

SA

waterbulletin

VOL 11 No 4

NOVEMBER 1985

WATER QUALITY:
MANAGEMENT
IN THE PWV

DROUGHTS:
WAS 1930 SA's
WORST?

PHOSPHATES:
HIGHLIGHTS OF
THE LISBON
CONFERENCE



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20—24 JANUARY 1986

Conference Centre
CSIR, Pretoria

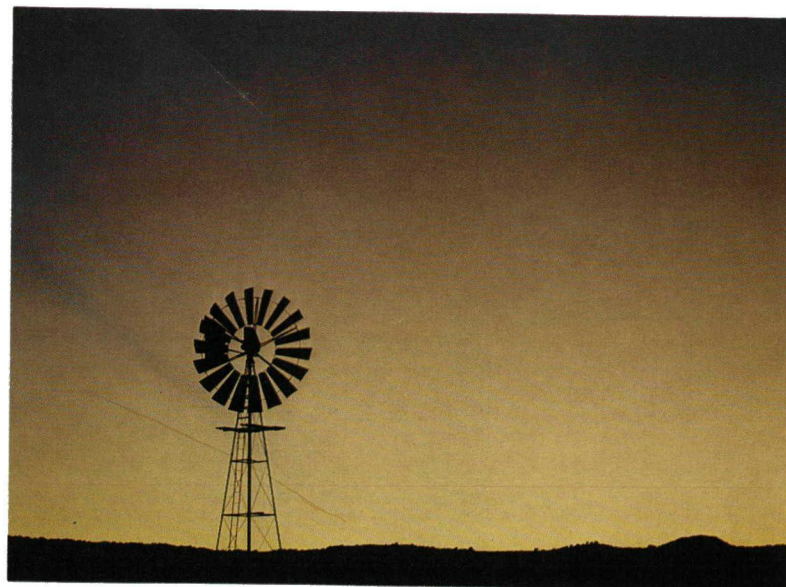
INTERNATIONAL SYMPOSIUM

ON AGRICULTURAL ENGINEERING

**Full duration R300/person.
(Attend all technical sessions.
All documentation/Technical
visits/All social functions/
Teas and luncheons.)
Persons wishing to attend
specific sessions: R100/day.**

English, French and German.

The symposium program is divided into three sections. Section 1 deals with *Soil and Water*, the theme being the optimum utilisation of natural resources. Papers from Utah, Hawaii, Canada, Australia and Brazil will deal with many aspects, ranging from weather modification for agriculture to mechanical irrigation in developing countries; from irrigation design and its



problems to the use of micro and drip irrigation for tropical crops.

Section 2, *Agricultural Buildings*, has as its theme the latest developments and future trends in agricultural buildings, related facilities and equipment, and grain storage. Experts from Israel, France, West Germany and Sweden are submitting papers on subjects such as the handling and packing of deciduous fruits, facilities for wine production and the design of milking parlours. A scientist from America will discuss the effects on the environment of animal waste in open feedlots.

In Section 3, *Agricultural Machinery*, with the theme *Developing Countries — Mechanisation and Energy*, opening papers will be read by visitors from Brazil, England, Bophuthatswana, Zimbabwe and America. The main thrust of this Section is appropriate technology in agricultural mechanisation systems; the potential use of alternative fuels for diesel engines especially the use of sunflower oil and alcohol; and engine modifications.

CAN YOU AFFORD NOT TO BE THERE?

Registration Form

Please complete and return to:
The Symposium Secretariate, S.337, CSIR, PO Box 395,
Pretoria 0001 (Attention Mrs M Meyer)

NAME:

TITLE:

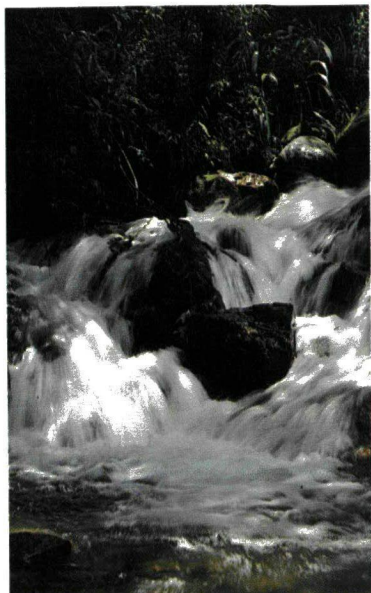
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WRC

Waterfall near Mbabane, Swaziland.

SA Waterbulletin is a quarterly magazine on water and water research published by the South African Water Research Commission (WRC), a statutory organization established in 1971 by Act of Parliament.

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

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SA Waterbulletin is 'n kwartaalike tydskrif oor water en waternavorsing wat uitgegee word deur die Suid-Afrikaanse Waternavorsingskommissie (WVK), 'n statutêre organisasie wat in 1971 by Wet gestig is.

Intekening is gratis. Stof in dié publikasie weerspieël nie noodwendig die oorwoë menings van lede van die WVK nie, en mag hergebruik word met erkenning van die bron.

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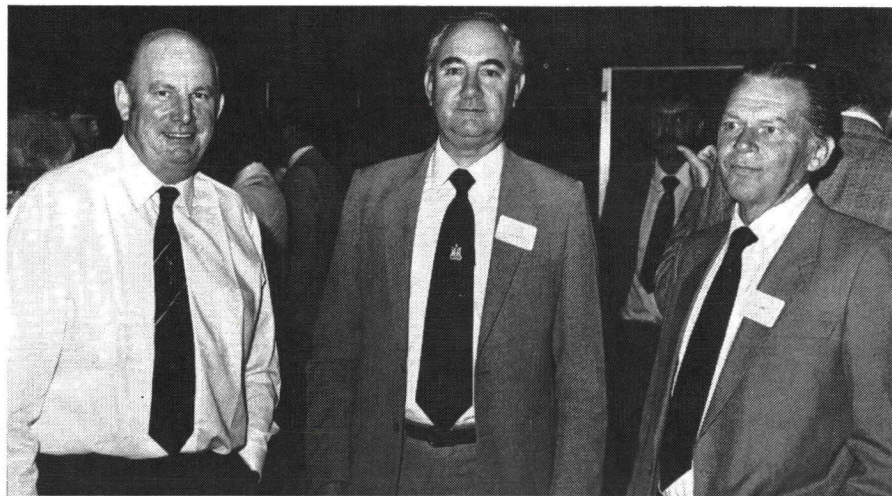
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Van links: Mnr B Blair (Bewater), N Crook (Bewater), LR Letcher (Babcock Ames Crosta.)



Mnr GJ Dreyer (links) voorsitter van die OVS-Goudvelde-Waterraad, in gesprek met mnr LD Hobbs, voorsitter, Randwaterraad.

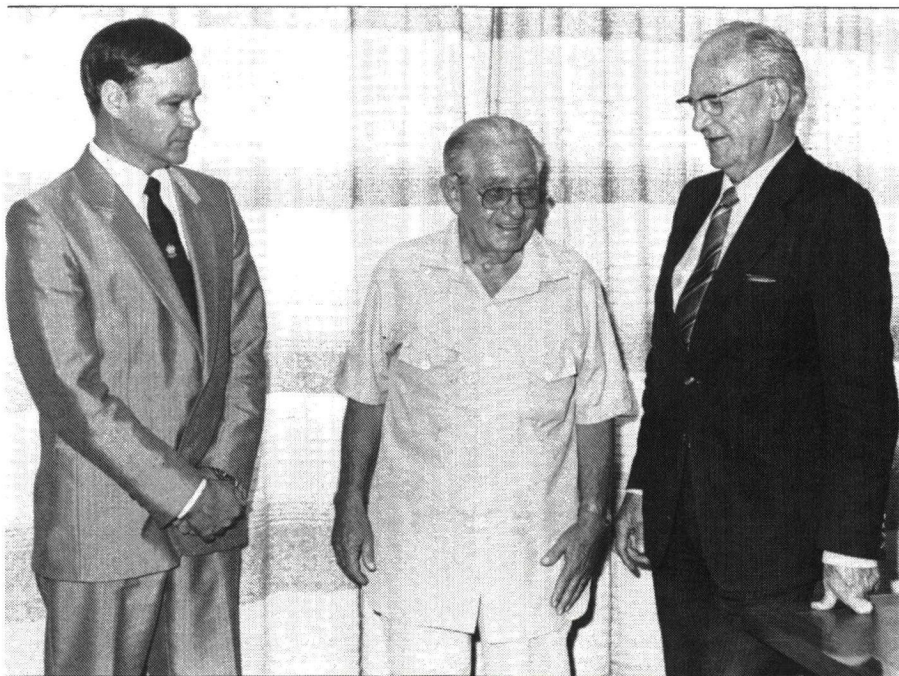


Van links: Mnr: PL Evans (Portals Water Treatment), AS Smit (Randwaterraad) en LHJ James (hoofingenieur, Randwaterraad).

Die jongste ontwikkelings in drinkwatersuiwering is onlangs op 'n eendag simposium by the WNNR se konferensiesentrum in Pretoria bespreek.

Die simposium is deur die afdeling waterboukundige ingenieurswese van die SA Instituut vir Siviele Ingenieurs in samewerking met die Nasionale Instituut vir Waternavorsing, WNNR, gereël. Mnr LD Hobbs, voorsitter van die Randwaterraad, was die openingsspreker.

Mnr PE Odendaal (links) pas-aangestelde uitvoerende direkteur van die Waternavorsingskommissie in gesprek met die nuwe voorsitter van die WNK, dr JP Kriel (regs) en dr GJ Stander, voormalige hoof van die WNK. Dr Stander en sy vrou was die gaste van die Kommissie tydens 'n WNK-geselligheid.





Professor P Meiring (Department of Agricultural Engineering, University of Natal), Mr D van der Merwe (WRC).

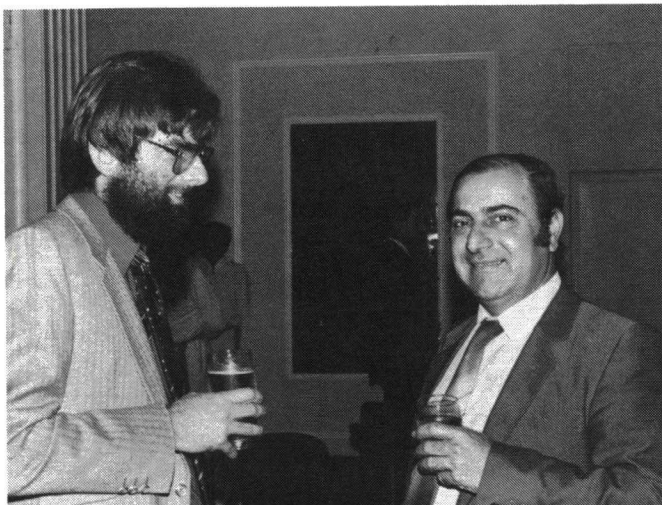


Mr A Seed (HRI), Dr R McKenzie (Bruinette, Kruger & Stoffberg).



Professor I Simmers (Vrije Universiteit, Amsterdam), Professor R Schulze (Department of Agricultural Engineering, University of Natal).

Pietermaritzburg recently was the venue for the Second South African National Hydrology Symposium. The symposium, which also included an excursion to the De Hoek and Ntabamhlope catchments, was organised by the Department of Agricultural Engineering at the University of Natal. Amongst others, topics such as flood peak estimation, water resources management, and models and land use effects were discussed.



Mr M Harrison (Climatology Research Group, University of the Witwatersrand), Mr E Katsiambirtas (Meteorological Services, Windhoek).



Mrs H Kriel, Professor G Schreiner (Vice-Principal, University of Natal).

WATER QUALITY MANAGEMENT IN THE PWV AREA

Additional costs for all water consumers in the PWV area will amount to approximately 140 million rand per annum if the water quality deteriorates from 300 to 800 TDS mg/l.

At a recent meeting of the Institute for Water Pollution Control (IWPC) Dr Chris Herold, Assistant Director of the Mathematical Modelling Unit of Stewart, Sviridov & Oliver (SS&O), spoke on water quality management in the PWV area. SS&O is currently researching different options for improving water quality of not only the PWV area, but also the area downstream of Vaal Barrage. The following article deals with these findings.

HISTORICAL BACKGROUND

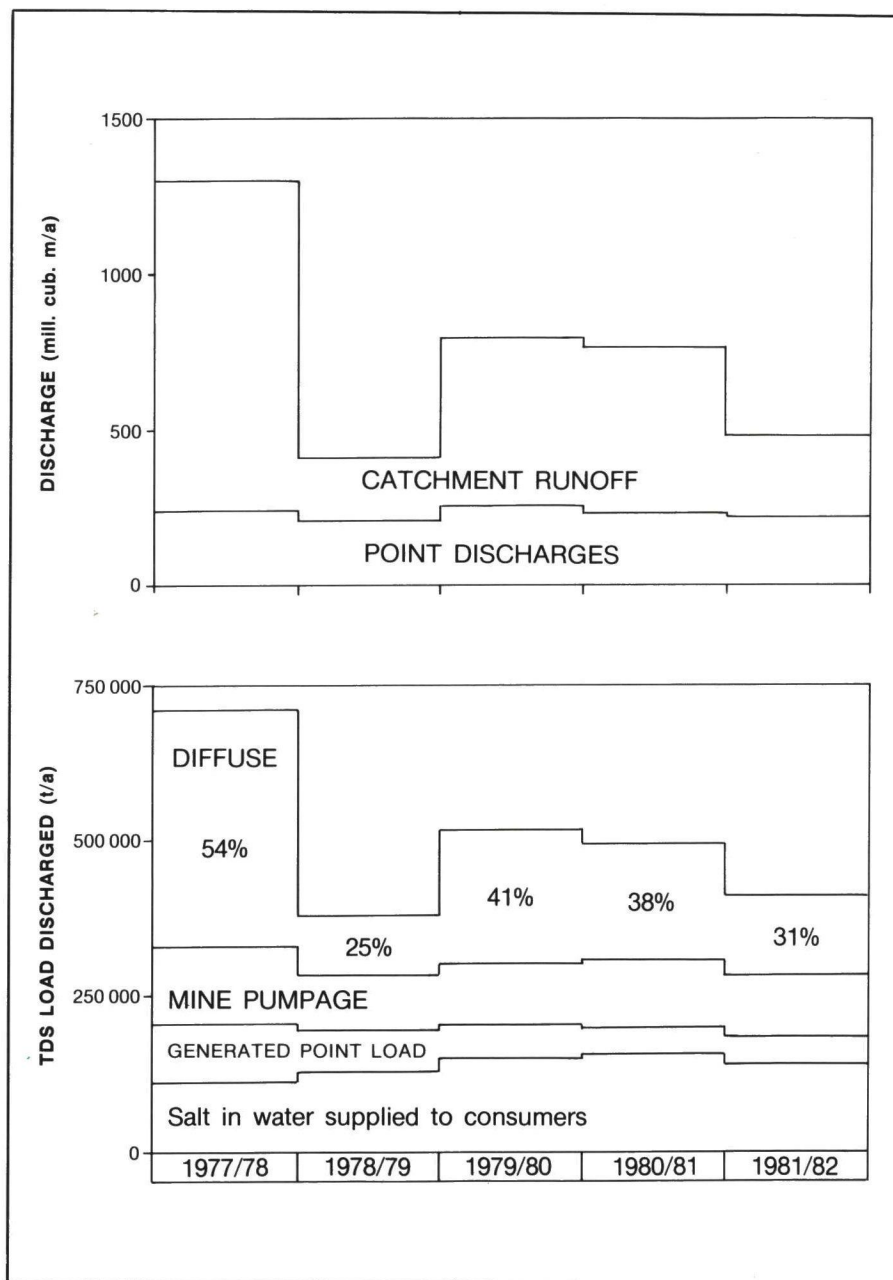
The PWV complex constitutes the largest and most highly developed concentration of human activity in Southern Africa. For its water supply the complex is dependant on the resources of the Vaal basin, supplemented by water pumped from the Tugela to Sterkfontein Dam.

The PWV complex is by no means the only consumer making demands on the Vaal River system. Grootdraai Dam, for example, was constructed to supply water to the oil-from-coal and power-generating installations of the Eastern Transvaal. Downstream of Vaal Barrage, water is abstracted by the Western Transvaal Regional Water Company and the OFS Goldfields Water Board.

Still further downstream the Bloemhof Dam helps to secure the water supplies to Vaalharts Government Irrigation Scheme and riparian irrigators, Kimberley and other towns down to the confluence with the Orange River.

The Rand Water Board, responsible for supplying water throughout the PWV complex, abstracts from three points between Vaal Dam and Vaal Barrage as well as direct from Vaal Dam.

Urban and industrial development of the region has brought about in-



Seasonal variation in diffuse salt contribution.

creasing salination of the rivers. Enormous economic losses to consumers result from increased salination of the waters of the PWV complex. Initial estimates which have been made by Mr Jan Heynike, a specialist consultant to the Water Research Commission, indicate that a rise in TDS concentration from 300 to 800 mg/l would add 19c per m³ to the costs of the consumer.

Salt pollution arises from both point and diffuse sources. Major point sources comprise highly saline mine pumpage and less saline industrial and domestic effluents.

About 35% of all water supplied to the PWV complex is discharged as effluent south of the Witwatersrand where it divides and returns to the Barrage reservoir via the Rivers Klip and Suikerbosrand. There is a

significant feedback effect which raises the TDS concentration in the Barrage reservoir. This feature of the system is particularly serious in view of the limitations in water resources which in turn dictates the need to recycle so as not to deplete strategic reserves of fresh water stored at the Vaal and Sterkfontein Dams.

It was found during the 1977/78 hydrological year that point sources contributed less than half of the total salt load originating in the PWV region. The remainder was derived from diffuse sources.

Particularly trying conditions arise during the first few rainstorms of the wet season, when the salts which have accumulated during the dry season are washed into streams feeding the Barrage reservoir. This causes a sharp rise in TDS concentration and industrial consumers are consequently forced to size their water treatment plants to meet the peak TDS concentrations.

THEORETICAL BASE

Before dealing with the more specific practical options which were considered in researching solutions for the high TDS concentrations in the PWV area, it is advisable

to first deal with the broad theoretical approaches considered.

The six broad approaches are to simply do nothing; to remove the salt either at its source or at the point of supply in the river; to exploit a new source with a better quality of water; to have a dual supply system where a better quality of water is supplied to the more sensitive industries and other more saline waters to those who are less sensitive to it; to dilute preferably in supply and not in the river; and finally to blend selectively in supply.

The approach which was finally favoured for practical application was blending.

SPECIFIC APPLICATIONS RESEARCHED

- At an early stage of the investigation an option was considered to collect all the mine pumpage from the different mines on the Reef at a certain point and by means of a pipeline transport them to a convenient evaporation pan. The nearest evaporation pan turned out to be 400 km away in the Orange Free State.

Although the costs are enormous, it may be an economical alternative,

provided the mines continue to pump water to the surface for some years to come.

- Instead of removing all the water from the mines, it could be desalinated locally from where only the brine would have to be pumped; a much smaller volume for which a smaller pipeline and evaporation pan would be required.

From an economical point of view, however, this alternative is not viable because of the costs involved with desalination.

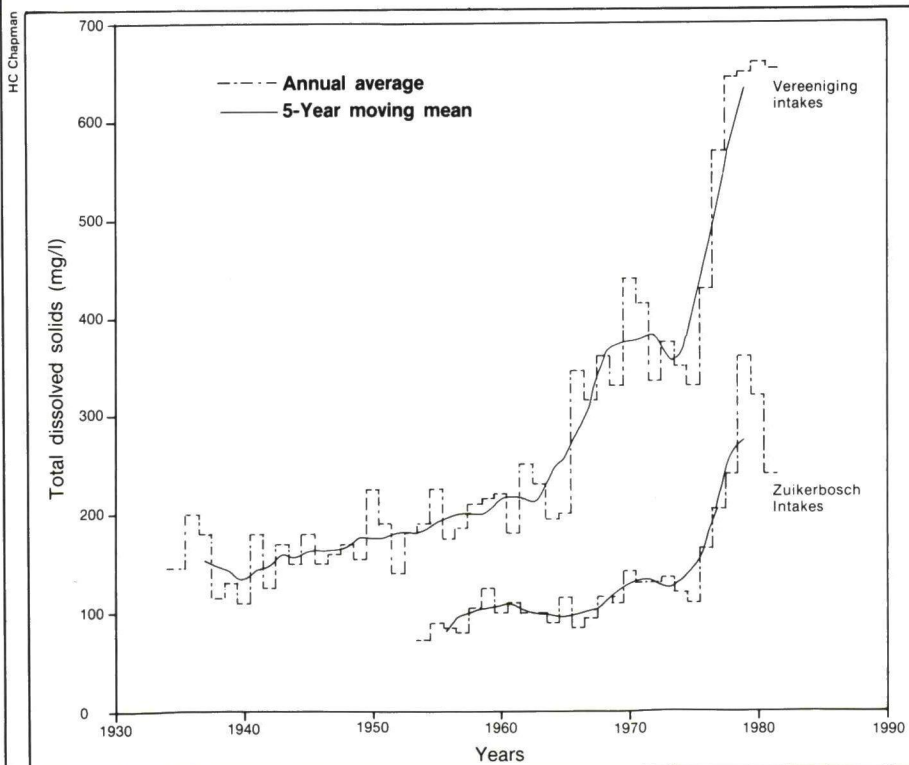
- Another alternative is to tighten regulations for the mines and industries on the quality of the water discharged to the Vaal River. Again this actually implies desalination or collecting saline water and putting it into evaporation pans.

Apart from the problem which arise in the provision of evaporation pans for the mines and industries, it also turned out that this option is uneconomical in terms of the costs to the community.

- The option of desalinating sewage effluent was examined and rejected on economic grounds. For example, if sewage effluent at a TDS concentration of 800 mg/l has to be desalinated to 300 mg/l, then side-stream desalination would require that 69 per cent of the effluent be desalinated at a cost of about 50 c/m³, giving an average cost of 34,5 c/m³ for the water produced. However, the saving in costs to consumers would only be 19 c/m³. Therefore, unless no other source of water is available, desalination, purely from an economical point of view, is not the desired alternative and it is much cheaper to suffer costs in terms of corroded pipes.

- Instead of taking water from the Vaal Barrage, one could also build a new dam at Kromdraai near Schoemansdrift, downstream of Parys. Whenever the Vaal Barrage spills fresh water, these volumes go through the Barrage in a few days.

If one can trap these flood waters as well as the returnflows from tributaries, in the Kromdraai Dam, the latter could then act as



Increasing salination of water in the Barrage.

a type of mixing tank where saline effluent water can be mixed with the fresh water spillage from Vaal Dam, resulting in lower TDS concentrations.

The Kromdraai alternative, however, has the disadvantage that large and long pipelines for returning water to the PWV complex will have to be built.

There are other justifications for building a dam at Kromdraai, not as a water source to supply the PWV area, but to increase the yield of the Vaal system and assist in the water demands further downstream.

- A comparison between the Lesotho Highlands Project and the Orange Vaal Weir Scheme indicated that the latter, from an engineering point of view, has quite a few advantages. In terms of engineering costs it is also very close to the Lesotho Highlands Project.

The idea was to build a whole series of weirs downstream of the confluence of the Orange and Vaal Rivers, pumping the water upstream from weir to weir.

This alternative was abandoned because of the following disadvantage. Approximately 80 per cent of the saline water is bled from the system going down the Vaal River, and will return to the system if the flow of the Vaal is reversed. The salt will then have to be removed from the system through the Rand Water Board's pipelines to the North with a consequent sharp rise in TDS concentration.

- Eventually the blending option seemed the most favourable. Blending in the PWV area is very simple and easy to apply. The Rand Water Board already has a pipeline and a canal with a large capacity from Vaal Dam to Zuikerbosch Purification Works. The Rand Water Board is therefore already in the position to blend at the Zuikerbosch Purification Works.

Although the canal was built in order to save energy, there is nothing to prevent immediate blending at Zuikerbosch.

At the moment the Lethabo weir is being built to isolate the Escom and Rand Water Board in-



Sterkfontein Dam.

takes from polluted tributary water and a pipeline is being built between the Lethabo weir and the Rand Water Board Vereeniging Purification Works. Once this pipeline is completed, the Rand Water Board will be able to blend at Vereeniging as well.

A large amount of money, relative to the cheapest alternative, can be saved through blending.

If the costs incurred by consumers are based on half of what Mr Heynike estimated (bearing in mind the uncertainties inherent in these estimates, it was deemed wise to carry out sensitivity analyses, one of which involved halving these costs), then blending to eliminate peak TDS concentrations above 400 mg/l would result in a present value cost saving of 280 million rand. Blending to less than 300 mg/l would bring about savings of 540 million rand. If one were to blend to 250 mg/l it would save 800 million rand.

Since the capital works are already available, capital costs for blending are minimal. The only possible future cost will be the next phase of the canal which has to be built earlier than was

planned, as well as the next phase of the pipeline from the Lethabo barrier to Vereeniging.

