SA WATERBULLETIN

Nuusbrief van die Waternavorsingskommissie
Newsletter of the Water Research Commission

MEI/MAY 1984

"Results consistently favourable":

SLUDGE TO SEA — FINAL REPORT AVAILABLE

The final report on the Durban research project into the disposal of sludge to sea was recently accepted by the Water Research Commission and released for general circulation.

The results from the project were consistently favourable according to Mr John McGlashan, senior adviser of the Water Research Commission, and showed that there was no pollution of the beaches, no deleterious effect on the quality of the sea water or the quality and well-being of the marine fauna, and no bacteriological and chemical pollution at any of the measuring points along the coastline and at sea resulting from the submarine discharges.

Mr McGlashan said that the reintroduction of the sludge from the sedimentation tanks to the settled sewage dischargers to sea had not affected the exceptionally good dilution and dispersion characteristics of the two discharge systems and that sophisticated mathematical modelling of the behaviour and fate of the modified discharges under a variety of different ocean current conditions had indicated that the pipelines will adequately fulfil their design capability when design capacities were reached.

Mr McGlashan also stressed the importance of the research findings and said that they were of considerable value to all coastal cities in South Africa.

"In order to make these findings more readily available the Water Research Commission in association with a number of other agencies, will use these results from the Durban project to develop a guide for the marine disposal of wastes," Mr McGlashan said.

Sedimentation tanks at Durban Central Works pictured against a backdrop of the Indian Ocean.

HISTORICAL BACKGROUND

The Durban Corporation has been discharging settled sewage (i.e. raw sewage from which detritus, floatable material and the majority of settleable material (sludge) has been removed) to sea via submarine outfalls since 1968. The discharge occurs via two deep sea pipelines and is operated under a permit initially granted by the then Minister of Water Affairs.

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In compliance with the permit a continuous monitoring programme was carried out for the initial five year period of operation to identify any possible effects of the discharge on the beaches and in the marine environment. The permit has been reviewed every five years and as no deleterious effects have been established since the commissioning of the pipelines, the permit has been renewed on both occasions when it came up for review.

The localities of the two pipelines at the Central and Southern Waste Water Treatment Works respectively are shown in *Figure 1.* The dimensions of the two pipelines are given in *Table 1.*

A physical check of this system, together with examination of the pipelines over their entire length by means of divers, is carried out biennially, and a video tape record of the inspection is retained.

The design of the two outfalls was based on an intensive research programme undertaken by the South African Council for Scientific and Industrial Research (CSIR), the results of which were published by the CSIR in 1965.

EFFLUENT TREATMENT BEFORE DISCHARGE

In order to comply with the permit requirements conventional screening and degritting plant was installed at the heads of each works, followed by primary sedimentation (see *Figure 2A*). The settleable material removed from the sedimentation tank, generally referred to as *sewage sludge,* was incinerated in an oil-fired incinerator in the case of the Central Works, and anaerobically digested and mechanically dewatered in the case of the Southern Works. The resulting residue from both works was disposed of on land.

WRC RESEARCH PROJECT

In 1979 the Durban Corporation submitted a proposal to the Water Research Commission, to investigate the feasibility of discharging settled sewage to which sewage sludge had been reintroduced, (see *Figure 2B*) through the existing pipelines.

This proposal was prompted by the rising diesel fuel costs associated with the incineration of sludge at the Central Works, and by the Corporation's long-term interest in obtaining the greatest

TABLE 1

	Central Works Outfall	Southern Works Outfall
Length of outfall from shore	3,2 km	4,2 km
Main diameter	1,23 m	1,37 m
Length of diffuser section	422 m	422 m
Number of diffusers	18	34
Average depth of diffuser section	48 m to 53 m	54 m to 64 m

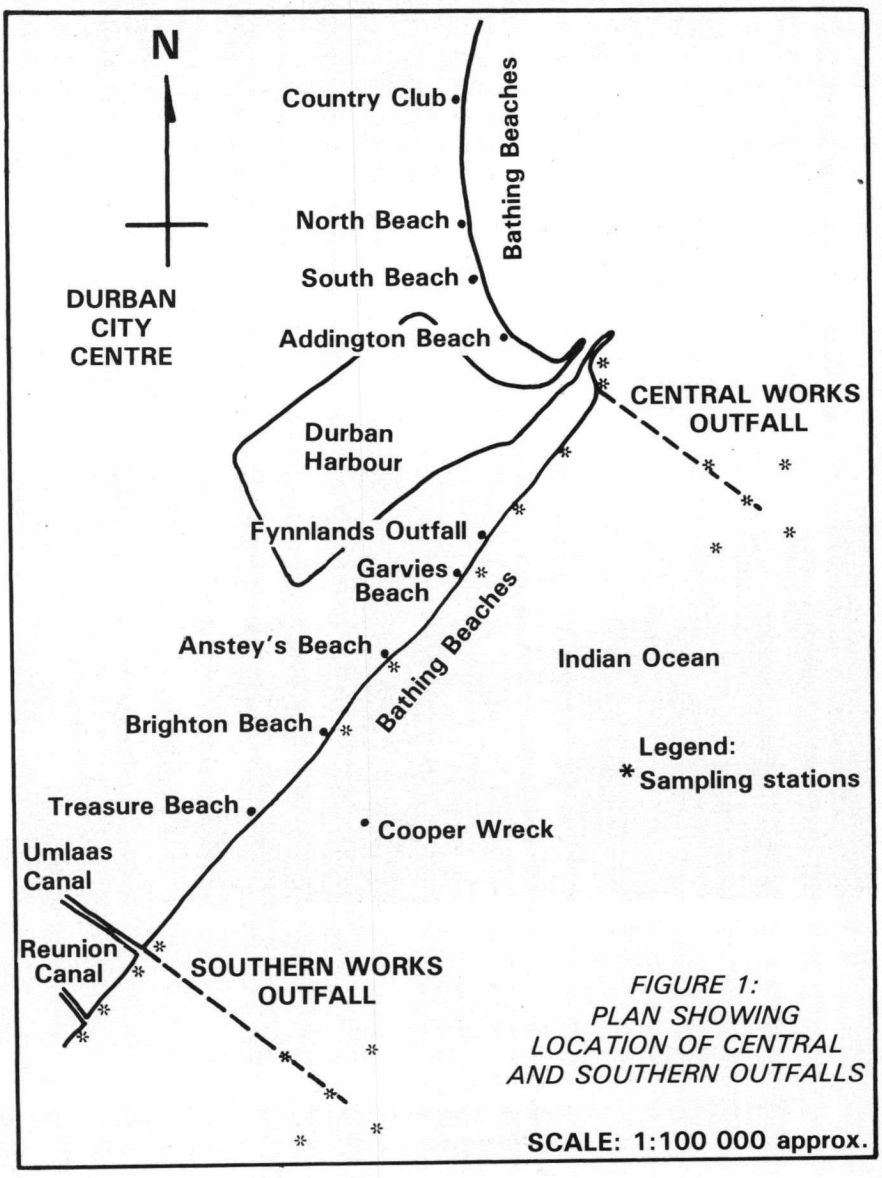

FIGURE 1: PLAN SHOWING LOCATION OF CENTRAL AND SOUTHERN OUTFALLS

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financial advantage from its two sea outfalls, particularly where this advantage could be passed on to industry.

The Water Research Commission in turn realised that the findings of such an investigation could be of importance to all coastal cities in South Africa. Design criteria for the sea discharge of buoyant liquids such as settled sewage were well established, in particular following the CSIR's work in Durban in the 1960's as well as in subsequent studies. It was uncertain however, whether these design criteria would apply with the re-introduction of the settelable sludge fraction to a settled sewage being discharged to sea.

In view of this consideration the Commission decided to co-fund such an investigation on a partnership basis with the Durban Corporation. The Corporation, in turn, subcontracted with the National Institute for Water Research (NIWR) to carry out the required monitoring programme, and later on with the National Research Institute for Oceanology (NRIO) to do supplementary studies on ocean currents in the area.

For the purposes of the investigation the Minister of Environment Affairs and Fisheries approved an amendment to the existing permit for the duration of the experiment which was not to exceed two years.

EXPERIMENTAL DESIGN

In order to study the effects of the modified discharge to sea on the marine environment and nearshore and inshore areas, a two year programme of research was designed.

Since extensive studies of a similar nature had been conducted prior to the construction of the pipelines in 1968 and 1969, and again after they had been com-

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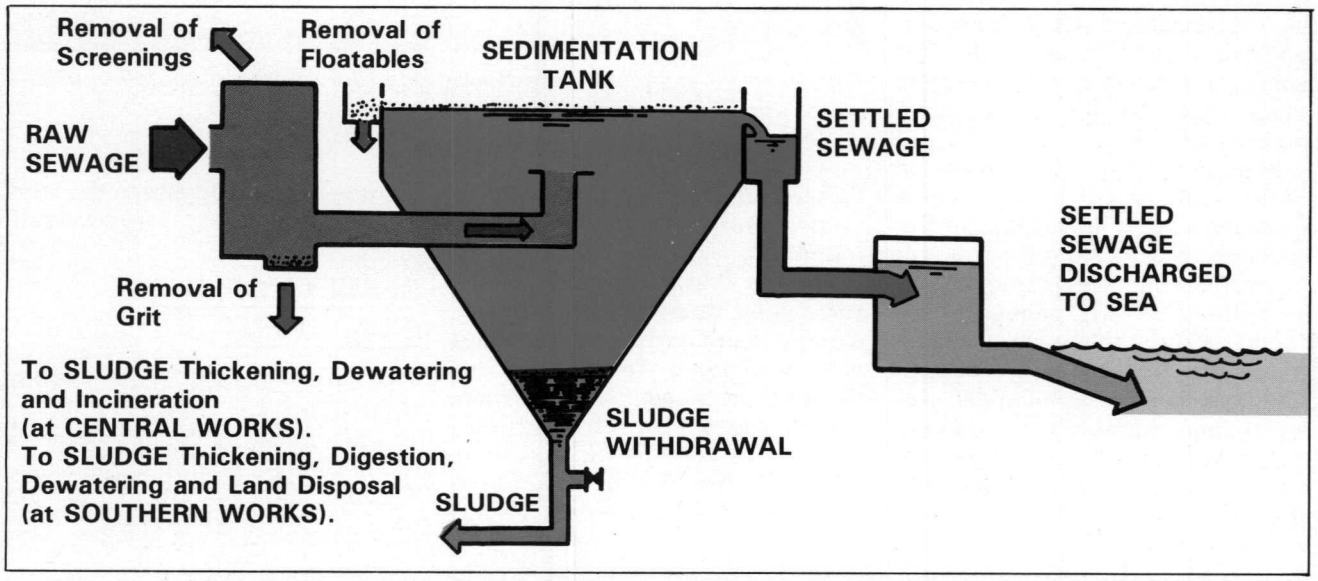

FIGURE 2A — Settled sewage and sludge disposal at Central and Southern Works prior to commencement of research project.

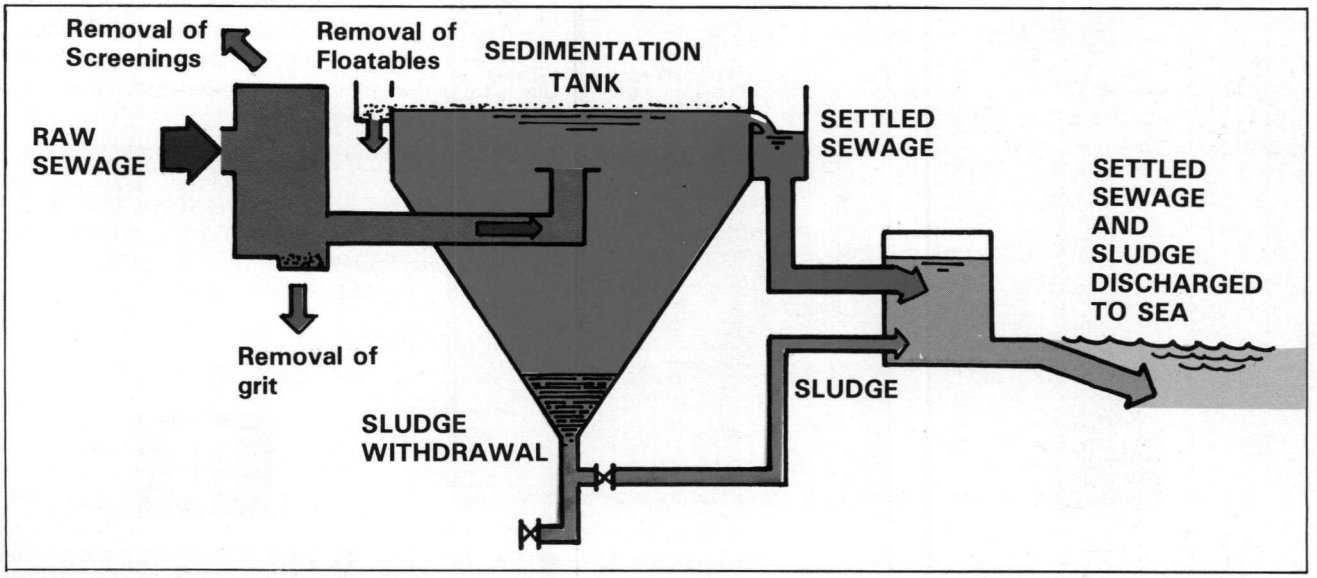

FIGURE 2B — Settled sewage and sludge disposal at Central and Southern Works during research project

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missioned, the new investigation was designed to be compatible with the previous work. Consequently, selected stations from the existing grid of sea and beach sampling stations were used. This involved five stations around the diffuser section of each pipeline, and eleven beach stations as shown in *Figure 1.* Due account was taken of possible current effects and provision was made to adjust or extend the grid accordingly. The results of the Durban Corporation's existing bacteriological survey of Durban's coastal waters were recorded for comparative purposes.

In order to ensure the protection of the public health and the marine environment, the research programme was designed to detect any deterioration in water quality or in the beach sands, seabed or sea fauna at the earliest possible opportunity. Consequently, regular and intensive bacteriological, biological and chemical monitoring of the beaches and the marine environment as well as the quality of the discharges was undertaken.

The research vessel Meiring Naudé *used for deep sea sampling of sea water and the ocean floor.*

Ocean currents in the vicinity of the submarine outfalls were also monitored.

For the first 12 months of the two year research programme, sludge mixed with settled sewage was discharged from the Central Works pipeline while the Southern Works pipeline discharged only settled sewage. The Southern Works pipeline therefore, acted as a control. During the last twelve months of the programme the roles of the two pipelines were reversed.

RESULTS OF THE EXPERIMENT

The detailed results appear in the final contract report entitled *"Detailed Report: Sludge Disposal to Sea"* (1983) and Appendices. The essential results of the two year study are as follows:

BASE-LINE DATA

The pre-experimental monitoring programme which had continued since commissioning of the pipelines in 1968 and 1969, provided the base-line data for the interpretation of observations during the experiment.

Bacteriological quality

The National Institute for Water Research's (NIWR) stringent and proven system of gradation of the bacteriological quality of water,

Mr G du Buisson of the city Engineer's Department, Durban (left) and Mr John McGlashan, senior adviser of the WRC, at the site where the 4,2 km long pipeline enters the sea.

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based on *Escherichia coli* counts, parasite units, staphylococci, salmonellas, shigellas and salinity, developed by Dr DJ Livingstone of the NIWR in Durban provided an objective method of classifying the sea water tested. The system established that the discharge from the outfalls was not polluting the beaches, and this picture was corroborated by the results from the ongoing routine monitoring by the Durban City Engineer's Department.

Bacteriological monitoring in the localities of the sea stations indicated a minor transient effect in the vicinity of the diffusers, but no permanent, widespread or accumulative effect. Marine bivalves and crayfish sampled from along the shore revealed no evidence of additional concentrations of pathogenic indicators.

Virological quality

From the virological investigations, it was concluded that the experimental discharge had no measurable virological impact on the waters and beaches of the target area.

Effect on benthic macrofauna

Benthic macrofauna counts consistently remained below the levels considered to be typical of enriched conditions, and the continued presence of a diverse and abundant benthic community indicated that no chronically toxic conditions occurred in the area during the research project.

Toxic metals

The following metals were monitored in the discharges, the sea, the sediments and in accumulator organisms: Mercury, Copper, Cadmium, Lead, Zinc, Chromium and Nickel.

Discharge of sludge, together with settled effluent, resulted in an average increase of approximately 50% and 65% respectively in the total metal concentration in the discharges to sea from the Central and Southern Outfalls. However, the maximum concentrations measured in these discharges at any time during the project remained well within the limits specified under the discharge permit.

Results for the sea and beach stations fluctuated widely, and no trends became evident. These fluctuations, as corroborated by previous monitoring, were not restricted to the site nor the research period. All results remained within acceptable limits at the conclusion of the experiment.

Chemical quality

Chemical monitoring of the beaches, sediments and sea water to detect changes in quality did not show deleterious effects with the re-introduction of sludge in the discharges. The results were con-

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Dr DJ Livingstone, project leader, on board the Meiring Naudé *preserving surface water samples for bacteriological, virological and other analyses.*

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sistent with normal background conditions, and there was no evidence of an accumulation of organic matter during the period.

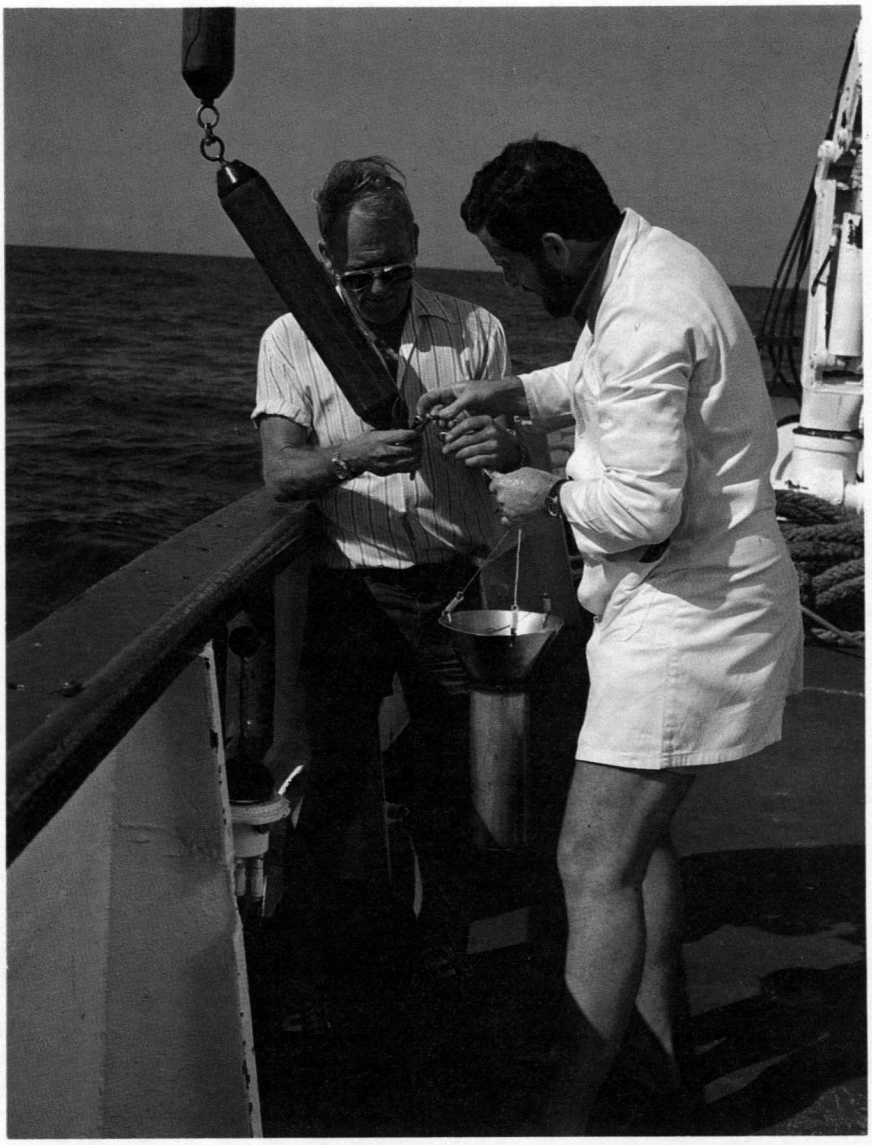
Chlorinated hydrocarbons

Chlorinated hydrocarbons refer to a group of synthetic organic compounds which include many pesticides. These compounds are toxic in very low concentrations and tend to build up in animal tissue.

In view of the proportions in which sludge and other effluents were mixed, at no time during the experiment did the levels of individual pesticides in the combined discharge exceed internationally acceptable limits.

The sea-bed sediments (with their associated organic content) and mussels, oysters, crayfish and soft coral were analyzed during the survey.

Sediments from around the ends of the pipelines were consistently unpolluted, as were all oysters and crayfish collected from nearer the shore. Mussels along the shore line contained dieldrin, DDT, DDE and TDE, the source of which was apparently the Reunion canal. The only pesticide possibly attributable to the discharges was dieldrin present in soft coral actually growing on the diffuser section of the Southern Works pipeline.



Dr Douglas Livingstone (left) and Mr Tim McClurg, both NIWR, preparing to take sediment samples from the ocean floor.

Toxicity testing

The toxicity tests have shown that the minimum dilution required to render the discharges harmless to very sensitive organisms was more than adequately achieved within the mixing zone over the outfall diffusers.

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DILUTION EFFECTS

Dispersion of wastewater in the sea is dependant on the density difference between the wastewater and receiving water, the depth at which the wastewater is discharged, the discharge rate, the design of the diffuser section and the speed and direction of the ocean currents.

Ocean currents

Analysis of current measurements confirmed that bottom currents are predominantly north-going, parallel to the shore, and that surface currents are predominantly orientated north-east/south-west parallel to the coast.

The existing outfalls were designed to ensure adequate dilutions and disperson of the settled sewage in the sea. The ''sludge'' content of the settled sewage (measured as settleable solids) amounts to about 2 ml/litre. Re-introduction of the sludge from the sedimentation tanks increases this figure to about 6 ml/litre. This increase in sludge content was not expected to affect the exceptionally good dilution and dispersion characteristics of the two discharge systems. This

hypothesis was tested not only by the monitoring programme, but also by simulations with mathematical models and laboratory tests.

