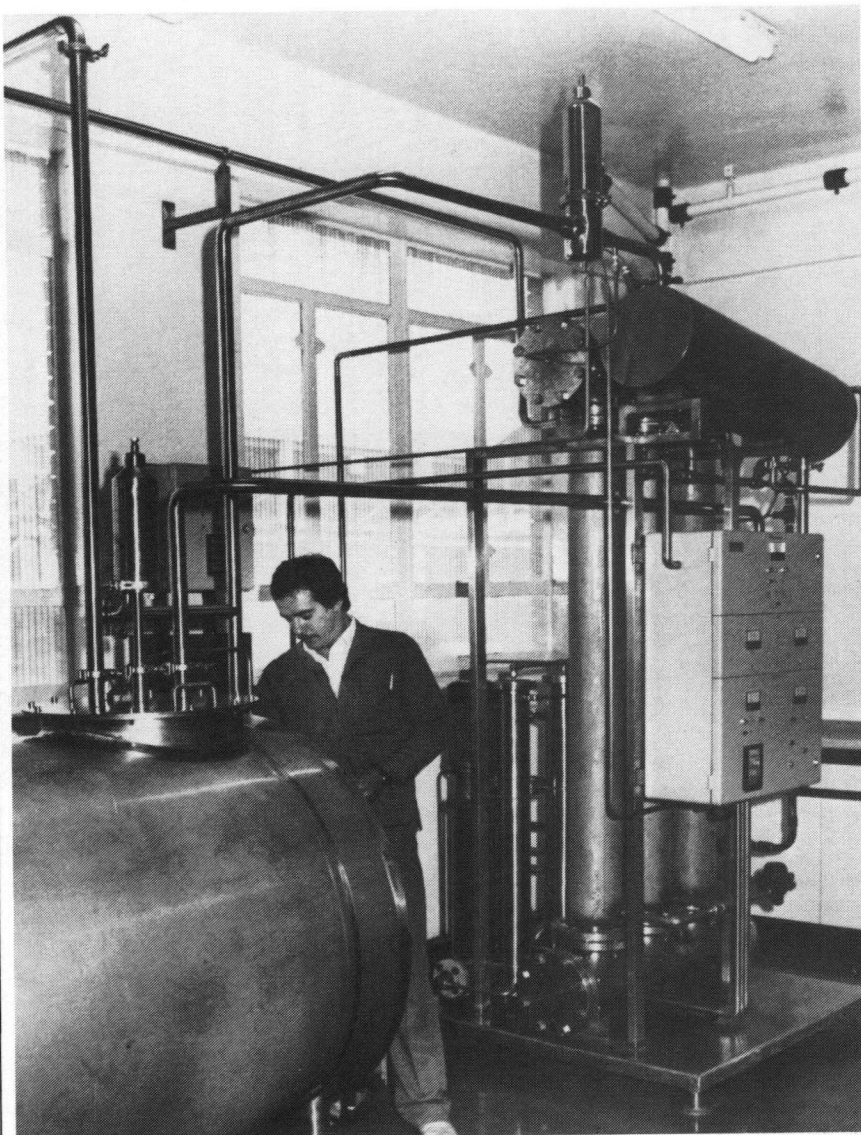
Moreover, tests were done on the chemical resistance of Epoxy 3576 which proved that components made from this compound are resistant to most chemicals which the butterfly valve is likely to come in contact with.

As these butterfly valves are also used in drinking water transport systems, the effect of this plastic on potable water has been tested and samples of Epoxy 3576 have been found to comply with the requirements of the United Kingdom Water Fittings Byelaws Scheme Tests of Effect on Water Quality.

Synres-Almoco states that, for butterfly valves, and for all applications where high mechanical strength with optimum density in thick sections is required, Epoxy 3576 is a most suitable material.

The Design Council in the United Kingdom has conferred a Design Award on the butterfly valve made from Synres-Almoco engineering epoxy.

Enquiries:
Synres-Almoco B.V.
PO Box 18
AA Hoek van Holland
The Netherlands



PURIFICATION PLANT

A new system for water purification has been designed and manufactured by Deomed (Pty) Ltd in collaboration with the overseas principals of Glaxo (Pty) Ltd, a Germiston pharmaceutical manufacturing company. The system employs standard equipment packaged to form a compact plant which can produce 400 l/h of pure water for general purposes, 250 kg/h of pure steam or 200 l/h of distilled water to the quality required for human injections.

The methods used in the system are reverse osmosis for the pretreatment of municipal water, pure steam generation, and distillation, all combined into a single unit. Reverse osmosis rejects 96 per cent of dissolved salts, organics, pyrogens and floating particles. The steam generation process removes a further 90 per cent of the remaining salts and more than 99 per cent of the pyrogens, organics, particles and bacteria.