Costs will also involve small additional water importations on certain occasions when saline water will have to be discarded in order to achieve the blending standard. Fortunately most of the extra water released from Vaal Barrage would be trapped in Bloemhof Dam, which in any event is usually the first dam to fail during a drought. The effect of blending would then be simply to delay the calls made on Vaal Dam to make good supply shortfalls at Bloemhof Dam during a critical drought.

The Department of Water Affairs and the Rand Water Board have agreed to go ahead with the blending option on a trial basis. The final date has not yet been finalised because of the critical water situation. Only after the drought has been broken, trials may be commenced. Consumers should not suffer any inconvenience in the interim since blending during severe droughts is not necessary because of the large volumes of fresh Vaal Dam water released to Vaal Barrage to satisfy downstream demands.

"THE VAAL RIVER ECOSYSTEM: STATUS AND PROBLEMS"

A symposium convened by the Foundation for Research Development (Inland Water Ecosystems Section) and the Vaal Catchment Association

THE TOPIC

The Vaal River is South Africa's most intensely utilized water resource, and is a system in which water demand already exceeds supply. At present irrigation expansion is restricted and potable and industrial water is imported from neighbouring catchments. This symposium will focus on the Vaal River and the factors affecting its utilization as a water resource.

VENUE AND DATE

The symposium will take place on 20 March 1986 at the CSIR Conference Centre, Pretoria.

WHO SHOULD ATTEND

- water resource planners
- consultant engineers
- water treatment specialists
- nature conservationists
- limnologists
- ecologists
- hydrologists

THE PROGRAMME

The programme will include presentations on topics such as:

- Water resources development
- Status of pollution
- General chemical quality
- Micropollutants
- Physical and chemical properties of sediments
- Macrophytes
- Blackfly problems
- Fish
- Areas of recreation and conservation
- Wetland areas and their value
- Algal problems
- Biotic indices and water quality
- Bulk water purification problems and economics

PUBLICATION

Proceedings will be made available to delegates prior to the symposium.

REGISTRATION

Registration will take place between 08h00 and 08h30 on 20 March 1986. A registration fee of R70,00 will be charged.

ENQUIRIES AND INFORMATION

Persons wishing to attend the symposium should fill in the enclosed reply card before 30 January 1986 and return to:

Miss M Robertse
FRD
CSIR
PO Box 395
PRETORIA 0001
Tel: (012) 86-9211 x 3769

DROUGHTS IN PERSPECTIVE

Contrary to popular belief, the drought of the early 1930's is not the most severe on record. If one considers a drought sequence of one and two years, the recent drought of 1981 - 1983 was the most severe. When it comes to the most severe long term drought, the drought of the late 1960's appears to be the worst.

This is the finding of a research study which was undertaken by the Department of Agricultural Engineering at the University of Natal and financed by the Water Research Commission. Mr Mark Dent, Senior Research Fellow with the Department of Agricultural Engineering, presented the findings at the Second South African National Hydrology Symposium, which was held in Pietermaritzburg in September.

Mr Dent explained the index which was developed, in the first place, to identify the driest period on record in the summer rainfall region of South Africa, and in the second place to depict the most severe drought spatially.

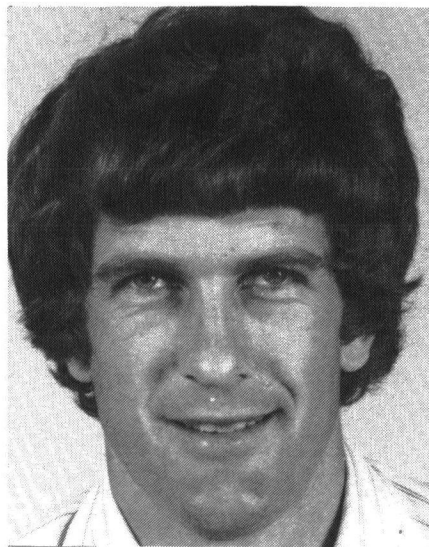
Summer rainfall totals were chosen as the basis for an index of drought, since most of the area covered in the investigation receives over 70 per cent of its rainfall in the summer months.

"Since droughts of varying lengths have different effects on different water users it was decided to investigate not only the one year summer totals, but the cumulative two, three and four year summer rainfall totals as well," Mr Dent said.

In order to determine which was the most severe drought, the rainfall records were first grouped according to Weather Bureau sectors and the mean rainfall was calculated for

each Weather Bureau sector. The daily data from 2 408 stations each with a rainfall record of more than 30 years were processed to yield monthly rainfall totals. These monthly totals were then aggregated to form totals of summer rainfall for the period September to March.

The summer totals for each sector were then calculated and ranked against the other summer totals in that sector. The mean sector rank-



Mr Mark Dent

ing for each period of analysis was then calculated. According to this index the period ending 1982/83 proved to be the most severe drought.

"In an analysis of this nature," Mr Dent said, "it is not only desirable to evaluate the relative severity and overall extent of a drought, but it is also essential to establish the location of the drought areas. This is in particular necessary when comparing the one year drought with a two, three or four years drought or when

comparing the current drought with historical ones."

Mr Dent said the analysis shows that the summer rainfall region of Southern Africa suffered from a very extensive and severe drought for the one, two, three and four year periods ending March 1983.

The two year drought was particularly extensive. It is estimated that during this period 35 per cent of the study area suffered a drought which was classed in the most severe of the categories. As far as the one, two, three and four year drought periods were concerned it is evident that the eastern part of Southern Africa was more severely affected than the central and western part.

It was also established that in many areas suffering from the so called 200 year drought, the summer rainfall totals for 1983 were considerably higher than the lowest on record. Isolated, and in some cases substantial, thunderstorms must have occurred.

DETAILED ASSESSMENT

In order to provide some facts of topical interest, the researchers selected three areas for more detailed assessment. These areas were the Vaal and Midmar Dam catchments as well as the Umfolozi catchment.

Results indicate that the drought for all four periods in the catchment area of Vaal Dam were very and moderately severe. "However, the flow into Vaal Dam was far lower relative to the flow during previous drought periods than is suggested by

	Single Summer	Two Consecutive Summers	Three Consecutive Summers	Four Consecutive Summers
driest	1982/83	1981/82 - 1982/83	1967/68 - 1969/70	1967/68 - 1970/71
2nd driest	1969/70	1968/69 - 1969/70	1981/82 - 1983/84	1966/67 - 1969/70
3rd driest	1967/68	1967/68 - 1968/69	1944/45 - 1946/47	1964/65 - 1967/68
4th driest	1948/49	1945/46 - 1946/47	1963/64 - 1965/66	1965/66 - 1968/69
5th driest	1972/73	1982/83 - 1983/84	1968/69 - 1970/71	1948/49 - 1951/52
6th driest	1951/52	1964/65 - 1965/66	1930/31 - 1932/33	1969/70 - 1972/73

Rank order of the six driest periods on record from 1925 - 1984.

the rainfall. A possible explanation for this anomaly is that the agronomic practices in the catchment have improved and hence a higher percentage of the rainfall is being retained on the land. Increases in the number of farm dams and also in upstream usage are additional contributory factors, "Mr Dent said.

"It is interesting to note that prior to cyclone Domoina in January 1984 the Umfolozi catchment was in the grip of a very severe long term drought. The Midmar Dam catchment, which was of particular interest to inhabitants of Durban and Pietermaritzburg, was affected more by the two, three and four consecutive year rather than the single season drought. Despite stringent water restrictions the level of the Midmar Dam dropped to 14 per cent of its capacity during this drought period."

Comparing the 1980's drought with the drought pattern for the three consecutive summers' rainfall ending in March 1983, it is evident that this much publicised drought of

Category	Single Summer			Two consecutive Summers			Three consecutive Summers			Four consecutive Summers		
	1	2	3	1	2	3	1	2	3	1	2	3
Catchment												
Vaal Dam	25	70	5	70	30	0	40	60	0	60	40	0
Midmar Dam	20	80	0	50	50	0	50	50	0	50	45	5
Umfolozi	80	20	0	80	20	0	70	30	0	80	20	0

Percentage of area covered by each drought category. Category 1 is most severe, category 2 severe and category 3 moderate.

the early 1930's occurred predominantly in the Orange Free State, Transvaal and Northern Natal. Perhaps the fact that this drought of 50 years ago was experienced in the most densely populated region of South Africa, namely the Southern Transvaal, and that it occurred concurrently with a major world-wide economic depression, accounts for the fact that it is still referred to as "the big drought".

Unlike the drought of the 1980's, the late 1960's early 1970's drought for the three and four consecutive summer periods which end-

ed in March 1970 and March 1971 respectively, was not concentrated primarily along the eastern seaboard of Southern Africa. The central and western parts of the summer rainfall region of South Africa were more severely affected by the drought of the late 1960's.

Mr Dent expressed the hope that the end of the drought has been reached, but stressed that the relatively good rains which fell over parts of the summer rainfall region in the summer of 1984/85 does not necessarily mean that the drought of the 1980's has finally been broken.

NATIONAL REGISTER FOR WEATHER, CLIMATE AND ATMOSPHERE

by AG Brunt, L Chalmers and JE Hetem

The major objective of this national register is to provide scientists and engineers with sufficient information about the existence of data records for them to make contact with the data collection agencies or individuals.

Entries have been grouped according to the type of organization, viz. Government Departments, Provincial Departments, Municipalities, Statutory Bodies, Universities, Public Corporations, Private Sector, Neighbouring States.

For each contributor the following information is supplied.

- Name, address and telephone number of contact person.
- Types of data available.
- Instrumentation and frequency of measurement.
- Media in which data are available.
- Geographic location of observation sites.
- Number of sites. This refers to the number of observation sites within a particular degree by degree grid.

- Begin Year. This refers to the year in which observations were first undertaken.
- End Year. This refers to the year in which observations were discontinued.
- Interruptions.
- Availability of data.

- Alternative source of the data stored by a particular organization.

Price: Free of charge
ISBN 0 7988 3259 2

Order from: Mr AG Brunt, National Institute for Informatics, CSIR, PO Box 395, Pretoria 0001.

SANCIAHS AND GROUNDWATER TEAM UP

A start has been made on the planning for the 3rd South African National Hydrological Symposium to be held in September 1987. SANCIAHS has reached an agreement with the Groundwater Division of the Geological Society of South Africa to run the 3rd National Hydrological Symposium in parallel with the Groundwater 87 Conference. This means that there will be common plenary sessions, while specialist sessions will run in parallel so that hydrologists can attend geohydrological papers of their choice and vice versa.

The venue for the joint conference will be Grahamstown — the Settler City — which has a variety of interesting sites for conference excursions relevant to both surface and ground-water problems.

A special request will be sent to the limnological and atmospheric science societies to encourage participation in the hydrological conference.

We look forward to hearing about their research related to water resources.

Please watch this space for further news.

Membrane technology in Industrial Water Management

by OO HART* and RC SQUIRES**

Advances in membrane technology during the last decade make membrane processes more and more attractive for the recovery of water, energy and by-products from industrial effluents. Various membrane types are now used in a wide variety of applications to reduce specific water intake and pollution loads discharged by factories.

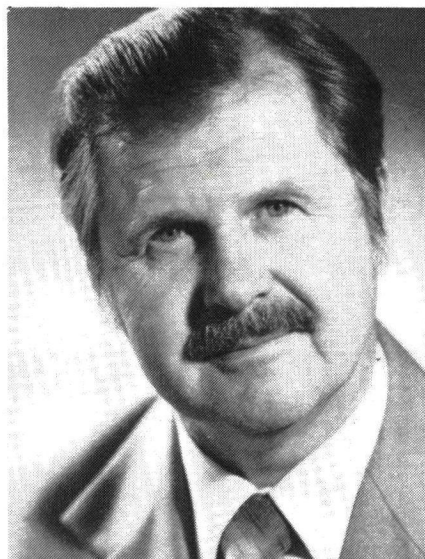
This article presents examples and potential beneficial uses of the different types of membrane technology for South African industry.

Higher standards of living inevitably results in a higher percentage of a country's total water demand being used by industry, which in turn leads to higher pollution loads to be disposed of. Whether it is limited water supplies or threatening environmental pollution, industry in both water scarce countries and countries with an abundant water supply has a moral responsibility, firstly to optimise its water intake per unit of product manufactured by using the smallest possible amount of water of the lowest acceptable quality for each process and secondly to purify its effluent to the highest possible quality so that down-stream users are not adversely affected.

To obtain optimal water utilization, industry has to reuse process waters and effluents to the highest possible degree. But to be feasible, reuse must at a minimum be economically attractive and capable of producing water that meets the quality requirements of the processes it is intended for. Extensive exploratory research and engineering studies have been carried out during the last few decades on the development and application of many physical/chemical processes

for the treatment of industrial effluents with the aim at raw material, chemical, energy and water recovery and thereby providing industry with an incentive to apply such technologies.

The process that holds the greatest promise as a recoverer of valuable commodities is membrane separation. Advances during the last decade in membrane technology are rapidly decreasing the energy requirements for separation of contaminants or demineralization of industrial wastewaters, thereby pro-



Dr OO Hart, senior adviser, WRC.

viding effective effluent treatment, water for reuse, and, depending on the contaminants present, offer by-products whose value offsets the cost of installing the equipment and in some cases a welcome monetary return.

In this article a few of the more recent applications of reverse osmosis (RO), ultrafiltration (UF), dynamic ultrafiltration (DUF) and crossflow microfiltration (CFMF) for the management and treatment of industrial wastewater in the Republic of South Africa, are given.

MEMBRANE TYPES

REVERSE OSMOSIS

Pressure-driven membrane processes, where molecules of different sizes were fractionated by filtration, were not considered as viable until the 1950s.

However, the real breakthrough in making membranes usable for pressure-driven membrane separation of small molecules was the development of the skinned type membranes cast from solutions of cellulose acetate with the addition of non-solvents and dipped into ice-water after casting, followed by heat treatment.

In recent years, polymeric membranes of polymers other than cellulose acetate have been produced specially for UF or brackish water desalination, and today it seems possible to produce membranes from a large number of soluble polymers.

Although the original main purpose behind the development of membrane processes has been desalination of sea water, brackish water desalination has been the main application of RO so far.

Industrial applications of RO have been introduced with success for a number of applications such as the concentration of whey, permeate from whey or skim milk ultrafiltration, egg white, sulphite liquor, and a number of pharmaceutical products.

Various types of sewage water, acid mine drainage, distillery waste, potato starch waste water, beet and cane juices, fruit juices and a number of other liquids are being or have been tested with varying degrees of success.

ULTRAFILTRATION

Ultrafiltration applications have been introduced much more quickly into industry than have reverse osmosis,

* Water Research Commission, Pretoria.

** Binnie & Partners, London, UK.

the reason being that while RO has strong competition from evaporation, UF is in many cases a purification method enabling the production of by-products, often from waste liquids.

Some of the main applications have been: UF of whey for protein recovery and of skim milk for the production of acidified products and cheese; enzyme purification; the removal of liquid from electrodeposit paint baths; purification of lignosulphonic acids and many applications within the pharmaceutical industry.

DYNAMIC ULTRAFILTRATION

Until recently there have been strong thermal and chemical limitations on the use of UF owing to a number of cleaning problems which could not be solved, such as pH, temperature and pressure compatibility, membrane-chemical interactions and fouling. Several of the recently introduced membranes, for example the UOP PA300, Filmtec FT30, Teijin PBIL and Toray PEC1000, have increased operating ranges and organic rejection but are susceptible to fouling. Thus, the treatment of high strength, high fouling or hot industrial effluents by conventional membrane technology is still problematic, but could be overcome by the use of dynamic membranes. The hydrous oxide ultrafiltration membranes and the Zr (IV)-PAA RO membrane provide a range of salt rejections from 10-95 per cent. They have the following advantages for the treatment of industrial effluents:

- high temperature stability
- long service life of the support tube
- dynamic membrane is replaceable in situ by solution chemistry
- a range of dynamic membranes are available for tailoring to a particular application
- high membrane flux rates

Because the dynamic membrane is replaceable, fouling considerations are minimised and high strength industrial effluents may be treated successfully.

CROSSFLOW MICROFILTRATION

Crossflow microfiltration is another pressure-driven separation techni-

que for liquids with suspended solids. Crossflow microfiltration equipment is used where demands are high, to replace filter presses, settling tanks, rotary drum filters and other separators.

Benefits are greatest in the treatment of liquids with one of the following classes of materials and applications:

- pigments
- metallic hydroxides
- colloidal metals (e.g. silver and gold), as used in the photographic industry in mirror-making and in electroplating
- ceramic particles
- grinding dust
- water filtration for injection wells in the mining and oil industry
- thickening of weak sludges
- removal of organic components from certain industrial effluents

Additionally, CFMF equipment is used to separate emulsified oils and petrol-water-mixtures, for prefiltration in RO processes, and for sterile filtration of wines and other beverages.

Crossflow microfiltration is in comparison with other techniques economical and has excellent separation characteristics.

REVERSE OSMOSIS

For multi-component effluents, within certain limits, RO may be considered as a concentrating device. Salt removals are high and good removals of most organic compounds are possible.

Reverse osmosis has an upper limit on concentration caused by osmotic back pressure but salt concentrations of 70 g/l can be reached. Many industrial effluents have initial salt concentrations of 1-5 g/l hence water recoveries in the range 92-99 per cent are feasible.

The following examples show where RO could successfully be used to concentrate and separate inorganic and organic contaminants in industrial effluents.

Coal Mining

At the Sigma Coal Mine, Sasolburg, RSA, 4 000 m³/d of drainage water is pumped to the surface for disposal. The salinity of this effluent is as high as 2 000 mg/l of which

500 — 800 mg/l is present as sodium, mainly in association with the bicarbonate ion. Owing to a restriction in the sodium permitted to be discharged in the area RO was considered a feasible treatment method since the permeate could be used for low pressure boiler feed water and sodium bicarbonate recovered for possible soda ash manufacture.

A pilot plant was erected to investigate the feasibility of high water recovery without acid pretreatment which would destroy the bicarbonate and hence the by-product. As the calcium/magnesium hardness was low, ion exchange units were used to eliminate these elements. A small-scale single membrane rig was used to explore the performance of various membrane types. Eventually the Filmtec BW membrane was selected for the large pilot unit.

The pilot plant was designed to demonstrate a water recovery of 90 per cent with a once-through passage of mine drainage water in a number of membranes arranged in series/parallel taper of 4:2:1. Stage 1 used 4 parallel lines of 4 membrane elements, stage 2 two lines each of 4 elements and the final stage used a single line of 4 elements. The plant was fed with pretreated water at the rate of 26 l/min (37 m³/d).

Pretreatment was accomplished using prechlorination for algae control, coagulation by dosing 2 mg/l of polyelectrolyte, dissolved air flotation, filtration and base exchange to remove the low Ca/mg hardness content of the water. The Silt Density Index (SDI) of this water was reduced from in excess of 100 to between SDI 4 and 5. Scale control was performed using Flocon 100 at a dose of 5 mg/l. The permeate produced at 90 per cent water recovery had the following analysis making it suitable for reuse as low pressure boiler feed water:

	mg/l	
NaHCO ₃	46	(Alkalinity 28 mg/l
Na ₂ SO ₄	8	as CaCO ₃)
NaCl	26	
TDS	80 mg/l	

The total hardness was less than 0,25 mg/l (as CaCO₃) and the soluble silica about 1,1 mg/l.

The concentrate produced had the following analysis:

	mg/g water
NaHCO ₃	16,58
Na ₂ SO ₄	2,97
NaCl	3,25
Sol Silica	0,10

The permeate fluxes obtained at 30 bar pressure were 45 l/m²h.

ABATTOIR EFFLUENTS

An industry which is being studied intensively under the aegis of the South African Water Research Commission is the abattoir industry.

In a red meat abattoir less than half of the water used contacts the product, thereby providing potential for reuse of renovated water provided the techniques used can satisfy the hygiene requirements.

Segregation of faecal-containing effluents, such as lairage effluent, from the remainder yields an industrial effluent rich in recoverable proteins and fats which account for a substantial portion of the organic load. The effluents, so segregated at an abattoir slaughtering 480 head of cattle per day with a water intake of 600 m³/d produced an effluent flow of 220 m³/d containing 3,2 t COD/d and 323 kg SS/d. The effluent was screened through a 0,55 mm mesh static wedge-wire screen and fed without further pretreatment to a tubular RO membrane plant. Figure 1 shows the graph of flux plotted against time for a series of batch concentration trials, using ZF99 membranes. The peaks on the graph represent the flux achieved on clean tap water and the troughs the terminal flux at the highest concentration of the batch recycle trial. The line joining the troughs to the peaks represents the flux restoration during cleaning of the membrane at the end of the trial.

It can be seen that after about 100 hours of operation, the optimum cleaning regime had been found. The cleaning regime adopted was flush with clean water, followed by a subsequent cleaning with a solution containing 0,1 per cent HNO₃ balanced by a further wash with 0,1 per cent NaOH.

The concentrate produced is valuable as an animal feed following dewatering and sterilization is a rendering plant.

PULPING INDUSTRY

The pulping of soft woods whether for cellulose or paper manufacture creates particularly strong effluents. These so-called spent black liquors originate from the wood digesters (digester liquor) and from the washing of the pulp (washpit liquors). The latter are on average approximately half the strength of the former. A typical analysis of the spent liquor from a sulphite mill situated on the South African East Coast, is shown in Table 1.

wash-pit liquor to the strength of the spent sulphite liquor was achieved with good membrane fluxes and a high quality permeate specification.

Average membrane flux for a batch concentration was 34 – 36 l/m²h at over four MPa feed pressure and 22 – 27 l/m²h at three MPa feed pressure. Water recoveries were over 50 per cent with 73 per cent reached on the first run.

Between each experiment, the membranes were cleaned with hot 0,1 per cent sodium hydroxide and

Table 1: Typical Analysis Sulphite Mill Digester Liquor

pH	TDS	TOC	Lignin	Ca	Sugars	Acetic Acid	Ash
	g/l	g/l	g/l	g/l	g/l	g/l	g/l
1,6	160	80	65	6	36	12	15

The effluent is discharged to sea via a 2,5 km sea outfall pipeline, but occasionally backwash of the plume creates foaming on shore which is aesthetically not acceptable to the public.

Pilot plant investigations were therefore instigated to study the feasibility of treating these effluents by way of UF, diafiltration (DF) and RO to concentrate the liginosulphonates to a valuable by-product and for possible water reuse of the permeates. The UF and DF results are given below under ultrafiltration.

Reverse osmosis using the ZF99 tubular thin-film composite membrane for the concentration of the

flux restoration was good.

The TDS of the wash-pit liquor was increased from 62 – 68 g/l to 137 – 216 g/l by the RO treatment. Rejections of TDS, lignin, TOC, sugars (xylose and glucose), sodium and calcium were all very high. The permeate contained under 200 (mostly 50) mg/l of TDS and very little sugar and lignin.

Acetic acid (and its contribution to conductivity) was only partially rejected with feeds of 3,2 – 5,0 g/l producing permeates of 1,1 – 1,8 g/l.

The permeates produced were clear and almost colourless. They would be suitable for reuse as a

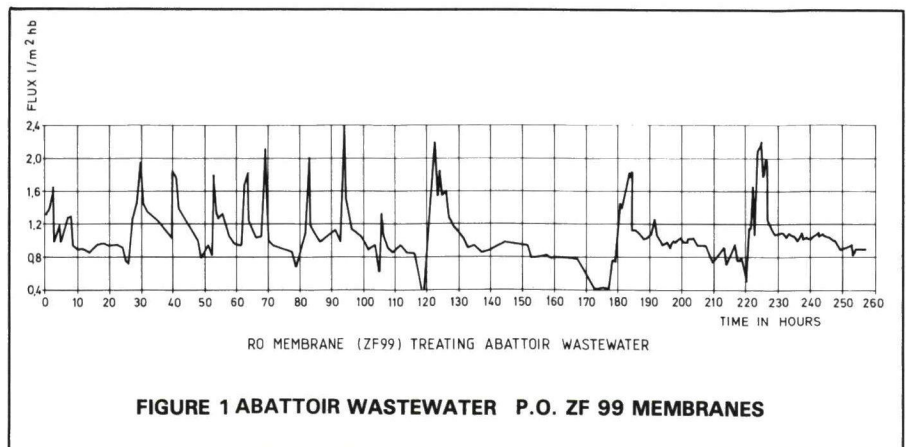


FIGURE 1 ABATTOIR WASTEWATER P.O. ZF 99 MEMBRANES

warm (45 – 50°C) industrial class water of relatively low pH which is caused by the acetic acid present.

ULTRAFILTRATION

The role of UF in wastewater management by industry is threefold viz separation, concentration and recovery. Because most UF membranes have wide pH ranges (1 – 11), high temperature limits (70 – 90°C) and a wide range of molecular weight cut-offs (500 – 300 000), UF technology finds a wide application in both the manufacturing industry and wastewater treatment.