A series of simulations with mathematical models to compare discharges with and without sludge, indicated no significant differences in the dilutions. Laboratory tests using materials over a range of densities to model the sludge content in the discharge confirmed that there was no separation of the sludge from the buoyant liquid which could influence the validity of the model simulations.

Vindicated

The dilution for the Central Works and Southern Works pipelines were also recalculated using a series of mathematical models developed by Dr PJW Roberts from the USA, extending the original work on which the design calculations were based. Modelling of the dilution and dispersion of the discharges under a variety of actual current conditions has fully vindicated the original pipeline calculations.

TABLE 2

	Central Works	Southern Works
Average rate of discharge of settled sewage	68 240 m^3/day	128 500 m^3/day
Average rate of discharge of sludge	1 720 m^3/day	2 900 m^3/day
Average total discharge rate	69 960 m^3/day	131 400 m^3/day
Design capacity	135 000 m^3/day	230 000 m^3/day
Average sludge solids concentration	0,64%	0,64%

DISCHARGE RATES

Design capacities of the Central and Southern Works pipelines are 135 000 m^3/d and 230 000 m^3/d, and the average discharge rates during the research period were 70 000 m^3/d and 132 000 m^3/d respectively. The Central Works pipeline was therefore discharging at about 50% of full capacity and the Southern Works pipeline at about 60%.

The relevant flow data of the two pipelines are presented in *Table 2.*

Dilutions achieved during the experimental discharges were much more favourable than the dilution adopted for the design of the pipelines. All indications are that when the design capacities of the pipelines are reached, dilutions achieved under the most adverse conditions will better the design dilutions at the beaches. Continued monitoring of the effects of the discharges at the beaches and in the sea, as has been the case since the commissioning of the outfalls, should ensure compliance with the design standards.

Copies of this final report on the disposal of sludge to sea are available on request from the Chairman, Water Research Commission, PO Box 824, Pretoria 0001.

A close-up view of the sedimentation tanks showing the discharge of settled sewage and the removal of floatables prior to the discharge to sea.

Hydrology:

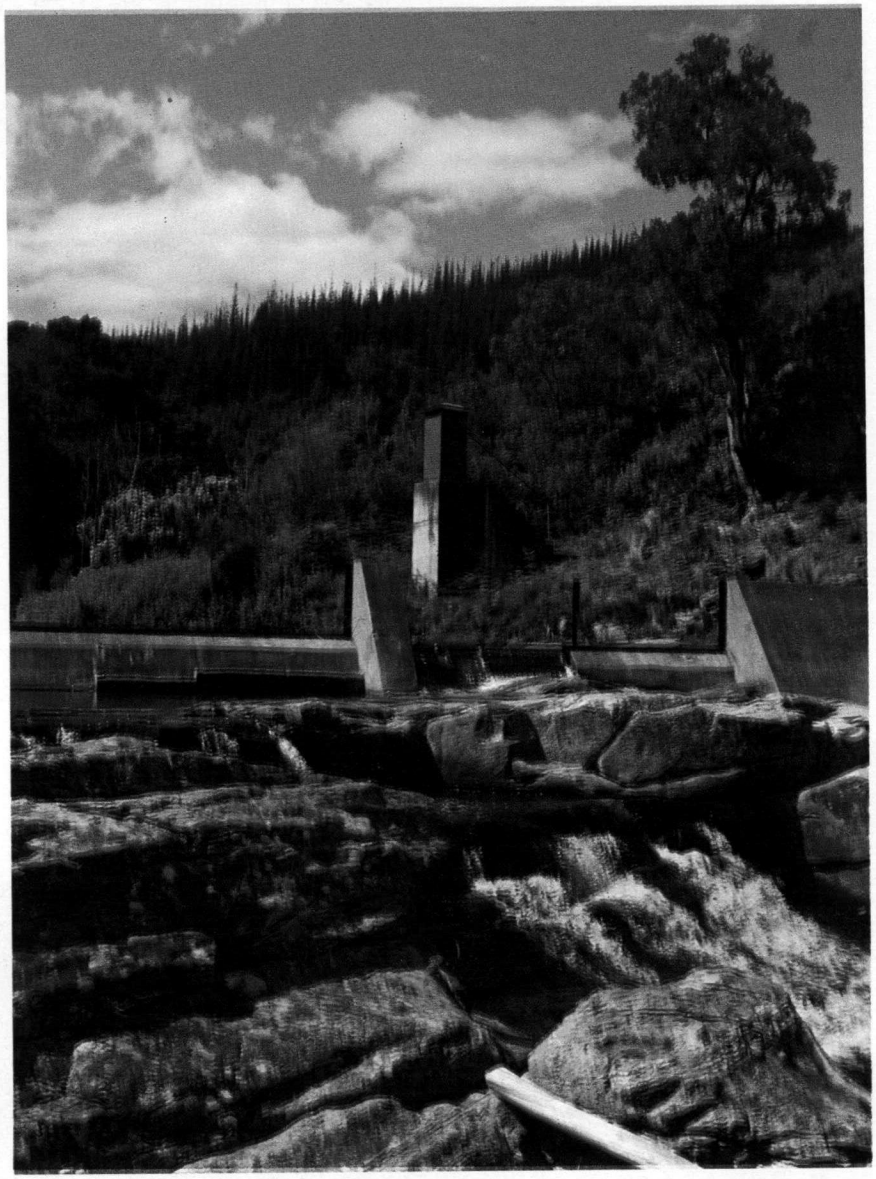
Ecca and Wilderness reports released

The final report on the Water Research Commission's hydrological research project in the Ecca and Wilderness catchments has recently been released for general distribution on request by the Commission.

The research was carried out by the Hydrological Research Unit (HRU) of the Geography Department of Rhodes University and the primary emphasis was on the development and testing of lumped parameter conceptual rainfall/runoff models in semi-arid and subhumid catchments. Particular attention was also paid to parameter transfer.

According to Mr DWH Cousens, senior adviser of the Water Research Commission, the results from the research suggested that for the adequate calibration in semi-arid catchments of both the montly-input and daily-input models chosen for testing a calibration period length well in excess of ten years was required. Vast improvements in the ability of these models to accurately reproduce long-term characteristics of stream flow can be effected by expanding a calibration sample from, say, a seven-year record to a fifteen-year record.

The results also indicated that increased complexity of model input requirements did not necessarily lead to improved accuracy of estimation of monthly or daily flow totals. However, some evidence was found of a correspondence between superiority of model performance and higher structural complexity of the models in the hourly and daily input categories. A minimum level of model complexity was indicated for the generation of daily and monthly flow series of acceptable accuracy.



A weir in the Wilderness catchment.

Furthermore, no evidence was found that either increased structural or more complex input requirements of the chosen models corresponded with superior transferability of parameter values for use in ungauged situations. According to Mr Cousens this suggests that, although these models may be suitable for certain purposes such as record extension and patching, they would probably not be suitable for prediction purposes or for the generation of records in an entirely ungauged environment. He indicated that the results suggested that research into model development must take more cognisance of physical processes and models of a more causative nature must be developed. This may mean a step away from the simpler, lumped type models tested in this research to distributed type models where the natural physical laws can be more adequately catered for.

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Conceptual modelling emerged, however, as an approach that was viable for semi-arid water resources studies but which required careful and, often subtle, *a priori* decision-making with respect to a number of factors.

The most important among the factors were the choice of calibration sample and parameter estimation procedure, the time resolution of model output required by the application in mind which in turn dictated the time resolution of input data, the highest level of model complexity that can be accommodated and, last but not least, the desired level of accuracy of the generated flow series.

Copies of the final report are available on request from the Hydrological Research Unit, Department of Geography, Rhodes University, PO Box 94, Grahamstown 6140.

Surface water:

GUIDE TO SURVEY

A Guide to the Survey "Surface Water Resources of South Africa" has been published by the Hydrological Research Unit of the University of the Witwatersrand under the leadership of Professor DC Midgley. The project was financed by the Water Research Commission.

The prime objective of the Guide is to help its readers to avoid pitfalls that have already been encountered by users of the Survey. Both publications provide extensive information on and alternative ways of solving water resources problems.

The Survey, which was published in 1981, provides a means to reach decisions on the basis of inadequate hydro-meteorological measurements as well as information for performing sensitivity analyses. It also developed means to determine the degree to which available water resources could be safely exploited and provided data for and demonstrated the methods of handling many of these and similar problems in the field of water resources.

GUIDE TO CHEMICAL CHARACTERISATION OF SLUDGE

A new publication *Guide K62: A laboratory manual for the determination of inorganic chemical contaminants and nutrients in sewage sludges* has just been published by the National Institute for Water Research of the CSIR.

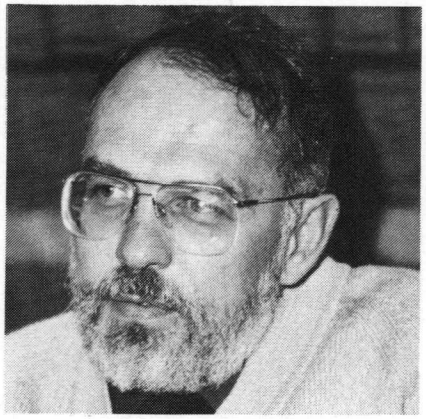
The manual, which deals with the chemical characterization of sludges was prepared by Mr R Smith of the NIWR under the auspices of the Water Research Commission Steering Committee for Sludge Characterization.

In the foreword to the manual Dr GG Cillié, Chief Director of the NIWR, says that the chemical characterization of sludges is of particular importance when sludges are to be disposed of on land.

"It has previously been established that the heavy metal content in particular may seriously prejudice a sludge's use as a soil conditioner and many overseas countries have already imposed strict limitations on heavy metal loading. It is therefore important to ensure that chemical analyses of sludges are standardized satisfactorily and that reliable methodology is used.

"An examination of the methods available for sewage sludge analysis showed that a wide variety of techniques are being employed not only for the actual analysis of the sludge sample but also for its collection, preparation, and pretreatment prior to analysis. This manual is an attempt to bring together, in one publication, the methods considered to be the most suitable for the determination of the most important constituents of sewage sludge. The methods have been selected as being the most suitable in terms of safety, speed and simplicity, and are based on well-known and well-tried analytical techniques. Most of the laboratories in South Africa involved in the analysis of sewage sludge will be equipped with the instrumentation necessary for the implementation of most, if not all, of the analytical methods described."

Copies of the manual can be obtained from the Librarian, National Institute for Water Research, Council for Scientific an Industrial Research, PO Box 395, Pretoria 0001.



TOERIEN LEI NIWN

Prof Daan Toerien, tans direkteur van die Instituut vir Omgewingswetenskappe van die UOVS, is onlangs benoem as die opvolger van dr GG Cillié as Hoofdirekteur van die Nasionale Instituut vir Waternavorsing van die WNNR.

Prof Toerien het sy opleiding aan die Universiteit van Pretoria ontvang waar hy in 1969 die D Sc (Agric) verwerf het, en het ook aan die Universiteit van Kalifornië in die VSA as na-doktorale genoot gewerk.

Hy was onder meer lektor in Mikrobiologie aan die Universiteit van Pretoria, vanaf 1966 tot 1976 aan die NIWN verbonde en het in laasgenoemde jaar die pos by die UOVS aanvaar.

Sy voorganger by die Instituut, dr GG Cillié, het 'n huishoudelike naam onder waterwetenskaplikes geword vandat hy as direkteur van die NIWN in 1972 by dr Gerrie Stander die leisels oorgeneem het. In 1983 het hy ook Hoofdirekteur van die NIWN geword.

SA Waterbulletin wens graag vir prof Toerien 'n vrugbare tydperk in sy nuwe amp toe, en ons beste wense vergesel ook vir dr Cillié in die jare wat voorlê.

"Ons moet die geduldige en oorontwikkelde Vaalrivier se lot verlig deur ander gewillige riviere in Suid-Afrika se groot potensiaal aan te wend," het mnr Sarel Hayward, Minister van Omgewingsake en Visserye, onlangs gesê toe hy 'n simposium in Pretoria oor watervoorsiening vir die Vaalrivieropvanggebied en die ekonomiese implikasies van waterkwaliteit geopen het.

Die eendaagse simposium waar die toekoms van die Vaal, Suid-Afrika se hardwerkendste rivier, indringend bespreek is, is deur die Vereniging vir die Vaalrivieropvanggebied gereël en deur talle vooraanstaandes in die waterveld bygewoon.

Minister Hayward het in sy toespraak gesê dat die las wat die Vaalrivier dra, verlig kan word met doelgerigte pogings om water- en arbeidsintensiewe ontwikkeling vanaf die PWVS-gebied weg te kanaliseer na ander streke soos die Tugela-bekken, die Oos-Kaap en Bloemfontein "waar nie alleen water beskikbaar is nie maar ook pendelarbeid."

MINISTER: VERLIG VAALRIVIER SE LOT

'n Blik op die Vaalrivier met die Barrage in die agtergrond.

Professor EJ Marais, voorsitter van die Wetenskapkomitee van die Presidentsraad het die demografiese tendense in Suid-Afrika en die invloed daarvan op die land se waterbehoeftes bespreek en gesê dat om die oorheersende demografiese doelwit soos bepaal deur die Wetenskapkomitee te bereik, naamlik dat die Suid-Afrikaanse bevolking moet stabiliseer op 70- of 80-miljoen teen die einde van die volgende eeu, beplanners nie kan bekostig om verkeerde aannames te maak nie. Ekonome, landboukundiges en waterverbruikdeskundiges het 'n ontsaglike verantwoordelikheid om politieke, kulturele en gemeenskapskapsleiers ingelig te hou aangaande die impak van onbeheerde bevolkingsgroei op die lewensbelangrike bronne van die land, aldus professor Marais.

Professor Marais het gesê dat op grond van die huidige tegnologie die Wetenskapkomitee van die Presidentsraad bevind het dat

- water die vernaamste beperkende faktor is wat Suid-Afrika se ontwikkelingpotensiaal betref. Op grond van die beskikbare tegnologie kan Suid-Afrika 'n maksimum van 60- tot 70-miljoen mense dra; en
- daar sal 'n tekort aan water in verskillende streke van die land ontstaan lank voordat die 70-miljoen bevolkingskerf bereik word.

Heynike

Mnr JJC Heynike, spesialiskonsultant van die Waternavorsingskommissie, het in sy referaat getiteld *Domestic Water in the PWVS-Complex: It usage and economic impact with increasing mineralization of the Vaal River Barrage Water* gesê dat die

toenemende skadelike soutinhoud van die Vaalrivier se water verbruikers in die PWVS-gebied nog baie geld uit die sak gaan jaag. Mnr Heynike het met 'n aantal berekenings getoon dat indien die waterkwaliteit van die Vaal van 300 na 800 mg/ℓ opgeloste soute sou verswak dit Blanke huishoudings in die PWVS-gebied, bereken teen 1980/81 pryse, ongeveer R80 per jaar ekstra sal kos weens skade aan loodgieterstoerusting, wasmasjiene, skottelgoedwasmasjiene, ketels, verswakking van klerasie en wasbare materiaal en ekstra seep en wasmiddels as gevolg van harde water. Die ooreenstemmende syfer vir Nieblanke huishoudings is volgens mnr Heynike nagenoeg R29 per huishouding per jaar. Gebaseer op die huidige verbruikersindeks beloop hierdie bedrae reeds nagenoeg R102 vir Blankes en R37 vir Nieblankes per jaar. Dit gee 'n totale bedrag van nagenoeg R76 miljoen per jaar, bereken teen huidige pryse, wat verbruikers ekstra sal moet betaal indien die skadelike soute in die Vaalrivierwater na 800 mg/ℓ sou styg, aldus mnr Heynike.

Randwaterraad

Mnr SW van der Merwe van die Randwaterraad het die gehalte van die water wat deur die Randwaterraad gelewer word, bespreek en gesê hoewel water van 'n goeie gehalte voorsien word, word probleme ondervind met piekwaardes ten opsigte van troebelheid, yster, geleivermoë, hardheid en sulfate. Hoë konsentrasies organiese stowwe, 'n hoë chlooraanvraag en bakteriologiese nagroei word ook ondervind, maar die Randwaterraad spandeer tans miljoene rande, om hierdie probleme te oorkom.

Besproeiing

Met verwysing na die ekonomiese implikasies van waterkwaliteit vir besproeiingswater het mnr HM du Plessis, assistent-direkteur by die Navorsingsinstituut vir Grond en Besproeiing, Departement Landbou, gesê dat wanneer besproeiingsboere gekonfronteer word met 'n toenemende soutinhoud van hul besproeiingswater daar verskeie maatreëls is wat hulle kan tref om die negatiewe ekonomiese implikasies teen te werk.

Sulke aanpassings moet egter, volgens mnr Du Plessis, in 'n globale benadering beskou word aangesien aanpassings in een gebied noodwendig ook 'n uitwerking op verwante gebiede het.

Die aanpassings wat mnr Du Plessis bespreek het, was die volgende:

- **Die gewaskeuse kan verander word sodat gewasse wat meer soutbestand is verbou word.**

  In die praktyk moet egter rekening gehou word daarmee dat die meer soutbestande gewasse oor die algemeen 'n laer inkomste lewer as die meer sout gevoeliges. Verder ontstaan daar meestal 'n infrastruktuur en kundigheid rondom 'n bepaalde gewaskombinasie (bv inmaakfabriek, wynkelder, suikermeule, graansuiers, tabakdroogoonde, bevroregroentefabriek ens). Hierdie fasiliteite kan dikwels nie deur 'n ander gewaskombinasie benut word nie en word dus 'n finansiële verlies. Die oorskakeling na 'n ander gewaskombinasie in 'n groot besproeiingskema kan ook die hele vraag-en-aanbodbalans wat in die land geheers het, versteur wat weer ekonomiese implikasies vir ander produsente inhou.

- **Meer loging** (deur die toediening van groter hoeveelhede besproeiingswater) kan toegepas word in 'n poging om die soutinhoud van die grond op dieselfde vlak as met 'n laer soutinhoud water te handhaaf en sodoende opbrengs op 'n konstante peil te hou. Die groter hoeveelhede besproeiingswater kan verkry word deur 'n kleiner totale oppervlakte te besproei of 'n groter hoeveelheid water vir besproeiing te bekom; beide waarvan negatiewe ekonomiese implikasies het. 'n Verdere potensiële probleem met groter loging is die gevaar van die opbou van 'n watertafel wat die installering van ondergrondse dreinering sal noodsaak, het mnr Du Plessis gesê.

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Industry's role in water management

"For many years South Africa has been a world leader in producing technical solutions to water management problems. What is now needed is a more effective systems approach to apply these techniques in an equitable and effective way." This was said by Mr AG Hammond-Tooke, Director of Economic Affairs of the SA Federated Chamber of Industries, when he spoke on *Industrialisation and the long-term water situation in South Africa* at the recent symposium in Pretoria on Water Supply for the Vaal River catchment Area.

Mr Tooke suggested the following set of principles to build a more equitable and rational self-policing system for water conservation and pollution control in South Africa:

- *The price must be right. Water tariffs* in South Africa should be completely revised to reflect (a) the underlying scarcity of water and (b) the escalating cost of bringing additional supplies to utilisation points. "It is an established principle in South Africa that the rationing of scarce resources should be done by price rather than by quota. Water tariffs should be brought in line with this principle. This would ensure that everyone uses water as economically as possible. It would also ensure that areas which have more abundant water, will have a lower tariff structure and can use this as a natural way of attracting industry."
- *There should be a graduated tax on all effluent discharged by all users.* This tax should be based on the pollution loads (and not on the degree of concentration of the effluent). "In this regard South Africa might well look to

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Industry

(From page 11)

the German Water Levy Act. In terms of the Act discharges pay a levy to the State depending on the number of "harmfulness units" ("Schade Imheiten") present in their annual dicharge. AFH Zunckel in a publication "Current Trends in South Africa Regarding Effluent Discharges legislation", Department of Water Affairs, has said that "the progressively increased levy not only provides an economic incentive to improve but also facilitates long term planning by dischargers."

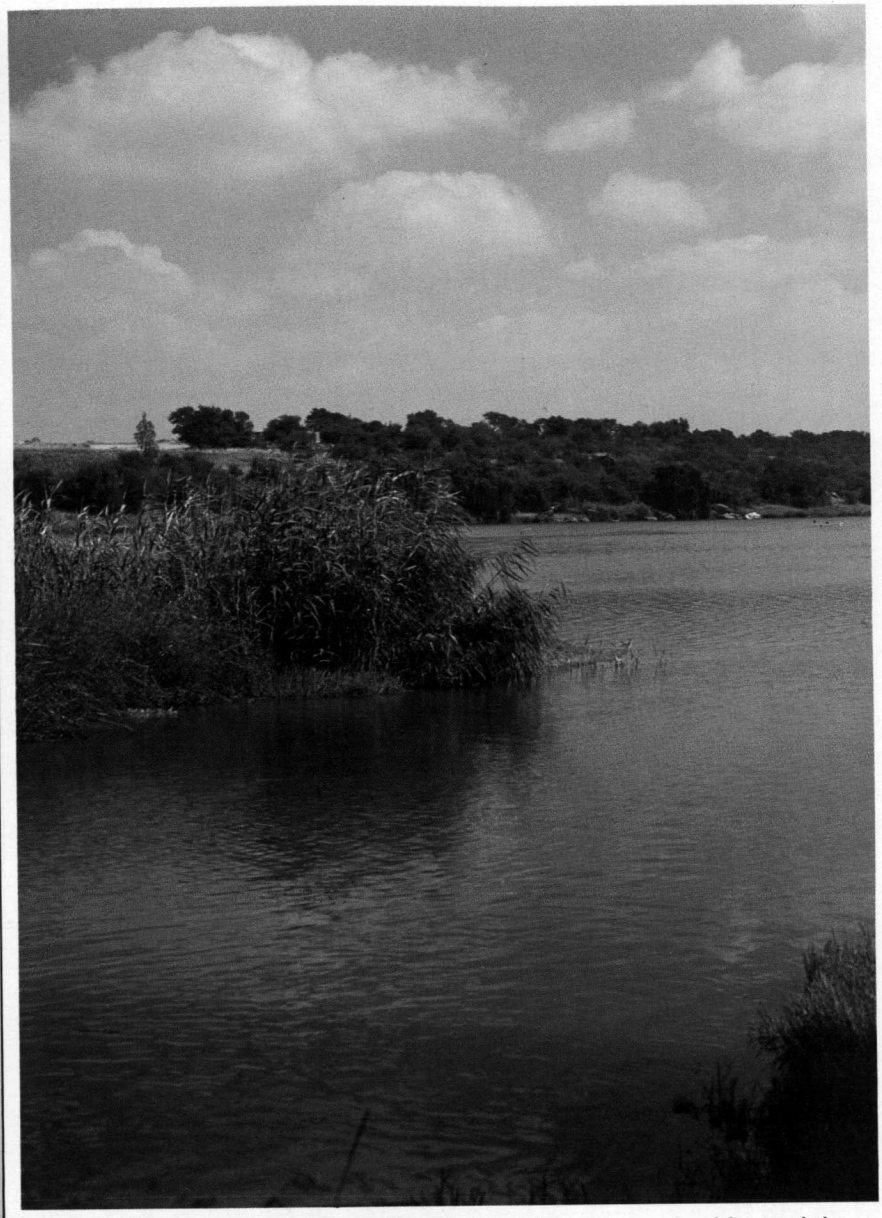
- The tax on effluent should be used to finance *tax rebates* (a) for the cleaning of polluted water, and (b) for exporting the concentrated brines/purges and solids out of the water system.