The remaining dissolved gases are removed by reboiling the distillate. Reverse osmosis can be used independently in the system or in conjunction with steam genera-

tion or with both steam generation and distillation.

The installation, made almost entirely of low carbon stainless steel, occupies only 1,5 m² of floor space, excluding the storage tank. A conventional water purification system of this capacity using the three methods separately normally requires 40 m².

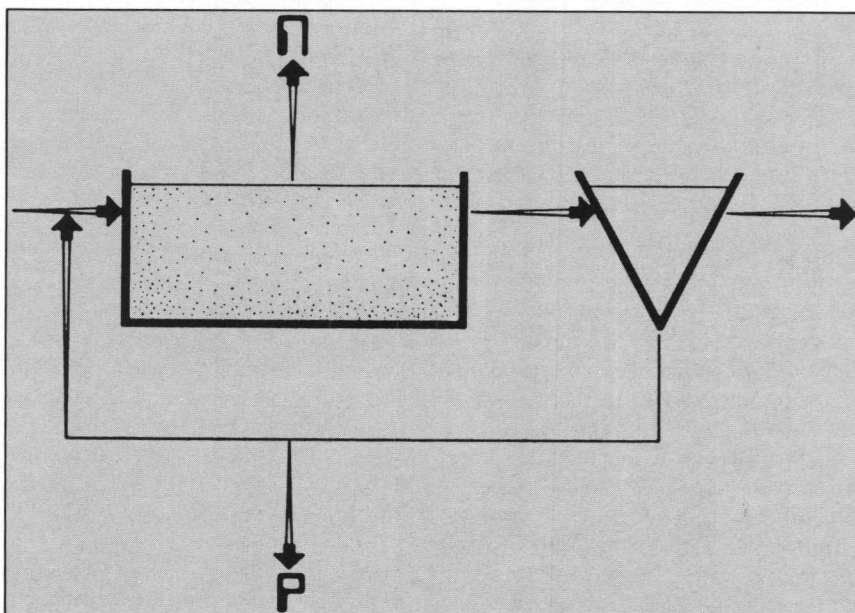
The total cost of the Glaxo system was R91 000 which is about 60 per cent of the cost of imported systems capable of producing purified water to British, European and US pharmacopoeia specifications.

The system can be extended simply by adding 100 l/h units.

Enquiries:
Deomed (Pty) Ltd
PO Box 32299
BRAAMFONTEIN
2017
Tel: 833-1300

FOR SALE:

Activated sludge computer program



NUTREM: DESIGN OR ANALYSIS OF NUTRIENT REMOVAL ACTIVATED SLUDGE PROCESSES

NUTREM, a computer program for the design or analysis of nutrient removal activated sludge processes, has recently been developed under the auspices of the Water Research Commission by the University of Cape Town in conjunction with Ninham Shand Inc. NUTREM has the capacity either to design or analyse processes under steady state conditions. It is based primarily on the theory contained in the Water Research Commission publication *Theory, design and operation of nutrient removal activated sludge processes*.

The program facilitates the design or analysis of any of the activated sludge process configurations currently being used in South Africa. In the case of design, only the influent flow and the wastewater characteristics are required as input and the program will calculate the relevant mass fractions, mixed liquor recycle ratios, effluent characteristics, process volumes and oxygen requirements. In the case of analysis, the process con-

figuration needs to be known and recycle ratios, effluent characteristics and oxygen requirements will be calculated.

The program is interactive with all input requested on the screen and with decisions taken by entering Yes/No answers or selecting options from a menu. It has been developed for the Hewlett Packard HP86/87 micro-computer but is in the process of being translated for Hewlett Packard "200 series" machines. A FORTRAN version using Calcomp plotting routine for PRIME and IBM PC machines will soon be available.

The program can be obtained from the Engineering Computing Company, P.O. Box 1347, Cape Town 8000 (Telephone (021) 21-4992). The cost of the program is R500 with an additional R100 per annum payable for support. Non-profit-making organizations can obtain the program free of charge but are expected to pay the R100 per annum support charge. The manual is available for R10.

L S S A

(From page 40)

cluded or presently under way in South Africa.

Delegates also had the opportunity to discuss a number of issues in workshop sessions. Topics ranged from coastal management, turbidity, water quality and problems in urban rivers to macrophytes, methods of assessing microbial populations and river research.

A highlight of the Congress was the presentation to Dr Tony Ribbink of the Society's Silver Medal for his work on the fishes of Lake Malawi. We should like to congratulate him and his team on this fine achievement.