In this article only a few examples of the increasing application of UF for the treatment of industrial wastewaters will be given.

PULPING INDUSTRY

A range of tubular and plate and frame membranes were tested on the spent sulphite liquor from the sulphite pulpmill discussed under reverse osmosis. The tubular type BX1 and BX6U and the plate and frame type DDS 61 were found to be suitable for the separation of lignosulphonates from the effluent. The spent sulphite effluent containing about 16 per cent TDS and 6 per cent lignosulphonate was consistently concentrated to above 30 per cent TDS with an estimated 90 per cent mass recovery of the lignin component. Several tests achieved TDS concentrations of above 40 per cent. Batch concentration membrane fluxes were found to be mainly dependent on pressure, temperature and fouling effect. The fouling effect was not consistent but varied with individual samples of effluent.

The operating conditions for the two experiments were similar at a temperature of about 50°C and an average pressure of 1,0 MPa. The flux performance of the two types of experiment were very similar although the concentration during the batch concentration was increasing (overall water recovery of 80 per cent). These results indicate that the membranes are fouled by components in the feed and this appears to override flux-concentration effects.

Chemical cleaning of the membranes was successful using 0,1 – 0,15 per cent sodium hydroxide

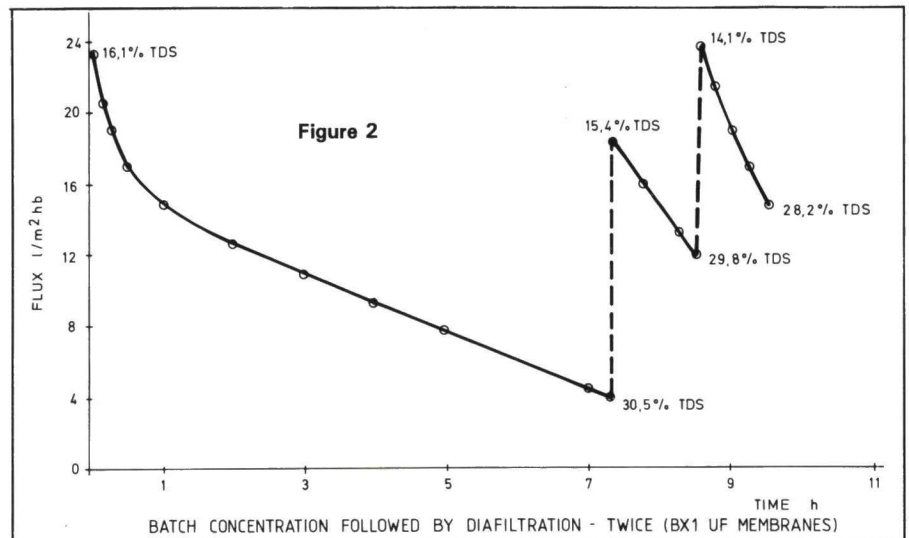
followed by hypochlorite or metabisulphite.

Diafiltration was used to increase the purity of the species rejected by the UF membrane. Because water recoveries are only moderate, significant amounts of the non-rejected materials remain in the UF concentrate on a weight basis partition between the concentrate and permeate in the ratio of their respective volumes.

water and then ultrafiltered to 50 per cent water recovery. The same procedure was used for the second diafiltration. No cleaning was used between the three sections of the run.

FISHING INDUSTRY

Fishmeal manufacture produces strong organic effluents, rich in protein and fats expelled from the fish



Diafiltration involves the dilution of the concentrate with good quality water and then reprocessing the diluted concentrate by UF. This may be repeated several times to obtain a high quality product concentrate.

The membrane flux – time results of a double diafiltration using BX1 membranes are given in Figure 2. During the batch concentration, the 161 g/l TDS feed was concentrated to 305 g/l TDS (81 per cent water recovery) at an average flux of 10 l/m²h. The concentrate from this was diluted with an equal volume of

at different stages of manufacture and if not treated at least partially, can cause severe pollution of the marine environment, especially in enclosed harbours. This is another major industry investigated under the aegis of the Water Research Commission in order to find economically feasible methods to substantially reduce the strength of fishmeal plant effluents discharged to sea. Table 2 shows a typical distribution of organic load in the effluent expressed in kg per ton of fish off-loaded.

Table 2: Distribution of Organic Load in Fishmeal Plant Effluents

PARAMETER	UNIT	DRY OFFLOADING	FISHMEAL PLANT	COOLING WATER
Flow	kl/t	0,40	0,71	3,62
Total COD	kg/t	24,71	16,20	8,10
Soluble Solids	kg/t	11,76	8,9	5,8
Total Solids	kg/t	21,04	46,5	117,0
Susp. Solids	kg/t	5,8	1,8	1,75

The majority of the pollutants originate at the dry off-loading process step owing to the body liquors (bloodwater) derived from the fish. Ultrafiltration trials were performed using tubular and plate-frame pilot plants.

Bloodwaters can be successfully concentrated to 13 per cent total solids at which concentration they can be passed into the fishmeal plant to increase the product yield.

The other major potential for pollution arises after the fish are cooked and pressed to expell the oils and liquors. The oils are separated and the resulting "stickwater" is evaporated. However, difficulties often arise with the evaporator plants, causing potential for direct discharge. Trials were therefore conducted using a plate and frame UF plant to examine the feasibility of using the more energy-efficient membrane process in place of evaporation.

Stickwaters were concentrated to 42 per cent total solids which competes with the current evaporator performance.

Cleaning of the membranes was readily accomplished to restore the flux to commencing values. It was found that initial cleaning using sea water recirculated through the plant followed by a wash comprising either 0,5 per cent Ultracil 11 or a combined solution of 0,1 per cent NaOH with 0,25 per cent sodium lauryl sulphate gave consistently the best performance.

DYNAMIC ULTRAFILTRATION

Presently the most suitable membrane technology for the treatment of fouling and hot industrial effluents is DUF membranes, using zirconium salts deposited on porous stainless steel tubes. Various such effluents exist, but one of the most difficult is wool scouring effluent.

WOOL SCOURING EFFLUENT

Wool scouring effluents are highly polluting and contain 10-20 g/l of grease, 7-15 g/l of suint salts and 30-50 g/l of total solids, including sand, fibre and vegetable matter.

A pilot plant investigation was car-

ried out on the treatment of this effluent for water reuse using Zr (IV) dynamic membraned stainless steel modules. The effluent is processed at 60°C, an inlet pressure of four MPa and a tube velocity of 2 m/s.

The feed constituents were highly fouling and this was reflected in the membrane flux dropping from 200 to 70 l/m²h over this period. Membrane rejections were 92-96 per cent for DOC, 85-92 per cent total solids, 48-62 per cent for conductivity, sodium and potassium, and 100 per cent for grease and suspended solids.

Because of the moderate salt rejection of the dynamic membrane, suint salts build-up in the recycle loop is controlled at adequate levels and over 90 per cent of the treated effluent may be recycled back to scouring before water quality problems exist. This ultrafiltration treatment process provides an effective and practicable solution to the wool scouring effluent problem. Major savings to the wool scourer are generated in terms of water recycle, heat energy savings, increased wool throughput and significant reduction in pollution loads.

CROSSFLOW MICROFILTRATION

The development of a new type of tubular microfilter by the Pollution Research Group, University of Natal, to provide a low cost, modular, robust and self-supporting system opened up a wide application range in water and wastewater treatment. This technology whereby dynamic membrane layers are formed in situ in woven tubes, utilizes two separate types of membrane:

- Addition of iron, aluminium or calcium hydroxides to form a membrane "layer". Flocculation is not important for the filtering effect. The layer provides a matrix for the collection of particles.
- Inert filtration aids (diatomaceous earth, activated silica, bentonite, asbestos or cellulosic fibre, (etc.) may also be used.
- Formation of a bonded membrane (e.g. hydrated zirconium oxide). This is removable, when necessary, by chemical treatment.

A number of investigations have

been done on pulp and paper effluents, textile dyeing and sludge thickening. The essence of these results are:

PAPER MACHINE EFFLUENT

The wastewaters from a liner/fluting mill after clarification typically contains 200-400 mg/l of colloidal and suspended solids. Microfiltration of this to 97 per cent water recovery gave complete suspended solids removal and 25-40 per cent TOC removal. Membrane fluxes were 30-50 l/m²h for suspended solids levels of 0,5 - 8 g/l at an inlet pressure of 300 kPa.

Tests were also carried out on the effluent prior to clarification and an internal circuit water. On these, colloidal/suspended solids removal was over 99 per cent and in addition over 60 per cent of the TOC and 20 per cent of the TDS were removed.

TEXTILE DYEING APPLICATIONS

Microfiltration with prior flocculation gives good colour and organics removal for textile dyeing effluents.

Treatment of polyester dyeing effluents containing colloidal disperse dyes gave colour and TOC removals in the range 90-97 per cent and 60-85 per cent respectively. Microfiltration performance was 50-120 l/m²h at an average pressure of 200 to 300 kPa, temperature of 40-50°C and a cross-flow velocity of 1,5-2,0 m/s.

SLUDGE THICKENING APPLICATIONS

An example of sludge thickening using microfiltration is the waste alum sludges from water works clarification. These typically contain 2-6 g/l of total solids, approximately 25 per cent aluminium hydroxide, 25 per cent organic matter and 50 per cent river silt.

By using crossflow microfiltration the sludge total solids was increased from 2 to 95 g/l, representing a water recovery of 98 per cent. Membrane fluxes were 30-60 l/m²h at 200-400 kPa average pressure for total solids levels of 20-95 g/l. Suspended solids removal was 100 per cent and the water quality of the microfiltrate was similar to that produced by the waterworks.

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SALINITY COMBATED IN AGRICULTURE

Water in South Africa has always been a cause for concern and as demands on the country's limited resources increase, it is in the interests of all users to protect the water resources from deterioration by pollution in all its forms.

In the agricultural sector, pollution largely takes the form of mineral pollution which, broadly speaking, is the addition of undesirable mineral salts to the water. As the salt content increases, the suitability of the water for agriculture (or any other) purpose declines, resulting in reduced crop yields.

In parts of the Western Cape and elsewhere, farmers store water in off-channel dams during the wet season for irrigation use during the dry growing season.

In the Berg River catchment, excess winter flows are pumped into farm storage dams and, while the water is free, capital and running costs of the pumping equipment are not inconsiderable.

Soils in the catchment tend to have varying salinity values ranging from less than 200 mg/l to in excess of 12 000 mg/l. Dams are usually located in minor depressions, very often without regard to the salinity values of the surrounding soils. Although little or no rain falls on the ground upstream of these dams during the summer period, rainwater which has infiltrated the soils during the winter months provides constant seepage flows which, after a good rain year, can easily be maintained throughout the dry season.

Because of the lengthy contact time with this water, salts are mobilised and dissolved by the water. Some seepage, now highly saline, finds its way into the farm dams and due to agitation caused by wind action on the surface of the dam, soon becomes completely mixed with the contents of the dam — so expensively pumped from the river.

Towards the end of the dry season, salt concentrations of the seepage flows tend to increase while water levels in the dams decrease. As there is less water



Surface flow being diverted from the dam.

available in the dam to dilute the seepage flows, salinity levels rise dramatically and the water becomes useless.

A SOLUTION

After many years of research, essentially the work of Dr Martin Fourie, formerly of the CSIR in Bellville, a promising method of combating this phenomenon has been developed and tested on a storage dam at Vlakenheuvel, a farm belonging to Mr Boet Le Roux in the Riebeeck-Kasteel district. Only surplus winter flow is pumped from the Berg River into the 300 000 m³ dam as the surface run-off in this area is known to be saline. By-pass ditches have been constructed to divert surface run-off from flowing into the dam. The source of the salinity in the dam was the inflow of the mineralised seepage along its sides and bottom,

below the full supply level. This saline seepage tends to creep along the bottom of the dam due to its higher specific gravity.

The seepage is then bled off from an outlet at the deepest point in the dam while irrigation water is withdrawn at the surface. During days when the water in the dam was not stirred by wind action the salinity of the bleeding water was up to 2 500 mg/l compared to 400 mg/l at the surface.

To improve the separation of seepage water from the fresh water an open brick sump was built at the deepest point and connected to the outlet. Cut-off drains were dug along the sides and bottom of the dam to intercept the seepage inflow, and these were connected to the sump. The drains were filled with broken stone and covered, firstly with plastic and then with a layer of clay. Wind induced turbulence is thus no longer able to mix fresh surface

water with the saline seepage collecting along the bottom of the dam.

OPERATIONAL EXPERIENCE

Over the first four years of operation, the salinity of the dam reduced to 250 mg/l from in excess of 1 100 mg/l initially. The dam was emptied at the end of each growing season. Seepage outflow from the open outlet of the empty dam maintains a rate of 50 to 80 litre per minute at a salinity of 3 600 mg/l indicating the continued inflow of sub-surface seepage.

After an exceptionally dry winter, the hydrostatic pressure of seepage from the surrounding areas drops to less than that of the water level in the dam and the flow of seepage into the drainage canals ceases. At or just after this stage water from the dam probably commences some movement into the surrounding soil and the difference between bleeding and surface water becomes small.

As the level of water in the dam drops due to irrigation usage, the reverse of the above process takes place. Hydrostatic pressure of the seepage again exceeds that of the head of water in the dam, resulting in a marked rise in the salinity of the bleed water. As the depth of water in the dam drops still further, seepage inflow rate could increase rapidly and exceed the bleed-off rate. This results in saline seepage diffusing into the shallow layer of overlying water causing the salinity of the water in the dam to rise rapidly.

A constant vigilance is, therefore, necessary to match seepage inflow rate to that of bleed-off rate, especially as the irrigation season progresses and the surface water level drops.

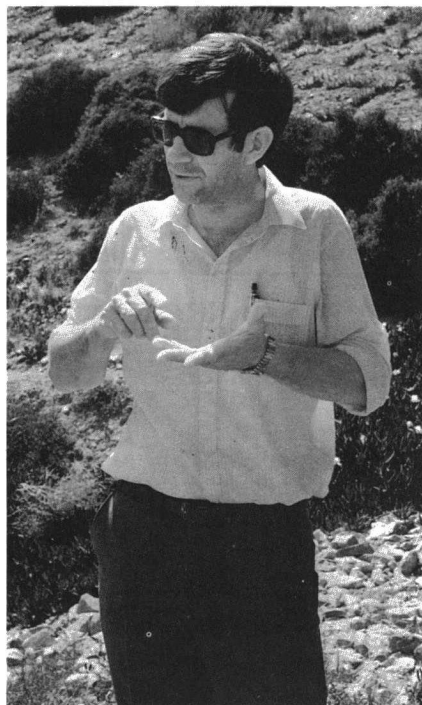
The water at Vlakkenheuvel is used partly for animal watering while the major portion is used for vineyard irrigation and after some eight years of operation Mr Le Roux's salinity problems have not recurred.

OTHER APPLICATIONS

This method of dam protection has also been applied to a dam on Mr Roselt Grobelaar's farm, BoNoree, in the Robertson district. In this instance the nature of the problem



Residue salts drained from the dam.



Mr Jannie Kriel.

was the dissolution of salts exposed during construction of the dam rather than a permanent inflow of saline runoff of seepage water.

Mr Jannie Kriel from the consulting agricultural engineering firm — Murray, Biesenbach and Badenhorst — monitored the results and

says that in the first year the results were not what they expected them to be due to incorrect drainage techniques and a system not properly stabilised.

Mr Kriel says that results obtained during the second year were good and that by the third year the salinity problem actually had been solved. This year's results are not available yet.

On the use of this technique Mr Kriel points out that it should only be used in certain necessary circumstances where the saline water cannot be prevented from entering the dam as prevention is always better than cure.

According to Mr Simon Forster, a hydrologist with the Department of Water Affairs, the Department is currently evaluating a similar technique to apply to larger dams constructed in the water course of the river.

Although they will not be draining seepage flow from beneath the dam, they will endeavour to remove saline inflows at low level outlets.

Mr Forster says that the technique has only been applied for one season and they will, therefore, only be able to comment on its effectiveness after a few more seasons.



Waterverliese in Natalse suikerlanderye bestudeer

Die bekamping van gronderosie en waterverliese in suikerlanderye word al meer as 'n dekade lank by die Suid-Afrikaanse Suikervereniging se navorsingstasie op Mount Edgecombe, noord van Durban, bestudeer.

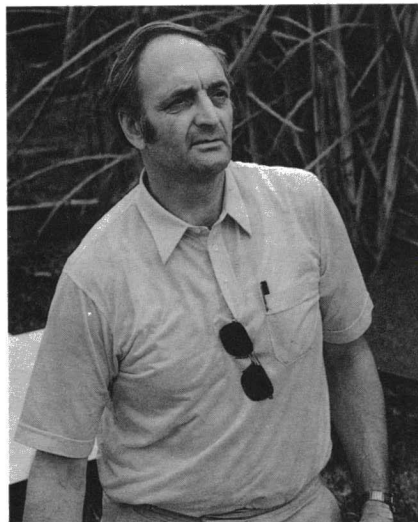
Die leier van die navorsingsprojek is mnr Gordon Platford, hoof van die plaasbeplanningsafdeling, en *SA Waterbulletin* het onlangs met hom oor die interessante navorsingswerk gaan gesels.

Volgens mnr Platford is data oor die hidrologie en sediment-lewering van landbou-opvanggebiede in die Natalse suikergordel nie algemeen beskikbaar nie. Dié data word benodig vir die ontwerp van doeltreffende en ekonomiese damme, keerwalle, waterbane en terrasse op die suikerrietlande. Die data help boere ook om beter bestuurstelsels soos strookverbouing en minimum grondwerking toe te pas en so hulle grond te beskerm en water te bewaar.

Mnr Platford sê redelike skattings kan gedoen word vir opvanggebiede waar die grond braak lê, of 'n beperkte gewasbedekking het. Suikerverbouing lei egter tot 'n groot

hoeveelheid materiaal bo-op die grond wat die tempo vertraag waarteen oortollige water in die natuurlike dreineringsvore invloei. Dié hoeveelheid rumateriaal verander gedurende die seisoene en tussen seisoene vanweë faktore soos herhaalde oeswerk, weersomstandighede, maalprogramme en verskillende verbouingsmetodes.

Dit is moeilik om te skat hoeveel water onder hierdie wisselende



Mr Gordon Platford.

omstandighede afloop, veral waar die suikerrietland op verskillende maniere uitgelê is. Om dié probleem te bowe te kom, en die nodige inligting te verkry is 'n klein opvanggebiedprojek op een van die navorsingstasie se plase aangepak.

Die klein opvanggebiedprojek by La Mercy word uitgevoer op 20 hektaar grond, noord van die Umdloti-rivier. Die gebied is deel van 'n plaas wat die Suid-Afrikaanse Suikervereniging vir 'n verskeidenheid navorsingsprojekte huur. Vier afsonderlike klein opvanggebiede is vir hierdie projek uitgesoek.

Die navorsingsgebied is tipies van suikerrietlande op die Natalse noordkus, waar hellings wissel van 5 tot 35 persent en waar die valleie en dreineringslote goed gedefinieer is. Die heuweltoppe is oor die algemeen rond en primêre opvanggebiede nagenoeg vyf hektaar groot.

In die navorsingsarea bestaan 72 persent van die grond uit die Arcadia-vorm (gevorm uit dolomiet), 25 persent is van die Swartland-vorm (uit middel-ekka-gesteentes) en die oorblywende drie persent van die Hutton-vorm (uit resente sand). Die twee oorheersende grondvorme



GORDON PLATFORD

Grondbewerkingsmetodes speel 'n belangrike rol by sedimentlewering en waterbewaring.

het naastenby dieselfde voorkoms en dieselfde fisieke eienskappe wat 'n invloed op die bewerking van die grond het.

Die Swartland-vorm het grys bogrond en is oor die algemeen vlak, terwyl die Arcadia-vorm grys tot swart bogrond het. Skalierwwe kom verspreid voor met hier en daar ronde dolomietrotse by die Arcadia-vorm. Albei profiele het 'n hoë klei-inhoud in die boonste horisonte.

In die ongerepte vorm of na kompaksie is daar goed gedefinieerde krake op die oppervlakte van die Arcadia-gronde wanneer hulle droog is. Reën laat hierdie krake gou toeswel en dit veroorsaak 'n lae infiltrasietempo. Water begin afloop kort nadat dit begin reën. Wanneer hierdie grond bewerk word, verbeter die waterhoue vermoë in die boonste laag asook die infiltrasietempo, maar dit duur nie lank nie aangesien die grond toeswel en kompakteer. Wanneer die bewerkte grond droog word, is die krake minder opvallend as in die ongerepte vorm. Die Swartland-gronde kraak minder as die Arcadia-vorm maar die oppervlakte verseël net so vinnig. Beide grondformasies is uiters glad as hulle nat is.

Die diepte van die gronde wissel van 0,3 tot 0,9 meter in die Arcadia en van 0,0 tot 0,6 in die Swartland-vorm. Die klein bietjie grond van die Hutton-vorm is dieper as een meter. Gronde onder in die valleie is alluviaal en dieper as op die heuweltoppe en die heuwelhange. Ondergrondse dreinerings veroorsaak dat hulle oor die algemeen nat is met 'n watertafel na aan die oppervlakte.

Meettoerusting

Afloop: Nadat die verwagte spitsvloei tempo geskat is, is 1,37 meter H-vormige geute met 'n 6 meter toegangskanaal gebou om 'n watervloei van tot 2,36 m³ per sekonde te meet. Dié vier geute is in Junie 1977 voltooi.

'n Meetput is aan die buitekant van die geut gebou. 'n Registrerende



GORDON PLATFORD

Die H-vormige geute het 'n ses meter toegangskanaal en kan 'n watervloei van tot 2,36 m³ per sekonde meet.

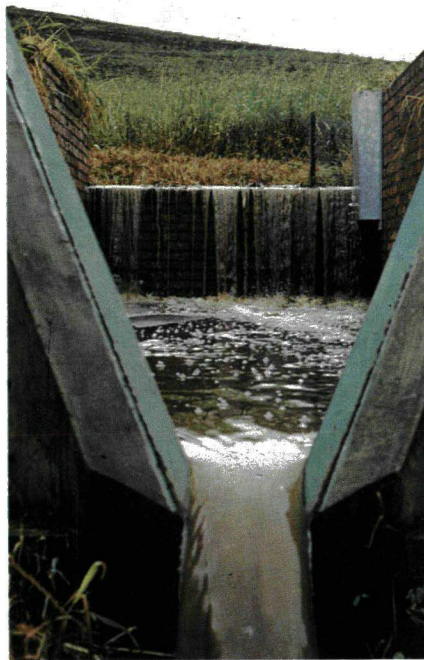
drukmeter is langs die put geïnstalleer. Die drukplaat in die bodem van die put is met 'n kappilêre buisie aan die opnemer verbind. Druk op die plaat laat die penarm vertikaal beweeg en dit teken gegewens aan op 'n draaiende tydkaart. Afvoerpype is ingebou sodat die put skoongemaak kan word nadat dit gebruik is.

Grondverlies: Na die eerste pogings om monsters aan die uitlaatkant van die geut te neem, is 'n aangepaste verdeler by die geut se ingang geïnstalleer vir die neem van monsters.

Die verdeler verwyder 'n vyf persent monster en stuur dit deur 'n tweede verdeler tot binne-in 'n kanaal langs die geut, waar nog 'n vyf persent monster van die vloei verkry word. Hierdie monster ($\frac{1}{400}$ ste) van die oorspronklike vloei, word in 'n versameltenk gestort wat 400 liters kan hou. Wanneer die tenk vol is, word die vloei oor 'n 0,8 Coschocton-wiel gestuur wat 'n $\frac{1}{100}$ ste monster onttrek en dit in 'n 200-liter tenk plaas. Na reën buie word die grootte van die monsters gemeet en die sedimentvragte vir elke tenk bepaal.

Reënval: 'n Horlosie-aangedrewe draaidrom wat die reënval-intensiteit aanteken, is in die instrumentwerk-winkel by die navorsingstasie gebou. 'n Maksimum van 350 mm reën kan geregistreer word voordat dit nodig is om die registrasiekaart te vervang. Die drom neem 24-uur om een keer in die rondte te draai. Die reën word in 'n gekalibreerde houër opgevang. Die reënwater laat 'n vlotter styg wat 'n pen vertikaal oor die kaart op die draaidrom laat beweeg. Hierdie meter is tussen twee opvanggebiede geplaas. 'n Standaard reënmeter is ook by elke geut geïnstalleer om die wisseling in reënval in die gebied te kontroleer.

Grondbewerking: Alhoewel gepoog was om 'n sogenaamde braakfase te implementeer gedurende die periode voordat suikerriet geplant is, was dit onmoontlik om die grond op al vier opvanggebiede heeltemal braak te hou. Veranderinge in die groeitempo van onkruid en verskille in grondtoestand het veroorsaak dat die grond nie altyd bewerk kon word wanneer dit



Afloopwater by die bek van die geut.



Die Coschocton-monsterwiel.