"The polluter-pays-principle must be seen as a two way street. Thus those companies making an investment in pollution control are acting in the social interests. Accordingly I would recommend a two hundred per cent tax deduction for capital investment in pollution control equipment approved by the Directorate of Water Affairs.

"The problem in the past has always been that once effluents have been concentrated they have been returned to the water supply; that is, in all cases except where they are extremely toxic. At present cost levels it simply does not pay the company under normal conditions to concentrate its effluent further to create a brine which can be transported out of the system and say discharged harmlessly into the sea.

"What I have in mind is a subsidy on transport costs and perhaps energy costs in order to make it attractive for companies to undertake the additional social cost of evacuating these minerals from the "system."

- All users of water and especially industrial, mining and agricultural users should be advised on the *best practicable means* for water conservation and effluent disposal. "This is an important principle in the Air Pollution Control Act which needs to be incorporated into the Water Act in South Africa. The Water Research Commission has already done major work analysing a number of industries to establish what Dr Oliver Hart, senior adviser of the Water Research Commission, has described in a publication called "A Strategy for Optimising Water and Effluent Management by Industry", (Water Research Commission, 1984) as the "best economic techniques". It appears imperative that this work should be encouraged with co-operation between public and private sectors."



Die Vaalrivier naby Vereeniging.

Besproeiing

(Van bladsy 11)

- **Hoë frekwensie besproeiing kan toegepas word.** Onder hoë frekwensie besproeiing word die grond nie toegelaat om baie uit te droog nie, wat die groei-onderdrukkende effek van soute in die grond teenwerk en help om steeds hoë opbrengste te verkry selfs wanneer hoër soutinhoud water gebruik word. Die implikasies van hierdie aanpas-

sing is dat sulke stelsels dikwels duurder is as die bestaande stelsels, hoër bestuursvernuf vereis en 'n waterbron vereis waaruit water op aanvraag onttrek kan word.

Dr LRJ van Vuuren, direkteur van die Nasionale Waternavorsingsinstituut by die WNNR, het in sy referaat oor die moontlikheid en beperkings van die hergebruik van water gesê dat in die PWVS-gebied die direkte hergebruik van water hoë prioriteit moet geniet vanweë die toenemende verswakking van waterkwaliteit in die omliggende opvanggebiede.

Minister SAS Hayward (derde van regs) afgeneem tydens die Vaalrivier-simposium in Pretoria. Saam met hom verskyn van l na r: Prof EJ Marais, voorsitter van die Wetenskapskomitee van die Presidentsraad; mnr J Heynike (konsultant, WNK); dr GJ Stander (voormalige voorsitter van die WNK); prof DC Midgley (konsultingenieur): mnr Hayward; dr FA van Duuren (voorsitter van die Vereniging vir die Vaalrivieropvanggebied); mnr G Botha (direkteur, NIWN).

Voordeel

Dr van Vuuren het gesê direkte hergebruik van water is 'n metode om besoedeling by sy oorsprong te bekamp. 'n Voordeel daarvan is dat dit beskikbaar is op die perseel van potensiële herverbruikers soos nywerhede en kragsentrales, asook vir besproeiing en huishoudelike doeleindes. Die grootste potensiële toepassing van direkte hergebruik lê egter by die kusgebiede waar goeie kwaliteit uitvloeisels na die see verlore gaan, aldus dr Van Vuuren.

FEMALE CHAIRMAN FOR IWPC

Mrs Susan van Biljon, Senior Chemist with the Germiston Municipal Laboratory, is the first woman to be elected Chairman of the South African branch of the Institute of Water Pollution Control.

Since passing the Institute's Diploma examination with outstanding success, Mrs van Biljon was examination secretary for the branch from 1969 and was Vice-Chairman in 1983 before becoming the current Chairman. She also manages to find the time to assist the Treasurer and is Chairman of the Education and Development Standing Committee.

Her career started as a chemist with the Johannesburg Municipal Laboratories after graduating from the University of the Witwatersrand with a B Sc degree and a teaching diploma. Her major subjects were Physics and Chemistry.

Mrs van Biljon joined the Germiston Municipal Laboratory after the death of her husband and is now as Senior Chemist mainly concerned with Industrial Effluent Control.

Her interesting career includes a period of teaching as well as a diploma in Drama from the University of Cape Town.

Mrs S van Biljon.

River Pollution condemned

Europe Environment reports that the International Water Tribunal (IWT) judged some 20 cases of pollution involving some 50 EEC companies in Rotterdam last year. They were charged with polluting several European rivers. Three giants of EEC metallurgy were accused of poisoning the atmosphere and rivers with industrial waste such as cadmium, lead, arsenic, copper and zinc.

At another meeting in Rotterdam representatives of relevant water companies were concerned about the threat that the nuclear power stations of Chooz, in France, and of Tihange, in Belgium hold for the quality of drinking water supplied from the river Meuse. *Europe Environment* says according to water distribution companies 5 million people are dependant on the river Meuse for their water, and they fear that the maximum tritium content fixed by the Water Health Council, 5000 PCI per litre per year, could be exceeded.

Water Savings:

LEAKS: STEP TEST TESTED

A water loss control exercise recently carried out in Pretoria showed that a waste flow determination was an effective method for establishing leaks in water distribution networks.

The water loss tests which were done in the Pretoria suburb of Queenswood by the Water Research Commission in collaboration with the NBRI and the City Council of Pretoria formed part of the WRC's sponsored research into the latest "state-of-the-art" electronic equipment designed to pin-point the position of the leaks in underground pressurised systems. (See special April issue of *SA Waterbulletin* on Leak Detection.)

The following report on the field work was received from Mr Charles Chapman, senior adviser of the Water Research Commission, responsible for leak detection research.

Mr Charles Chapman, senior adviser WRC, observing the TOA strip chart recorder during the early morning exercise.

The scheme

The proposed water loss control exercise involved the isolating of a number of properties from the water distribution network by means of boundary valves and then determining the minimum night flow (MNF) for the area.

Thereafter a step-test would be undertaken to identify sections of pipe line where leaks could exist. These sections would then be surveyed using a leak noise correlator (LNC) and the leaks repaired. After repeating the above procedure two or possibly three times, a practically achievable minimum flow rate would be established for the area. Future checks on the area would use this figure as a reference.

The area

The arbitrarily chosen area involved 3,02 km of distribution pipe network serving 150 houses in the purely residential suburb of Queenswood in Pretoria. The area is shown in *Figure 1.*

The equipment

The equipment used comprised the following:

Quadrina QXL 25J waste flow meter
Quadrina QS 11/HS recorder with instantaneous flow rate display
TOA strip chart recorder coupled to the QS 11 HS recorder
Bristol 24 hour recording pressure gauge
6 × 30 m fire hoses and couplings
Control manifold incorporating a control stop valve and pressure gauges
Hydrant key

The Modus Operandi

The original plan was to operate in the field for eight nights from midnight until approximately 05h00 from Sunday, March 18th, to Monday morning, March 26th.

Due to equipment failure on the first night, however, the exercise only got underway on Sunday, April 1st and continued intermittently until Wednesday, April 11th

To determine the MNF, the boundary valves B1 — B7 (refer *Figure 1*) were closed and water was diverted into the area from hydrant H1, through fire hoses to the waste flow meter and control manifold, and into hydrant H2.

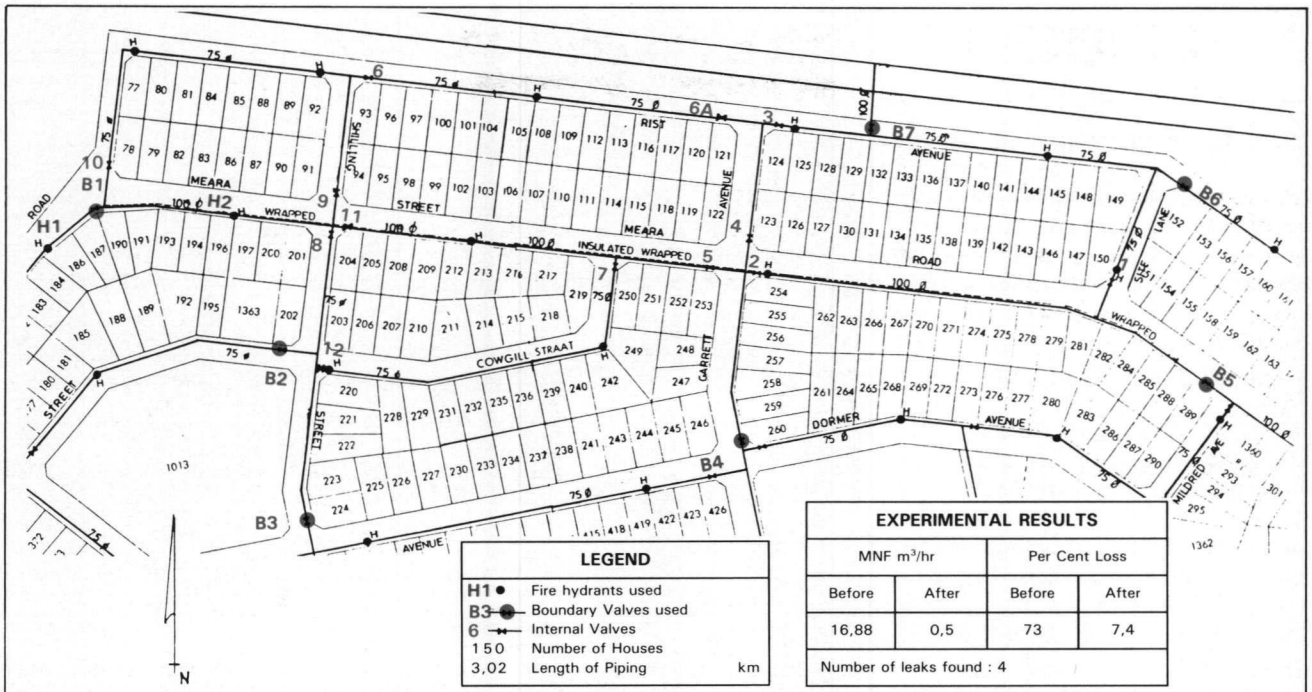


Figure 1. The area used for the Water Loss Control experiment in Queenswood, Pretoria.

Field experience

On the first attempt on the night of March 18/19th, the turbine waste flow meter failed due to ballbearing collapse. This postponed the exercise until April 1/2nd when a replacement meter was obtained. On this occasion the MNF was established at a flow rate of 16,88 m^3/h steady.

On Wednesday night April 4/5th a step test was carried out and a major step in the recorder was noticed when Valve 6 was closed, indicating a major leak of around 14 m^3/h between valve 6 and valve 4. Other lesser steps were observed between valves 12 and 7 in Cowgill Avenue and in Meara Road between Shilling Street and Garret Avenue (valves 11 and 5). Because of the huge influence of the first leak, it was decided to first locate and repair this leak only. This was done using the LNC on Thursday, April 5th, when a complete break in a 75 mm ϕA.C pipe was found in Garret Avenue. The escaping water was flowing directly into a large box-culvert storm water drain with the main inflow through the joint between the floor and wall.

On Thursday night, April 5/6th

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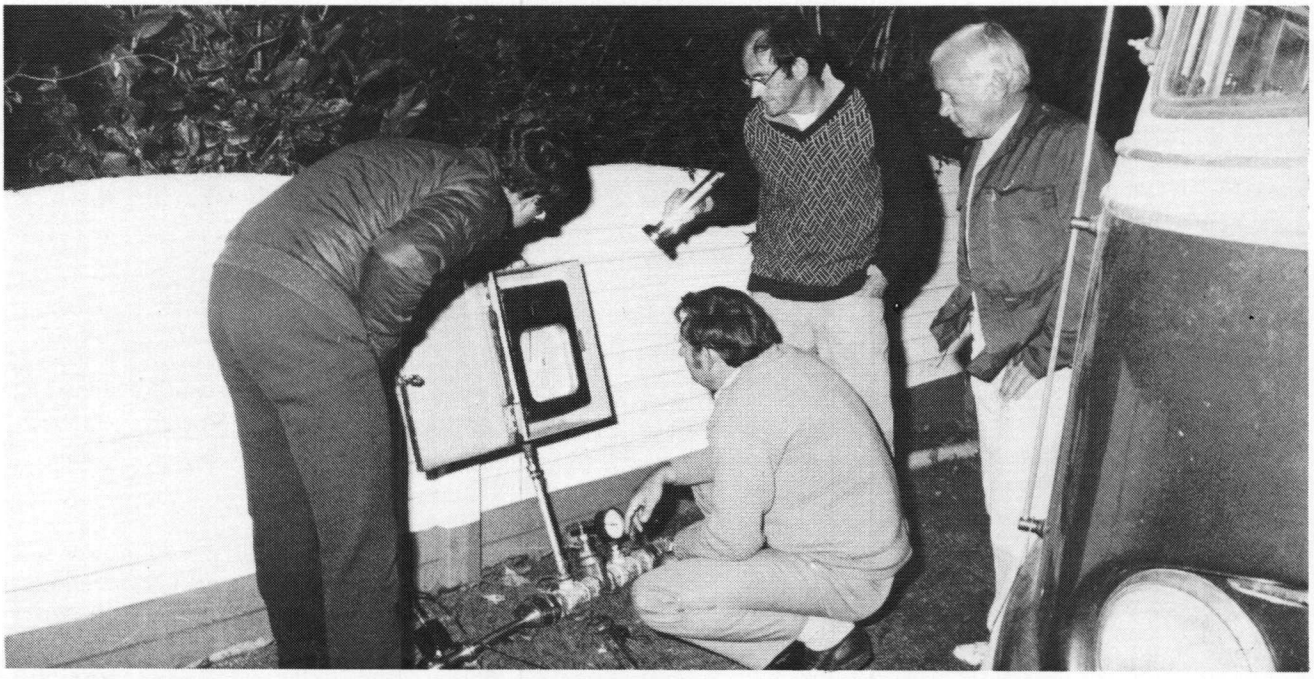


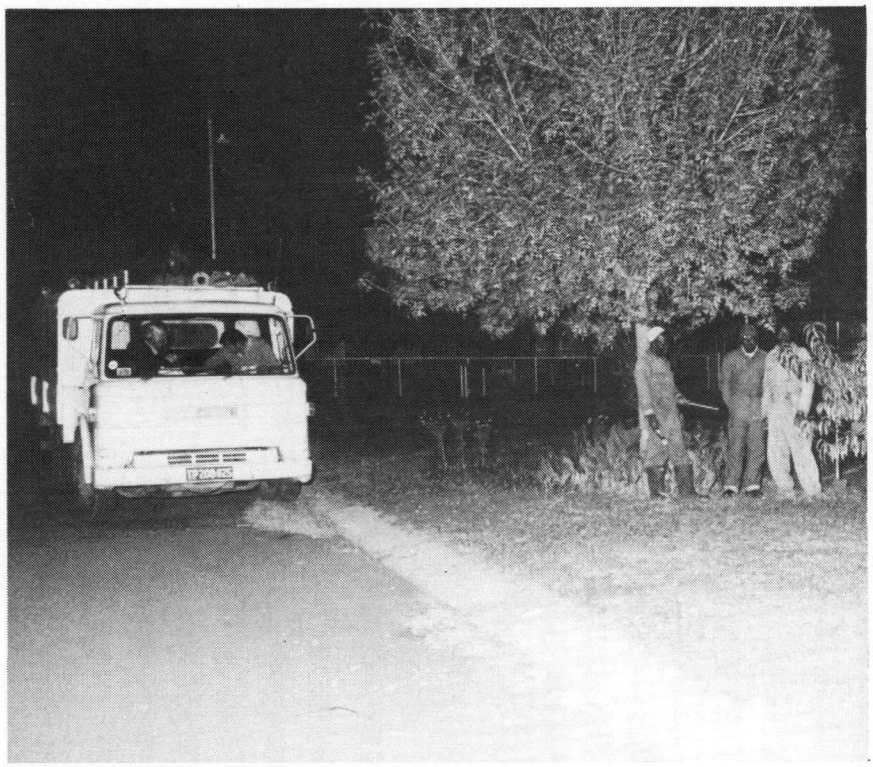
(From left) André Marais, Paul Odendaal, Charles Chapman and Pieter Swanepoel observing the pressure drop test necessary to confirm total isolation of the area.

LEAKS

(From page 15)

the step test was repeated. On this occasion the MNF was recorded at approximately 1,6 m^3/h. Steps in the recorder again indicated leaks in Garret Avenue and Cowgill Street. These leaks were pinpointed on Friday, April 6th and Sunday, April 8th, and two leaks were repaired on Monday, April 9th.

On Monday night, April 9/10th, the MNF was 0,8 m^3/h and a step test indicated a further leak in Cowgill Street. This was pinpointed and repaired using the LNC on Tuesday night, April 10th. The step test was repeated on Tuesday night, April 10/11th with the MNF around 0,5 m^3/h which is on the lower limit of the waste flow meter. On this occasion no steps larger than 0,1 m^3/h were observed.



Water Works personnel moving from valve to valve isolating the area.

Conclusions

- We believe that 0,5 m^3/h is the lowest practically achievable waste flow for this particular area giving an acceptable MNF of 3 l/property/hour. If the purchase price of water to the local authority is taken at 20c per m^3, maximum loss will be R2,40 per day.

  However, at least some of this waste flow will occur within the property boundary and will therefore be metered.
- It is generally assumed that the normal consumption for this type of housing is 1 m^3 per day, or for the area of 150 houses as a whole, 150 m^3/day. Leakage at the rate of 16,88 m^3/h results in a daily loss of 405 m^3. The percentage loss is therefore

  $\frac{405}{555} \times 100$ or 73 per cent.
- Pre-maintenance, that is, ensuring that all valves operate and close "drop-tight" before MNF determinations, is an important factor.
- Four leaks were found not one of which was visible on the surface as running water.
- A waste flow determination is an effective method for establishing that leaks exist and approximately where.
- Sounding of house connections can reduce the length of pipe work to be surveyed with the LNC.
- The LNC is an essential piece of equipment for the precise location of leaks. All four leaks were located within acceptable limits. One "dry" hole was dug more out of curiosity than with conviction.

André Marais relaying the valve-closing sequence to the Water Works team.

SCHOEMANSVILLE WATER TREATMENT PLANT DEMONSTRATED

A demonstration of a new modified water treatment plant was recently held by the Local Areas Committee of Schoemansville.

One of the speakers, Director of the NIWR, Dr LRJ van Vuuren, said that extensive laboratory and pilot-scale studies on dissolved air flotation (DAF) were conducted at various localities such as Empangeni, Kloof Mine, Richards Bay and Schoemansville where full-scale designs are in progress or have been completed. Today Schoemansville can be credited as the "first" to implement this technology on a practical scale for surface water treatment in South Africa.

Also present at the demonstration where Drs Packham and Zabel who are internationally known for their pioneering work on the application of DAF. They are from the Water Research Centre in the UK, a country where there are currently about 20 DAF plants in operation.

With the increasing occurrence of eutrophication in South Africa and associated water treatment problems, recent activities in South Africa have also been directed towards this particular field and according to Dr van Vuuren there has been a great deal of cross-pollination between the NIWR and the Water Research Centre in the UK.

The following advantages of the DAF process were briefly summarised by Dr van Vuuren:

- Algae or coagulable organics can be removed effectively without the need for prechlorination which is known to contribute to taste and odours as well as trihalomethane formation.
- Longer filter runs can be achieved with less wastage of backwash waters.

Four well-known water personages pictured at Schoemansville water treatment plant. In the usual order appear: Dr LRJ van Vuuren (director NIWR), Dr RF Packham (Water Research Centre, UK), Dr Gawie Cillié (retired chief director of NIWR), and Dr T Zabel (also attached to the Water Research Centre, UK).

- Operational control of the DAF process is not a problem.
- Design criteria for implementation of the DAF process are available and can readily be confirmed or adjusted by simple laboratory or pilot-scale testing.

Regarding the history of DAF Dr van Vuuren said that the NIWR had initiated the DAF process during the early sixties for reclaiming maturation pond effluent at Windhoek and subsequently had confined their applications mainly to the reclamation of various types of domestic and industrial effluents. A full-scale plant (25 Mℓ/d) at Sappi Enstra was commissioned in 1970 for the reuse of secondary effluent to augment process waters. This was followed in 1974 by a Mℓ/d plant at Sappi Adamas to reclaim waste pulp and water from the factory effluent. NIWR investigations were also extended to various types of organically contaminated effluents such as meat-processing wastes, sludge thickening and harvesting of algae.

VUIL WATER 'N PROBLEEM IN EUROPA

Luidens 'n berig wat in die Nederlandse tydskrif H_2O verskyn het, blyk dit dat munisipaliteite in Nederland voortdurend deur besoedeling van openbare bronne bedreig word. Ondanks alle pogings om die kwaliteit van die oppervlaktewater te verbeter, word die riviere wat vir drinkwater gebruik word steeds besoedel.