Conclusions

In summarising the overall proceedings of the Congress, Prof Brian Allanson (Rhodes University) concluded that

- Ecological processes such as nutrient cycling and decomposition are in fact remarkably similar in fresh waters, estuaries and the sea.
- We have a clear idea of the questions to ask about ecological processes but answering some of them will require a careful study of appropriate methodology and attention to such details as the significance and magnitude of microbial loops and the factors affecting both nutrient cycling and decomposition.
- Limnology and marine biology stand to gain enormously by active exchange of information, techniques and ideas between aquatic biologists.
- The standard of work presented in the general papers and posters as well as the reviews by the keynote speakers was such that South African aquatic sciences are of world standing. We do not have to look overseas for expertise.

Dr Jenny Day
Zoology Dept.
University of Cape Town.

CONFERENCES AND SYMPOSIA

WATER PURIFICATION

A symposium on the latest technology in drinking water purification will be held at the CSIR Conference Centre, Pretoria, on 30 September 1985.

Enquiries: The Chief Director, NIWR, PO Box 395, Pretoria 0001. Telephone: Mr P Coombs (012) 86-9211 X2231

DESALINATION

The 2nd World Desalination Congress and Exhibition will be held in Bermuda from 17 to 23 November 1985.

Enquiries: International Desalination Association, c/o WSIA, PO Box 387, Topsfield, MA 01983, USA.

NITRATES

An international congress on nitrates in water will be held from 20 to 22 November 1985 in Paris, France.

Enquiries: Mrs Janine Lindenbaum, Compagnie Générale des Eaux, 52 rue d'Anjou 75384 Paris Cedex 08, FRANCE.

AGRICULTURAL WASTES

The 5th international symposium on agricultural wastes will be held in Chicago from 16 to 17 December 1985. Papers will include research reports, case studies and state-of-the-art reviews.

Enquiries: American Society of Agricultural Engineers, 2950 Niles Road, St Joseph, Michigan 49085-9659, USA.

DRINKING WATER

The 2nd national conference on drinking water will be held in Edmonton, Canada, from 7 to 8 April 1986. The theme is: *Treatment for organic contaminants*.

Enquiries: Dr WJ Hargreave, Department of Civil Engineering, University of Alberta, Edmonton, Alberta. T6G2G7 Canada.

AQUATIC ECOSYSTEMS

The 3rd international GAP workshop with the theme *Respiration and its effects on the measurement of aquatic primary productivity* will be held in Durban, South Africa, from 27 April to 3 May 1986.

Enquiries: Dr Richard Robarts, Chairman, Organising Committee, c/o Symposium Secretariat S371, CSIR, PO Box 395, Pretoria 0001.

SEWERAGE

A symposium on *sewerage — value for money*, presented by the Institute of Water Pollution Control will be held from 19 to 20 May 1986 in London, England.

Enquiries: Roy Harris, Flanchford, Bassetsbury Lane, High Wycombe HP11-1HS, Buckinghamshire, UK.

FLOODS

An international symposium on flood frequency and risk analysis will be held in Baton Rouge, USA, from 18 to 21 May 1986.

Enquiries: International Symposium on flood frequency, Department of Civil Engineering, Louisiana State University, Baton Rouge, LA 70803-6405, USA.

SLUDGE

A conference on the utilization of land for the treatment and disposal of liquid wastes and sludges will be held from 13 to 15 August 1986 in Salvador, Brazil.

Enquiries: Dr RG Ludwig, BNC/IAWPRC, c/o ABES, Avenida Beira-Mar 216-13º andar, 20021 Rio de Janeiro, RJ, Brazil.

IAWPRC

The 13th IAWPRC biennial international conference will be held in Rio de Janeiro, Brazil, from 17 August to 22 August 1986.

Enquiries: IAWPRC, Alliance House, 29-30 High Holburn, London WC1V 6BA, UK.

WATER VIROLOGY

A specialised seminar on water virology, associated with the 13th IAWPRC biennial conference will be held from 17 to 22 August 1986 in Rio de Janeiro, Brazil.

Enquiries: Dr WOK Grabow, National Institute for Water Research, CSIR, PO Box 395, Pretoria 0001.

MARINE DISPOSAL OF WASTEWATER

A seminar on the planning of marine disposal systems will be held from 25 to 27 August 1986 in Rio de Janeiro, Brazil.

Enquiries: Dr RG Ludwig, BNC/IAWPRC, c/o ABES, Avenida Beira-Mar 216-13º andar, 20021, Rio de Janeiro, RJ, Brazil.

SA WATERBULLETIN

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Subscription is free. Material in this publication does not necessarily reflect the considered opinions of the members of the WRC, and may be copied with acknowledgement of source.

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