Die verdeler verwyder 'n vyf persent monster van die afloopwater.

wenslik was nie. Na 'n reënstorm of 'n nat periode kon bewerking gewoonlik slegs 'n aanvang neem sodra dit prakties moontlik was om in die land te kom. Die gebied is eenkeer per jaar geploeg en twee of drie bewerkings met 'n skotteleg per jaar was nodig om die grond braak te hou.

Nadat resultate vir afloop en sedimentlewering gedurende die braaklandperiode verkry is, is in Augustus 1984 met die eerste fase van die huidige projek begin. Die landerye in elke opvanggebied is toe op verskillende maniere uitgelê.

Resultate

Die totale reënval, afloop en grondverliese vir elke jaar word in tabel A aangegee.

Die reënvalintensiteitregistreerder het goed gedurende die proef-tydperk gefunksioneer. Data vir slegs 1,9 persent van die 317 aange-tekende storms was foutief. By sulke gevalle is die reënval bereken as die gemiddelde van die vier volumemeters. Soos verwag is, het die afloop toegeneem namate die hoeveelheid reënval toegeneem het gedurende die jaar. Lineêre regressie van die sewe jaar se resultate vir afloop en reënval het 'n korrelasie-koëffisiënt van 0,903 getoon met geen afloop by 'n jaarlikse reënval van 725 mm. Die helling van die lyn was 1,91.

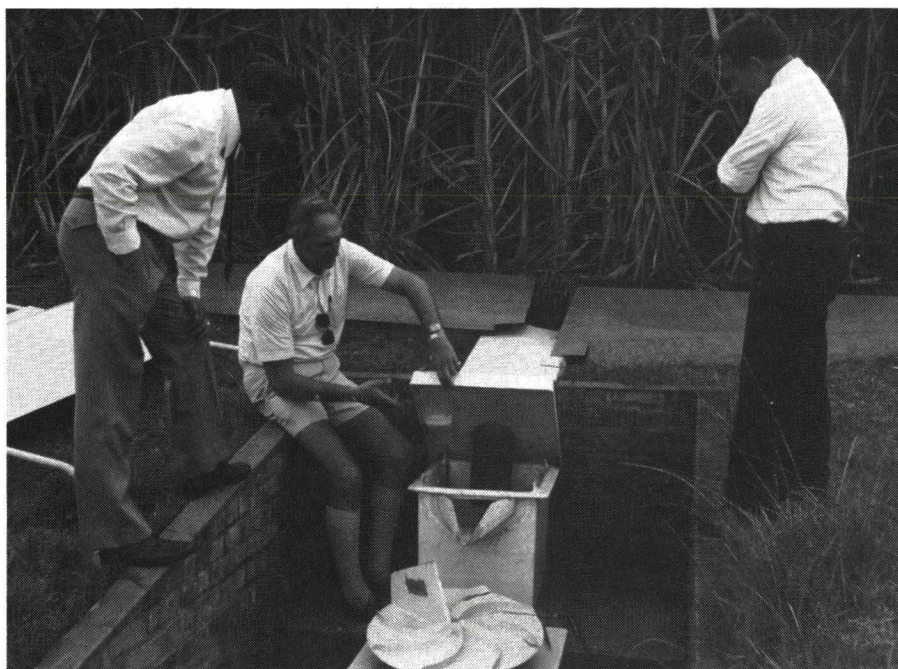
In 1979 het dit op 61 dae gereën en die maksimum reënval was 67 mm. Gedurende 1984 het dit op slegs 44 dae gereën maar die maksimum daaglikse reënval was 169 mm. In 1980 toe die derde laagste reënvalsyfer gemeet is, was die hoogste reënval op een dag 263 mm. Die afloop van hierdie storm was nie so groot soos die afloop wat aangeteken is van 'n storm in September 1981 toe slegs 102 mm reën 87 mm afloop gelever het.

Die grootste reënstorms het afloop in al vier die opvanggebiede veroorsaak behalwe gedurende 1979 wat baie droog was. In 1978 het agt storms 60 mm afloop gelever, in 1980 het drie storms van altesaam 365 mm 84 mm afloop gelever. In 1981 het ses storms met 'n totaal van 394 mm 156 mm afloop geproduseer. Net een storm in 1982 het enige afloop veroorsaak terwyl vier

GORDON PLATFORD

GORDON PLATFORD

GORDON PLATFORD



Mnr Gordon Platford (middel) van die SA Suikervereniging se navorsingstasie verduidelik die werking van die meetapparate aan mnr David van der Merwe (links), hoofadviseur, WNK, en dr George Green, senior adviseur, WNK.

storms in 1983 en 1984 onderskeidelik 27 mm en 157 mm afloop opgelewer het.

Aangesien dit moeilik is om sedimentmonsters te verkry oor die hele reeks gemete afloopvolumes van drie tot $15,9 \text{ m}^3$ moet die resultate volgens mnr Platford met die nodige omsigtigheid geïnterpreteer word. In September 1980 het 'n storm wat 263 mm reën gelewer het die monstertenteks weggespoel. Die metode waarop monsters verkry is, is toe verander en die monster is by die ingang van die geut geneem. Die grootste enkele hoeveelheid sedimentlewering van 73 ton per hektaar het voorgekom tydens die grootste hoeveelheid afloop, naamlik 87 mm.

Hoewel daar 'n konstante waterbeweging deur die grondmatriks is, is slegs die "snelvloei"-element of die afloop wat waargeneem kan word, in ag geneem. Die volumes afloopwater wat gemeet is, is omgeskakel na 'n waterdiepte wat verband hou met die grootte van die opvanggebied waarvandaan die afloop afkomstig was. Hierdie hoeveelheid is afgetrek van die stormreënval om 'n waarde vir die effektiewe reënval te bereken.

Al hierdie effektiewe reënwater kan nie noodwendig deur die gewas gebruik word nie. Sommige gaan verlore as grondwater en sommige

kan deur die grondmatriks teen 'n hoë spanning vasgehou word. Die effektiewe reënval wat gemeet is, is vergelyk met 'n berekende waarde wat verkry is deur reënval van meer as 40 mm op enige dag uit te skakel. Die gemete waardes was konstant hoër as die berekende waardes en daar word verwag dat dit nog hoër sal wees namate daar suikerriet op die lande gevestig word wat die reënval onderskep en afloop só verder verminder.

Oppervlaktetoestande was deurgaans dieselfde gedurende die projek en volgens mnr Platford wil dit voorkom of die steilte van die hellingen en die afstand oorlandvloei die grootste invloed op afloope gehad het.

Die intensiteit en die veranderings in intensiteit van die reën gedurende 'n storm is belangriker vir die afloopproses as die totale hoeveelheid reënval. Vergelykings tussen die reënvalgrafiek en die afloophydrografiek (op dieselfde tydskaal) toon dat veranderings in die intensiteit van die reën nou verband hou met veranderings in die hidrografiek as die vloei eers 'n aanvang geneem het.

Die Arcadia en Swartlandgronde is swaar en goed gestruktureer en waardes vir gronderodeerbaarheid in die onversteurde vorm of wanneer erodeerbaarheid met nomografiese

metodes bepaal word, is klein. Met hierdie eienskappe kan verwag word dat daar groot volumes water met min sediment sou afloop gedurende reënstorms.

Ongeag die tekortkominge van die tegnieke wat gebruik is om sedimentmonsters by La Mercy te verkry, wil dit eerder blyk of die teendeel waar is. Sedimentvragte wat groter is as die aanvaarde waardes van tussen vyf en tien ton per hektaar is gemeet. Die oorsaak van hierdie groot grondverliese is moontlik die volgehoue grondbewerking (eg en ploeiery) wat die boonste 20 cm van die gronde verpoeyer.

Die onversteurde ondergrond onder hierdie laag het 'n lae infiltrasietempo en reageer amper as 'n versperring teen waterbeweging. Die oppervlaktelaag raak dus versadig en water wat oor die oppervlakte beweeg, spoel groot hoeveelhede sediment weg. Dit wil voorkom asof die hoeveelheid sediment wat uit die opvanggebied kom, bepaal word deur die hoeveelheid afloopwater. Die verhoging in die sedimentvrag namate die volume van die afloopwater vermeerder, versterk die siening dat dit die hoeveelheid van die water is wat die sedimentvrag bepaal.

Na die eerste twee jaar van die projek het dit duidelik geblyk dat 'n hele aantal ingewikkelde faktore by die hidrologiese en sedimentleweringssiklusse betrokke was en dat absolute reaksiewaardes moeilik bekombaar sal wees.

Die omvang van die gemete resultate het bevestig dat dit noodsaaklik was om soveel data as moontlik van die ander afdelings van die navorsingsprogram te verkry. Infiltrasiewaardes, grondeienskappe, die uitwerking van grondbewerkingsmetodes en ander data is versamel met aflooppersele en reënvalsimuleerderproewe en gebruik om die resultate van die opvanggebiede te interpreteer. Die waarde van die perseelproewe sal verder bevestig word soos wat die uitwerking van die suikerriet op die opvanggebied algaande groter word.

Die CREAMS-rekenaarmodel wat in Amerika ontwikkel is, is ook gebruik om die volume en die tempo van afloop, asook die sedimentvragte van drie reënstorms te bepaal.

BELOWENDE SA VLOEIMETER BEMARK

Nuwe, plaaslik vervaardigde 'n vloeimeter wat goedkoper gaan wees as soortgelyke vloeimeters, sal vanaf 1986 op die mark wees.

Hierdie vloeimeter, bekend as 'n differensiale drukvloeimeter, vorm deel van 'n navorsingsprojek wat uitgevoer word om 'n geskikte monitoringstelsel te ontwikkel wat daartoe sal bydra om die doeltreffendheid van kommersiële besproeiing in Suid-Afrika te verhoog. Die navorsing word gedoen deur die Departement Siviele Ingenieurswese aan die Universiteit van Stellenbosch en deur die Waternavorsingskommissie gefinansier.

Volgens mnr Wessel Wessels, Senior Navorsers aan die Departement Siviele Ingenieurswese, is die doel van die navorsing om sensore vir die monitoringstelsel te ontwikkel ten einde plaaslike vervaardiging van die toerusting aan te moedig. Dit sal daartoe bydra dat toerusting van hierdie aard goedkoper aan beproeiingsboere en -skemas voorsien kan word.

ALLEENREGTE

Alleenregte vir die vervaardiging en bemarking van die vloeimeter is vir 'n periode van 5 jaar toegestaan aan die firma JFK Elektronika. Mnr Jan Schreuder, Besturende Direkteur van die maatskappy, sê die eerste werkende prototipe van die meter is alreeds vervaardig en hulle verwag om teen Januarie 1986 in produksie te gaan.

Mnr Wessels meen die vloeimeter se grootste voordeel is dat in teenstelling met ander tipiese vloeimeters wat ook vir besproeiingsdoeleindes aangewend word, hierdie meter nie bewegende dele soos ratte en laers het nie.

"Weens die vretende werking van water en aanpakking van onsuiverhede het meters met be-

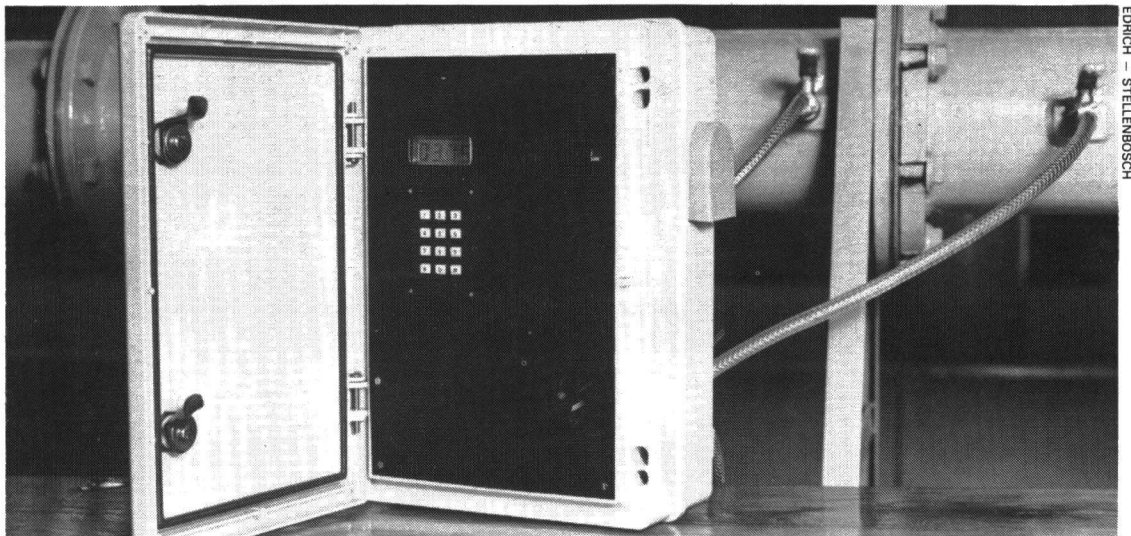
wegende dele baie aandag nodig. Opgeleide tegnisi met gespesialiseerde kennis is nodig om hierdie meters jaarliks of elke tweede jaar skoon te maak en te versien," sê mnr Wessels.

In teenstelling hiermee kan die differensiale drukvloeimeter maklik skoongemaak word indien dit deur aanpaksels benadeel is. Dit kan

verder sonder moeite onderhou word en personeel kan maklik opgelei word om dit wel te onderhou.

"Hoewel ander vloeimeters op dieselfde beginsel gebaseer is, word hierdie meter plaaslik met beskikbare onderdele vervaardig en is dit derhalwe goedkoper," sê mnr Wessels.

Vir mnr Schreuder het die meter die verdere voordele dat dit maklik



Die nuut ontwerpte differensiale drukvloeimeter.



Mnr Wessel Wessels.

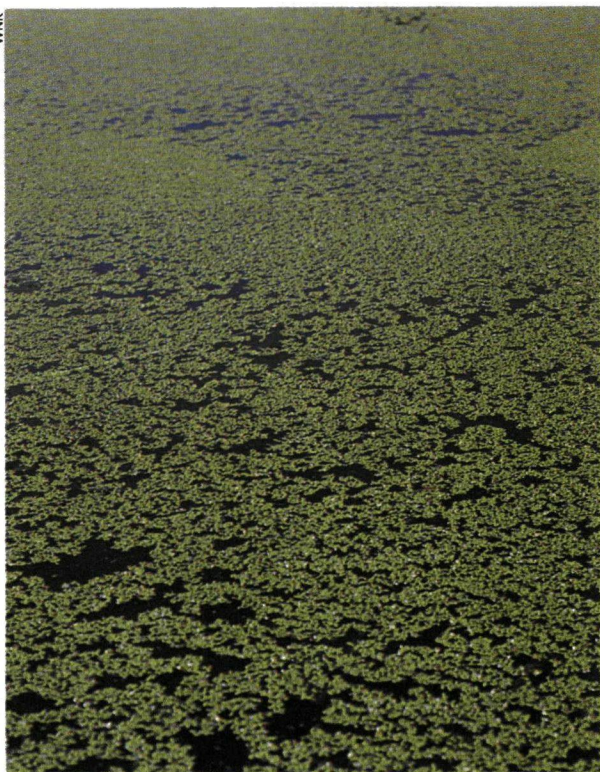
kan inskakel by elektroniese beheerstelsels en dat dit 'n ykbare meter is.

PRAKTIESE AANWENDING

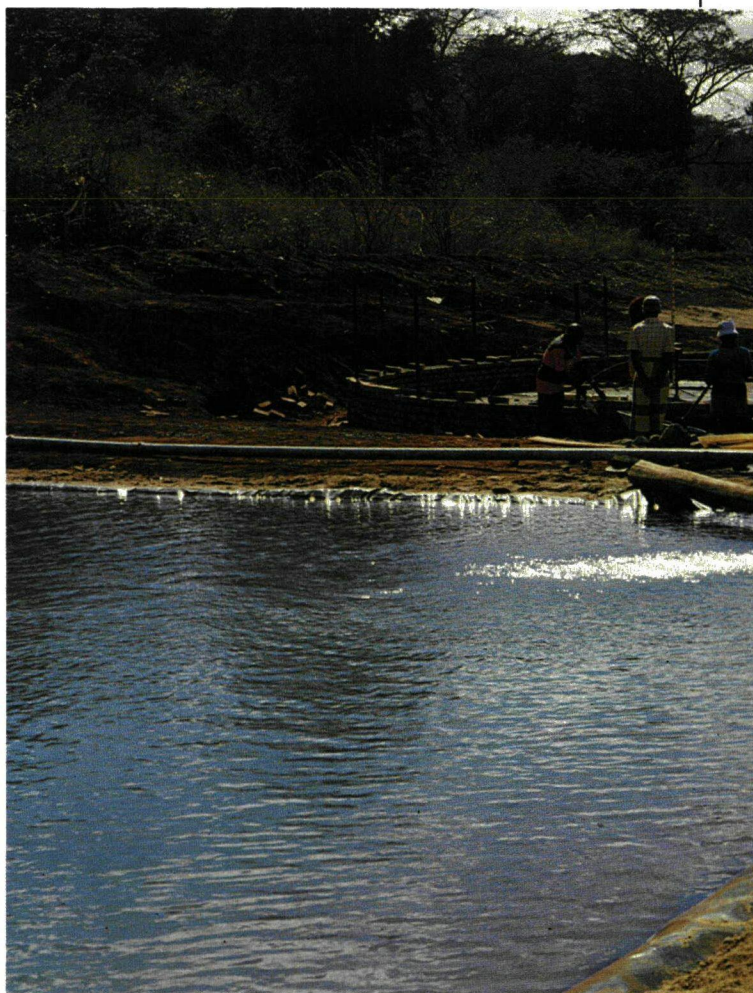
"Die meter kan in die praktyk aangewend word vir die besproeiingsboere en -skema. Dié selfstandige meter kan sy eie ingeboude sleutelbord en vertooneenheid gebruik om enige inligting wat verlang word op te roep soos byvoorbeeld die deurstroming in liter per sekond en die totale volume wat deurgevloei het," sê mnr Wessels.

Hy sê verder dat die meter oor 'n afstand met behulp van 'n datalyn gelees kan word. Dit is veral in hierdie geval wat die meter vir besproeiingsskemas gebruik kan word waar 'n mens 'n groot aantal meters wil installeer. Met 'n rekenaarbeheerde data-insamelingsstelsel word die meters dan gelees en is inligting oor elke individuele meter op kort kennisgewing beskikbaar sonder dat die meters besoek word.

WINK



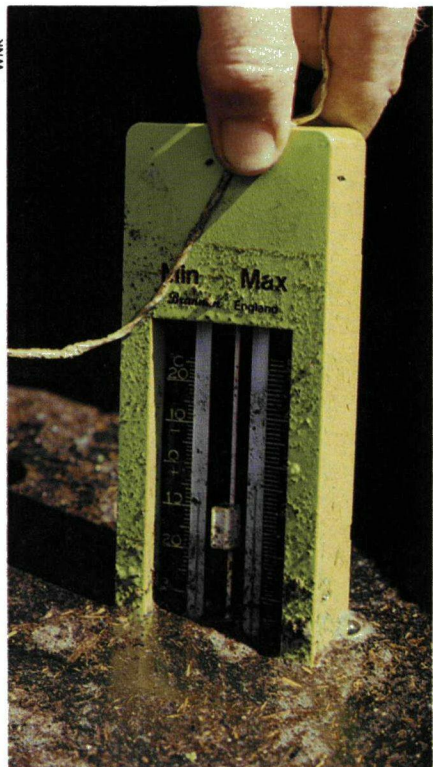
Die eendegras wat as voedsel vir die visse dien.



Visdamme by die Universiteit van Venda.

Die temperatuur van gefermenteerde organiese afval word met 'n termometer gemeet.

WINK



"Ek glo eendegras is een van die moontlikhede om die proteïenkrise, wat ons binne die volgende dekades gaan ondervind, af te weer. In Amerika is al heelwat navorsing op eendegras gedoen en die resultate is alles optimisties," sê professor Ian Gaiger, hoof van die Departement Dierkunde aan die Universiteit van Venda.

Eendegras is 'n klein plantjie wat op die water dryf en geweldig vinnig groei. Die plant is hoog in proteïene, het 'n gebalanseerde aminosuursamestelling en kan as voedsel dien vir die mens en dier. Eksperimente het getoon dat 'n produksie van tot 12 gram droë massa per vierkante meter per dag gelewer kan word, wat 'n geweldige hoë opbrengs vir landbouproduksie is.

Professor Gaiger sê met sy navorsing by die universiteit, wat deur Standardbank gefinansier word,

EUREKA VI

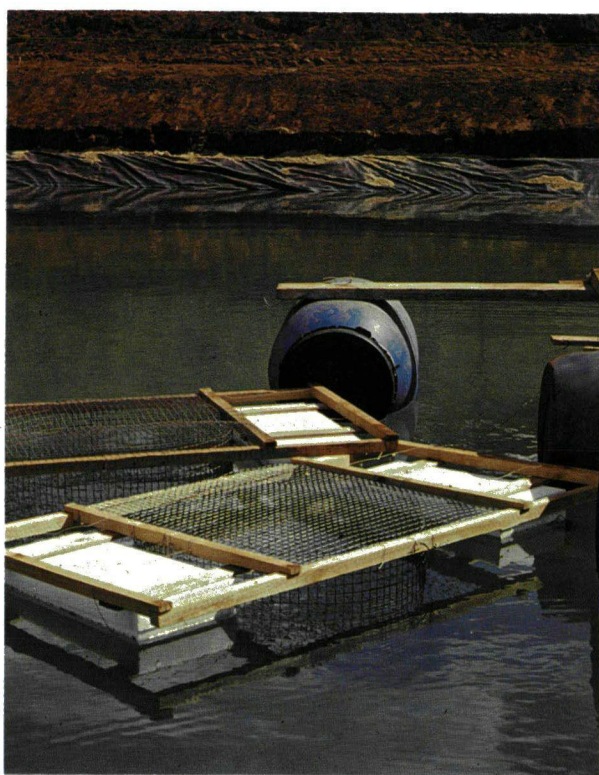
beoog hy om die eendegras te gebruik as voedsel vir visse wat in hokke aangehou word. Die eendegras sal gekweek word met organiese afval wat anaerobies gefermenteer is.

Die vis wat gebruik gaan word is die rooiborstilapia (*Tilapia rendalli*). "Ek verwag om goeie groeieresultate te kry," sê professor Gaiger. "Ek het voorheen navorsing gedoen in Israel op 'n gekruisde tilapiaspesie wat op alge voed en nie op hoër plante soos eendegras nie. Die resultate was goed en daarom verwag ek om moontlik 'n beter omsetting met die rooiborstilapia te kry omdat dit 'n visspesie is wat net op hoër plante voed en sy fisiologie aangepas is om dit te verteer."

Met die navorsing in Israel is die vis ook in 'n intensiewe stelsel geproduseer. Hulle het die afval uit die visstelsel gefermenteer, eende-



WINK



WINK

Rooiborstilapia word in hokke aangehou vir die navorsing.

R PROTEÏENKRISIS

gras daarmee gegroei en dit dan weer teruggevoer aan die visse. Op die manier is die voerkostes met die helfte verminder.

"Uit 'n akademiese oogpunt wil ons die werking van die stelsel en al sy veranderlikes verstaan. Sodra ons sien die stelsel is geslaagd en nie te gekompliseerd vir derde wêreldtoestande nie, kan ons byvoorbeeld by 'n hoenderplaas 'n fermentasie-eenheid oprig, 'n eendegrasproduksiestelsel daaraan koppel en die eendegras terugvoer aan die hoenders om 'n deel van hulle proteïene te vervang.

"Met die populasietoename gaan daar binne die volgende 20 jaar 'n proteïentekort wees en ons wil graag van lokale energiebronne gebruik maak, soos die afval, dit hersirkuleer en op die manier voedsel produseer. Dit is ook 'n stelsel wat op 'n eenvoudige manier deur die

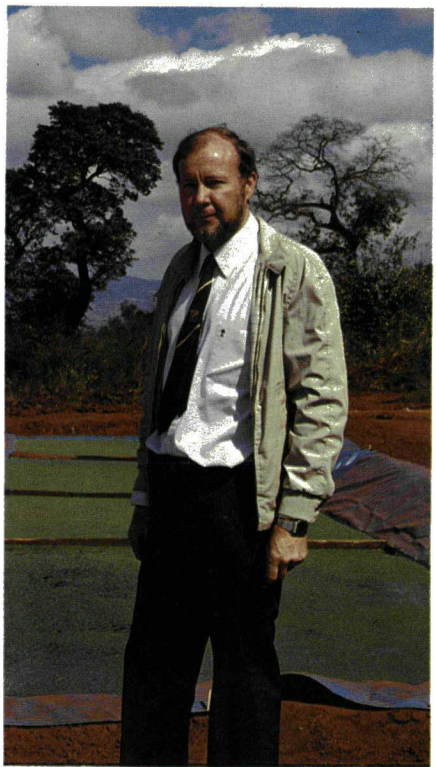
plaaslike bevolking aangewend kan word," meen professor Gaiger.