Tot dusver was die grondwatervoorrade in Nederland 'n skoon en betroubare bron van drinkwatervoorsiening, maar bedenkinge het ontstaan oor die grondwater op verskeie plekke.

Die Ryn- en Maasriviere wat saam een-derde van die drinkwaterbehoeftes moet voorsien, is steeds besig om probleme op te lewer.

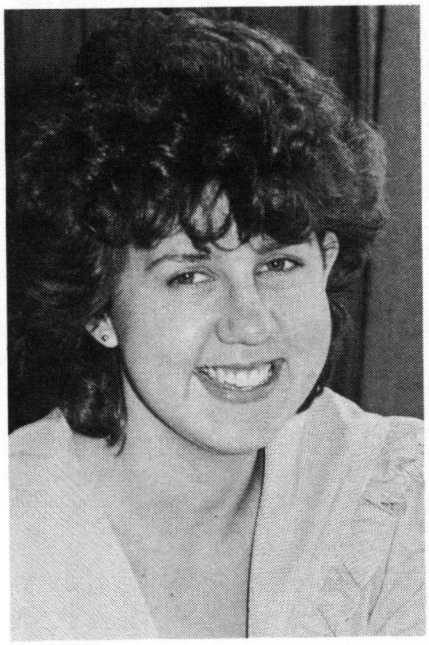
FRANSA/WRC SEMINAR: ENROLL NOW

A seminar on 'Some new advances in water technology' will be held jointly by the Water Research Commission and the French South African Trade Development Corporation (FRANSA).

The seminar, which is to take place at the CSIR conference centre in Pretoria on 3 and 4 July 1984, will offer a presentation of techniques developed by a number of French and US companies in the fields of water exploration, management and treatment. It will be of particular interest to scientists, public authority officials, engineers, industrialists, mining engineers, technicians, entrepreneurs and students.

Each of the two days will be devoted to a distinctly different theme (see programme outline below), and provision is made that participants can register for one day only.

BY BULLETIN



Mej Marietta Theron wat onlangs in die redaksie van SA Waterbulletin *aangestel is. Mej Theron hou 'n BA (Kommunikasiekunde) van die Potchefstroomse Universiteit vir CHO en het onder prof Johan de Jager gestudeer. Benewens haar werk by die Bulletin, sal sy ook met perswerk gemoeid wees.*

The papers to be presented during the seminar are as follows:

Tuesday 3rd July:
WATER RESOURCES MANAGEMENT AND WATER SUPPLY CONTROL:

- Water resources management and mathematical models — Dr Gérard Dassonville, Chief Engineer, in charge of external relations of the Water Division — Lyonnaise des Eaux.
- Water quality modelling: some cases studied in France — Dr Jacques Gaillard, Deputy General Manager, Training and Research Centre for National Resources and Environmental Sciences Management, Centre d'Etudes et de Recherche pour la Gestion des Resources Naturelles et de l'Environment — CERGRENE.
- Mathematical modelling and ground water management with or without artificial recharge; cases studied: Le Pecq (Paris suburb) and Dunkerque, France — Dr Gérard Dassonville, Chief Engineer, in charge of external relations of the Water Division — Lyonnaise des Eaux.
- New Techniques implemented in France in Hydrological and geotechnical explorations — Dr Erik Siwertz, Regional Director, South East France, Compagnie de Prospection Géophysique Francaise — CPGF.
- Optimal operations of large supply systems. Case studied: Lyonnaise des Eaux, West Paris district — Mr Pierre Alla, in charge of drinking water production, West Paris district, Lyonnaise des Eaux.
- Water quality data bank: the computerisation of Lyonnaise des Eaux Central Laboratory — Mr Francois Fiessinger, Director, Lyonnaise des Eaux Central Laboratory.

Wednesday 4th July:
WATER AND EFFLUENT TREATMENT:

- Waste water recycling for reuse on high pressure boilers (report on long run pilot study in Venezuela) — Mr Jean Marie Rovel, Head of Industrial Water and Waste Treatment Department, Degrémont. Responsible for R & D and international consulting concerning process water treatment, sewage and industrial waste treatment, water recycling and reuse.
- Sludge thickening and new developments in high rate clarifiers — Dr Yves Richard, Head of Physico Chemical Research Department, Degrémont: research on coagulation, flocculation, sedimentation, filtration, disinfection, sludge treatment and use of activated carbon in potable water treatment.
- Treatment systems for high efficiency removal of organic micro-pollutants from surface water — Dr Yves Richard, Degrémont (see 2) and Mr Francois Fiessinger, Director, Lyonnaise des Eaux Laboratory.
- Evaporation technologies and their viability in water reuse systems — Mr Richard M Ahlgren, Technical Director, Aqua Chem Inc. USA.
- Physical chemical and biological sensors for control of organic micro-pollutants in drinking water — Mr Francois Fiessinger, Director, Lyonnaise des Eaux Central Laboratory.
- Biological treatment of underground water (iron, ammonia, manganese and nitrates) — Dr Yves Richard, Degrémont (see 2).

The registration fee is R15-00 per day, which includes lunch. Registrants are invited to cocktails at the conclusion of each day's programme.

Registrants are requested to complete and mail the form on the post-card before 25 June 1984 to:

The Chairman
Water Research Commission
P.O. Box 824
PRETORIA
0001

Biological phosphate removal

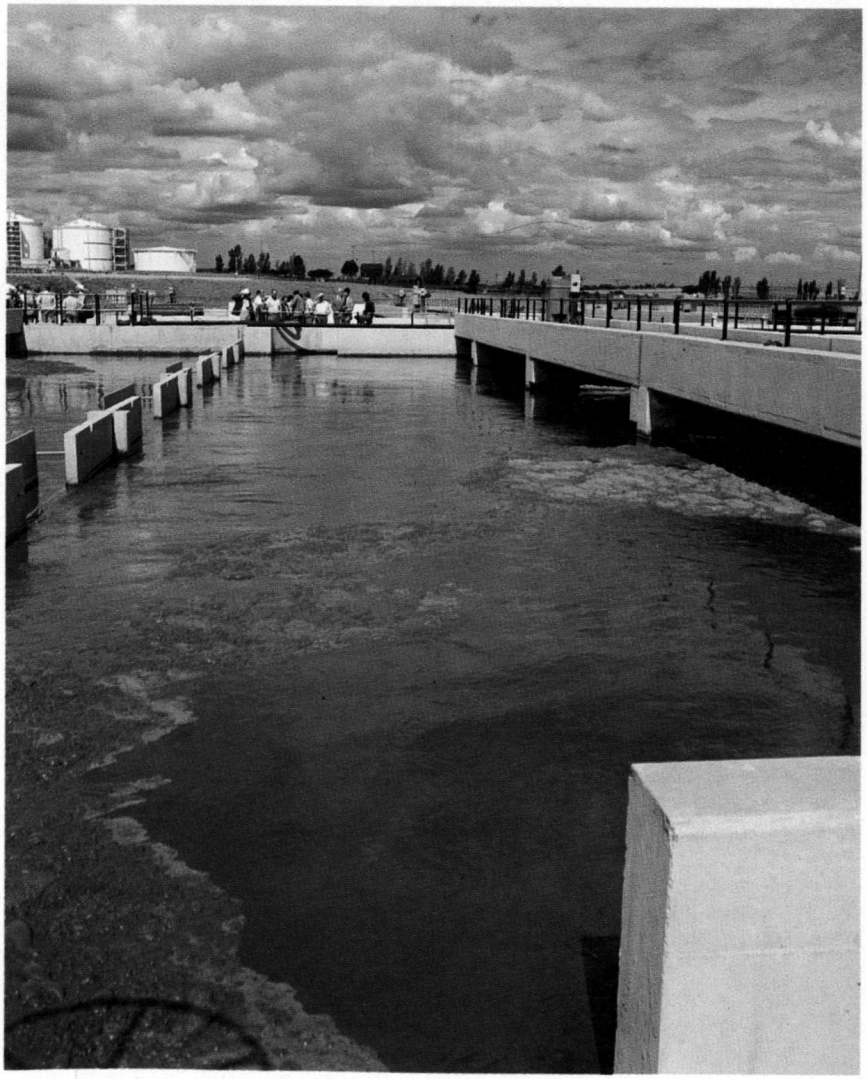
JOHANNESBURG CITY COUNCIL REMAINS IN THE LEAD

The City Council of Johannesburg has been a pioneer in the RSA in the application of innovative sewage treatment processes. As early as 1972/73 they took the lead in implementing a new technology for biological nutrient removal, by designing this then novel technology into their Goudkoppies Works. After fourteen years of follow-up research as well as practical experience at the Council's Goudkoppies and Northern Works, the staff of the Council are now considered international authorities on biological nutrient removal. This was recently reaffirmed when three of the Council's staff had their papers on biological phosphate removal accepted for presentation at the IAWPRC's Amsterdam Conference to be held in September this year.

At present the research on biological phosphate removal is continuing on a joint venture basis with the Water Research Commission. The background, objectives and research programme contained in a contract signed during August 1983, between the Council and the Commission for research into the enhancement of biological phosphate removal from sewage by altering process feed composition are set out in this article.

Research and development on biological nutrient removal from sewage over the last ten years has resulted in significant advances in knowledge of the process and its successful application in practice. This knowledge is currently being transferred to user agencies, such as consulting engineers and local authorities, by way of a comprehensive information document entitled ''Theory, design and operation of nutrient removal activated sludge processes'' (available from the Water Research Commission).

The factors controlling phosphate removal from sewage have been identified and to a limited extent quantified. The more important of these factors are the composition of the sewage which is to be treated, the bacterial species which remove the phosphate and the process reaction conditions. Of these three factors the composition of the sewage to be treated is the most crucial. Parameters of importance are the concentration of short chain organic compounds such as acetic acid in the sewage, as well as the relative proportions of nitrogen and phosphorus present in relation to the oxidizable organic matter. Mathematical models developed by the University of Cape Town relating phosphate removal to the above parameters have been applied and found to give reliable but conservative estimates of phosphate removal achieved in practice.



The biological reactor, Northern Works.

The operation of Johannesburg's Goudkoppies sewage works has been optimised for biological removal, producing a high quality effluent which conforms for 95 percent of the time to the 1 mg/ℓ phosphate (as PO_4.P) standard. However, the excellent phosphate removal capability of the plant could only be realised after the

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Biological Phosphate Removal

A general view of the Northern Works with the primary settling tanks in the foreground.

(From page 19)

composition of the sewage feed had been altered by the inclusion of an industrial effluent from a yeast factory. This effluent enhanced the content of short chain organic compounds in the sewage feed and improved the relative proportions of nitrogen and phosphorus to the oxidizable organic matter content. Prior to the inclusion of this industrial effluent in the feed to the plant, it could — even under optimised operation — only meet the phosphate standard for 66 percent of the time.

A survey of fifteen biological nutrient removal plants operating in Southern Africa during 1980/81 by the National Institute for Water Research indicated that only the Goudkoppies Works met the standard for a minimum of 95 percent of the time. The performance of the other works varied from excellent phosphate removal for part of the time, to virtually no phosphate all of the time. A variety of reasons for this poor performance were identified with one of the most important being the unfavourable characteristics of feed sewage for biological phosphate removal.

Preliminary investigations by a number of organisations in South Africa have identified several ways in which the composition of feed sewage may be altered to make it more amenable to biological phosphate removal. These techniques are based on supplementing the feed to the biological reactor with additional organic matter, preferably short chain organic compounds, or changing it to contain a higher fraction of this form of organic matter, and include:

- Addition of industrial effluents containing high concentrations of readily biodegradable organic material.
- Returning all or part of the primary sludge removed from raw sewage to the biological reactor instead of anaerobically digesting and stabilizing it.
- Altering the anaerobic digestion process to proceed only up to the acid formation stage and discharging the resultant acids (i.e. short chain organics) to the head of the works or to the biological reactor directly.
- Operating primary sedimentation tanks to induce acid formation within an accumulated sludge layer and recycling this sludge to a point ahead of the primary clarifier to permit fermentation products to be elutriated into the feed to the biological reactor.
- Expanding the anaerobic zone in biological nutrient removal processes to facilitate the generation of the required short chain organics within the process.

The above options all show potential for enhancing biological phosphate removal. If one or more could be perfected, it would present a practical means of upgrading works which currently show poor or only limited phosphate removal to meet the standard or even produce effluents of a quality better than that required by the standard.

In the light of the impending strict implementation of the phosphate standard from 1 August 1985, as well as problems current-

Biological Phosphate Removal

ly being experienced by a large number of biological phosphate removal plants to meet the standard for 95 or more percent of the time, it was considered essential for current techniques to be further developed and optimized. Furthermore, from studies currently underway on the impact of phosphate loads on the trophic status on South African impoundments it would appear that even stricter effluent phosphate standards may be required in future and hence appropriate technology to meet this need must be developed.

Consequently an agreement was negotiated between the City Council and the Water Research Commission with the objective to study at full-scale methods for the generation of short chain organics and their optimal application for biological phosphate removal. These studies are already under way at the Northern Works and will also commence at the Bushkoppie Works once it is fully commissioned. At the Northern Works short chain organics have been produced in the primary sedimentation tanks and in a conventional anaerobic digester operated as a high rate acid digester and these processes will be further optimized. At the Bushkoppie Works, the short chain organics will be produced in the primary sedimentation tanks.

R & D PROGRAMME

Production of Short Chain Organics

Facilities for the generation of short chain organics in sedimentation tanks exists at both the Bushkoppie and Northern Sewage Works. At Bushkoppie raw sludge can be accumulated in primary sedimentation tanks and allowed to go anaerobic, while at Northern Works primary sludge can be partially recycled back to the inlet of sedimentation tanks to assist in the leaching out of soluble organics and increase the retention time of the sludge in these tanks. The main operational variables which will be investigated are sludge retention time and recycle ratios. In addition, the effect of temperature will be noted.

High rate digestion of primary sludge will be studied at Northern Works where preliminary studies have already taken place. Operational variables to be examined will be sludge feed rate to digester, sludge concentration in the digester, retention time, temperature, degree of mixing, necessity for solid/liquid separation and the effect of various inhibitors to limit methane production. These studies will be undertaken in collaboration with the University of Cape Town which is currently studying the process kinetics of the high rate anaerobic digestion process for the production of short chain organics.

Both the sedimentation tanks and the digester will be intensively monitored during the evaluation and optimisation studies. The parameters which will be monitored include: retention time, temperature, total volatile fatty acids, easily biodegradable COD, nitrogen, phosphates, solids, COD, pH and alkalinity. The organics in the overflow and underflow from the sedimentation tanks and waste stream from the digester will be fractionated and characterised. The response of various cultures of phosphate accumulating bacteria to these various organic fractions will be tested to establish the best fraction(s) for phosphate accumulation.

Evaluation of Plant Response to Addition of Short Chain Organics

Both the response of the Bushkoppie and Northern Sewage Works to the addition of the process streams rich in short chain organics from the primary sedimentation tanks and the digester (only at Northern Works) will be studied. Various procedures for adding these process streams will be evaluated, i.e. semi-continuous addition e.g. 4 hours out of every 24 hours, continuous addition over the full day, if possible, and addition during periods of low organic load on the plant e.g. during weekends. Parallel experiments will be undertaken where one module of the plant receives short chain organics and the other does not. The quantity and composition of the added process stream, as well as the point of addition will be varied to establish the best procedures for optimal nutrient removal. The response of these plants will be monitored by measuring the changes in microbiological populations, efficiency of nitrogen and phosphate removal, as well as the degree of phosphate release and uptake.

In addition to the evaluation of the effect of short chain organics on nutrient removal in the Bushkoppie Works, other novel features of this plant, e.g. the two hour anaerobic zone, the diffused air aeration system, and the variable mixed liquor recycle points, and their effect on nutrient removal will be evaluated and optimized.

Cooperation with other Research Organisations

The Johannesburg City Council will closely liaise with other research groups working on Water Research Commission projects related to nutrient removal in the activated sludge process, e.g. study on the generaton of short chain organics by high rate anaerobic digestion will be undertaken in collaboration with the University of Cape Town.

Design and Operation Manual

At the end of the study a manual will be compiled based on the results and findings of the research and will delineate the design and operational criteria developed for optimal nutrient removal. It will augment the existing monograph: *"Theory, Design and operation of Nutrient Removal Activated Sludge Processes"*, which is available on request from The Chairman, Water Research Commission, PO Box 824, Pretoria 0001.

Hidrologie

REGISTRASIE VAN ALLE SUID-AFRIKAANSE HIDROLOË

'n Register van alle hidroloë in Suid-Afrika word tans deur dr PJT Roberts, voorsitter van die nuutgestigte Suid-Afrikaanse Nasionale Komitee vir die Internasionale Genootskap van Hidrologiese Wetenskappe (SANCIAHS), opgestel.

Volgens dr Roberts bestaan die Internasionale Genootskap van Hidrologiese Wetenskappe (IAHS) uit ses internasionale kommissies en een internasionale komitee en word aktiwiteite bevorder en gekoördineer deur 'n netwerk van nasionale komitees. Die nasionale komitee van elke land bestaan gewoonlik uit 'n Nasionale Korrespondent vir die IAHS en een korrespondent (die kommissiekorrespondent) vir elke internasionale kommissie.

Die eerste vergadering van die Suid-Afrikaanse Nasionale Komitee vir die IAHS (SANCIAHS) is op 28 September 1983 gehou. Die stigting van hierdie komitee stel Suid-Afrikaanse hidroloë uiteindelik in staat om 'n eie amptelike liggaam te hê wat hulle belange verteenwoordig en om 'n gemeenskaplikheidsgevoel te bevorder tussen diegene wat in die hidrologiese veld werksaam is. Die stigting van SANCIAHS was 'n voorvereiste vir betekenisvolle deelname van Suid-Afrikaanse hidroloë aan internasionale aktiwiteite en die komitee het alreeds voelers uitgestoot om namens die IAHS die gasheer te wees van 'n internasionale byeenkoms.

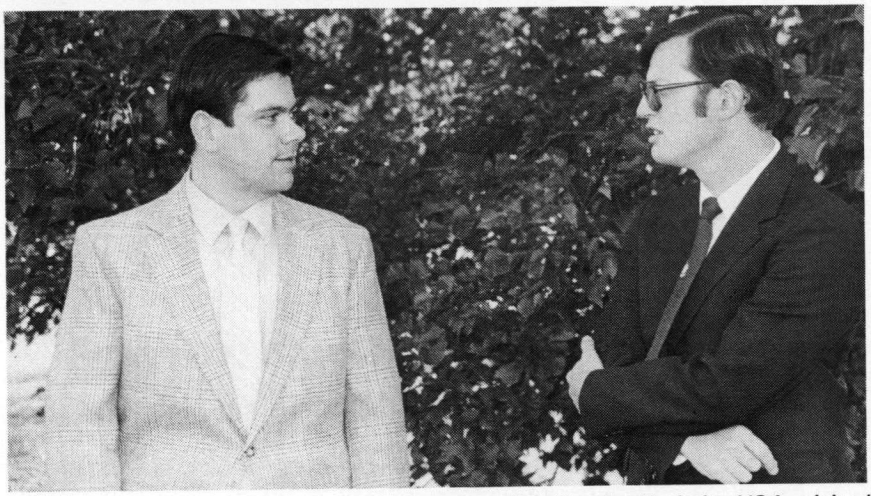
Volgens die IAHS se riglyne vir nasionale komitees is een van SANCIAHS se eerste take om 'n register saam te stel van alle hidroloë in die land. Die register sal ook elke hidroloog se belangstelling in die aktiwiteite van 'n internasionale kommissie van die IAHS bevat en word om die volgende redes saamgestel:

- die IAHS oorweeg dit om individuele lidmaatskap in te stel en dit moet verkieslik persone wees wat by die nasionale komitee geregistreer is.
- Die register sal doeltreffende verspreiding van inligting na die hidrologiese gemeenskap vergemaklik en sal van groot hulp wees in die organisering van nasionale seminare.
- Organiseerders van internasionale werksessies en seminare asook leiers van internasionale projekte sal in staat wees om te bepaal watter persone van elke land vir deelname genooi kan word.
- Die register gaan in die toekoms die basis vorm vir die verkiesing van SANCIAHS-lede. By die eerste vergadering is besluit dat lede elke vier jaar verkies sal word wat in ooreenstemming sal wees met die vierjaarsiklus van die moederliggaam, die Suid-Afrikaanse Nasionale Komitee vir die Internasionale Unie van Landmeetkunde en Geofisika. Die hidroloë wat hulle name by die onderskeie internasionale kommissies geregistreer het, sal die Kommissiekorrespondent vir daardie kommissie verkies.

Dr Roberts sê dat die registrasie van Suid-Afrikaanse hidroloë by SANCIAHS 'n duidelike omskrywing verg van wie of wat 'n hidroloog is. Daar is besluit dat 'n hidroloog vir registrasiedoeleindes gedefinieer kan word as enige persoon (ongeag sy geslag, ras of geloof) wat aktief of geïnteresseerd is in die aktiwiteite wat verteenwoordig word deur die internasionale kommissies of komitees van die IAHS. Die klem val dus op aktiewe belangstelling of deelname op alle terreine van hidrologie eerder as op akademiese kwalifikasies.

Persone wat belangstel om as 'n hidroloog te registreer by SANCIAHS word vriendelik versoek om die registrasievorm wat in hierdie uitgawe van die *SA Waterbulletin* ingevoeg is, te voltooi en aan dr PJT Roberts, Waternavorsingskommissie, Posbus 824, Pretoria 0001 te stuur.

Sludge expert in SA



Dr Michael Richard (left) from the University of California, Berkely, USA, visited South Africa at the invitation of the Water Research Commission in March this year. He presented specialized courses on the indentification of activated sludge filamentous organisms in Pretoria, Cape Town, Pinetown and Johannesburg. The picture shows Dr Richard in conversation with Dr H. Wiechers, senior adviser WRC.

CROP WATER USE EFFICIENCY

by
DERRICK M OOSTERHUIS

Soil and Irrigation Research Institute, Private Bag X79, Pretoria 0001

The importance of efficient and judicial use of available water in these times of increasing populations, food shortages, dwindling supplies of water for agriculture, and unpredictable droughts cannot be overemphasised. Attaining high water use efficiency while maintaining high productivity is now a major objective in current research. This paper discusses the practical concepts of water use efficiency in crop production and emphasises methods of increasing efficiency.