Behalwe dat die gefermenteerde afval ook gebruik word vir die produksie van eendegras kan die biogas wat tydens fermentasie vrygestel word, ook as 'n energiebron aangewend word.

Dit is 'n eenvoudige tegnologie wat reeds in Taiwan op grootskaal toegepas word. Die biogas word van varkafval verkry, gebottel vir stowe en selfs voertuie word daarmee aangedryf. Nog 'n voorbeeld waar dit redelik algemeen gebruik word is in Indië wat dieselfde tipe wêreldtoestande as ons in Suid-Afrika ondervind.

Omdat die projek so pas begin het is daar nog geen resultate beskikbaar nie. Professor Gaiger sê hy hoop om teen die einde van hierdie somer reeds resultate bekend te maak.

Professor Ian Gaiger.



WINK

NAVORSING OP INHEEMSE VISSPESIES

In Suid-Afrika is akwakultuur nog in sy beginstadium. In die mate wat dit wel bedryf word, word hoofsaaklik van uitheemse visspesies soos die karp en forel gebruik gemaak.

In 1979 het die Departement Dierkunde aan die Universiteit van die Noorde begin met navorsing op die ekonomiese lewensvatbaarheid van inheemse visspesies. Om verskeie redes het die keuse op die baber (*Clarias garipinus*) geval. Hy kom algemeen voor, is 'n geharde vis, het min parasiete, eet alles, het 'n goeie groeivermoë en vervoer maklik. Vanweë hierdie eienskappe kan die baber in hoë digthede in akwakultuur gehou word sonder dat ernstige probleme ontstaan.

Hy het verder ook uitstekende eet- en rookwaliteite. Sy gehalte vleis is goed, bevat geen klein grate nie, kan ingemaak word, is geskik vir verwerking en word sonder moeite lewend bemark. Volgens professor JE Saayman, hoof van die Departement Dierkunde aan die Universiteit van die Noorde, kan letterlik alles van die baber gebruik word. Daar bestaan selfs 'n jellieresep waarvoor baberkoppe nodig is.

In hierdie stadium word die baber kommersieel op grootskaal by die Turfloopteelstasie, 'n klipgooi van die Universiteit af, gebroei.

Aanvanklik is heelwat probleme ondervind met die kunsmatige broei van die baber. "Sy eiers is geweldig klewerig," sê professor Saayman. "In die natuur sal die klewerige eiers aan die gras in die riviere kleef, maar dit is 'n nadeel wanneer die eiers kunsmatig gebroei moet word. Anders as by die karp en forel waar eiers maklik in broeitregters met 'n stroom water deur gebroei kan word, kleef die babereiers aanmekaar vas."

Deur die eiers aanvanklik in 'n ureumoplossing te roer is daarin geslaag om die klewerigheid ('n proteïenlaag) te verwyder. Die eiers is daarna in volroommelk geroer om 'n beskermende vetlagie daarom te plaas, waarna dit vrylik kon rond-beweeë in die tregters.

In die tussentyd het hulle oorgeskakel na die broei van vis in broeirakke; 'n proses wat behels dat eiers afgestroop, bevrug en dadelik in die rakke geplaas word. Soos in die geval van die broeitregters loop die water nog steeds bo in en

beweeë dan deur al die laaie. Die eiers is dus nog steeds in die water, maar kan individueel vaskleef aan die gaas van die broeier.

Oor die resultate met die broeirakke sê professor Saayman: Vroeër moes die wyfie se eiers, nadat dit gestroop is, 30 minute onderskeidelik in 'n ureumoplossing en melk geroer word voordat dit in die tregters geplaas is. Dan eers kon die volgende wyfie gestroop word. Omdat wyfies ongeveer gelyktydig ryp word, word eiers as gevolg van hierdie proses soms oorryp en kry jy nie goeie bevrugting nie.

"Met die broeirakke kan 'n groter hoeveelheid wyfies binne 'n korter periode gestroop word. Dit is nie alleenlik goedkoper omdat 'n mens melk uitskakel nie, maar 'n reeks eksperimente namekaar het getoon dat beter resultate verkry word met hierdie metode," sê professor Saayman.

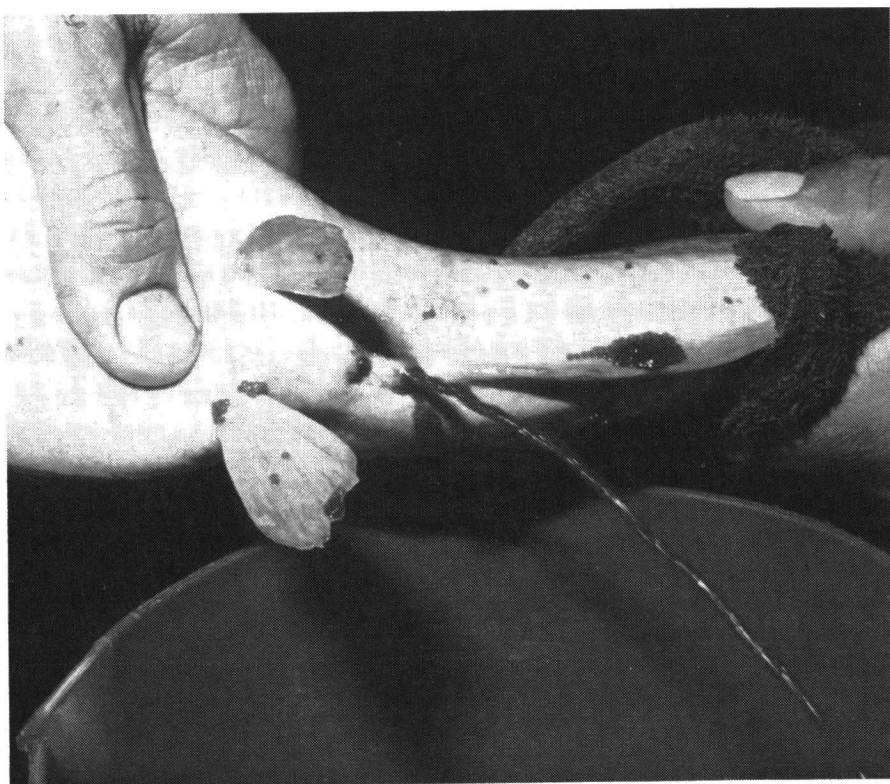
Broeirakke hou ook die voordeel in dat die bakteriegevaar tot 'n groot mate uitgeskakel word en die suksespersentasie derhalwe groter is. Met 'n baberboerdery moet so bakterievry moontlik gewerk word. Wanneer eiers in 'n broeitregter gebroei word, kom baie van die eier-doppe in die water en in die bak waarin die larwes uitloop en is dit onmiddellik 'n groeimedium vir bakterieë.

'n Ander probleem wat aanvanklik met die kunsmatige broei van die babers ondervind was, is dat hulle die mannetjies nie suksesvol kon stroop nie en moes slag vir hierdie doel. Die testes is uitgehaal, oopgesny en uitgedruk oor die eiers. Omdat dit nie moontlik was om vas te stel watter wyfie se eiers en watter mannetjie se sperms die beste ontwikkel en gegroei het nie, kon seleksie-eksperimente nie voortgesit word nie.

Sedertdien kon die mannetjies, deur sy hormoonbehandeling te wysig, ook suksesvol gestroop word. Hy ontvang sy eerste inspuiting wanneer die wyfie haar tweede inspuiting ontvang sodat hulle gelyk ryplopend is. Die doseringsverhouding van die hormone verskil ook.

Professor Saayman sê die navo-

BERT POLLING



Ryp eiers word van 'n baberwyfie gestroop.

sing hieroor gaan voort aangesien hulle nog nie dieselfde bevrugtingsresultate kry soos wanneer die mannetjie opgeoffer word nie. Hoewel hulle nog nie tevrede is met die resultate nie, is die proses sodanig suksesvol dat dit wel op 'n kommersiële basis gedoen word.

Professor Saayman vertel ook van 'n bonus wat hulle tydens hulle navorsingeksperimente ontdek het — die sogenaamde "meermin"-generasie. Hulle het by een wyfie 'n werpsel gekry wat 'n groot persentasie visse het wat sonder hulle borsvinne is. Mnr Bert Polling, Hoof Tegnisk by die Departement Dierkunde, sê dat so 'n vis, omdat dit nie vinne het nie, die voordeel het dat dit by kommersiële verspreiding meganies maklik in verskillende groottes gesorteer kan word.

Ongelukkig is die "meermin"-generasie nog nie broeigereed nie en sal die universiteit se navorsingspan eers in die volgende broeiseisoen kan voortgaan met navorsing om vas te stel of daar enige genetiese vaslegging van hierdie besondere eienskap is.

MAKRIEL

'n Tweede inheemse visspesie waarop die Departement Dierkunde tans navorsing doen, is die makriel

(*Eutropius depressirostris*). Soos die baber is dit ook 'n visspesie met min grate en goeie rookwaliteite en word dikwels na verwys as die varswater tongvis.

Navorsing op die makriel pas goed by die baber aan omdat beide die visspesies naastenby dieselfde geografiese verspreiding het. Sy broeiperiode is heelwat later as die van die baber en dit gee die navorsers genoegsame tyd om eers die baberbroeiseisoen af te handel.

Dr Eugene Kruger, senior dosent by die Departement Dierkunde, sê dat hoewel die makriel redelik suksesvol gebroei kan word, hulle nog nie dieselfde resultate behaal as met dié van die baber nie en sal broeitegnieke nog verfyn moet word.

In die natuur kry 'n mens 'n eienaardige skeiding tussen die makrielmannetjies en -wyfies. Die mannetjies kom voor in 'n een tot tien verhouding met die wyfies en is ook heelwat kleiner. Volgens dr Kruger kon hulle nietemin goeie broeimateriaal vind, en deur middel van eksperimentering het hulle 'n redelike suksesvolle program ontwikkel om die vis te stroop.

"Soos by die baber het die makriel ook 'n klewerige eier, maar dit is meer suurstofbehoefdig en word maklik aangeval deur protozoa. Die water word vooraf geakklimatiseer

sodat die eiers nie gedurende die uitbroeiproses vernietig word nie. By die makriel word ook van broeirakke gebruik gemaak.

"Ons grootste probleem in hierdie stadium is om die larwes in genoegsame getalle tot vingerlingstadium te kry," sê dr Kruger. "Dit wil voorkom of dit 'n voedingsprobleem is. Die larwes word nog gevoer op 'n natuurlike dieet van daphnia en plankton en omdat die getalle so groot is, is die natuurlike voedsel nie voldoende nie. Wanneer die larwes in kunsmatige toestande aangehou word, neem die getalle af namate die larwes toeneem in grootte."

Dr Kruger sê hulle gaan poog om die probleem te omseil deur die visse op 'n baie jong stadium in nethokke in damme uit te plaas wat vooraf bemes is. Dit is 'n tegniek wat hulle verder wil voer hierdie seisoen en kyk of daar op die manier genoegsame vingerlinge geproduseer kan word.

Die makriel is nie 'n vis wat baie groot word nie. Waar 'n uitgegroeide makriel ongeveer 600 — 700 gram weeg, is hy egter al merkbaar op 300 gram. Dit neem hom ongeveer een en 'n halfjaar om merkbare grootte te bereik. Indien die larwes tot eetbare groottes gekry kan word, hou die makriel kommersiële baie potensiaal in.

FOTONIK STUDIO



Dr Tony Ribbink.

MEDAL AWARDED

The first silver medal of the Limnological Society of Southern Africa has been awarded to Dr Tony Ribbink of the JLB Smith Institute of Ichthyology.

According to the Society's newsletter Dr Ribbink was the leader of a team of a South African and Malawian research team which worked for six years on Lake Malawi.

Many of the fishes of Lake Malawi form the basis of a growing, lucrative trade in ornamental fishes and, as there was very little known about most of these fishes (mainly mbuna), the Malawi Government initiated the programme, run by Dr Ribbink, which developed management guidelines, a means to identify the fishes and an understanding of

the zoogeography and biology of these fishes.

The work provided detailed information on the distribution, breeding biology, ecology, depth tolerances and habitat preferences of over 250 species, and provided valuable field data for certain new theories of species identification and specification. By spending several thousand hours underwater on SCUBA, Dr Ribbink and his team were able to document the live colours and mating behaviour of the mbuna, and place the taxonomy of this difficult group on a sound footing.

The Lake Malawi research has not only made an outstanding contribution to Southern African limnology, but also focussed international attention on the African Great Lakes.

"AQUACULTURE 1986"

Aquaculture aims at the controlled cultivation and harvesting of aquatic organisms for commercial utilization. Although aquaculture is in its infancy in South Africa, the symposium held at Cathedral Peak in 1984 indicated that there are numerous interested parties involved in the technology. Following on the success of the Cathedral peak symposium, the Foundation for Research Development and the South African Agricultural Union have decided to convene another symposium in 1986.

The objectives will be to:

- provide a forum for interaction between the aquaculture communities in South Africa, both freshwater and marine;
- highlight developments in practical, technological, scientific and marketing aspects of aquaculture;
- make the aquaculture community aware of attempts to coordinate research and development;
- discuss problems hindering the development of aquaculture in South Africa.

VENUE AND DATE

The symposium will take place on 23 and 24 July 1986 on the campus of the Rand Afrikaans University, Johannesburg and will coincide with the Johannesburg centennial celebration.

THE PROGRAMME

The programme will involve sessions under the following categories:

- candidate species and genetics
- hatcheries
- production systems
- nutrition and feed
- pathology and diseases
- economics, processing and marketing
- farm management.

as related to any aquaculture organism which has high commercial potential (eg trout, oysters, mussels, tilapia, ornamental fish and crocodiles etc).

REGISTRATION

Registration will take place between 17h00 and 19h00 on Tuesday 22 July and 8h00 and 9h00 on Wednesday 23 July 1986. A registration fee of R50,00 will be charged.

ENQUIRIES AND INFORMATION

Persons wishing to attend the symposium should fill in the enclosed reply card **before 15 January 1986**.

Ornamentele visboerdery onder bespreking

Ornamentele vishandel is 'n wêreldwye bedryf wat in 1984 ongeveer 1,8 biljoen dollar gelewer het, maar tot nou toe nog min aandag in Suid-Afrika geniet.

Ongeag Afrika se ryk visfauna produseer hy tans slegs 2% van die vis in die internasionale ornamentele vishandel. Suid-Afrika het self ook verskeie geskikte inheemse see en varswater ornamentele vis asook verskeie ander vreemde spesies wat hier gebroei kan word met die oog op

herverkoop.

Vanweë die behoefte wat in Suid-Afrika bestaan om die bedryf te organiseer, het die Akwakultuurkomitee van die Transvaalse Landbou-unie in Oktober 'n inligtingsvergadering gehou waarna verskeie persone in die veld van ornamentele vis genooi is.

Tydens die vergadering het dit duidelik geblyk dat daar 'n behoefte bestaan na die intensivering van die bedryf om die mark konstant van vis

te voorsien. Die broei van ornamentele vis vereis gespesialiseerde kennis en dit is beklemtoon dat daar 'n gebrek is aan sulke inligting en inligtingsbronne in Suid-Afrika.

Daar is besluit dat 'n sub-komitee van die Akwakultuurkomitee gestig gaan word vir ornamentele visboere, waar probleme rondom die bedryf geïdentifiseer en bespreek kan word. Die besluit om die stigting van 'n subkomitee is tans by die TLU vir goedkeuring.

Management strategies for Phosphorus in the environment



Dr Herman Wiechers, senior adviser of the Water Research Commission, was invited to participate in a conference on management strategies for phosphorus in the environment, held in Lisbon, Portugal, earlier this year.

The conference dealt with a unique blend of topics, viz biological and chemical phosphate removal from wastewater, eutrophication and phosphate management strategies, and Dr Wiechers presented a paper entitled *Environmental Phosphorus Management in South Africa* in the plenary session.

SA *Waterbulletin* spoke to Dr Wiechers about his impressions and some of the high-lights of the Lisbon conference.

BIOLOGICAL PHOSPHATE REMOVAL

International interest and research activities in this field are still at a high level. Both fundamental studies as well as pilot and full scale studies

were reported. Particularly noticeable was the interest of the British, with Professor Rodger Perry's group at Imperial College, London, starting a major activity in this field. The reason is that the UK Control of Pollution Act will be brought into full operation by mid 1986 and will tighten controls on municipal and industrial effluent discharged to lakes and rivers. The American interest in the field appears to be stimulated by the high cost of conventional chemical phosphate removal, problems and cost associated with the handling, treatment and disposal of chemical sludges and the very active marketing of the process by various commercial firms.

Mr HP de Vries of the Agricultural University of Wageningen in The Netherlands reported on pilot plant biological phosphate removal in low loaded processes, a situation also requiring solution in South Africa. He demonstrated that partial phosphate stripping of the sludge had a very beneficial effect on overall process phosphate removal. Addition of small quantities of acetic acid or ethanol greatly enhanced

phosphate release in the stripper unit.

Mr J T'Seyen of the Centre des Sciences de l'Environnement of Metz, in France reported on laboratory studies on the optimisation of a separate anaerobic reactor to produce acetic acid from raw sewage for enhancing biological phosphate removal. Different sludge loading rates were tested and they succeeded in producing acetic acid yields of 50 to 125 mg/l. They also identified the micro-organisms which produced the acids. This information is of considerable value to South African researchers at the University of Cape Town and the City Council of Johannesburg who are addressing the problem of changing sewage characteristics to make it more amenable to biological phosphate removal.

A report by Mr JW van Groenestijn of the Agricultural University of Wageningen on the effects of cultural conditions on phosphate accumulation and release by *Acinetobacter* Strain 210A has added to the basic knowledge on the

process and factors which control it. Of particular interest was the fact that they demonstrated that *Acinetobacter* 210A was able to grow anoxically, reducing nitrate to nitrite.

Papers presented by Des Kerdachi and Mike Roberts from South Africa, Professor Eric Arvin from Denmark and Peter Kainrath stressed the finding that direct chemical precipitation of phosphate or biologically mediated chemical phosphate precipitation may play a significant role in "biological" phosphate removal processes. However, analytical techniques, the exact magnitude of the chemical precipitation phenomenon and the factors which control it have not been adequately quantified and require further investigation.

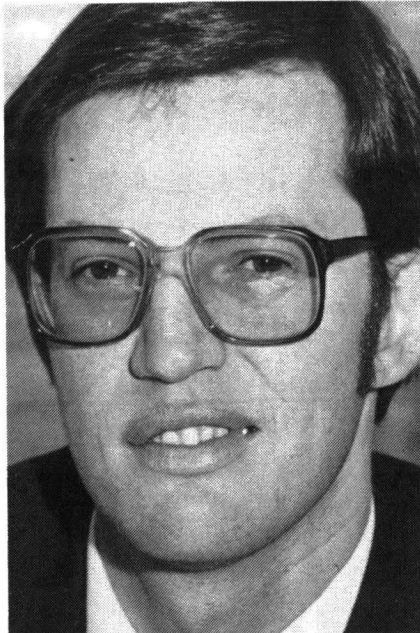
CHEMICAL PHOSPHATE REMOVAL

The most widely applied technique for phosphate removal in North America, Europe and Scandinavia is chemical phosphate removal. The conference created a forum for reviewing about 20 years' experience in this field as well as the latest innovations and developments.

Kjell Stendahl from Sweden stressed the benefits of chemical sewage treatment, particularly for Scandinavian countries with their low winter temperatures and high electricity costs which makes biological sewage purification less attractive to them. It is doubtful whether these arguments would hold to the same extent in South Africa, but the principal of costing different processes for process selection is a valid one. Accurate cost comparison between biological and chemical phosphate removal (with all their implications) have not been undertaken in South Africa and therefore requires attention.

Mr W Hatton from the UK compared different aluminium based chemicals, i.e. aluminium sulphate, aluminium chlorohydrate and poly aluminium chloride, for coagulation of sewage effluents and phosphate removal. Poly aluminium chloride was found to be superior to the other two chemicals for both flocculation and total phosphate removal.

Dr Lorenzo Liberti from the Italian Water Research Institute reported on extensive laboratory and pilot plant investigations on the RIM-NUT process, a combined ion-exchange-precipitation process to remove nutrients from municipal sewage with recovery of $MgNH_4PO_4$, a slow-release fertilizer. A detailed economic analysis in Italy indicated that the cost of the treatment can be completely recovered by the revenue from the sale of the fertilizer recovered. The $MgNH_4PO_4$ precipitation step of this process may hold potential for application in South Africa in the immobilization of NH_4 and PO_4 from anaerobic digester effluent. This aspect is already receiving attention by the City Council of Johannesburg.



Dr Herman Wiechers, WRC.

Viktor Mertsch from the Karlsruhe University, Germany demonstrated the inherent advantages of phosphate removal by pre- and simultaneous coagulation/precipitation in biological wastewater and sludge treatment. He emphasized: enhanced COD removal, improved phase separation, improved process stability and control over sludge bulking with simultaneous precipitation. Pre-precipitation was recommended for situations where strong seasonal variations in COD load were anticipated. Additional reduc-

tion in suspended solids in primary settling tanks can lead to savings in plant operation cost due to reduced requirements for aeration and possibly increased production of biogas.

Dr PWW Kirk from Imperial College in the United Kingdom reported on phosphate removal by pre-precipitation of sewage and elaborated on the metal removal, sludge characteristics and treatment efficiency. Of particular interest was their finding that although increased quantities of sludge were produced as a result of chemical treatment, consolidation resulted in only a 15 per cent increase in volume for a aluminium sulphate and poly-electrolyte treatment. They reported higher metal content in the chemical treated sludges but commented that this was unlikely to detract from its agricultural value.

Dr A Grohmann from Germany reported chemical phosphate removal from river water, prior to discharge to a lake, at Berlin's Tegel plant. The process comprises a chemical flocculation stage followed by sand filtration. The design capacity of the plant is $6\text{ m}^3/\text{s}$ and it reduces the phosphate content from 5 to $0,01\text{ mg}/\ell$ (as P). The plant was commissioned in July 1985. This approach is similar to the one adopted at the Wahnbach reservoir (also in Germany) and the technology is similar to that developed by Sulzer Ltd of Switzerland, i.e. their flocculation-filtration process. Should it be necessary in South Africa to reduce phosphates to very low levels, this experience and technology could usefully be considered.

EUTROPHICATION

Dr RA Vollenweider from the National Water Research Institute of the Canadian Centre of Inland Waters, the pioneer of lake phosphate load-trophic status response modelling, gave the key-note address on "Phosphorus, the key element in Eutrophication Control". He stressed the role of phosphate in eutrophication control and the use of the OECD modelling approach to predict the amount of load reduction required for improvement in water quality. He stressed that different

lakes respond differently to renovation techniques. Lakes which have only been subjected to eutrophication for short periods generally respond rapidly, whereas lakes which have been subjected to eutrophication for long periods may take 10 or more years to respond.

PHOSPHATE MANAGEMENT STRATEGIES

Mr Ed Barth formerly with the US EPA, described the current status of technology for phosphate removal in the USA. He indicated that a wide range of processes are available to remove phosphates and stressed the need for careful selection of process type to meet the specific needs for a particular situation.

Dr Peter Matthews of the Anglian Water Authority of the United Kingdom indicated that, with the existence of catchment-based water authorities in the United Kingdom, they were in a position to approach phosphate management in a more holistic way. To date they feel that the most cost-effective approach is to treat eutrophied waters, rather than applying point source phosphate control. However, all practical approaches are being studied and eventual selection of a particular strategy will depend on the most cost-effective solution for each particular situation.

Mr W van Dieren of the Institute for Environmental and Systems Analysis in Amsterdam, The Netherlands, described the complex eutrophication situation in The Netherlands, the initial over optimism of policy-makers that the problem would soon be solved and the conflict between the authorities and the detergent industry, which was singled out as major culprit. Construction of a system dynamics model with strong participation by experts and policy-makers from various disciplines and backgrounds was the route followed in an attempt to resolve these problems. This technique was considered a successful socio-technical tool for solving complex environmental problems.

Dr Adolf de Jong of Uniliver N.V. Detergent Division of The Nether-

lands reviewed the topic of "Detergents, the consumer and the Environment". He stressed that reducing or forbidding the use of phosphate in laundry detergents for environmental reasons created a major dilemma, but pointed out that there need not be a controversy between the quality and washing and the quality of the environment. He demonstrated with figures for Germany, Switzerland and the Netherlands that it is far more effective and cheaper to remove phosphate from sewage than from detergents.

CONCLUSIONS

The conference confirmed that valuable world-wide experience with phosphate management to prevent or control eutrophication has been built up over the last 20 years. Refinements of these techniques and the results of their implementation are now becoming available. South Africa is in the fortunate position that it can learn from and use results obtained elsewhere. However, a number of aspects still require further investigation or research before they can be applied locally:

- **Biological Phosphate Removal:** Research on techniques for making sewage more amenable to biological phosphate removal should continue. Biologically mediated chemical phosphate precipitation and the factors which control it should be more thoroughly investigated. Care should be taken to protect inventions in this field from exploitation by commercial opportunists.
- **Chemical Phosphate Removal:** There is a lack of accurate cost data on both chemical and biological phosphate removal, as well as on the factors which significantly influence these costs. The benefits of chemical phosphate removal were highlighted at the conference and indicated that they merit careful consideration during process selection. Combined biological and chemical phosphate removal is possibly the most cost-effective approach for the South African situation. The process of

$MgNH_4PO_4$ precipitation holds potential for treating nutrient-rich anaerobic digester supernatants and should be investigated. Technology now exists to reduce riverwater phosphate concentrations to as low as 0,01 mg/l (as P), should it be required locally.

- **Phosphate sludge management:** To date local research and development has been pre-occupied with phosphate removal from sewage, but little attention has been given to the resulting sludge. The problems associated with the treatment and disposal of these phosphate-rich sludges needs to be urgently addressed.
- **Eutrophication:** Areas requiring further research are: the quantification of lake response with time to restoration actions and the role phosphate-rich sediments play in retarding the restoration process; the bio- and positional availability of phosphates; and the dynamics of phosphates in river systems.
- **Phosphate Management Strategies:** Examples of successful management of eutrophication through point source phosphate control have been reported. However, a holistic approach considering all practical strategies, from point source phosphate control to water treatment to remove the deleterious products of eutrophication, is advocated in deciding on a final management approach. Each waterbody and its catchment should be considered on an individual basis. Models of system response to reduced nutrient loading exist, but should be further refined for the South African situation. It was stressed that a successful model will be one that is developed jointly by experts from the fields of limnology and water quality, and policy-makers. Reducing or forbidding the use of phosphates in laundry detergents should be considered with circumspection for South Africa and be preceded by a study to assess if this strategy will be more cost effective than phosphate removal at sewage works.

BETER OPLEIDING VIR OPERATEURS

Tydens 'n gesamentlike vergadering van die Instituut vir die Bestryding van Waterbesoedeling (IBWB) met die Vereniging van Waterbehandelingspersoneel oor probleme wat op water- en rioolwatersuiweringswerke ondervind word, het dit duidelik geblyk dat daar nog heelwat probleme rondom die opleiding van operateurs bestaan.

Verslag is gedoen oor verskeie geleenthede waar duisende rande verlore gegaan het vanweë die feit dat operateurs en ander bedryfspersoneel nie voldoende opgelei was nie.

'n Voorbeeld is genoem waar 'n tenk by 'n rioolwerke met Ferrichloried gebars het. Teen 120 rand per ton Ferrichloried en 8 000 rand vir die tenk het die skade byna 10 000 rand beloop. In 'n ander geval is 'n lugblaser verkeerdlik afgekakel deur 'n operateur wat nie reg opgelei was nie. Die kostes verbode aan die regstelling was om en by 6 000 rand.

Veral by die kleiner werke waar die operateurs nie altyd opgelei is om dit behoorlik te bedryf nie, word daar dikwels gevind dat die verkeerde toerusting aangekoop word. Daar is veral verwys na die probleme wat rondom die aankoop van vloeieters bestaan.

Die nuwe fosfaatstandaard vir uitvloeiensels bring mee dat heelwat nuwe toerusting aangekoop moet word en die waarskuwing is gerig om te waak teen die aanskaffing van



Onwettige storting van rioolslyk in 'n rivierbedding.

toerusting en middels wat reeds in die praktyk onsuksesvol bewys is.

Verskeie van die sprekers wat opgetree het, het 'n ernstige beroep op die owerhede gedoen om erkenning en status aan die bedryf te verleen. Dit is beklemtoon dat persone in die operateursbedryf geregistreer moet word en dat erkende opleidingsentra daargestel moet word vir gestandaardiseerde indiensopleiding.

Registrasie van die bedryf hang af van formele wetgewing en daar is verwys na 'n konsep wetsontwerp

wat reeds in 1984 vir kommentaar gepubliseer is, wat vereis dat alle werke en operateurs geregistreer moet word. By nadere navraag van die SA Waterbulletin het dr Koos Barnard, Adjunk-direkteur, Waterbesoedelingsbeheer by die Departement van Waterwese, gesê dat die kommentaar in die nuwe waterwysigingswet opgeneem is en dat dit reeds na die Minister onderweg is vir goedkeuring. Volgens dr Barnard verwag hy dat die wet vroeg volgende jaar goedgekeur sal word.

Chemical back-up a must

Biological phosphate removal plants present a high risk to the water environment should something inadvertently go wrong in their operation as a result of electrical or mechanical failure.

At the first open meeting of the Institute of Water Pollution Control's Working Committee for Nutrient Removal it was stressed by both the Department of Water Affairs and designers of biological phosphate removal plants that chemical back-up is absolutely essential.

From discussions it became evident that chemical back-up does not necessarily need to be expensive since chemicals would only have to be used seldomly. It insures that local authorities are protected against disastrous phosphate discharges to the water environment. In addition, should biological phosphate removal not be capable of bringing the phosphate concentrations down to the required effluent standard, the chemical back-up system can also be applied to reduce

these concentrations.

It was also stressed that research to date concentrated on phosphate removal from the liquid phase and little attention has been given to the treatment, handling and disposal of resultant sludge. Full-scale experiences with biological phosphate removal at a number of sewage works have identified problems associated with nutrient rich sludges. These include the leaching of phosphates from the sludge and difficulties with the dewatering and

drying of sludges. It was agreed that this matter requires urgent attention.

PROBLEMS

A number of problem areas relating to compliance with the phosphate standard were raised. These include the analytical technique used for determining the phosphate concentrations as well as the frequency of sampling. Mrs Maria D'Oliveira, Deputy Director, Rand Area, Water Pollution Control of the Department of Water Affairs, pointed out that preliminary studies by the Department indicated that there is little difference between dissolved and total orthophosphates analysed on the same samples and that the norm would consequently remain dissolved orthophosphates. As regards the frequency of sampling, this is specified by permit conditions for individual discharges.

Although the meeting took place

approximately two months after the implementation of the standard, Mrs D'Oliveira stated that compliance with the standard was still very poor. Only five out of the 35 works investigated complied. She indicated that strict measures will have to be taken if local authorities continue to disobey the law.

Little information is available on the costs of various technologies for phosphate removal. It was felt that although costs of chemicals are well-defined, the optimal quantities of these chemicals used are not, nor are the hidden costs associated with chemical sludge treatment and disposal.

Similarly very few comparative cost figures are available on biological phosphate removal. As in the case of chemical phosphate removal many hidden costs have not been adequately quantified, for example the costs associated with poorer sludge settling properties and the

treatment and disposal of this sludge.

Practical experiences at a few full-scale plants have indicated that the introduction of volatile fatty acids such as acetic acid, enhances biological phosphate removal. The on-site generation of these acids or the use of commercial acetic acid or industrial waste streams containing volatile fatty acids, requires assessment in terms of cost and effectiveness in enhancing phosphate removal.

It is planned to present these meetings bi-annually and the idea is to provide a forum for those active in this field to share experiences and views.

The next meeting will be held on 26 March 1986 and those interested in attending should contact: Working Committee Chairman, Dr Herman Wiechers, c/o Water Research Commission, PO Box 824, Pretoria 0001. Telephone: (012) 28-5461.

A DIFFERENT LOOK AT MATHEMATICAL MODELLING

Mathematical modelling should be an inherent part of the design of a waste water treatment system, regardless of the approach used, according to the International Association on Water Pollution Research and Control (IAWPRC).

These modelling techniques make use of empirical approaches and research in this field has given rise to the development of many models. There is, however, no consensus as to which model is best for real design and practice. The IAWPRC has therefore formed a task group with researchers in the field of kinetic modelling to look into the problem of modelling activated sludge systems with a view to propose a model which finds general acceptance for design purposes as well as practical use.

They had to present this model in a way which gives clear insight into the processes incorporated in the treatment system, as well as the procedures for its use.

The task group consisted of Professor CPL Grady (Clemson University, USA); Dr W Gujer (Swiss Federal Institute for Water Resources and Water Pollution Con-

trol, Switzerland), Associate Professor M Henze (Technical University of Denmark, Denmark); Professor Gvr R Marais (University of Cape Town, South Africa); and Professor T Matsuo (University of Tokyo, Japan).

Four meetings were held to discuss the different modelling approaches. The first one was held in Clemson, USA, the second in Tokyo, Japan, the third in Dubendorf, Switzerland and the final meeting, which also included the presentation of the preliminary report on the model, at a seminar in Copenhagen, Denmark.

NEW MODEL

SA Waterbulletin spoke to Professor Marais, Professor of Water Resources and Public Health Engineering at the University of Cape Town, on the new model, the direction it has taken and its significance from a South African point of view.

Professor Marais says an interesting development is the presentation of the model in a matrix form. This presentation provides a concise description of a complex model,

clearly identifying the processes involved, their kinetic formulation and their action on the compounds.

It also allows ready comparisons of different models and a consistent procedure for solution and analysis of dynamic process response. It furthermore allows rapid modification of the computer program to incorporate changes to the model or addition of processes and compounds.

Professor Marais also referred to the model's handling of the conversion process of particulate COD to readily biodegradable COD. His research group has always believed that the particulate COD releases a dissolving enzyme which adheres on the outside of the organism. After the material dissolves, it is immediately absorbed.

It is now believed that the organism dissolves the particulate material which then passes into the bulk liquid where it joins the other readily biodegradable COD that comes from the influent. All the micro-organisms then compete for the material.

Professor Marais says that in modifying their approach on the manner in which food is being utilised, it was also possible to under-

stand and model the growth of filamentous organisms, which cause bulking in the activated sludge process. Although this problem has not been solved, the approach provides new perspective on the behavioural characteristics of filamentous organisms.

South Africa was also able to make a unique input to the IAWPRC model with regard to the composition of sewage and the way in which micro-organisms react to different types of sewages.

At the conclusion of the seminar in Copenhagen Professor P Harremoës from the Technical University of Denmark and chairman of the seminar, remarked that the contribution to the model by the South African researchers was one of the most substantive contributions and their work ranks amongst the most significant in recent times.

The preliminary report is currently in the process of being approved by all the members of the task group and the final report will be presented at the next IAWPRC conference which will take place in Rio de Janeiro next year.

Ferric Chloride dangers

The introduction of the effluent phosphate standard has created new opportunities for the chemical industry which has to supply the required chemicals to sewage treatment works and assure that these chemicals are supplied on a continuous basis.

The increased demand for chemicals has not only created certain opportunities, but unfortunately also poses certain dangers. It is for this reason that a seminar, "Safety with Ferric Chloride", was organised by National Chemical Products (NCP) at Chloorkop in November.

The objective of the seminar was to discuss a crucial need identified by local authorities viz. to learn more about the safe application of Ferric Chloride. During the discussions it became clear that current practices leave much to be desired and it was recommended that NOSA (National Occupational Safety Association), the chemical industry and local authorities get together to draw up

Diploma vir Waterversorging



Agter (van links na regs): Mnr IB Schutte, mnr PR Bouwer, mev M Conradie, mnr PA du T Carstens, mnr FA Lems. Voor: Mev A Visagé (lektrise), mnr S Schwarzer (departementshoof), mnr C Knoetze (senior lektor).

Water is 'n aktuele en lewensbelangrike hulpbron. Daarom is die opleiding van geskikte persone wat leiding kan neem in die ontwikkeling en instandhouding van waterbronne 'n uiters belangrike noodsaaklikheid. Die Technikon in Pretoria bied sedert 1983 'n kursus, die Nasionale Diploma in Waterversorging, aan.

Die doel van hierdie diplomakursus is om aan studente 'n grondige opleiding te verskaf in die praktiese en teoretiese aspekte van waterversorging. Dit behels nie alleen die

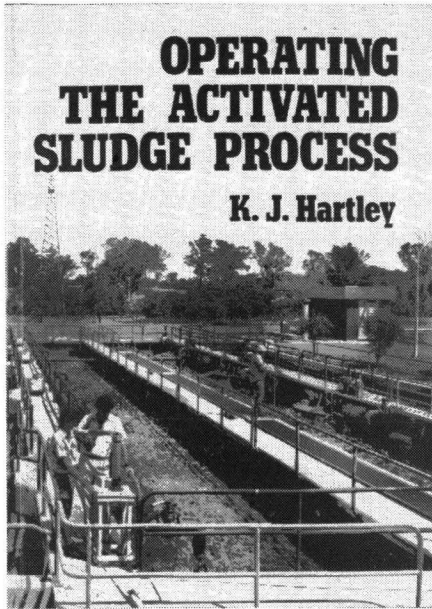
behandeling van water en rioolwater nie, maar ook aspekte soos die veilige wegdoening van uitvloeiselreste en vaste afval sonder enige sekondêre besoedeling. Die kursus sluit 'n omvattende ondersoek in na die analitiese aspekte van water asook die beheer- en wetsaspekte wat betrekking het op alle waterbronne — op die oppervlak sowel as ondergronds. Toelatingsvereistes, vir hierdie kursus is 'n Senior Sertifikaat, of 'n gelykstaande kwalifikasie met Wiskunde en Natuur- en Skeikunde.

a code of practice relating to safety in the application of Ferric Chloride.

Of the many safety aspects highlighted at the seminar, possibly the most dramatic aspects reported was the failure of fibre glass bulk storage tanks at the Boksburg and Johannesburg sewage works. Fortunately these failures did not result in loss of life or serious harm to staff, but expensive loss of chemicals and operational time on the process were experienced. The reasons for the failures are still being investigated.

The chemical industry undertook to assist users of chemicals with any technical back-up information required, as well as the safe delivery of these supplies.

The seminar included addresses by eight speakers. They are: Messrs C van Niekerk (NCP Chloorkop); W Loots (NOSA); TI Breytenbach (NCP Chloorkop); A Sugden (Lectratec); W Engelbrecht (Johannesburg Municipality); D Louw (Boksburg Municipality); W Enslin (NCP Chemical Marketing); and Dr S Pretorius (NCP Chloorkop).



**OPERATING THE
ACTIVATED SLUDGE
PROCESS**

by KJ Hartley

This book developed from the operating manuals written for a series of treatment plants in Queensland, Australia. Its purpose is to explain the principles of operation of the activated sludge process and to stimulate an interest in tuning for better performance. The emphasis is on understanding of process behaviour and simplicity of operation.

The orientation of the book is as follows:

- Only the activated sludge process itself is covered; other parts of the treatment plant are ignored.
- The text is written around the treatment of municipal sewage, however the same basic principles apply in the case of industrial wastewater.
- Nutrient removal is included only insofar as denitrification can be used as an operating technique in secondary treatment plants.
- There is an orientation towards operation in warmer climates, the special problems of which have received little attention in the past; the peculiarities of cold climate operation are not covered.
- BOD₅ is used throughout, rather than the theoretically

more appealing COD, because of its widespread use and familiarity.

- Maintenance aspects are not included.
- The generic title operator is used to distinguish all operations personnel, and does not refer to any particular level in the operating hierarchy.

1985 177 pages
\$19.00, plus packaging and postage
ISBN 0 9590012 04

Available from: Gutteridge Haskins and Davey (Pty) Ltd, 87 Wickham Terrace, Brisbane, Qld 4000

**THE FUTURE OF
WATER REUSE**

*Water Reuse Symposium III
Proceedings*

Published by the AWWA Research Foundation, a nonprofit organization established for centralized water supply research, *Future of Water Reuse* provides the complete record of the symposium held in San Diego, California, August 26–31, 1984.

Organized into twelve chapters, this three volume set provides the most up-to-date description of the state-of-the-art of water reuse and recycling available today. Building from an introductory base that discusses managing and financing reuse projects, the books address the topic of reuse from the viewpoint of the end user, whether a municipal water supplier, industrial, agricultural or other large water consumer.

Separate chapters highlight international projects, as well as military applications of water reuse. The discussion of health effects and water quality criteria is probably the most comprehensive presentation of this critical aspect of water reuse to be found. Although it is developed from the proponent's viewpoint, it fairly presents both the benefits and concerns of wastewater reuse, and therefore addresses the demands of public health officials, water suppliers, and public interest groups.

The concluding chapter on research needs not only points to the future of water reuse, it contains numerous discussions of the specific research areas and projects that must be started in order to make water reuse and recycling a wide-

spread, practical, alternative water supply for both potable and non-potable demands.

This proceedings set will provide a valuable addition to the library of all organizations and agencies involved in water supply, wastewater treatment or environment control.

1985 1 830 pages \$70.00
ISBN 0 915295 02 4

Order from:
AWWA Research Foundation,
6666 W Quincy Avenue,
Denver, CO 80235

**ENVIRONMENTAL
INORGANIC CHEMISTRY**

by Kust J Irgolic and Arthur Martell

Traditionally, studies of the transformations and fate of chemicals in the environment dealt almost exclusively with organic compounds. The true role of metals and metalloids in biochemical cycles has only recently begun to receive well-deserved attention of inorganic chemists. In this manner the new field of *Environmental Inorganic Chemistry* is created.

Generally environmental problems can be completely understood and solved, or prevented before they occur, only when their chemical foundations have been elucidated and the nature of the metal compounds involved has been determined.

This book edited by KJ Irgolic and AE Martell presents the proceedings of a seminar and workshop which addressed ongoing and planned future activities in the area of molecular environmental inorganic chemistry. It provides information on the reactions of inorganic and organometallic compounds on the molecular level, examines the present state of knowledge and evaluates hypotheses that have been advanced to explain the observed reactions.

These proceedings serve to report on major research trends, status and concerns of fundamental significance to inorganic chemistry and the environmental sciences.

1985 XIV/654 pages with 105 figures and 102 tables \$85.00
Obtainable from:
VCH Verlagsgesellschaft,
PO Box 1260/1280,
D-6940 Weinheim

WETLANDS FOR WASTEWATER TREATMENT

by Fiona EJ Rogers, Kevin H Rogers and Jenny S Buzer.

Water quality standards are becoming increasingly stringent and the cost of conventional wastewater treatment are rising. As a result considerable attention has been directed in the last decade towards the use of both natural and artificial wetlands as wastewater treatment systems.

This review consists of two parts: the first is an introduction to the wetland ecosystem and the second is a discussion of the processes involved in wetlands as wastewater treatment systems as well as the management potential and cost effectiveness of such systems.

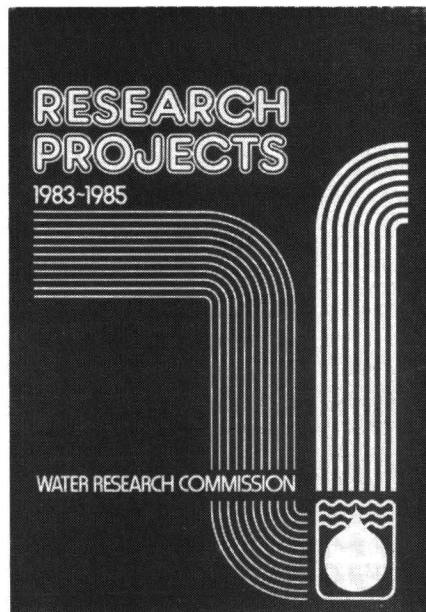
1985 122 pages
R10 plus 30c postage
ISBN 0 85494 843 0
Order direct from: Witwatersrand University Press, 1 Jan Smuts Avenue, Johannesburg 2000.

CONTROL ANALYSES FOR WATER PURIFICATION PLANTS — OPERATORS' MANUAL

The manual gives step-by-step analytical methods for carrying out the following physical and chemical analyses: Colour, turbidity, pH, electrical conductivity, total dissolved solids, alkalinity, total hardness, calcium hardness and free and total chlorine. Procedures for stability calculations, flocculation tests and determination of chlorine demand are also given.

This manual (K76) entitled *Control Analyses for Conventional Water Purification Plants* is available from the Librarian, NIWR, CSIR, P.O. Box 395, Pretoria 0001. It comes in two versions, an ordinary board cover or plastic cover with ring binding. The ordinary version may be ordered against code number 620/6079/3 on prepayment of R10,00 plus GST. The special version is available on prepayment of R12,00 plus GST against code number 620/6080/1.

An Afrikaans version of the manual entitled *Analises vir Kon-troledoeleindes by 'n Konvensionele Watersuiweringsaanleg* (K72) is also available. The cost of the ordinary version is R6,00 plus GST (code number 620/6083/5) and that of the special version R8,00 plus GST (code number 620/6081/9).



RESEARCH PROJECTS OF THE WATER RESEARCH COMMISSION FOR 1983 — 1985

Compiled by Dr MJ Pieterse

Although the Water Research Commission's activities are reported in the annual reports of the Commission, the research projects sponsored by the Commission are not individually covered. This publication is issued in order to provide more information on the research projects *per sé*.

This is the second in the series. The first dealt with projects which were in progress during 1982 while this publication covers projects for the period 1983 to 1985.

Contents: Surface hydrology; Ground water; Hydrometeorology; Irrigation; Mineralisation; Eutrophication; Municipal wastewater; Sewage sludge; Industrial effluents;

Water purification and reuse; Desalination; Water economy in urban areas; Water economy at power stations; Information and technology transfer.

1985 102 pages

Price: No charge

ISBN: 0 908356 331

Available from: The Executive Director, Water Research Commission, PO Box 824, Pretoria 0001. Telephone: (012) 28-5461.

IRRIGATION REQUIREMENTS OF CROPS

Memoir no 2 in the series Memoirs on the Agricultural Natural Resources of South Africa, entitled *Estimated Irrigation Requirements of Crops in South Africa*, is now available in the form of two books.

Part 1 consists of the Eastern Cape, Karoo, Natal and the Winter Rainfall Region and part two includes the Highveld, Orange Free State and Transvaal Region.

Crops include vegetables, agronomic crops, pastures, deciduous fruit, vines, citrus and subtropical fruit. Data are provided for 120 localities.

Provided the user knows the water holding capacity of the soil he is dealing with, each of the many tables indicates how the mean irrigation requirement of a given crop at a given locality is distributed through the growing season.

The tables also contain data on total water requirements, effective rainfall, peak irrigation requirements and irrigation design capacities associated with various levels of risk.

The contents of the tables are based on soil water balance computations under simulated optimal irrigation management conditions, designed to realise maximum yields while maintaining high water use efficiencies.

The computations make use of calculated evapo-transpiration rates, typical root development patterns and assumptions concerning soil water availability to crops.

Evapo-transpiration rates were calculated using daily pan evaporation data and recommended crop

factors or coefficients, the values of which are given in the memoir.

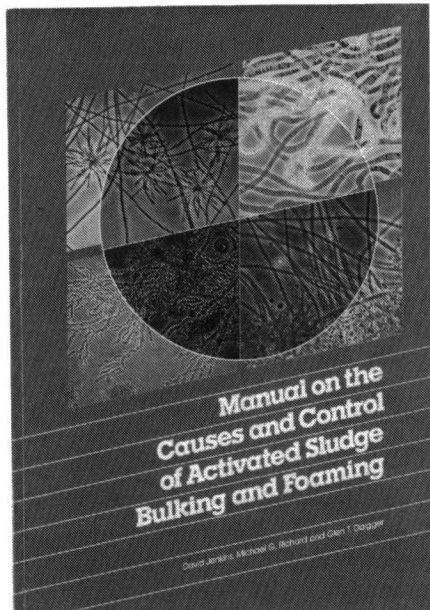
The English and Afrikaans texts are contained in the same volume of each part.

1985 Part 1 409 pages;

Part 2 448 pages

R14,00 post free, plus GST

Obtainable from: The Director,
Agricultural Information,
Private Bag X144, Pretoria 0001



MANUAL ON THE CAUSES AND CONTROL OF ACTIVATED SLUDGE BULKING AND FOAMING

by David Jenkins, Michael G Richard
and Glen T Daigger

Sludge bulking and foaming are problems which are commonly experienced in activated sludge plants. A recent survey of 111 RSA plants indicated that approximately half periodically experience significant problems with either bulking or foaming. This results in solids carry-over in the final effluent and hence significant pollution of receiving rivers, streams and impoundments.

During 1981 the Institute of Water Pollution Control brought the urgency of these problems to the attention of the Water Research Commission. Consultation with organisations affected by these problems identified the need to compile a manual of existing knowledge of the causes and control of activated sludge bulking and foaming.

Professor David Jenkins of the University of California, Berkeley, USA, is recognised as one of the world's leading experts in this field. After visiting South Africa and seeing and discussing sludge bulking and foaming problems with local authorities, industries and researchers, he agreed to compile a manual based primarily on his group's research and extensive USA practical experience. Where appropriate and available, South African data has been included in this publication. This manual represents a first step to equip the user with available technology to deal with sludge bulking and foaming.

1984 165 pages

Price: Free of charge

ISBN 0 908 356 374

Available from: The Water Research
Commission, PO Box 824, Pretoria
0001

STREAMFLOW CHARACTERISTICS

by HG Riggs, Falls Church, VA, USA

Reliable estimates of streamflow characteristics are required for planning, design, and operation of works for providing water supplies and for protection from flooding. Methods for making these estimates are however widely scattered in the literature.