Crop yields are more dependent on an adequate supply of water than any other single factor. With a rapidly growing world population, man is forced to try and increase food production but these efforts are limited to a great extent by a lack of water. This is further complicated by an increasing competitive demand for water from urban and industrial development. It has thus become very obvious that man's very existence depends on proper management of the water resources within the ecosystems of the world and on maximising water use efficiency (WUE). For these reasons increasing WUE is a major aspect of plant productivity. This can only be achieved with a thorough understanding of plant water use and the concepts involved in WUE. Furthermore, for WUE, it is important to consider all characteristics of the plant and its environment.

Definition of WUE

Water use efficiency refers in general terms to the amount of water used per unit of plant material produced. The term (WUE) is fast becoming a key-phrase in irrigation scheduling and water management. Different definitions of the term are used by agronomists and physiologists. Agronomists usually define WUE in practical terms of the dry matter or yield produced per unit of water used, often using the total water lost by evapotranspiration (ET) which combines both evaporation and transpiration. Physiologists, on the other hand, are more likely to discuss it in terms of photosynthesis, expressed as the amount of carbon dioxide fixed per unit of water used. This paper makes use of the former definition which is easier to understand and more meaningful in agriculture:

$$WUE = \frac{\text{dry matter or crop yield}}{\text{water used in evapotranspiration}}$$

If yield ws completely independent of ET, any factor which caused an increase in yield, or a decrease in ET, would have a favourable effect on WUE. However they are not independent of each other, and both can be influenced, either independently or differentially by crop management and environment. Yield is greatly dependent on soil water such that, within limits, the more water available to the crop the higher the yields will generally be. The greater water supply will, however, also increase the ET. The practical conclusion therefore is that every effort should be made to increase the amounts of water available to the crop for production, and at the same time reduce to the minimum the losses of water due to evaporation and transpiration.

Stomates and tranpiration

Crops lose water mainly by transpiration through the many thousands of small apertures, or stomates, on the leaves. A typical stomatal frequency for soybeans for example is 35 000 stomates per square centremetre or 250 0000 per average sized leaf. Crops also lose water to a lesser extent by evaporation from the soil and leaf surfaces. Soil evaporation is usually only about 15% of transpiration in a fully developed crop. During drought and water shortages, stomatal closure reduces water loss by transpiration but by so doing also reduces uptake of carbon dioxide by the leaf and therefore lowers productivity. In theory, when the diffusivities of the two gases as well as the various resistances encountered in the two opposite pathways are considered, partial closure of stomates should reduce water loss more than it reduces the rate of photosynthesis. In practice, however, the rate of photosynthesis. In practice, however, the rate of photosynthesis often decreases at the same rate as transpiration when stomates close gradually.

Stomatal sensitivity for preventing high transpiration rates could be important for improving WUE. For example, midday closure of stomates during periods of high evaporative demand could be a useful strategy for increasing WUE; particularly in horticultural crops. The loss of CO_2 assimilation that results from midday stomatal

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closure would have to be compensated for by an extended growing season.

Calculation of water use efficiency

When considering WUE in terms of the plant material produced by a crop per unit of water used, it is important to define clearly the manner in which the plant productivity is assessed and also the manner in which the water used, is calculated. Productivity may be defined in terms of yield expressed as economic yield, such as wheat grain, soybean seed or citrus fruit, or as forage in the case of pastures, or as dry weight of the entire plant. If the roots or other vegetative organs are neglected the WUE will be lower than if the entire plant is used in the WUE calculation.

The second important aspect of calculating WUE is whether to use only the water lost by transpiration or the combined losses of evaporation and transpiration (evapotranspiration, ET). Use of ET is more realistic with respect to agriculture but results in greater variability in WUE because evaporation is affected by a number of parameters including leaf cover and frequency of soil wetting.

WUE and agricultural crops

Water use efficiency varies greatly between different crops and cropping areas depending on the method of calculation, the climate, the cultivar used, weed control, tillage, fertilizer and other management practices, and also depending on the rainfall or irrigation patterns. Sorghum for example has been found to be about 3 times more efficient than soybeans in terms o both total dry matter production and seed yield. Sorghum supposedly was more adapted to using available water efficiently than soybeans through better stomatal control of transpiration and a more efficient root water extraction. It is obvious that WUE should be greater in humid regions with low evaporative demand than in arid regions with high evaporative demands.

Water production functions

In all irrigated systems an important consideration is the relation between final yield and the amount of water used to achieve the yield. This is studied using ''water production functions'' (Fig 1) which show that the efficiency of water usage (yield per unit of water) remains constant for low and intermediate yields but decreases at higher yields due to the difficulty of avoiding some wastage of water and also the possibility of other factors (eg. nutrients, genetic potential) becoming limiting. Generally

A healthy, well managed, crop of irrigated soybeans at Roodeplaat near Pretoria.

speaking any position to the left of the curve in Fig 1 indicates an increase in WUE, whereas positions to the right of the curve indicate more water used to produce a unit amount of yield and therefore a decrease in WUE. These curves and considerations are useful in assessing irrigation efficiency and for predictive and planning purposes.

Increasing WUE

The two main approaches to increasing WUE by crop plants are through plant breeding for more stress tolerant varieties and by improving crop and irrigation management practices.

Plant breeding

The aim in plant breeding would be to select plants that either yield better or use less water under drought conditions. This can be achieved by screening large numbers of different cultivars for growth response and yield under stress and then looking for an explanation in terms of differences in structure or processes. The more modern approach is based on a clearer understanding of how water stress affects plant growth and yield, and the recognition of which characters contribute to more efficient use of water.

According to Dr. Paul Kramer of Duke University in North Carolina, plant breeders and physiologists need to work much closer in order to understand and specify which morphological and physiological characters are involved in drought tolerance. For example, what is the importance of morphological characters such as leaf size, deep roots or thick cuticles compared to physiological characters such as osmotic adjustment, responsive stomates, C4 carbon metabolism or protoplasmic tolerance. With the understanding and identification of desirable characters, relatively simple tests will have to be developed to screen a wide range of plant material and this is likely to be the biggest stumbling block because most of the plant processes involved in drought tolerance require time consuming measurements.

Improved photosynthetic efficiencies or alteration of the composition of plant products would lead directly to increased WUE. Greater opportunities exist for improving photosynthetic efficiency and hence WUE in C3 species than in C4 species but many technological problems stand in the way. Alteration in the biochemical composition of the plant products is technically a more feasible option although in many cases the current levels of proteins, lipids or carbohydrates are a major reason for the initial selection of the species for crop production.

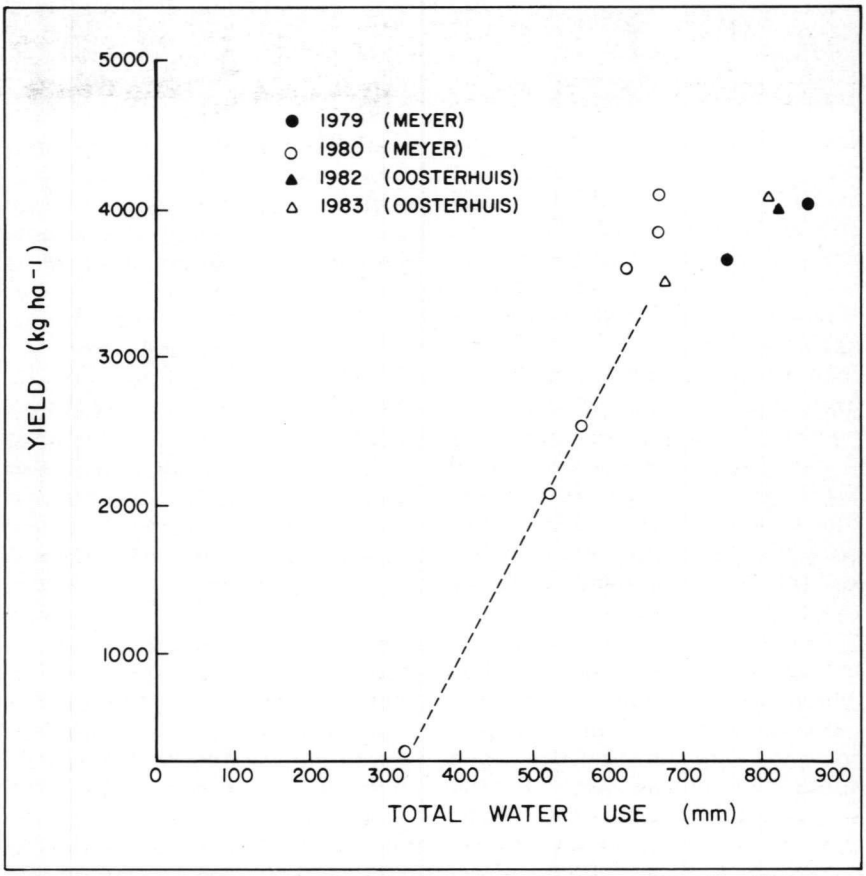

Fig. 1. Water production function for soybeans over the last few years at the Roodeplaat Experimental Site

Other biochemical or physiological possibilities of increasing WUE include increasing the ratio of mesophyll cell surface to leaf surface as this would presumably increase photosynthesis more than it would increase transpiration. If photrespiration could be decreased, the efficiency of photosynthesis would improve. The rate of photosynthesis could also be increased relative to transpiration by increasing the carbon dioxide concentration of the atmosphere above crops. In the future, genetic engineering as well as cell tissue culture techniques should make important contributions in plant responses to drought and in WUE. In the immediate future, however, the chance of developing cultivars with greater WUE is very small. This is because although extensive germ plasm pods containing genes for greater WUE do exist, heavy selection pressure is necessary to identify these genes.

Uncertainty exists concerning the possibility of stress tolerant plants which yield well under stress, actually not yielding so well in the absence of stress. In other words a negative correlation may exist between maximum yield and drought tolerance, i.e. between a high rate of photosynthesis (high stomatal conductance) and reduced transpiration.

Energy cost of adaptations

Some argument exists as to the energy cost of plant adaptions for survival under conditions of

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drought. Large root systems use a major proportion of the total photosynthate and may in times of drought, compete with the shoot or seeds for the photosynthate. However, fruits and seeds are generally much stronger 'sinks' than roots and any competition from the roots should be unimportant. It is well accepted that drought adaptations (acclimations) such as osmotic adjustment, thicker cuticles, and responsive stomates do require some 'extra' energy from the plant but only relatively little compared to root growth.

Therefore, unless the period of water stress that leads to the adaptations is not too severe or prolonged, the energy cost of increased survival should be offset by the smaller yield decreases that result. If the water stress encountered is mild, there is unlikely to be much drought adaptation and therefore very little energy cost and probably no reduction in yield will be encountered. If, on the other hand, the drought is more severe, then there is likely to be some energy investment in drought adaptations, and some yield reduction could be expected.

Management practices

Management practices that reduce injury from drought and increase WUE include early planting, use of irrigation, increasing water storage in the root zone, effective weed control, rapid coverage of soil by a crop canopy to reduce evaporation, and the choice of suitable crops and cultivars. Effective management practices to reduce or prevent injury from drought require a detailed knowledge and understanding of crop water use and the effects of water stress on plant growth and yield. Knowledge of drought sensitive stages in the life cycle of the crop is also important. Reliable weather predictions and comprehensive climatological data are also required.

It is well established, for example, that water stress during internode elongation in wheat seriously reduces grain yields, and that hot dry weather at silking reduces maize yields. Supplementary irrigation at such times could offset possible yield reductions. Or, if the probable dates of such weather perturbations are well established, farmers could choose varieties and planting times that minimise the probability of injury from drought. Success of this kind of management requires co-operation between agronomists, physiologists, soil scientists, plant breeders and crop climatologists to provide the necessary information and understanding.

Increased water storage in the root zone can be achieved by control of runoff, improved infiltration and by water harvesting methods. Crop management practices such as tillage and rotation are very effective in this respect and can also improve yields. Reducing water loss due to evaporation from

A mature citrus orchard at Addo, in the Eastern Cape, used for studying plant water use.

the soil can result from mulching and from chemical treatment of the soil. Decreasing soil evaporation improves WUE by increasing the proportion of transpired water. Management practices that minimise surface runoff, soil evaporation and deep percolation would be beneficial by allowing more water to be available for transpiration. Water losses due to transpiration can be reduced by plant treatments aimed at directly decreasing transpiration such as weed control, and use of suitable planting densities and row patterns. Unfortunately, however, high rates of transpiration usually accompany high yields because conditions favourable for photosynthesis (i.e. open stomates, warm temperatures and light) are also favourable for maximum transpiration, and some sort of trade-off or balance is obviously required.

Windspeed can effect WUE and therefore the use of windbreaks or shorter crops offers some potential for increasing WUE. This is because the turbulent transfer of energy is the 'linking' mechanism between the crop surface and the bulk atmosphere and strongly influences crop water use.

Improvement in harvest index (i.e. the ratio of marketable crop yield to total crop biomass) would also increase WUE. Large increases in harvest index with current modern varieties are considered, however, to be unlikely. The best way to achieve an optimum harvest index is to assure, by using irrigation, an adequate supply of water during periods of reproductive growth.

Another approach to increasing WUE is by reducing the evaporative demand on the crop by growing the crop in a more humid environment, or by growing crops during times of the year when evaporative demand is low. The main problem here is that crop growth is usually very much slower in cool temperatures and the growing season may not be of sufficient duration. Use of short-season varieties and production systems for cotton is one example of the genetic and cultural advances that have already been capitilized on for one major field crop.

Some argument exists as to the consequences of moderate plant-

Research on wheat water use and the effects of water stress at the Soil and Irrigation Research Institute's 4 hectare experimental site at Roodeplaat. Various irrigation treatments are accurately applied to 12 m × 12 m plots using overhead microjet systems. Equipment used to measure plant and soil water status can be seen in the middle of the picture. In the background is the field laboratory in which the automatic data logging equipment is housed.

water deficits on yield and WUE. Plants can generally withstand mild water deficits without undue effects on yield. Experimental evidence according to Dr JT Ritchie indicates deficits that plants can use stored soil water more efficiently if they experience moderate water deficits, causing root systems to absorb water from deeper in the soil. It has been shown that when irrigation is delayed until soil water was depleted to 70% of available soil water, seasonal evaporation was reduced by 10-20% but yields were reduced 20-25%. However, some question exists as to the acceptable soil water depletion levels that a plant can withstand before yields and WUE are adversely affectd. The use of high frequency irrigation has been shown to result in high WUE in well watered production systems and particularly in orchards. However, in crop production under conditions of limited water or when the possibility of water deficits exist, the opposite could be true.

Irrigation and WUE

In the USA, as in many other parts of the world, the need for efficient use of limited water supplies is becoming increasingly important, and for this reason irrigation scheduling has received increased attention in the past decade. Scheduling or irrigation involves estimating when to irrigate and how much water to apply. Current irrigation scheduling practices are generally designed to maximise application efficiency without adversely affecting crop yields.

A number of different ways of scheduling irrigation are available including the use of evaporation pans and crop factors, tensiometers, and water balance methods. In all these methods it is necessary to estimate evapotranspiration water losses. A good first approximation of evapotranspiration can be gained using pan evaporation together with the crop factor. Pan evaporation data has the advantage of being readily available. However, any such empirical relationship is of limited value in understanding the interaction between soil, plant and atmosphere. A number of other methods of predicting evapotranspiration have been tried and, at present, the most successful appear to be those which are based on energy balance concepts. The suc-

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cess of these methods can probably be attributed to the fact that they attempt to model the actual system rather than use some artificial approximation.

Work at this and other centres has shown that prediction of evapotranspiration from properly calibrated energy balance formulae produces good results and contributes to our understanding of the process of evapotranspiration. Results further indicate that evapotranspiration rates will exceed those predicted by energy balance formulae in summer rainfall areas where irrigated winter and spring crops are surrounded by large non-irrigated areas. The USDA irrigation scheduling model, calibrated for local conditions, has been used for a number of seasons and found to be suitable for irrigation scheduling at the Soil and Irrigation Research Institute's experimental farm at Roodeplaat.

Other aspects of efficient irrigation include: choice of the correct and best suited irrigation system, irrigation during times of low wind and low evaporative demand to reduce water losses, accurate measurement of soil water levels, care not to over irrigate in order to prevent wasted runoff and crop damage through waterlogging, and the correct end of season termination of irrigation to prevent wastage when the crop is senescing and water use is declining.

Antitranspirants

Antitranspirants refer to various leaf coatings that reduce surface evaporated or canopy transpiration during times of drought. Unfortunately, treatments that decrease water loss from leaves also decrease the entrance of CO_2 for photosynthesis. Thus the use of antitranspirants is based on the assumption that an increase in resistance at the leaf surface would decrease transpiration more than it will decrease CO_2 uptake. Antitranspirants, however, have only limited practical usefulness, particularly in transplanted seedlings. Results with crop plants have either been disappointing or inconsistent although these have been some reports of antitranspirants successfully decreasing evapotranspiration (i.e. in India).. Films are of limited usefulness on growing plants during a drought because repeated applications are required to cover new leaf surfaces. At present, there seems to be no satisfactory compound that can cause partial closure of stomates. Generally speaking, the basic idea of antitranspirants to reduce transpiration is very attractive and has several advantages in droughts, but unless it could be used without reducing photosynthesis, antitranspirants seem to offer no practical advantages.

Research into crop water use and irrigation requirements at Roodeplaat. The control board for an automatic irrigation system can be seen in the foreground, as well as the rain-out shelter used to cover the plots for water stress studies.

With the dwindling supplies of water available for agriculture through competition with increased urban and industrial demand, and the occurrence of severe droughts, crop WUE has become a central aspect of crop productivity in both dryland and irrigation farming. An important aspect in all considerations of WUE is that crop production is inextricably linked to crop production.. Increases in WUE can be achieved by improved management practices and careful plant breeding and selection for drought tolerant crops. In both cases a clear basic understanding of plant water use and the effects of water stress on plants are imperative. Success in increasing crop WUE calls for an honest and detailed evaluation of available water resources, present management practices (particularly irrigation scheduling), and existing objectives in plant breeding programmes.

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Aquaculture:

NEW RESEARCH PROGRAMME TO SUPPORT FOOD PRODUCTION IN SA

During the past year the Council for Scientific and Industrial Research has been involved in assessing the potential and research needs in aquaculture in South Africa. An Aquaculture Working Group was appointed, a research strategy developed and priorities on major areas in aquaculture suggested. Subsequently a national cooperative scientific programme has been initiated.

SA Waterbulletin recently had the opportunity to speak to Dr Ora Safriel, coordinator of the aquaculture programme, at the CSIR.

Asked what aquaculture meant Dr Safriel said that aquaculture in its broad sense aimed at the controlled cultivation and harvest of aquatic organisms for commercial utilization. She said the practice of aquaculture was based on the assumption that proper management of systems by optimal input of feed and energy can produce higher yields than was possible in unmanaged natural systems.

"Invested materials may return a dividend on investment and produce a more profitable crop. Furthermore the successful implementation of aquaculture is determined to a great extent by local considerations such as environmental conditions, human resources and economic factors, on one hand, and utilization of available technology on the other," she said.

According to Dr Safriel fish culture had been practised for over 2000 years, but only during the past few decades had aquaculture developed in certain parts of the world into a commercial activity which was dependent upon advanced technology and scientific research.

Dr Ora Safriel.

She said that the world had in recent years become increasingly aware of the finite nature of its natural resources and of the importance of food production in controlled systems. Aquaculture offered a means to increase that production. Annual worldwide aquatic catch in recent years stood at around 70 million tonnes. It was not anticipated that world protein supply from natural resources would continue to keep pace with demand. Alternative methods for fish production such as aquaculture had therefore, to be sought.

Total worldwide aquaculture production increased from about 6 million tonnes in 1975 to 9,4 million tonnes in 1980. The total

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for the year 2000 could be as much as 50 million tonnes. The contribution of aquaculture to aquatic production increased by nearly 54% between 1975 and 1980, while the growth of sea fishery production did not show similar a trend, Dr Safriel said.

Dr Safriel said that the situation in South Africa differed radically from other parts of the world and in the Republic aquaculture could serve both the First and the Third world as there was a need for the more up-market species (such as prawns) as well as a staple food. Different management and technology should however be used.

She said that the new aquaculture research programme will be aimed at providing scientific knowledge to facilitate the production of food in controlled aquatic systems which may become complementary to food production based on the harvesting of natural resources.

"It will also aim at providing the necessary scientific information to support and promote existing aquaculture activities, providing knowledge to facilitate more rational and optimal use for food production of available sources such as water and effluents within existing systems, as well as to generate knowledge which may improve the selection and adaptation of available technology related to the practice of aquaculture and to generate and reinforce problem-orientated research."

Waterblommetjies

Dr Safriel said a close look will also be taken at current and potential culturable species such as rainbow trout, waterblommetjies, marine and freshwater prawn, catfish, St Peter fish, bivalves (such as oysters and mussels), turbot crayfish and a wide range of other species. In addition hatcheries, broodstock and genetic selection, spawning, incubation techniques, larval rearing, overwintering and transport, nutrition and feeds, diseases, economics and marketing will also be investigated.

Fish from an aquaculture programme in Venda.

Aquaculture in South Africa began over one hundred years ago with the introduction of trout, mainly for angling purposes. Today the cultures of trout and oysters are the only commercially viable aquaculture industries in the country. The latter still depends on government support for seed production. In 1982 South African production did not exceed 550 tonnes and the contribution toward the gross national product was approximately R4 million.

Dr Safriel said that in the past aquacultural attempts for most species had not been developed beyond an initial research stage. The marine industry was exclusively based on the harvest of the oceans, and in spite of the large quantities of marine products locally available, fish molluscs and crustaceans costing R102 million were imported into the country in 1981.

"There is therefore wide scope for import replacement with an increasing demand for freshness and quality," she said.

She said that scientific research should play a key role in attempts to achieve the optimal utilization of water resources in South Africa. Recurring droughts emphasised this urgent need.

Aquaculture also offered possible means to utilize environmental pollutants such as thermal effluents and wastes, for food production. The use of warm water from power stations could facilitate the year-round practise of aquaculture in areas where climatic conditions were unsuitable or allowed only seasonal production. The use of thermal effluents could therefore increase the profitability of culturable species and allow the successful culture of new candidates.

Dr Safriel said that scientific information of a multidisciplinary nature was also needed to facilitate the practice of aquaculture within prevailing human and environmental constraints.

"Since the task is a large one and the small research community is widely spread among the different organizations involved, it will be necessary to coordinate and harmonize their existing scientific efforts, to generate new research and encourage the training of scientists and technologists interested in entering the field of aquaculture."

Dr George Green, senior adviser at the Water Research Commission, recently addressed graduate students and staff at the University of Antwerp at the invitation of Prof Impens of that University's Department of Biology. In this extract from his talk, we present Dr Green's views on the importance and future of irrigated agriculture.

A GREEN LOOK AT IRRIGATION

Climatic diversity and also the wide variety of soil conditions in South Africa, add much complexity to agricultural research in our country. On the one hand a wide variety of crops are grown and on the other, certain crops are produced over an astoundingly wide range of climatic and soil conditions.

If one should look at an agricultural map of South Africa, we find in the south-western corner of the country a Mediterranean type climate (temperate, with winter rainfall) where the wine and deciduous fruit industries thrive and where wheat production is also important. Orchards and vineyards are commonly irrigated, while wheat is mainly under dryland (or rainfed) cultivation.

In the subtropical lowlands (below – 700 m), situated mainly in the north-east of the country and in pockets along the eastern and southern coastlines, subtropical commodities such as sugar cane, cotton, citrus, bananas, pineapples, avocadoes, tea and coffee are produced mainly under irrigation, but sometimes also as dryland crops.

The lowlands are separated from the highlands (above – 1500 m) by a very clearly defined escarpment area. A vast triangular area of this highland plateau is the area where dryland production of summer grains (mainly maize and sorghum) takes place, while small grains (mainly wheat) are produced in pockets all around the country where soil moisture conditions are favourable, either as a result of rainfall during the growing season (as in the winter rainfall region of the Western Cape), or as a result of water stored in the root zone (as in the summer rainfall areas), or as a result of irrigation. Where dryland wheat production is dependent on water stored in the profile during the preceeding rainy season, it stands to reason that the storage capacity of the soil profile is a critical factor. Also, because few soils will store more than 200 mm of readily extractable water, yields under such conditions are low, seldom exceeding 1,5-2 tonnes/ha.

I have already indicated that South Africa has a strongly seasonal rainfall pattern, with the greater part receiving its rainfall in the summer months November to March. Vast areas in the south and west of the country receive on average less than 300 mm p.a. while only the eastern part of the highland plateau, the escarpment areas and adjacent lowland or midland areas commonly receive as much as between 750-1250 mm p.a. To quote some annual evaporation totals will place these rainfall data in perspective. Class A pan evaporation varies from approximately 1500 mm per annum in the humid coastal areas to about 3800 mm per annum in the drier semi-desert areas in the west of the country.

The author, Dr George Green, senior adviser WRC who recently received a Ph D from the University of the Orange Free State with this thesis: 'Certain weather related aspects of citrus, banana, wheat and soy bean production.'

Under these climatic conditions irrigation is becoming vitally important as a stabilizing factor in South African agriculture. In total we have just over one million ha under irrigation which includes just about all our fruit and vegetable production, a considerable proportion of the vineyards and generally a smaller proportion of sugar, wheat, cotton, maize and fodder production. Because of riparian rights to water, private initiative has been able to develop irrigation most extensively in those areas where surface water (in rivers) is most abundant, viz. in the eastern and southern parts of South Africa. Our two major rivers, the Vaal and the Orange flow west into the arid areas, and it is on these rivers, along with other smaller rivers, that the State has constructed major dams and provided water to several state-developed irrigation schemes.

A few facts and figures concerning South Africa's water balance will clearly indicate that we have no unlimited irrigation potential, and that utilizing every drop as efficiently as possible may soon be demanded of us if we are to continue satisfying the food needs of a rapidly increasing population.

With a mean annual rainfall of about 480 mm on approximately $1,3 \times 10^6 km^2$, the whole of South Africa on average receives $620 \times 10^9 m^3$ of water. Once we have deducted losses (through evapo-transpiration, percolation to groundwater, uncontrollable runoff due to floods, evaporation losses from reservoirs, etc), what can be effectively stored annually is about

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A green look at irrigation

(From page 31)

$32 \times 10^9 km^3$. Already we are about 90% of the way toward developing our water resources to accommodate this annual storage potential. With an estimated $2 \times 10^9 km^3$ available from groundwater, we will thus shortly have a potential storage of $34 \times 10^9 km^3$ annually to satisfy the needs of agriculture, industry and other users of water.

If we consider our present requirements, there appears, at first glance, to be no reason for concern. Agriculture uses some $9 \times 10^9 m^3$, and other users together a further $3 \times 10^9 m^3$, in total about 40% of the annual storage potential. Even in 25 years' time we anticipate that agriculture will be allocated some $16 \times 10^9 m^3$, and other users another $10 \times 10^9 m^3$, in total about 76% of the storage potential. However, experiences during periods of drought emphasize just how precarious even the present position really can be. Last year, even when we nominally required only 40% of our annual storage potential, over half of our 70 state irrigation schemes had to cut farmers' water quotas by between 50 and 100%. In 25 years' time, when we are committed to using 76% of the average annual storage potential, a similar drought could be catastrophic, unless we upgrade water use efficiency all the time.

WRC

It was during the subnormal rainfall period late in the 1960's that leaders in government, agriculture and industry, and the public at large, became so aware of these potential water problems, that a Government Commission of Enquiry was able to recommend the formation, by an act of Parliament, of a body called the Water Research Commission. Using funds derived from a levy on all sales of water, this organisation now coordinates and promotes water-oriented research in South Africa. We provide support where it is needed, mainly to universities, but also to Government institutions and other organisations that are capable of doing the research that is needed to bring us within reach of our goal of optimal utilization of water resources. The idea is to work according to a master plan, devised, and regularly revised, in consultation with leading scientists and technologists. The Water Research Commission obviously has a wide field of responsibility, which apart from irrigation research, also includes subjects such as water reclamation and desalination, municipal and industrial effluents, surface hydrology and groundwater, and even rainfall stimulation. In the rest of this discussion, we shall focus on research problems and approaches concerning efficient use of irrigation water. We shall also assume that wasteful methods of distributing and applying water, which can be a major cause of inefficiency, have been eliminated.

UTILIZATION

In earlier years the Government developed irrigation schemes mainly for socio-economic reasons. The availability of suitable dam sites and sufficient irrigable soil suitably located in relation to these sites generally also played, and continue to play an important part in demarcating areas for irrigation development. This has led to our bigger irrigation schemes being located along the lower reaches of our major rivers (the Vaal and the Orange), in areas which can generally be described as arid. Additional arid areas have also been earmarked for further irrigation development. More and more frequently, however, the question is being asked — is this a correct policy from the viewpoint of optimal use of our irrigation water resources? Would it not be better, from now on, to site all future irrigation development in the humid regions, i.e. nearer to the source areas for irrigation water? In support it may be argued that because such areas have much lower atmospheric vapour pressure deficits, total water consumed per unit of crop yield should be considerably lower than in the arid areas. Moreover, because summer rainfall could supply a considerable part of the total water requirement in such areas, a little irrigation could be made to go a long way. Counter arguments are that because radiation intensities are lower in such areas, potential productivity is also lower. Furthermore, preferential utilization of water in the upper parts of major river basins, with lower parts able to use only surplus water, increases the risk associated with irrigation in arid areas,

(To page 33)

Welsh to export water

Welsh Water may soon enter the international field of water export, selling water to the Arab countries, says Mr Roy Webborn, Welsh Water's assistant director of finance and its water export manager in a recent issue of *Water Bulletin.* This extraordinary idea is not new since France is already exporting water to Spain.

According to Mr Webborn Welsh Water is in the fortunate position to be able to use the facilities of Milford Haven, the UK's finest oil port. The water authority noticed that one of the oil refinery terminals was closing down and the piping, previously used for loading oil tankers, could now be used for loading water. The loading arms of the jetty will simplify the operation. This in effect will mean that Welsh Water will be in a position to deliver water directly to a tanker at the rate of 250 000 tonnes per day compared to the 100 000 tonnes per week the French could manage, says Mr Webborn.

The water that is likely to be exported from Wales comes from Llys y Fran reservoir with a capacity of just over 9 million cubic metres.

Irrigation

(From page 32)

to the extent that irrigation development in such areas may be too unattractive to take place. Consequently, such surplus water may go to waste.

RESEARCH NEEDS

The question of where best to utilize our irrigation water may not look, at first glance, to be a research problem, but if we analyse it we discover research needs which can keep both fundamental and applied researchers busy for a long time. Basically we need to be able to model crop growth, yield and water use with models which are firstly user-oriented (i.e. they employ commonly observed climate, soil and genetic characteristics as inputs, and secondly, sufficiently versatile to function well given the whole range of typical climate and soil conditions experienced in South Africa. In addition, in each potential irrigation area, we must be able to identify constraints on production, and work out what measures are needed to counter them. Obviously the model itself should be useful in identifying certain constraints of a chemical (e.g. water quality), physical (e.g. soil depth), biological (e.g. canopy structure) or managerial (e.g. soil cultivation practices) nature; furthermore, by comparing actual yields with modelled yields in an area, certain constraints possibly not considered by the model (say soil fertility) may be identified, researched and attended to. Once able, in this way, to model maximum yield and associated water use, and once able to establish what inputs are needed to achieve these goals, we should potentially have a much more rational means of deciding where to utilize scarce water resources than we have at present.

Possibly through lack of concentrated effort, our crop modelling to date has not yielded results which are sufficiently precise to put this goal clearly within sight. This clearly points to deficient understanding of certain key areas of the models used.

South African water scientists have been saddened to have learnt of the death of Mr John van der Post, chief executive of the Water Research Centre, in March.

He was born in England but spent most of his youth in South Africa and graduated from Natal University in 1951.

In a short tribute published in the British *Water Bulletin,* Mr Bernard Henderson, chairman of Anglian Water, said: 'John van der Post's skills and technical abilities will be sadly missed at WRC. His warmth, generosity and infectious enthusiasm produced a friend for all seasons'.

INFORMATION REQUIRED

Dear Sir — I have recently begun work on a CSIR funded project to examine the ecological status of South African rivers and streams. This is a synthesis project of very broad scope, and the main aims will be:

- To summarise and collate previous research on rivers. (Which rivers have been or are being investigated, and what aspects have been researched?)
- To compare the present state of rivers with that established by previous baseline studies.
- To identify priorities for research input. (Which river habitats are most threatened? Which are most worthwhile conserving? How best can conservation priorities be established? What aspects should have priority for investigation?)
- To identify and establish a dialogue with all those people in South Africa who are involved in research, conservation or management in lotic systems (including industrial, domestic and recreation use).

The purpose of this letter is to solicit help with the latter aims above. There are many people in this country who have a great deal of experience of many aspects of rivers and streams. It is obviously important to make use of this reservoir of knowledge if a coherent research policy is to be established.

I am therefore interested initially in hearing from anyone with an interest in running water ecology, and especially those who are presently, or have been, involved in research programmes (particularly those not included in the CSIR "National Register of Research Projects", which I already know about). I would like to know where, on what subjects, and on what scale research is currently being carried out. I would also appreciate suggestions, ideas, information, and literature reference lists relating to the four points listed above.

Geographically, I am restricting the project to flowing water in South Africa, Lesotho, Swaziland, and the homelands. I am specifically excluding estuaries and impoundments (except in so far as they affect their parent rivers downstream), since there are separate thriving research programmes on these aspects.

I would be grateful for any reactions from your readers.

Dr J.H. O'Keeffe
Institute for Freshwater Studies
Rhodes University
P.O. Box 94
Grahamstown 6140

TOERUSTING

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

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

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

Anton Prinsloo
REDAKTEUR

SA Waterbulletin
PO Box/Posbus 824
Pretoria 0001

EQUIPMENT

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

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

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

Anton Prinsloo
EDITOR

PLASTIC PLUMBING SYSTEM

A plumbing system that lasts a lifetime; can be installed faster than any other available; needs no solvent welding; no special equipment for cutting, bending of threading; and has flexibility that makes it the most versatile system in existance for new and replacement installations . . . the answer to the prayers of architects, plumbers and merchants? Just that. It's the Acorn plastic plumbing system, by Duropenta, South Africa's innovative market leader in the field of plastic piping.

Acorn polybutylene pipes and fittings, are designed to operate continuously for 50 years at temperatures of 82°C and at 400kPa., or at 20°C at 1600kPa. Permanent and completely watertight joints are made by cutting the pipe to length and pushing into the selected Acorn fitting. Use of Acorn eliminates all electrolytic and corrosion problems associated with traditional types of piping, Duropenta claims. It is non-toxic, and therefore recommended for the transportation of potable water. Both pipes and fittings can be buried in soil or concrete and can, where necessary, be painted with standard household paints, according to Mr Bob Haynes, Duropenta's marketing manager.

Finally, Acorn is compatible with both 15mmOD and 22mmOD copper pipe, and with galvanised steel pipe. Stainless steel pipes can be adapted to push-fit into Acorn fittings.

Enquiries:
Duropenta (Pty) Ltd
PO Box 86
NEW GERMANY
3620
Tel (031) 71-2581

POSTCARD

THE CHAIRMAN
WATER RESEARCH COMMISSION
P.O. BOX 824
PRETORIA
0001

REGISTRATION

Name .....

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Area Code ..... Telephone Number ..... Telex .....

I wish to register for the seminar

SOME NEW ADVANCES IN WATER TECHNOLOGY

and enclose my cheque for R ..... as registration fee for the following:

3rd July:	WATER RESOURCES MANAGEMENT AND WATER SUPPLY CONTROL	R
4th July:	WATER AND EFFLUENT TREATMENT	R
	TOTAL	R

Signature .....

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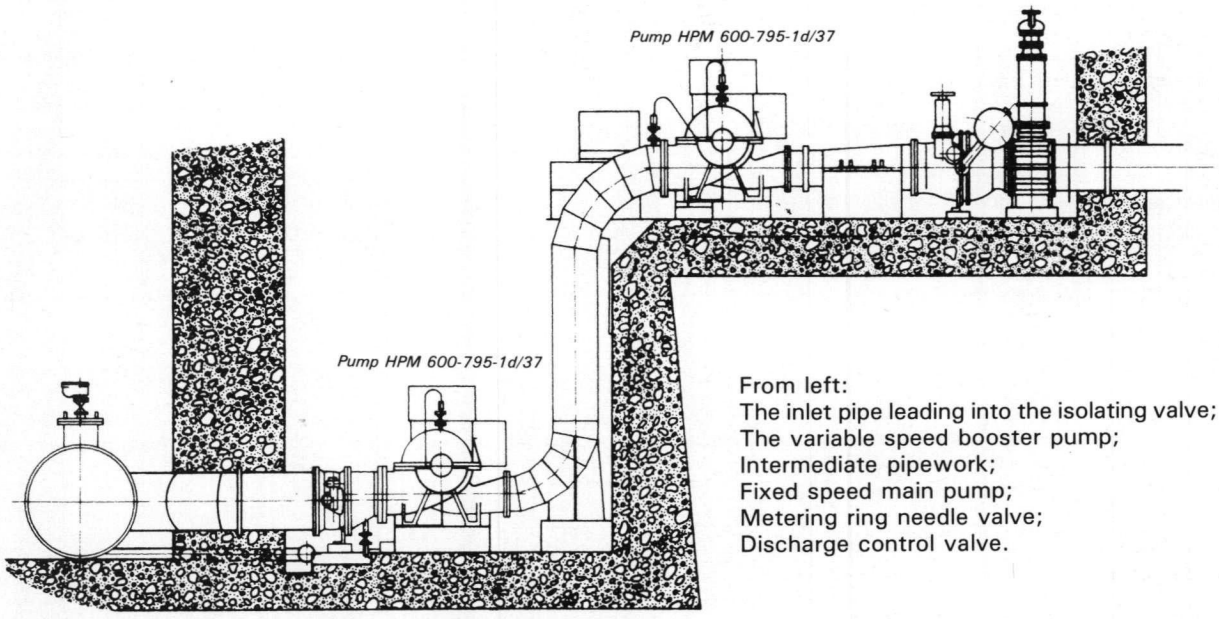
PUMP LINES FOR USUTU SCHEME



From left:
The inlet pipe leading into the isolating valve;
The variable speed booster pump;
Intermediate pipework;
Fixed speed main pump;
Metering ring needle valve;
Discharge control valve.

Sulzer Brothers (South Africa) Ltd of Johannesburg are to manufacture, supply, install and commission four pump lines for the next stage of the Usutu Vaal Water Scheme. Eight Sulzer HPM 600-795-1D/37 pumps, four of which are variable speed, horizontal booster pumps, and four fixed speed main pumps, will pump water from the Heyshope pump station about 20 km away.

The horizontal layout of the booster pumps, one of the three schemes submitted by Sulzer, is more efficient than a vertical pump system, and it also affords considerable savings by using eight identical pumps at the station.

The speed range of the booster pumps is from 635 r/min to 886 r/min, and each will be driven by a 1 232 kW motor. The main pumps operate at 990 r/min and will be driven by 1 683 kW motors. The pumps are designed for a peak capacity of 1,85 m^3/sec against a head of 184 m.

The first of the pumps, which will be 100% locally manufactured, are scheduled for delivery in March 1984.

The Toshiba cascade type variable speed drive motors will be the first of their kind to come to South Africa.

One of the fixed speed main pumps for the scheme mentioned above will now be delivered some months ahead of time for use in the emergency water supply scheme at Grootfontein pump station in the Eastern Transvaal.

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

LEAKS

The recently announced higher water tariffs in Johannesburg, together with the already implemented penalty tariff in Pretoria, is causing consumers to literally take another look at their water meters and to eliminate all possible sources of leakage. Blocks of flats, commercial and other industrial premises, are particularly hard hit as hidden leaks which develop under paved areas can cost thousands of rands monthly and yet not be visible at all on the surface. A new service specifically aimed at locating hidden leaks is now being offered in Pretoria and on the Reef.

Enquiries:
M.R. Brett
Leak Detection Services
PO Box 5617
PRETORIA 0001
Tel 47-6776

FILAMENT TANKS

Empro introduces their range of EMGLASS filament wound tanks, which they feel have reached the stage of development to be of most interest to the Effluent/Water Purification/Chemical Industry professions.

Like winding cotton onto a bobbin, resin impregnated glass filaments are wound onto a mandrel together with glass mat woven roving, etc., in consecutive layers until the requisite thickness is built up. Since glass has an extremely high tensile strength, this self same property is transferred to the tanks.

The tops and bottoms are fabricated separately and then incorporated onto the barrel to manufacture a tank.

Being essentially a fibreglass structure, the designer is able to use the various physical and chemical properties of available resins to best effect, as well as to have flexibility of design.

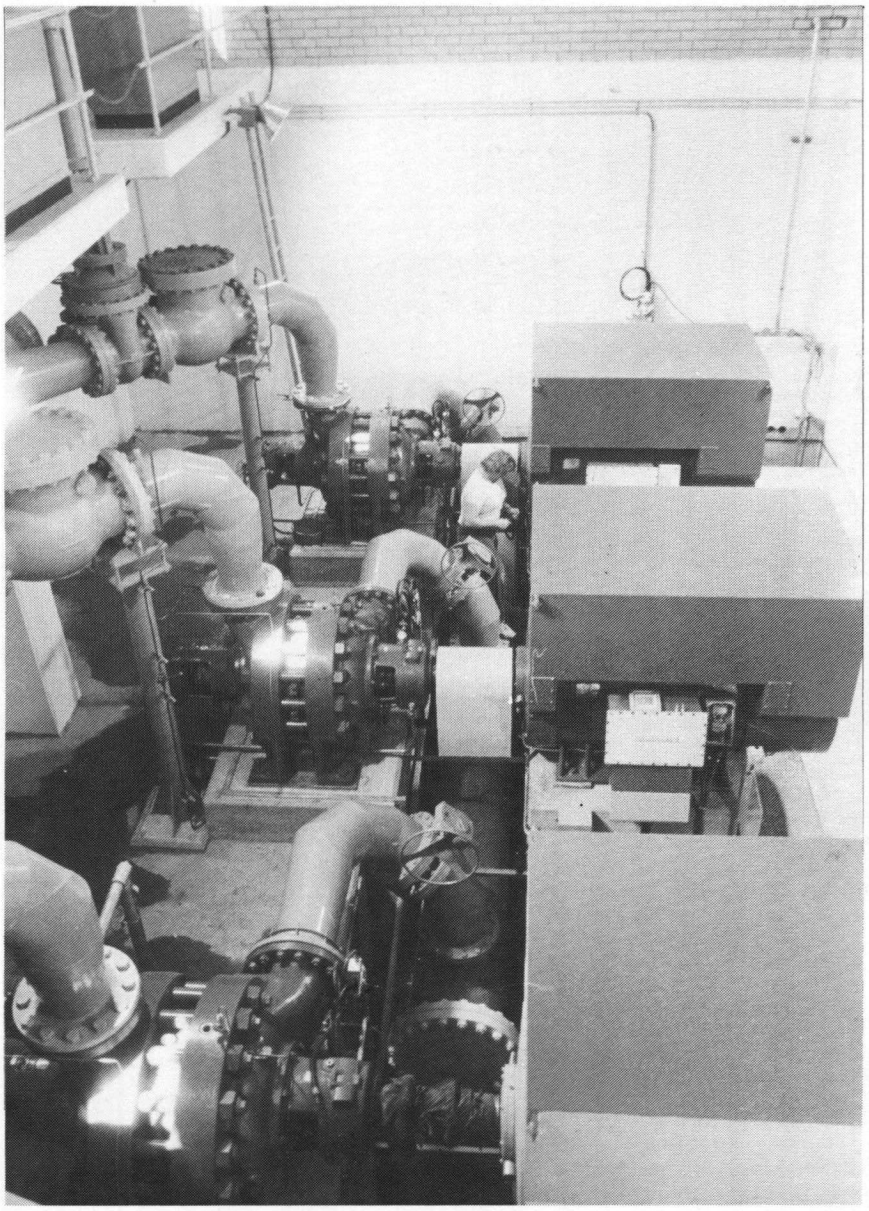
What are the benefits of filament wound tanks? Apart from the fact that chemically- and corrosion- resistant resins can be chosen:

They are
- designed for a specific task with a large built-in safety factor;
- manufactured with a smooth glossy interior which facilities cleaning;
- light weight and hence easier and in turn more economical to install;
- easily modified to accept additional fittings if so required;
- easily repaired in the event of a mishap.