This new book brings together some of the most useful methods — those that are simple, practical, and require only commonly available or readily obtainable data. These methods produce results comparable in accuracy with those derived from more sophisticated methods. The author describes how streamflow data are collected, how the characteristics are computed both at gauged and at ungauged sites, how they are changed by man's activities, and how they are used in planning and design.

1985 viii + 250 pages. US \$53.75

ISBN 0-444-42480-6

Order from:

Elsevier Science Publishers.

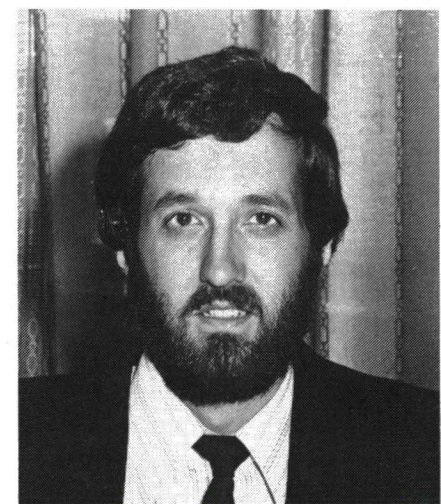
PO Box 211, 1000 AE Amsterdam,
The Netherlands.

Dr Hattingh bevorder



Dr WHJ Hattingh is bevorder tot hoofadviseur van die Waternavorsingskommissie. Hy volg mnr PE Odendaal op wat as die nwe uitvoerende direkteur van die WNK aangestel is. Dr Hattingh was voorheen direkteur van die Hidrologiese Navorsingsinstituut te Roodeplaatdam.

AWARDED



Mr D Cousins, senior adviser, WRC, recently received one of Federale Volksbeleggings' annual awards to the two top students in the first year MBL course at the UNISA Graduate School of Business Leadership. Mr Cousins holds a B Sc Eng (Agric), from the University of Natal, and a M Sc which was done on hydrological modelling.



A laboratory at the National Institute for Water Research, CSIR.

SA spearheading water quality research in the world

Poor quality water can be as detrimental as no water at all.

In South Africa, water quality is of particular importance because of limited natural resources which have to be utilized optimally to meet the demands of rapid growth in population as well as industrial and agricultural activities.

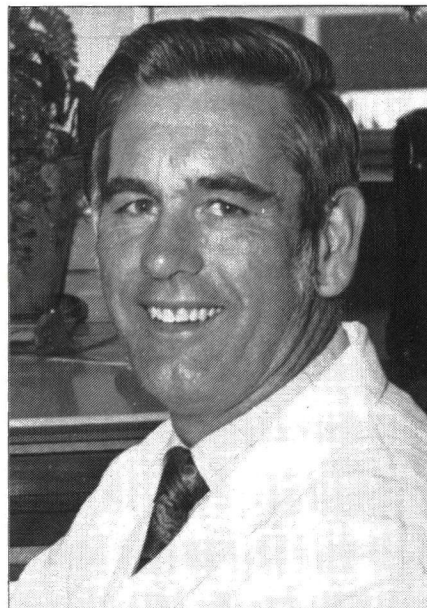
In this extract from a paper presented by Dr WOK Grabow at a symposium on recent developments in drinking water purification some aspects of the research at the National Institute for Water Research of the CSIR aimed at water quality assessment and control are summarized.

MICROBIOLOGICAL QUALITY

Expertise developed for research on health-related microbiological quality aspects of water include practical methods for the standard plate count, total and faecal coliforms, acid-fast bacteria, *Clostridium perfringens*, faecal streptococci and some others including *Vibrio cholerae*, intestinal parasite ova and

the yeast *Candida albicans*. The *Limulus* amoebocyte lysate assay is being used for the detection of bacterial endotoxins.

Special attention has been given to human enteric viruses. A Sensitive ultrafiltration method for the recovery of viruses from relatively small volumes of water, and an ad-



Dr WOK Grabow.

sorption — elution procedure for large volumes of water, have been established. Techniques developed at the NIWR for the detection and enumeration of viruses are probably the most sensitive available in the world today.

Progress has been made in research on the type A hepatitis virus (HAV), which is frequently transmitted by water, but cannot be detected by conventional methods. Following initial experiments with laboratory animals, a practical cell culture technique was introduced for research on the behaviour of an adapted strain of HAV in water treatment processes. The study also led to the development of an affinity chromatography method for the specific recovery of hepatitis viruses from water, and revealed reasons for the rare transmission of the hepatitis B virus by the water route.

Microbiological research included the selection of practical water quality indicator systems. In endeavours to eliminate the need for expensive, complicated and time-consuming enteric virus tests from routine quality surveillance, coliphages proved

valuable viral indicators. Sound evidence is now available that the microbiological safety of water can be reliably assessed without enteric virus tests, using indicator systems within the capabilities of most laboratories. Apart from sophisticated facilities and know-how, the cost of an enteric virus test is about R250, while the indicator tests can be performed for some R50.

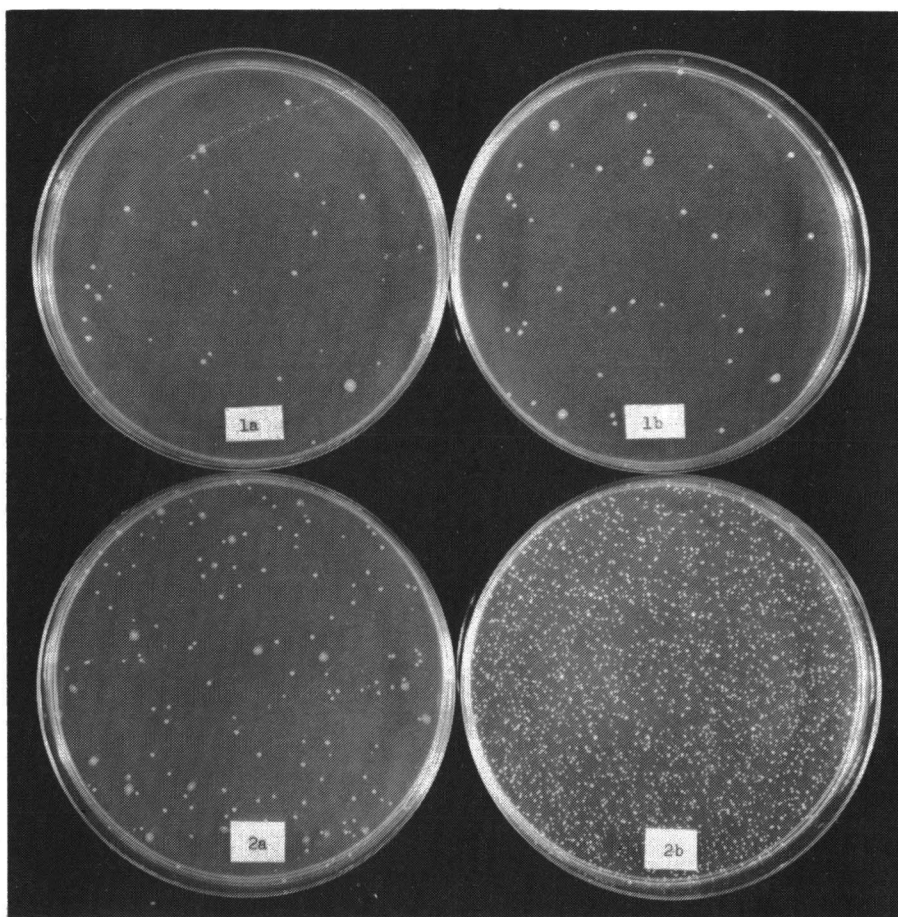
In order to keep up with the water quality implications of trends in water-borne diseases, it is essential to obtain information on the incidence and behaviour of various pathogens in water environments. At present there is a backlog in this regard, because there are virtually no details even on long-known pathogens such as *Vibrio cholerae*, *Giardia* and *Naegleria* in South African waters.

Indicator systems will have to be continually revised to keep up with changing patterns in health risks and new technology. Currently used indicator systems and quality surveillance procedures can certainly be made more practical, economical and reliable. Important challenges in this regard include the development of techniques which yield results faster, the distinction between faecal pollution originating from humans or other animals, and possibly even systems for the continuous monitoring of microbiological quality.

New water treatment technology also brings new questions. For instance, activated carbon filtration has been found to extensively increase levels of endotoxins in water, and there is reason to believe that the carbon may support the growth of pathogens such as *Legionella*. Disinfection of water by means of chloramination, instead of free chlorine residuals in order to limit the formation of chlorinated hydrocarbons, may completely change the relative sensitivity of different microorganisms to disinfection processes.

CHEMICAL QUALITY

Procedures have been established at the NIWR for the analysis of some 50 different inorganic-physical quality determinants. Analyses have to a large extent been automated, using Auto-Analyzer systems and an advanced computer facility for pro-



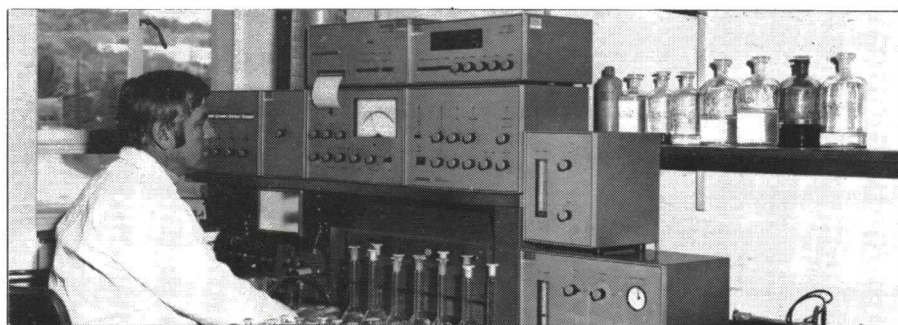
The Ames Salmonella test for certain mutagens in drinking water.

cessing of results, quality control, and data storage and retrieval. In the order of 100 000 analyses on some 14 000 samples are being carried out each year as an analytical service to various research projects of the Institute.

Sophisticated instrumentation and facilities, including a modern gas chromatograph-mass spectrometer system with integrated computer, are being used in research on organic compounds which pose special challenges due to their complexity and diversity. Research on the simplification of analyses for purposes of practical quality surveillance, has

met with success in various areas. Evaluation by means of organic pollution indices (OPI), in which levels of related individual compounds are classified in five different groups, has greatly facilitated the assessment of the general organic quality of water.

In studies on practical methods for the assessment of organic compounds as a total, combined determinant, traditional biological and chemical oxygen demand tests were replaced by analyses for total or dissolved organic carbon (TOC or DOC) which have important advantages, and instrumentation was



A modern gas chromatograph-mass spectrometer system.

developed for the automatic DOC analysis of individual water samples. Following an explosion in international awareness of the health significance of halogenated hydrocarbons in water, instrumentation was developed for the automatic analysis of total organohalogens (TOH) in individual water samples.

Obviously, the ultimate in water quality surveillance and control is automatic continuous on-line monitoring. Research along these lines has resulted in the recent construction of micro-processor operated, analog instruments for the on-line monitoring of DOC and TOH. Results are presented as single print-outs or graphic displays. The instruments proved successful in laboratory and field trials, and in pilot plant studies on activated carbon filtration.

Application in studies on quality aspects of water supply in practice is due to commence soon, and the possibility of marketing is being investigated. Apart from the advantages of local expertise and equipment, the DOC analyser would cost about R20 000, and an equivalent imported commercial instrument some R60 000.

Research on further simplification and reduction in cost of organic carbon monitoring, revealed a meaningful correlation between DOC and ultraviolet light absorption (UVA) under many circumstances, which implies that DOC monitoring could possibly be replaced by UVA monitoring. This would have the important advantage that a UVA monitor with recorder costs only about R5 000, while operation is simple. In order to further investigate the feasibility of UVA monitoring, the DOC monitor currently used is equipped with a UVA monitor on an integrated circuit for direct comparison of results.

Since new chemicals are released on the market at a rate of about 1 000 each year, it will be necessary in future to develop methods for their detection, and study their incidence in water and removal or inactivation by existing and new water treatment processes.

There are limited details on pesticides and their implications in water, and no information on the incidence and behaviour of obscure

compounds such as tumour promoters and co-carcinogens. Efforts are currently in progress to identify certain mutagens in drinking-water supplies detectable by Ames tests, but this is a highly complicated task which would require a much larger input to obtain meaningful results within a reasonable period of time.

New technology and research progress continually open new possibilities for improvement of analytical techniques in terms of accuracy, cost, speed of analysis, spectrum of detectable determinands, and efficiency of data processing and interpretation. The development of apparatus for the automatic, continuous monitoring with integrated computer processing of results for determinands such as trihalomethanes is currently in pro-

gress. This field has enormous potential with far-reaching implications.

Attractive possibilities of various chemical indicator systems for water quality assessment and control remain to be explored. These include the utilization of coprostanol as an indicator of faecal pollution, which could possibly even be monitored on a continuous basis.

BIOLOGICAL QUALITY

Compared with physical-chemical analyses, the utilization of living organisms for water quality surveillance has important advantages. All compounds and conditions which affect biological systems are detected, synergistic and antagonistic effects are recognized, continuous monitoring is in various cases readily applied, and testing, particularly in terms of a general wide-spectrum screening procedure, is relatively economical with regard to cost, facilities and technical know-how. However, physical-chemical analyses are often more sensitive, and even though bioassays may reveal valuable clues about the compounds to which they respond, physical-chemical testing remains essential for final identification. Bioassays and physical-chemical analyses should, therefore, fulfil complementary roles in a closely integrated analytical strategy.

Toxic compounds with immediate effects are readily detectable. Relatively simple fish biomonitoring systems, originally used for this purpose, were developed into highly sophisticated and sensitive computer-controlled units applied for the continuous monitoring of wastewater effluents as well as drinking-water directly reclaimed from wastewater in Windhoek. Since there is no single system that meets all requirements of water quality testing, a variety of additional bioassays has been developed, each with its own functions. Sensor organisms include protozoa (*Tetrahymena pyriformis*), bacteria (*Pseudomonas putida*) and mammalian cell culture systems.

The latest bioassays detect toxic compounds by their inhibitory effects on reactions between enzymes and their substrates. The enzyme-substrate reactions are observed by

NIWR WATER QUALITY SYMPOSIUM

A symposium on water quality assessment, organised by the water quality division of the National Institute for Water Research, will be held on 26 and 27 May 1986 at CSIR conference centre in Pretoria.

Topics will include:

- Recommended methods for micro-organisms, organic compounds, inorganic compounds and biological quality assessment.
- Inter-laboratory comparison studies.
- Standardization of techniques.
- Water quality criteria.

The water quality division of the NIWR will be visited for demonstrations and discussions at the laboratory bench.

Delegates are invited to submit posters for presentation at the symposium.

Products and equipment relating to the subject of the symposium will be exhibited.

Registration fee: R120,00

Enquiries: NIWR, S403, CSIR, PO Box 395, Pretoria 0001. Telephone: (012) 86-9211 x 2231 (Mr P Coombs or Mrs R Oellermann)



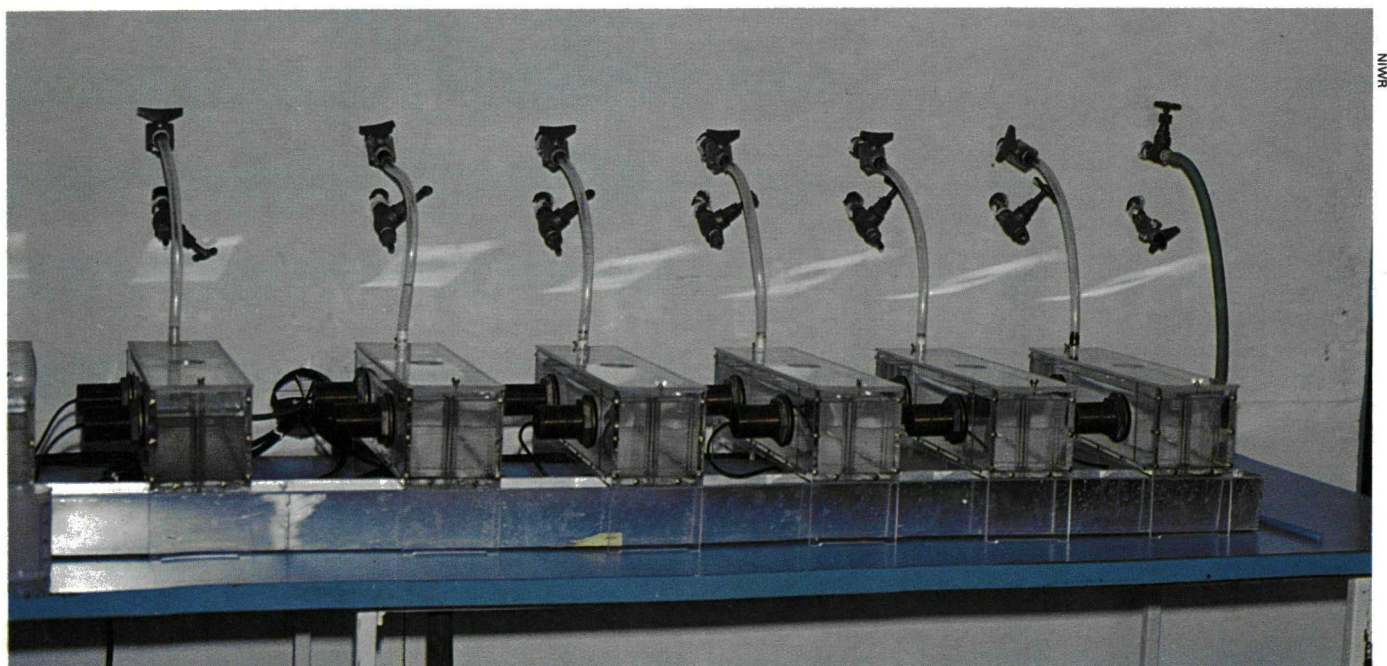
An enzyme microcalorimeter is used in the continuous automatic enzyme monitoring system. This system is R20 000 cheaper than a biological monitoring system.

colour conversions induced by the products of the reactions, or by microcalorimetric measurement of heat energy released by the reactions, which can be used to readily monitor inhibitory effects. The colour reaction is applied in a simple pocket size field test kit, and microcalorimetry in a computer-controlled continuous monitor. The enzyme assays are exceptionally sensitive. Results are available within 5 minutes and, in contrast to whole organisms, they do not adapt to slow changes in water quality. Since enzymes are selectively inhibited by various toxicants, a monitor consisting of a battery of appropriately selected enzymes can detect a wide variety of toxicants and also give an

indication of the type of compound detected. The cost of a fish monitor is about R30 000, and that of an enzyme monitor in the order of R10 000.

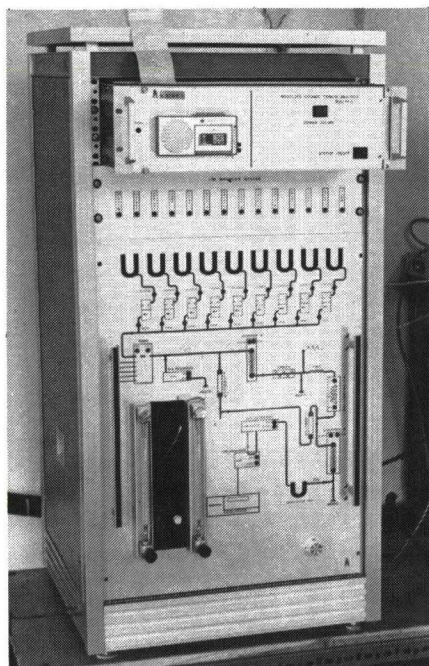
Mutagenic, carcinogenic or teratogenic activity, or effects of long-term exposure to low levels of harmful compounds, are not as readily detectable as responses to toxic substances with immediate effects. In an early experiment, groups of rats received samples of water from various treatment stages of a reclamation plant as the only source of water over a period of 25 months, after which they were autopsied, and tissue microscopically examined for signs of tumour formation. These rat experiments were follow-

ed up by Ames *Salmonella* mutagenicity assays which are simple, inexpensive and yield results within two days. In the Ames test, genetically defined bacterial tester strains respond to mutagenic activity which gives an indication of potential carcinogenicity. The Ames test responds to some 85 per cent of known carcinogens. Techniques were also developed for assessment of carcinogenic activity by means of mammalian cell culture transformation assays, which are more complex, but also more sensitive, than Ames tests. A modified Ames test sensitive enough for the direct detection of mutagens in drinking water is currently being used for routine purposes.



The sensor chambers housing the fish in a biological monitoring system.

DISSOLVED ORGANIC CARBON ANALYSER



The RF10 autoanalyser is an on-line system utilizing ultraviolet/peroxodisulphate oxidation of the organics in a water sample followed by infrared detection of the carbon dioxide liberated. Inorganic carbon is removed by acid treatment and gas-liquid separation. Oxygen is used for inorganic stripping, sample segmentation and as carrier gas to the NDIR detector.

FEATURES INCLUDE:

- Local manufacture. No costly and lengthy importation time.
- Capital investment less than 50 per cent of similar imported equipment.
- Continuous on-line monitoring, better effluent control.
- Immediate assessment of individual process behaviour at water treatment plants.
- Local service, maintenance and advisory services.

PERFORMANCE CHARACTERISTICS

- Alpha numeric display on micro-computer prompts operator to select operation keys.
- LCD readings and print-out of DOC concentrations.

- DOC linear range 1 to 30 mg/l.
- Precision within 10 percent.
- LCD when system is ready to commence analyses.
- Multi-channel analyser.
- For one sampling source print-outs can be obtained for any time intervals.
- In multi-channel mode analyses are obtained every 16 min.
- Alarms, print-outs and visual display identifies system status.
- Exceeding concentration limit warnings.
- Loading and storage of programme by magnetic tape.

FUNCTIONAL CHARACTERISTICS

- Operating temperature $> 10^{\circ}\text{C}$.
- Electrical supply 220 V AC.
- Oxygen flow rate 300 ml/min.
- Replacement of pump tubes every 7 days.
- Reagent volume 15l/week.
- Moisture removal from gas stream entering NDIR detector.
- UV oxidation source minimum lifespan of 5 000 h.
- Cl concentrations in water sample to be $< 400 \text{ mg } \ell^{-1}$.

Details are inherent to the RF10 experimental model. Marketing of this instrument will depend on interest and demand.

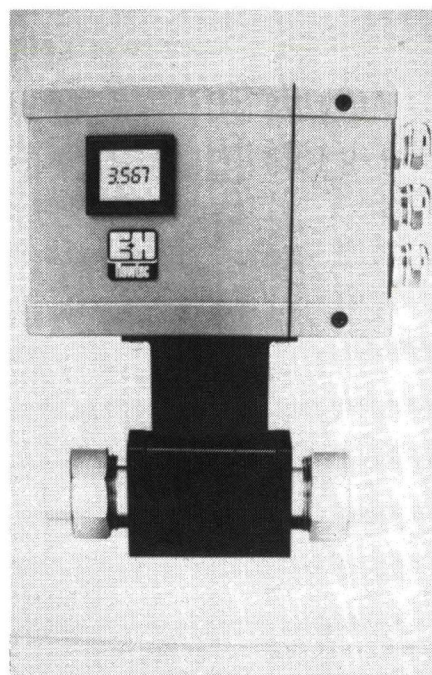
Enquiries: For further information contact: The National Institute for Water Research, CSIR, P.O. Box 395, Pretoria 001. Telephone: (012) 86-9211 x 2259

PICOMAG FLOWMETER FOR MEASURING A WIDE RANGE OF LIQUIDS

The Picomag flowmeter from Endress & Hauser is a compact, microprocessor control instrument with automatic zero correction, a wide measuring range of 20:1, accuracy of 1 per cent of measurement and applicable in 1 uS/cm conductivity in flow rates from 0 to 300l/min.

Picomag is capable of measuring most liquids such as water, pastes, slurries, beer, acid and alkaline solu-

tions. The measurement is independent of flow profile and takes place without pressure loss. Measurement



accuracy is unaffected by pressure, temperature, density and viscosity. Rubber, Teflon and aluminium oxide lining materials are available for the measuring pipe and a variety of electrode types for material temperatures up to $+180^{\circ}\text{C}$ and for aggressive liquids.

The measuring range is adjustable by pushbutton and allows simple and reliable measuring range selection in situ. The current measurement can be directly read off at the measuring point (0 to 100 per cent or as volume flow) providing a direct process control facility. Galvanic separation of mains and signal output permits auxiliary instruments to be connected.

Two pushbuttons control the programming using a 4-position LCD display to set up the measuring range, current output (0/4 to 20 mA), pulse output, time constant, creep suppression and interference suppression. In addition, the microprocessor prevents the selection of an incorrect measuring range, in that it stores minimum and maximum values appropriate to each nominal diameter.