They have
- enormous hoop strength;
- applications for outdoor, indoor, underground and transport purposes.

Enquiries:
Empro (Pty) Ltd
PO Box 68
Elsies River
7480
Tel 98-1843

TWO-STAGE PUMPS



Three of the Sulzer HPH58 two-stage pumps, driven by 760 kW motors commissioned by Turbo Engineering at the Walkraal pump station. The pump station at Zoetmelk is almost a replica of this station.

Turbo Engineering (Pty) Ltd recently supplied, installed and commissioned the mechanical equipment and ancillaries for the Walkraal and Zoetmelk booster pump stations which form part of the South Ndebele State Regional Water Supply Scheme. The contract was worth R1 million.

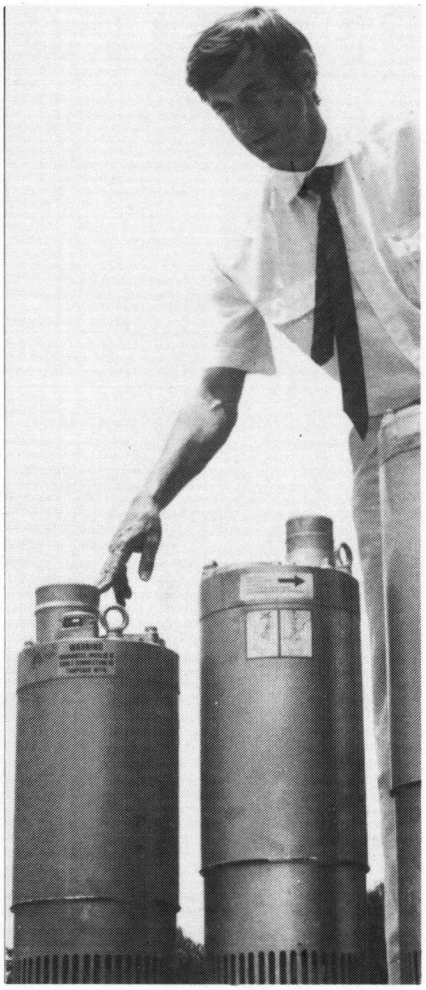
The scheme will provide potable water, drawn from the Elands River and purified at Weltevreden, to some of the more densely populated districts of South Ndebele.

The order, which was placed by the Department of Environment Affairs and Fisheries includes six Sulzer HPH 58-25 multistage high lift pumps driven by 760 kW Siemens high volt motors, as well as pipework, valves and overhead cranes. Each pump station will deliver 390 ℓ/s against a head of 240 m, with two pumps running in parallel.

The civil work for the Rhenosterkop dam, the Weltevreden purification works and pump stations and these two booster pump stations is being undertaken by the Department's construction division.

The consulting engineers for the project were Geustyn Forsyth and Joubert of Pretoria.

Enquiries:
Turbo Engineering (Pty) Ltd
PO Box 782005
SANDTON
2146
Tel 786-5244



Submersible pumps

Three new pumps have been added to the Flygt family of submersible pumps. These are slim portable dewatering pumps, with high-head characteristics, and designed for operating in confined spaces.

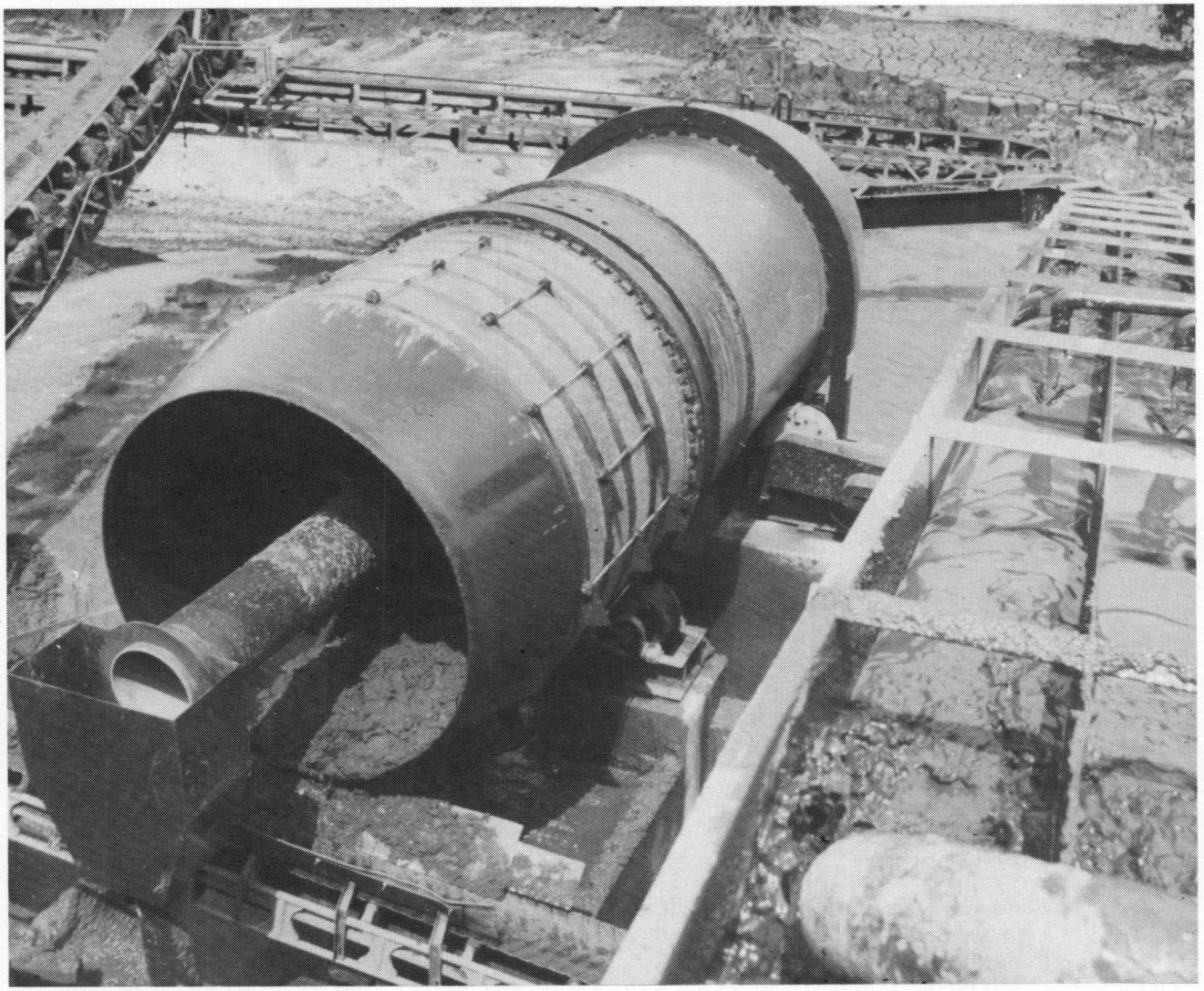
Known as the BS 2083 series, the new pumps are designed to pump clean or abrasive and contaminated liquids and because of their slim design, they can be used in confined spaces where conventional drainage pumps cannot be used. Diameter of all three is constant at 244 mm, and the largest unit is less than 1 m in height.

The BS 2083 units offer greatly improved ratings over the 2082 family which they replace. The BS 2083's can deliver up to 800 ℓ/min and heads up to 120 m, with a choice of three sizes, viz one, two, or four stage.

The stator housing and outer casing are made from corrosion-resistant aluminium, the impellers of hardened steel alloy (55-60 HRc) and the wearing parts are rubber lined.

All three sizes are stocked by Hugh Mellor, and their distributors throughout RSA.

Enquiries to:
Hugh Mellor & Co (Pty) Ltd
PO Box 700
Edenvale 1610
Tel (011) 609-4030



PELLETIZING SLUDGE

Located in a simple horizontal cylinder, the DEHYDRUM is capable of pelletizing, separating and dewatering various kinds of sludge.

As the cylinder is designed to revolve rather slowly, the system requires only a minimum power cost. In addition, the structure of the DEHYDRUM is so simple and solid that maintenance is rendered extremely easy and economical when compared with other dewatering approaches such as vacuum filter, filter pressing, centrifuge and so forth.

The DEHYDRUM is most suitable for treating sludge of massive volumes as often discharged from plants for water purification, wastewater treatment, gravel and coal washing, dredging operations, and shield-drive tunnelling works.

Enquiries:
M Fukumura
Ebara-Infilco Co Ltd
Kasuga Bldg 34-2
Shiba 5-chome
Minato-Ku
TOKYO
Tel (Tokyo) 455-7111

Ultrafiltration: brochure available

A new brochure entitled "P.C.I. Ultrafiltration Systems" is now available from Paterson Candy International Limited.

The brochure gives an introduction to the process of UF, its potential applications and the benefits of P.C.I.'s open tubular system. Typical P.C.I. commercial installations are shown for Dairy, Food, Industrial, Chemical and Pharmaceutical applications.

Copies of the brochure are freely available on request.

Enquiries:
PCI International Ltd
Laverstoke Hill
Whitchurch
Hampshire
ENGLAND
RG 28 7NR

1984: BIG BROTHER IS WATCHING YOU!

Being reminded by a computer of the water consumption for the day is the latest development in America's computer-pecked age.

This highly verbal water meter with a vocabulary of some 3200 words, was developed in an attempt to reduce the average use of water from 220 gallons to 52 gallons per day.

The meter's voice is connected with speakers in kitchens, bathrooms and laundry rooms and is flavoured with a natural sound and personal touch. A Warning from His Majesty might sound like this: "Attention, you have used more than 168 gallons of water today".

Off the press . . . Off the press . . . Off the press . . . Off the press . . .

WATER SUPPLY AND WASTE-WATER DISPOSAL — ALMANAC by Alfred Kepinski & Waldemar A.S. Kepinski

The ALMANAC is the one and only international bibliography for the transfer, evaluation, adaptation and use of existing knowledge in the fields of water supply and wastewater disposal. It enables any specialist or researcher to find adequate references and information on all questions and aspects of the subject. The increase in the scientific, technical and professional literature has made the specialist's job difficult. Compounding this difficulty has been the lack of a comprehensive bibliography devoted entirely to the literature on water supply and wastewater disposal. Effective selection of bibliography items and elaboration of the specified, classified, comprehensive, international bibliography on all relevant subject areas is the intention of a new reference work published by the International Institute for Water Supply and Wastewater Disposal. Six volumes have been published and the seventh will be issued in 1985. The six volumes contain 10,000 bibliographical entries.

The six volumes each cover a particular area. Volume 1 covers general and multi-disciplinary problems (health, hygiene, housing, human environment, communities, authorities, public utilities, public utilities, administration, management, planning, public relations, law, legislation, social factors, costs, economic factors, financing, human resources, education, training, research, investigations, methodologies, information, documentation, international relations; Volume 2 — water supply (types and characteristics of water supply systems, geographical survey of water supply systems, filtration of water, rural water supply, water supply in developing countries); Volume 3 — ground water and wells (characteristics and types of groundwater intaking, characteristics and types of wells, well hydraulics, well design and construction, efficiency and operation of wells, ageing, corrosion, incrustration and renovation of wells, pollution and protection of wells and ground water); Volume 4 — pipelines (types and characteristics of pipelines, planning, designing and hydraulics of pipelines, materials and construction, operation and maintenance, ageing corrosion, damages and protection of pipelines, contamination and water quality deterioration in pipelines, planning of networks, water meters and water metering); Volume 5 — wastewater characteristics and treatment, sludge processing and disposal; Volume 6 — wastewater disposal systems (planning, designing, operation and geographical survey of wastewater disposal systems, types and characteristics of wastewater collection and sewer systems).

Volumes 1-6 are available for 130 Dutch Guilders (approx. $50) each from:

International Institute for Water Supply and Wastewater Disposal
Gooiland 11
2716 BP Zoetermeer
The Netherlands

DESIGN OF NETWORKS FOR MONITORING WATER QUALITY

Thomas G Sanders, Robert C Ward, Jim C Loftis, Timothy D Steele, Donald D Adrian and Vujica Yevjevich.

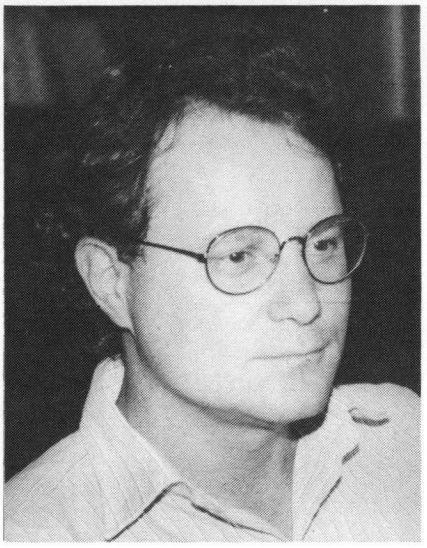
Published by Water Resources Publications, Colorado, 328 pp., illustrated.

This book is an edited summary of the manual and notes which were given to the participants of the short course *"DESIGN OF WATER QUALITY MONITORING NETWORKS"* presented by the authors at Colorado State University, first given in 1979 and represents an excellent compendium of information for practical application in the design of water quality monitoring networks.

The book deals with network design aspects which include sampling locations, the determination of sampling frequencies and the selection of variables to measure, in a more statistical and hydrological context. Procedures for sample collection, preservation and analysis, and the method of data storage and retrieval are not dealt with in the book.

Network design is discussed in the context of stream and groundwater monitoring. Many of the

APPOINTED



Walter Zucchini, well-known South African scientist, has been appointed professor in the Department of Mathematical Statistics at the University of Cape Town with effect from 1 January 1984.

Professor Zucchini researched droughts and storms in South Africa for the WRC and his final report (with rainfall maps) should provide useful information for agricultural scientists on computer-generated rainfall patterns.

He is a member of the Institute of Statistics (UK) and of the South African Statistical Association. He was born in Italy but came to South Africa in 1966 to study at the University of Natal in Mathematics, Computer Science and Mathematical Statistics where he also obtained his doctorate.

Prior to his latest appointment, he was associated with the universities in Göttingen, Lesotho and Stellenbosch.

Off the press . . . Off the press . . . Off the press . . . Off the press . . .

principles, however, apply to lake, reservoir and estuary monitoring as well.

Statistical sampling design procedures and hydrological considerations are used to enhance the design of water quality monitoring networks. A range of design techniques are presented, beginning at the more basic and concluding with techniques that are classified as intermediate. Advanced, statistically sophisticated techniques are referenced.

After an introduction to the subject, the monitoring network design problem is discussed from systems and stochastic perspectives, and the questions of location of monitoring stations, sampling frequency and water quality variable selection are dealt with in detail. A final concluding chapter deals with the step by step review of the design principles presented in the preceding chapters.

The text is supplemented by a comprehensive list of references, and problems are given at the end of a number of chapters.

This is a very useful book for undergraduate or graduate courses in the water engineering field and is an excellent basic reference for the practical design of a water quality monitoring network while it also serves to introduce the fundamentals of design to pollution control authorities, water quality professionals and the general public.

JEMc.

The American Chemical Society has just published a book on *The treatment of water by granular activated carbon,* edited by MJ McGuire and IH Suffet, in the series on Advances in Chemistry.

The book will be of interest to environmental scientists and all public water supply professionals. It reports on research in the expanding field of activated carbon adsorption for water treatment applications, this book studies theoretical modeling, competitive adsorption, biological adsorptive interactions, and case histories. Discussions are included.

Contents: Activated carbon and EPA's regulatory program; estimation methods for adsorption; adsorption of organic homologues; adsorption from dilute solutions; adsorption from the aqueous phase; surface characteristics of activated-carbon adsorption; discussion I: theoretical approaches; removal of carbon tetrachloride from water; calculating multicomponent adsorption; controlling mechanisms for GAC columns; the dynamic mini-column adsorption technique; adsorption equilibria in multisolute mixtures; discussion II: modeling and competitive adsorption aspects; adsorptive and biological TOC removal by GAC; pilot scale evaluation of ozone-GAC combinations; the Mont Valerien experiment; microbial population dynamics; mathematical description of microbial acitivity; discussion III: biological/adsorptive interactions; error estimates associated with pilot investigations; distribution profiles; chlorine dioxide and GAC; compared removal of organic compounds; GAC and carbonaceous resin compared; behaviour of organics in GAC columns; operating a full-scale GAC system; discussion IV: pilot- and large-scale studies. Index.

Information:
The American Chemical Society,
1155 Sixteenth Street,
N.W. Washington DC 20036

RSA PRESTEER

Suid-Afrikaanse waterwetenskaplikes het weer hul staal getoon deurdat nege referate uit die RSA vir die tweejaarlikse IAWPRC-konferensie aanvaar is. Dié konferensie vind in September vanjaar in Amsterdam plaas, nadat die RSA in 1982 as gasheer opgetree het.

'n Totaal van 102 referate uit 24 lande is aanvaar. Die VSA is bo-aan die lys met 20, gevolg deur Nederland met 15, en die derde plek word deur Suid-Afrika en Japan gedeel met nege referate elk.

DEVELOPMENTS IN HYDRAULIC ENGINEERING — 1

Edited by P Novak

Published by Applied Science Publishers Ltd., Ripple Road, Barking, Essex, England. 240 pp. illustrated, 1983.

This book represents an authoritative, comprehensive state of the art publication written by specialists familiar with the background and current research in their subjects. It deals with computational methods broadly related to hydraulic structures, to sediment transport problems and computation with special reference to irrigation structures and systems, and to special features of irrigation structures.

The first chapter deals with computer aided design of hydraulic structures and is aimed at better acquainting the designer with the modelling tools available.

The second chapter deals with the application of the finite element method to a wide range of problems related to flow in hydraulic structures while the third chapter deals with the essential basics of the various computational methods in the analysis and design of closed conduit hydraulic systems and recent developments in this regard.

The fourth chapter describes recent developments in designing irrigation canal systems for sediment conveyance as well as for water conveyance.

The fifth and final chapter describes some developments in irrigation structures during the last few decades and considers the main features of some non-conventional structures.

The text is well supplemented by useful references and represents a good practical evaluation of the state of the art and presents the designer with practical design tools. This is a very suitable book for practising engineers and for undergraduate or graduate courses in the field of civil engineering hydraulics, hydrology and hydraulic structures.

JEMc.

INTERNATIONAL OZONE CONFERENCE

"Although a relatively young and small country, South Africa has developed a healthy, worldclass scientific research community with expertise in a number of fields of which, one of the most important is water research".

This was said by Dr CF Garbers, President of the Council for Scientific and Industrial Research in South Africa, when he recently opened the annual International Ozone Association Conference held in Pretoria.

Attending the conference were 250 delegates from South Africa, Federal Republic of Germany, Switzerland, Belgium, Netherlands, United Kingdom, Argentina, USA, Israel and Taiwan.

In his opening speech Dr Garbers said that the IOA provides an important international platform for exchanging information on advanced water technology.

He stressed the importance of continued research to alleviate the effects of pollution and to improve water treatment technology. It is anticipated that the quality of raw water supplies will deteriorate progressively and therefore more sophisticated treatment methods are imperative and must follow suit.

"The use of ozone or alternate oxidants may offer a practical solution if any risks are involved in the continued use of chlorine as disinfectant for water," Dr Garbers said.

In his keynote address the President of the International Ozone Association, Dr Maarten Schalekamp of Switzerland sketched the most important issues of the water supply position in the world today and stressed the fact that only one third of the world population have adequate water supply and sanitation facilities.

"Since eleven million people annually die from water that carry diseases, the prevention and alleviation of pollution is a factor of prime concern. The most important target in the world for water is to give every human being an impeccable drinking water supply and a water disposal system. The water supply and water disposal problems could be solved if the priorities in every country are correctly set," dr Schalekamp said.

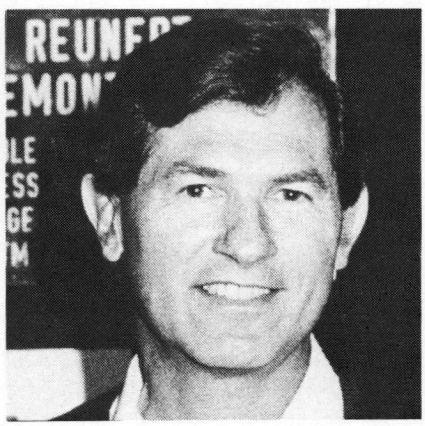
Dr Schalekamp also discussed the problems and mentioned the achievements of the water supply bodies in Switzerland and Europe. Every service water treatment plant in Switzerland uses ozone as a treatment stage and Dr Schalekamp encouraged national organizations. He said they must do everything in their power to ensure that water problems are optimally solved world-wide.

The following extracts are a summary of the papers presented at the Conference.