Enquiries to: Endress & Hauser (Pty) Ltd), Box 783996 Sandton 2146. Tel. (011) 802-5620.

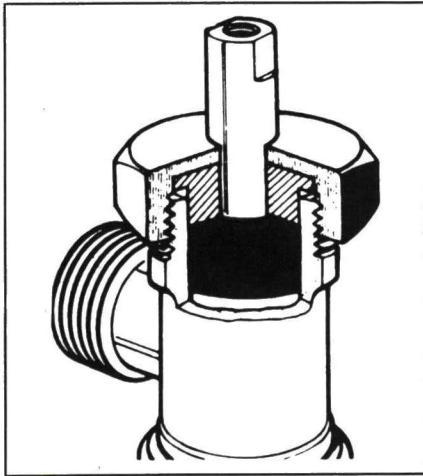
SS6 VALVE PACKERS

The effectiveness of a valve can be measured against its sealing capability. If it is allowed to leak then a great many problems, including environmental damage and production loss, can arise.

At the small end of the valve market Crane Packing (Pty) Ltd of Springs — a company more often associated with high technology sealing products — offers manufacturers a one piece valve packer designed to speed up valve and tap manufacture and give long trouble-free life.

Available in three materials, one-piece valve packers are accurately moulded from a mixture of high quality asbestos fibre and graphite for the Style SS6, or asbestos and PTFE for Styles 168 and 223. In addition totally non-asbestos versions are available.

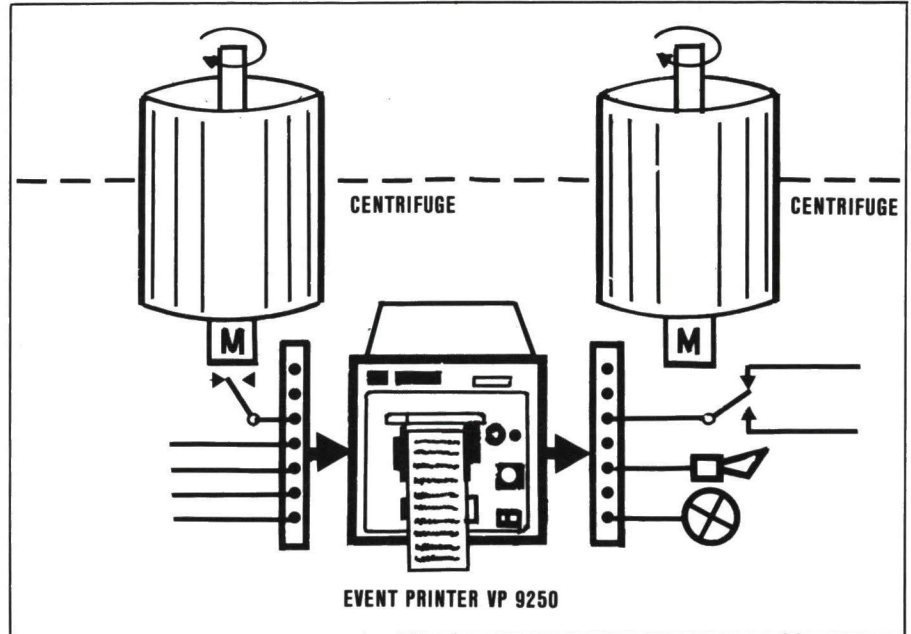
Style SS6 one-piece valve packers have been tested with air and hot and cold water, all at 3,4 MPa and steam at 1,7 MPa. The maximum operating temperature of the SS6 material is 450°C.



In addition this style of packing will operate satisfactorily with caustics and mild chemicals, mineral and vegetable oils and petroleum distillates.

Due to the uniform density of the one-piece valve packer, the gland need not be tightened very much and the sealing efficiency is greater with low spindle torque. On production lines torque settings can be maintained at a constant figure.

Enquiries: Crane Packing (Pty) Ltd, PO Box 890, Springs 1560. Tel: 818-2031.



PRINTER MAINTAINS CORRECT CYCLE TIMES

In many industries, to eliminate wastage and maintain quality it is essential that correct cycle times are maintained. For example, in the textile industry, after production, textile fibres contain a lot of water which is dried out in centrifuges in approximately 10 minutes. To ensure a constant quality fibre, it is important that a constant spin drying time is applied during this operation. The Event Printer VP 9250 from Endress & Hauser registers the time, date and centrifuge designation of each spin. The printer is available in 8, 32 and 64 channel versions and can be wired to trigger an alarm and print

out only when the spin drying operation fails to meet the programmed time.

The VP 9250 can be applied to monitor any on/off switching condition. Where fast multiple changes occur, data is stored in memory and printed in the correct chronological order with the time of each occurrence. A detailed brochure on the VP 9250 is available from Endress & Hauser.

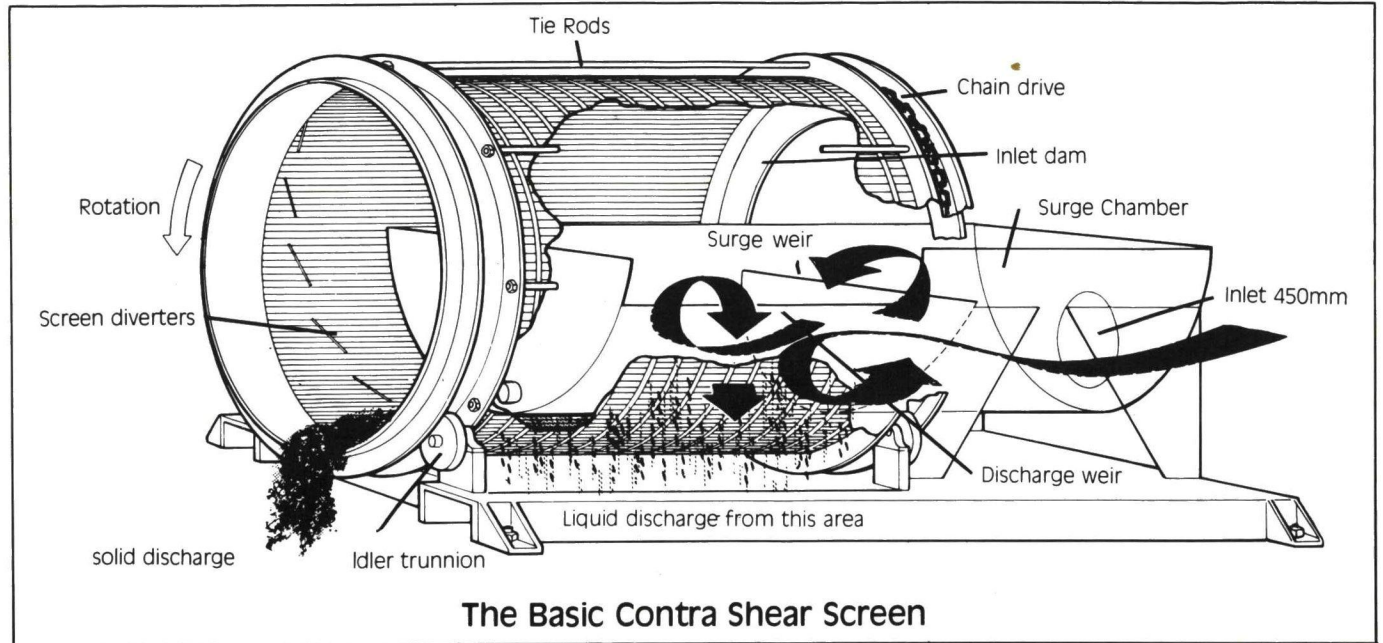
Enquiries: Endress & Hauser (Pty) Ltd, Box 783996, Sandton 2146. Tel. (011) 802-5620.

COUNTER ROTATING WEDGE-WIRE SCREEN

In any system which is designed to reuse water, from product flow to sewage waste, *screening* is the first stage of treatment. The efficiency of the screen and its ability to remove the large as well as the smallest possible particle size, will determine the degree and cost of further treatment. Be it simple filtration, aeration of settling ponds, life of sedimentation tanks or reduced equipment maintenance. Furthermore, the prompt removal of solids from product flow by screening can reduce COD and BOD levels, again saving on further treatment, purification costs and tariff payments.

In all applications, whether it be

sewage treatment, plant effluent screening, or process product flow solids separation, the best results are obtained by passing the full flow of product or waste over Contra-Shears patented counter rotating wedge-wire screen. The resultant shearing action (which is double that of a static screen) effectively separates 96 per cent of all particles the same size as the wedge-wire aperture and larger, plus about 50 per cent of particles half of the aperture size on heavy solids loading waste water. The screen is sized to handle the full water flow to the screen face and all screens can be automatically cleaned with both in-



side and outside showers if the type of waste water or product being screened demands it.

This type of screening must *not* be confused with the *wire mesh* or punched hole plate type of screen of which there are many in operation.

Wedge wire technology puts the Contra-Shear screen ahead of the early types of rotating screen and provides

- Higher screen capacities with less clogging.
- Stronger screen surface — longer maintenance free life.
- More efficient solids separation by creation of effective shearing action on wedge wire.

- Range of screen apertures from 0,25 mm upwards to cater for wide range of applications.

- Faster pay back periods from greater solids removal.

A new Zealand company has specialised in wedge-wire screening technology and has drawn on the experience gained in the relatively large red meat abattoir industry. With 62 million sheep and a human population of only 3 million, New Zealand probably has more abattoirs per head of population than any other country in the world. This technology is now available in South Africa and the larger model screens used in all applications are being

locally manufactured under licence to Contra-Shear, the New Zealand developers.

New developments in screening will pay excellent dividends in the form of reduced capital cost of further treatment, reduced Municipal sewage tariffs, increased recoverable material, protein, etc and reduced energy consumption and equipment maintenance down the line.

Enquiries: Autrex Industrial (Pty) Ltd,
PO Box 298, Durbanville 7550.
Tel: (021) 96-3073/4. Telex
57-26617 SA

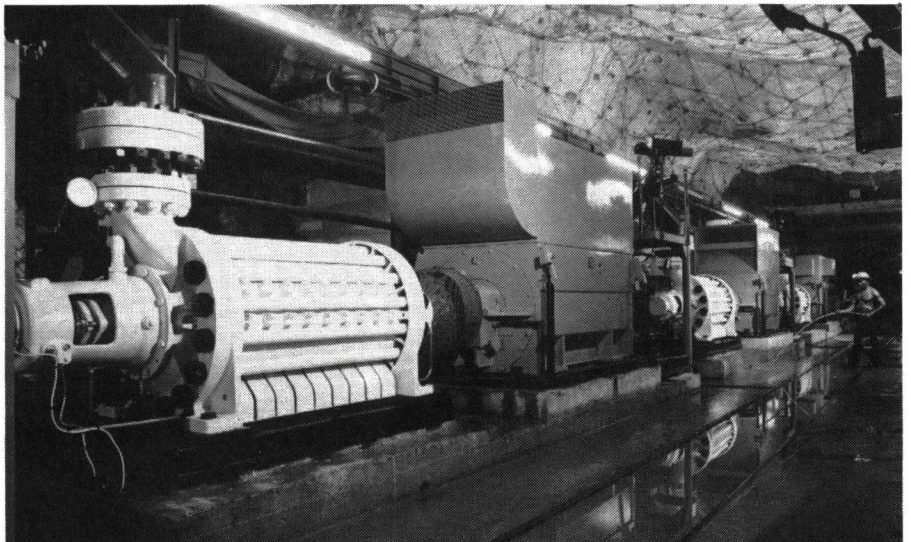
POWERFUL MINE DEWATERING PUMP DELIVERS 15 MILLION LITRES PER DAY

The Sulzer HPH 58-25 mine dewatering pumps seen here at JCI's Western Areas North Shaft, 41 Level, are each capable of pumping 15 million litres per day to the surface from 1,25 km underground.

At 3 450 kW, the motors for these 10 stage pumps are the most powerful dewatering pump drivers in South Africa.

Starting local manufacture over 30 years ago, Sulzer Brothers (South Africa) Limited of Johannesburg have supplied nearly 800 pumps of this range to the mining industry.

Enquiries: Sulzer Brothers (South Africa) Ltd, PO Box 930, Johannesburg 2000. Tel: 618-4125.



USE OF SOIL FOR TREATMENT AND FINAL DISPOSAL OF EFFLUENTS AND SLUDGE

is a pre-IAWPRC conference event which will take place in Salvador from 13-15 August 1986. The seminar programme will include sessions covering the many alternatives for soil disposal of liquid and solid wastes, emphasizing research and operation programmes developed or in development, in many parts of the world.

The main topics are:

- Alternatives for soil treatment and disposal of raw industrial effluents, such as from sugar alcohol production, wood processing, and others
- Advantages of land farming as a method of final disposal of sludge from biological treatment plants
- Land farming as a method for the degradation of oily and/or acid sludges from the petrochemical industry
- Alternatives for the utilization of biological sludge for agricultural purposes
- Studies and research for the determination of design parameters and area selection, to be used in the degradation of organic wastes
- Monitoring in areas where

organic wastes are applied to the soil

- Selection and sizing of equipment involved in the many methods of treatment and disposal of organic wastes in the soil

Enquiries: Mr AMP Silva, CETREL, Km 19 da BA. 536, Estrada de Camaçari, Monte Gordo Camacari, 0453 Salvador, Bahia, Brazil,

MARINE DISPOSAL OF WASTEWATER SEMINAR

takes place in Rio de Janeiro from 25-27 August 1986. The seminar is planned as being a very practical one with samples of programmes developed and being developed in all parts of the world which could have application in other countries. Principal topics will be:

- The advantages of marine disposal systems utilizing long outfalls and minimal pre-treatment
- The effects and/or non-effects of wastewater disposal on the near-shore marine ecology
- Parameters for wastewater disposal to provide protection to marine resources and public health
- Alternate pre-treatment systems for removal of floatables prior to marine discharge
- Pre-design oceanographic studies required for planning of marine disposal systems with demon-

stration of new techniques for conducting such studies and for analysis of data, including studies of ocean currents, seawater density structure, and bacterial disappearance

- Functional design of outfalls and diffuser systems with demonstration of the latest models for determining initial dilution and horizontal dispersion with full consideration of ocean currents and density structures
- Final design on submarine outfalls and demonstration of innovations in construction techniques using various pipeline materials for both surf zone and offshore construction zones including costs
- Post construction activities including verification of dilution estimates monitoring and outfall cleaning programmes.

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

CISTERN SYSTEMS

The third international conference on rain water cistern systems will be held in Khon Kaen, Thailand, from 14 to 16 January 1987.

The use of rain water cistern systems is increasing in both developed and developing countries. In developed countries, rain water use may supplement public water supplies which are inadequate to sustain urban growth. In rural areas, rain water collection may be the only alternative where groundwater is unfit for consumption.

In developing countries, rain water use is particularly suitable for the rural areas where the cost of piped water supplies would be economically prohibitive. In these areas, villages rely on rainwater in the rainy season, reverting to groundwater from deep or shallow wells in the dry season. The use of well water, however, may not be possible or advisable in areas where the high mineral content or bacteriological quality render it unfit for human consumption. Promotion of rain water cistern systems which provide adequate storage for year-round use may alleviate some of these problems.

The seminar will provide an opportunity to review, update, and ex-



**Third International Workshop
Durban, South Africa
27 April — 3 May 1986**

GAP is a small working group of international experts whose objective is to understand the process of photosynthesis, the factors that control it and to develop and improve methods for measuring it in aquatic ecosystems.

The theme of the Third International Workshop is *Respiration and its effects on the measurement of aquatic primary productivity*. The GAP Workshop will be a hands-on exercise where scientists from many disciplines and from around the world will be working side by side calibrating and comparing their techniques on sea water and clear and eutrophic impoundments.

Enquiries:

Final circular, registration form and preliminary programme are available from:

Dr Richard Roberts, Chairman, Organising Committee, c/o Symposium Secretariat S371, CSIR, PO Box 395, Pretoria 0001, Republic of South Africa.

Telephone: National (012) 86-9211 x 3979 (Maureen Ruane)
x 3580 (Richard Roberts)

International + 27 12 86-9211

change information on the latest developments made in rain water cistern systems. Some emphasis will be placed on the technology transfer of rain water cistern systems to the rural areas of developing countries.

Enquiries: Secretary Technical Committee, Third International, Conference on, Rain Water Cistern, Systems, Faculty of Engineering, Khon Kaen University, Khon Kaen (40002), THAILAND

THE USE OF MACROPHYTES IN WATER POLLUTION CONTROL

is the first of the post-IAWPRC conference seminars and will be held in São Paulo from 24-27 August 1986. Conventional methods of controlling river pollution are expensive and thereby impossible for use in less developed countries. For them, the use of macrophytes has proved to be an effective and cheaper way for purifying waters. The main objective of this seminar will be to identify practical ways in which the techniques that have been developed can contribute on a national and international level. The seminar will be divided into three major sessions and have a keynote speaker to introduce each one.

Session 1: Pollution Abatement Using Macrophytes

- Types of plants used for various purposes
- Mathematical models related to the use of macrophytes
- Use of macrophytes as the only treatment process as opposed to its use for effluent polishing
- Removal of trace pollutants, especially heavy metals and chlorinated hydrocarbons
- Growth rate of macrophytes — natural aquatic systems, water reservoirs, cropping systems.

Session 2: Problems and Advantages Related to the Biomass

- Production of excess biomass
- Final disposal of excess biomass, especially that containing hazardous pollutants

- Energy production from biomass.

Session 3: Soil Treatment Associated with the Use of Macrophytes

- Use of drained soils to filter water after treatment with macrophytes
- Conditioning of such soils to increase porosity and CEC
- Use of drained soils for agricultural purposes.

Enquiries: MR FM Wiendl, Seminar on the Use of Macrophytes in Water Pollution Control, CENA, Caixa Postal 96, 13400 Piracicaba, São Paulo, Brazil.

WATER TECHNOLOGY

A conference and exhibition on the Mediterranean region with emphasis on pollution control and North African water supply will be held in Monte Carlo, Monaco from 24 to 27 February 1986.

Enquiries: International Conferences & Exhibitions Ltd, 6 Porter Street, Baker Street, London W1M 1HZ, UK.

WATER MANAGEMENT

An international conference on water and wastewater management in Asia will be held from 27 February to 1 March 1986 at the World Trade Centre in Singapore.

Enquiries: The Conference Manager, Interfama Pty Ltd, PO Box 533, Marine Parade, Singapore 1544.

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 14 to 15 May 1986 in London, England.

Enquiries: Roy Harris, Flanchford, Bassetsbury Lane, High Wycomb 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.

WATER AND DEVELOPMENT

An international conference on water and development will be held in Marseille, France, from 9 to 11 June 1986.

Enquiries: Colloque International, L'eau, La ville et le Developpement, 52 Rue Madame, 75006 Paris, France.

AQUATIC PLANTS

A conference on research and applications of *aquatic plants for water treatment and resource recovery* will be held from 20 to 24 July, 1986 in Orlando, Florida, USA.

Enquiries: Dr Wayne H Smith, Chairman, Aquatic Plants Conference Steering Committee, University of Florida — IFAS, McCarthy Hall, Room G 040, Gainesville, FL 32611 USA.

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.

ORDER NOW!

AVOID THE FLOOD

The Scientific Services of the Department of Water Affairs announces the following list of published hydrological reports:

TR 89:

Some unsolved problems in river flow, by W.J.R. Alexander, 1979. 86 pages with figures. Price: R4,02.

TR 102:

Southern African storm rainfall, by P.T. Adamson, 1981. 45 pages & tabulated 1 to 7 day point rainfall frequencies at more than 2 000 stations. Price: R31,73.

TR 105:

Maximum flood peak discharges in South Africa, by Z. Kovács, 1980. 16 pages & figures, flood peak catalogue. Price: R2,90.

TR 116:

Documentation of the January 1981 floods in the South Western Cape, by Z. Kovács, 1983. 46 pages & 17 figures, 32 photo's, summary of rainfall and runoff at 85 sites, hydraulic principles. Price: R22,63.

TR 119:

South African National Hydrological Symposium — Proceedings, edited by H. Maaren, 1984. 32 papers on 405 pages. Price: R90,09.

TR 120:

Documentation of the March–May 1981 floods in the South Eastern Cape, by D.B. Du Plessis, 1985, 55 pages & figures, photo's, summary of rainfall and runoff at 53 sites. Price: R14,84.

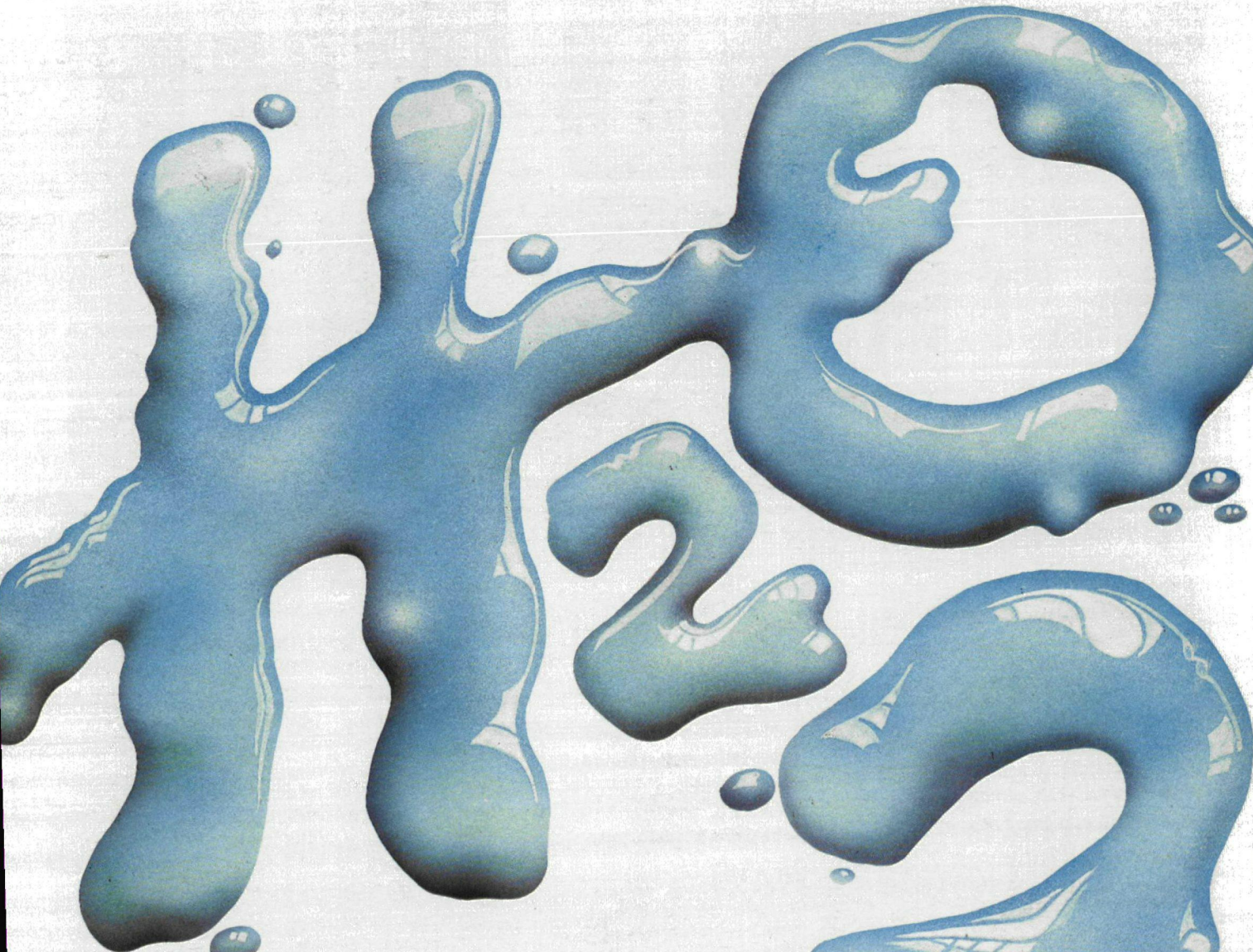
TR 122:

Documentation of the 1984 Domoina floods, by the Sub-directorate Flood Studies (Directorate Hydrology), 1985. 46 pages & figures, 55 photographs, summary of rainfall and runoff at 85 sites. Price: on enquiry.

The reports are obtainable at:
Department of Water Affairs
Manager: Scientific Services
Private Bag X313
0001 PRETORIA

Contact person:
Mrs. M. Blomerus,
Tel.: (012) 821021





KRY WATERINLIGTING GRATIS EN GOU KONTAK WATERLIT

Waterlit is 'n gerekenariseerde databasis met wêreldwye inligting oor water.

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En die aantal verwysings styg steeds.

'n Span indekseerders fynkam gereeld sowat 600 wetenskaplike en tegniese tydskrifte en voer elke maand oor 'n duisend nuwe verwysings na inligtingsbronne oor water in die databasis in.

Waterlit hou jou op die hoogte.

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