Dr TF Zabel
Water Research Centre, Stevenage, England

The application of ozone for water treatment in the United Kingdom — current practice and recent research

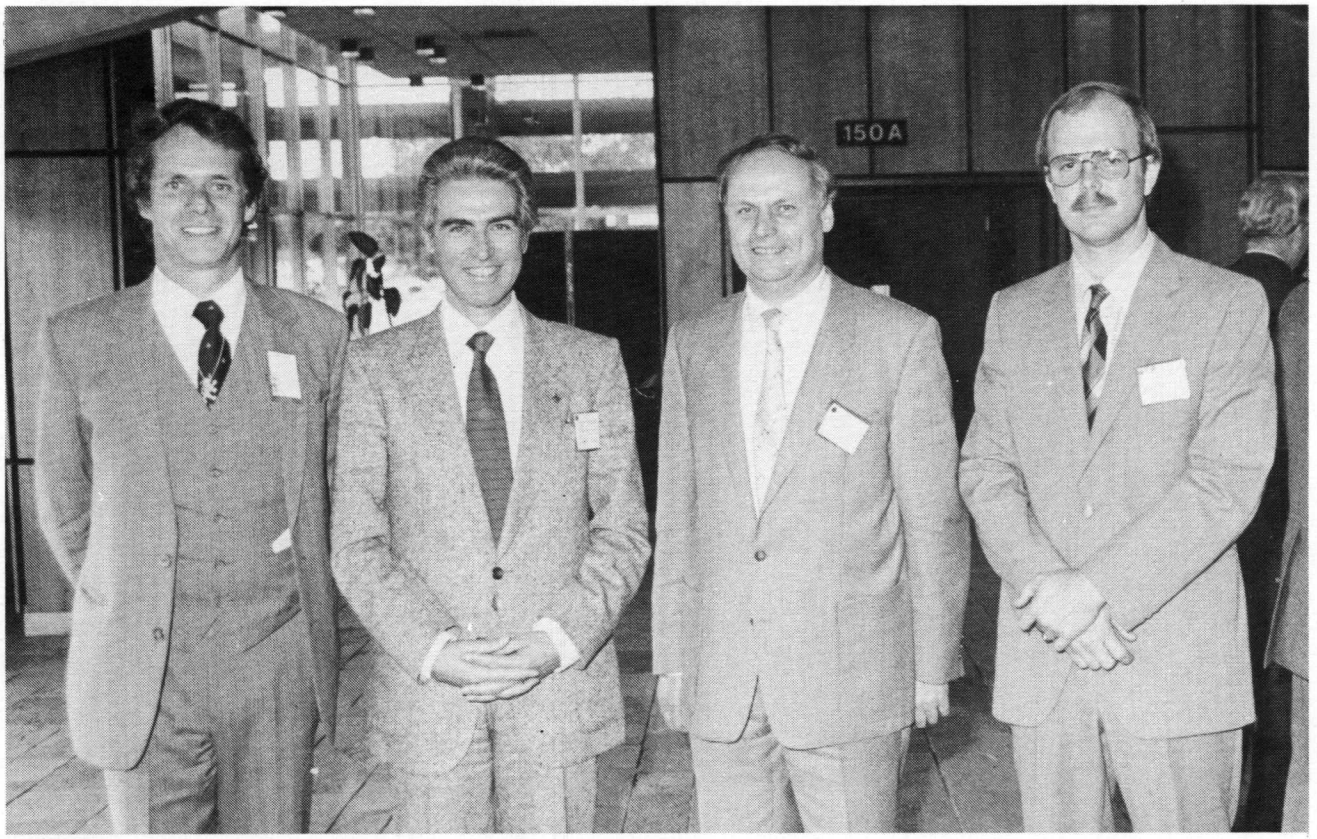
- Two water works in the UK are presently employing ozone as part of their treatment, one for taste and odour control and the other for colour removal.
- For both applications ozone was the most economical option and is successful in producing acceptable water quality.
- Trace organics in potable water is a concern which has stimulated research in the UK to use ozone for enhancing organics removal on slow sand filters and by granular activated carbon.
- Pre-ozonation followed by slow sand filtration is effective for removing the colour from coloured upland water. However pre-ozonation was generally associated with shorter filter runs.
- Pre-ozonation proved to be most promising in the treatment of lowland surface waters. It significantly increases the TOC removal in the slow sand filter and doubles the filter run length.



Y Richard
Degrémont, France

Principles of ozone disinfection and oxidation design

- Ozonation has firstly been used to improve the organoleptic qualities of drinking water.
- The improvement in knowledge of ozone transfer and the kinetics of oxidation made it possible to choose ozone-water



Members of the IOA management committee pictured at the opening of the Conference. From l to r: Mr J van Leeuwen (South Africa); Dr M Schalekamp (Switzerland); Mr A Böhme (West Germany) and Dr BM van Vliet (South Africa).

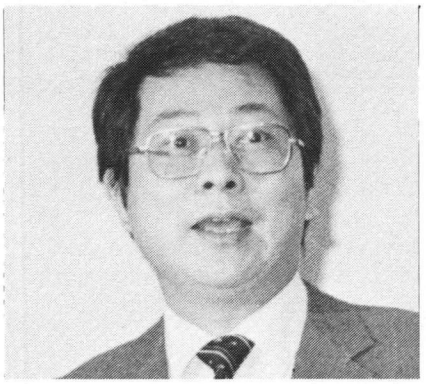
contact systems as a function of the final aim.

- To achieve the virulicide effect recommended by hygiene specialists, the system of successive contact columns seemed to be the best adapted. Techniques required for reliable monitoring of this technique are now available.
- As far as the effect of ozone on organic pollutants or minerals is concerned, new application systems can be envisaged, especially the deep U-tube.

Dr Joseph P Gould, *EP Minchew and FM Saunders, Georgia Institute of Technology, USA.*

Multistage decomposition of ozone in dilute aqueous solutions

- The kinetics of ozone decomposition in aqueous media have been investigated.
- The decomposition of ozone in water was found to be strongly influenced by the presence of trace levels of organic compounds and exposure to ultraviolet radiation.
- Once these factors were eliminated as sources of error, kinetics of ozone decomposition were shown to be strongly influenced by accumulation of ozone decomposition intermediates with changes in the reaction order (with respect to ozone) occuring as the concentration of ozone decreased.
- At a pH of 1.85, the reaction decreased from 2 to 1 to 0. These findings provided some indications of the sources of inconsistencies found in previous research on ozone decomposition.
- Such factors as the presence of trace contaminants in the reaction medium, methodology of preparation of ozone solutions and mechanics of sampling and analysis of ozone have substantial impacts on ozone decomposition kinetics.



Prof Yue-Hwa Yu, *National Taiwan University, Taiwan.*

Chemical oxidation of leachate by ozonation and O_3/UV

- Leachate collected from a local refuse fill in Tapei Metropolitan area was treated in a laboratory by various methods.

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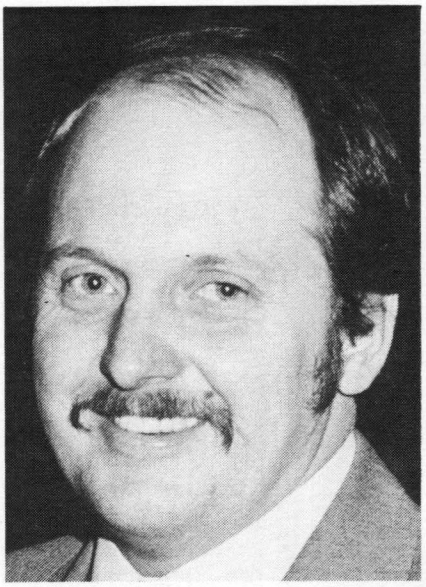
- One of the methods concerning chemical oxidation was that of the diluted and undiluted raw and prior-treated leachate by using ozone in the presence or absence of ultra-violet radiation.
- Laboratory results indicated that 6 hr ozonation with or without uv had little effect on the reduction of COD of the raw leachate, however, on the diluted samples of raw and/or biologically treated leachate, ozonation in the presence of UV showed two distinct effects over the pure ozonation process.
- Noticeable COD reductions themselves and apparent conversion of non-biodegradable organic contents into BOD were demonstrated only when UV light was turned on.

Dr KW Roennefahrt, *Preussag AG, Hemmingen, Federal Republic of Germany*

Swimming pool water treatment with ozone and granular activated carbon mixed bed filter

- Conventional swimming pool water purification uses iron or aluminium salts for flocculation filtration via sand or multiple layer filters and chlorine as a disinfectant.
- A considerable improvement in water quality is achieved by insertion of an ozone stage with an activated granulated charcoal filter.
- Experimental results and operational findings were discussed.



GJ Deysel and P Legg, Western Transvaal Regional Water Company, South Africa.

Pre-ozonation — a practical experience

- The paper dealt with the increase in the heavy metal and algae load in the Vaal River and the subsequent approach and steps taken that eventually lead to a tender for a 30 kg/h ozone plant.
- The Western Transvaal Regional Water Company purifies water for industrial and domestic bulk users. The water is drawn from the Vaal River near Orkney.
- A high heavy metal (manganese) concentration in the river water causes a major purification problem.
- Concentrations vary hourly and at times may exceed 5 mg/ℓ. High algae loads at times increase the problems.

Ozone plants for drinking water treatment and water reclamation

Peter Dyer-Smith *and Hans-Peter Klein, Brown Boverie & Co Ltd, Switzerland*

- The effect of ozone application and the performance of modern ozone plants are demonstrated with the plants in Los Angeles, USA; Dordrecht, Holland; and Jeddah, Saudi-Arabia.
- These plants have the objective to produce water of a potable quality and meet the stringent demands for water treatment plants regarding reliability, economy and flexibility.
- The use of ozone at high concentration in these three examples improved process operating parameters as well as reduced cost of either operation and/or investment.
- The reliable and efficient production of ozone at high concentration (3wt% in air and 6wt% in oxygen) by means of medium frequency ozone generators utilizing electronic components for their power supply system is well proved.

William J Cooper, *Drinking Water Research Center, Florida International University Florida, USA.*

The effect of bromide in water treatment in the presence of chlorine, chlorine dioxide and ozone

A literature review of ozone and bromide interactions and the formation of organic bromine

- Where bromide is found in water used as a source of drinking water, there are presently no treatment techniques available for economic removal of it.

- If chlorination is used for disinfection, bromide is oxidized to bromine and can result in the formation of organic bromine compounds.
- A potential treatment strategy is to use an alternative oxidant; ozone is one such alternative.
- Reactions of ozone and bromide were discussed as well as possible treatment strategies to minimize the formation of trihalomethanes when ozone is used in the presence of bromide.

Long contact time ozonation for swimming pool water treatment

Dr Dieter Eichelsdörfer and Dr J Jandit, Institut für Wasserchemie und Chemische Baineologie der Technischen Universität München, Federal Republic of Germany.

- According to the "Ozone — activated Charcoal Method" swimming pool water during oxidative purification is strained, flocculated and filtered and then vigorously mixed in a reaction container with ozone.
- Because of Germany's health regulations the water is filtered through activated granulated charcoal to remove the ozone, before it enters the pool.
- Disinfection is achieved with a depot action, by adding small quantities of chlorine to the purified swimming pool water.
- Ozone and water are in contact for a maximum 2 to 3 minutes.
- Because reaction between the ozone and the swimming pool impurities occur slowly, the purification efficiency can be enhanced by increasing the duration of the contact between the ozone and the water.
- Protracted contact periods of up to 20 minutes are achieved with the newly developed "Ozone — Kombiblock Method." In a single unit the ozone reaction container, the intermediate reservoir and an open multiple layer filter are combined.
- Studies of the trihalogen — methane formation potential at various points in the purification show that the formation of these undesirable volatile chlororganic compounds can, to a great extent, be avoided by this process.

Dr Chaim Rav-Acha, *the Hebrew University of Jerusalem, Israel, E (Goldstein) Choshen, E Serri and B Limoni.*

Combination of chlorine dioxide and chlorine as a means for minimizing the formation of undesirable by-products during the disinfection of drinking water

- Although chlorine dioxide does not form trihalomethanes (THM) in drinking water and produces very few non-volatile haloorganic materials, intensive investigations bearing on the chlorite by $C\ell O_2$ disinfection reveal that the rate of chlorite formation reflects the rate of $C\ell O_2$ consumption and as long as the amount of $C\ell O_2$ applied is behind its demand, about 60% of the chlorine dioxide consumed is converted into chlorite.
- This is in accord with data reported on $C\ell O_2$ reactions with organic models, for which each mole reacts with two moles of $C\ell O_2$ converting one mole into chlorite and the other into chlorine or other chlorinated species.
- From the point of view of health effects this is of great significance, as high concentrations of chlorite may cause hemolytic anemia.
- Mixtures of $C\ell_2$ and $C\ell O_2$, which may successfully reduce the formation of haloorganic compounds, as well as of chlorite in the absence of bromide, fail to do this where water rich in bromide is concerned.
- As a result of bromide oxidation by chlorine, bromine is formed, which in turn reacts more intensively with organics than does chlorine, and thus favours the formation of THM and other halogenated organic materials.
- This problem can, however, be circumvented if $C\ell O_2$ is allowed to react in water with the organic precursors before chlorine is introduced. A pretreatment with 1 ppm of $C\ell O_2$ two hours before the application of 2 ppm $C\ell_2$, was found to reduce the formation of THM by 60% relative to its formation by chlorine alone, and the chlorite is reduced in this case by up to 90% relative to its formation by chlorine dioxide alone.
- This is of particular importance since it can solve some of the major problems bearing on the impact of disinfection upon the formation of undesirable by-products.

Sulpher dioxide disinfection for agricultural reuse of wastewater

V Dean Adams, Utah State University, Utah, USA, Robert T Green, International Environmental Inc, Salt Lake City, Utah, USA and Richard Lewish, Environmental Inc, Johannesburg South Africa.

- Wastewater disinfection with sulphur dioxide is technically feasible.
- Sulphur dioxide disinfection is a function of free sulphur dioxide concentrations, pH, and contact time.
- Irrigation with sulphur dioxide acidified water can result in increased crop yields.
- Acidification of irrigation water with sulphur dioxide will reduce soil sodium levels, and irrigation water alkalinity.

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- Reuse of sulphur dioxide disinfected wastewater can be accomplished with or without an available source of dilution water for final pH adjustment.

Dr Walter J Weber *Jr, University of Michigan, USA.*

Activated carbon systems for treatment of waters and wastewaters

- The presentation centred on the role of activated carbon in the removal of organic compounds from waters and wastewaters.
- Examples of common trends and of differences in adsorption were given for representative compounds of concern, and the effects of such variables as carbon type and background waste composition were illustrated.
- The application of mathematical modelling techniques for design of adsorbers for organic pollutant removal was demonstrated.
- The role of bioactivity in granular activated carbon systems and the synergistic use of powdered activated carbon in biological waste treatment systems were summarized.

The influence of ozone and chlorine on biological activity in biological activated carbon

J van Leeuwen, University of Pretoria, EM Nupen and PA du T Carstens, National Institute for Water Research, South Africa

- Ozone treatment of activated sludge effluent lead to increased biodegradability of the organic substances not removed during activated sludge treatment compared with no treatment or chlorine treatment.
- Pre-ozonation of activated sludge effluent before BAC treatment resulted in increased microbial growth on BAC compared with no pretreatment, prechlorination or preoxygenation.
- Pre-ozonation of activated sludge effluent was most effective in resulting in larger microbial populations on BAC at a dosage of about 5 mg/ℓ. Smaller or larger dosages were less effective.

Dr A Netzer, *University of Texas, USA, JL McNutt & RP Smith*

Ozone and activated carbon for tertiary wastewater treatment

- Ozonation followed by activated carbon for tertiary wastewater treatment for biologically and physically-chemically treated wastewater effluents was studied at Duck Creek Wastewater Treatment Plant in Garland, Texas.
- This 30 MGD treatment facility operated in a split-stream mode, with 7.5 MGD treated by biological processes and 22.5 MGD treated by physical-chemical processes.
- Final treatment for both systems consisted of granular activated carbon treatment and chlorine disinfection.
- The tertiary treatment of the biologically and physically-chemically treated wastewaters by ozonation followed by activated carbon was evaluated in terms of TSS, BOD, COD and TOC.

Dr Enos L Stover, *Ali Fazel and Don F Kincannon, Oklahoma State University, USA*

Powdered activated carbon and ozone assisted activated sludge treatment for removal of toxic organic compounds

- Industrial wastewater effluent standards in the United States are being established in terms of both conventional parameters like BOD and toxic specific organic compounds called priority pollutants.
- Some of these compounds are difficult to treat biologically and the removal mechanisms may include biodegradation, stripping, sorption, and/or combinations of these removal mechanisms.
- The biological treatability of over 30 of these compounds has been investigated in detail in the Bioenvironmental Engin-

Suid-Afrikaanse Nasionale Komitee vir die Internasionale Genootskap van Hidrologiese Wetenskappe

Registrasievorm vir Suid-Afrikaanse Hidroloë

1. Titel en volle name: .....

2. Besigheidsadres: .....

   .....

   .....

3. Telefoonnr. (Kantoor): .....

4. Vakrigting (bv. siviele ingenieurswese, geografie, limnologie, landboukunde ens.):

   .....

5. Hoogste akademiese kwalifikasie .....

6. Toon asb. (deur af te merk) watter van die volgende Internasionale Kommissies u belangstelling in hidrologie weerspieël.

   Internasionale Kommissie vir Oppervlakwater
   Internasionale Kommissie vir Grondwater
   Internasionale Kommissie vir Sneeu en Ys
   Internasionale Kommissie vir Watergehalte
   Internasionale Kommissie vir Waterbronstelsels
   Internasionale Kommissie vir Vastelanderosie
   Internasionale Kommissie vir Afstandsaftasting en Datatransmissie.

7. Merk asb. hoe u tans by hidrologie betrokke is.

   ☐ Student
   ☐ Onderwyser/dosent
   ☐ Voltydse navorser
   ☐ Praktiserende hidroloog
   ☐ Hidrologiese Tegnikus
   ☐ Bestuurder
   ☐ Afgetree maar stel belang
   ☐ Hidrologie 'n klein komponent van u beroep.

Stuur asb. aan dr PJT Roberts, Waternavorsingskommissie, Posbus 824, Pretoria 0001.

(Bylae tot SA Waterbulletin: Mei 1984)

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eering Laboratories at Oklahoma State University over the past few years.

Use of ozone and activated carbon in German waterworks

Dr Wolgang Kühn, University of Karlsruhe, Federal Republic of Germany

- Adsorption onto granular activated carbon filters and ozonation are treatment steps which have commonly been used in German waterworks for a number of years.
- These treatment steps also have their advantages and disadvantages with respect to water quality.
- Possible contradicting effects when using chlorine are well known, e.g. formation of haloforms and other more polar chloroorganics. But adsorption and ozonation may also lead to problems if improperly used.
- The advantages and disadvantages of both activated carbon filters and ozonation were discussed in detail.

JC Geldenhuys, *SW van der Merwe and GP van der Walt, Rand Water Board, South Africa.*

Pilot scale evaluation of granular activated carbon as a unit treatment process in the production of potable water

- The pilot study at the Rand Water Board has shown that easily measurable chemical and physical properties of water such as DOC content and UV-extinction can give an indication of the performance of an activated carbon.
- Results show that the use of the granular activated carbon treatment process could be beneficial to the Board in the production of potable water with regard to:
  - Reduction in total dissolved organic carbon content
  - reduction in the concentration of THM precursors and thus the reduction of THM compounds found in water after chlorination.
  - reduction in colour and
  - reduction in chlorine demand
- The only true test to evaluate the performance of an activated carbon is in a column study where the carbon is subjected to the water that will be treated in practice.
- Indications are that a granular activated carbon which would be suitable for the treatment of clarified Rand Water Board water should have a medium high iodine number, a small effective particle size and show adsorptive activity in both of the micro- and mesopores areas.

The kinetics and products of ozonolysis of synthetic dyes

JP Gould and KA Graff, Georgia School of Technology, USA

- The application of ozone to the removal of several synthetic organic dyes from dilute acqueous solutions has been examined under carefully controlled conditions of concentration and pH.
- Included among these dyes are several of wide use in the paper industry.
- The dyes have been ozonated at pH values in the range of 5-9.
- The poster also dealth with product identification studies being conducted by use of innovative chromatographic and mass spectrometric techniques.

Dr H Winkler, *Lurgi Umwelt and Chemotechnik GmbH, Federal Republic of Germany*

Granular activated carbon used to combat groundwater pollution by chlorinated hydrocarbons: present experience in Germany

- Latest research on groundwater quality in areas of intensive industrialization, shows various levels of contamination with chlorinated hydrocarbon solvents. These compounds are known to be hazardous to health.
- Activated carbon adsorption is the most reliable and practical technology and helped to control and abate this new threat to potable water supplies.
- At various industrial sites in Germany, co-operative efforts are being conducted to get chlorinated hydrocarbon levels controlled and reduced.
- Dr Winkler's presentation also dealt with the efficiency and results of using particular qualities of activated carbon, as well as the treatment schemes that have successfully been applied.

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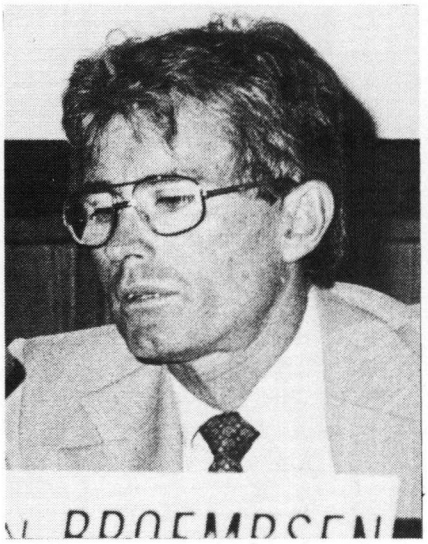
The fate of polycyclic aromatic hydrocarbons (PaH's) upon the disinfection of drinking water with chlorine dioxide

Dr Chaim Rav-Acha and R Blits, The Environmental Health Laboratory of the Hebrew University Medical School, Jerusalem

- Polycyclic aromatic hydrocarbons (PaH's) are considered as an unique and important class of aquatic micropollutants because of their prevalence in the aquatic environment and many water sources, and because of their exceptional tumorigenic potency.
- A comparison between $C\ell_2$ and $C\ell O_2$ with regard to their reactions with a series of polycyclic aromatic hydrocarbons (PaH's) showed that the $C\ell O_2$ reactions are more unique.
- While the highly carcinogenic compounds, benz(a)pyrene and 1,2-benzanthracene react with $C\ell O_2$ much more rapidly than with $C\ell_2$, other PAH's such as naphthalene and fluoranthene, which ract quite easily with chlorine, react very slowly or not at all with chlorine dioxide.
- In contrast to chlorine which reacts by few possible pathways, chlorine dioxide reacts mainly as a one-electron acceptor.
- Where water rich in bromide is concerned, it was found that while $C\ell O$ reactions are not affected by bromide, the reactions of $C\ell$ with various PAH's become considerably faster. It seems that as a result of bromide oxidation by chlorine, bromine is formed, which in turn reacts much faster than chlorine with various PAH's. Chlorine dioxide on the other hand does not oxidize bromide.



DS von Broembsen *and PA Laxen, Council for Mineral Technology, South Africa*

OVERSEAS VISITORS AT IWPC SEMINAR

Dr WHJ Hattingh (extreme right) senior adviser WRC, who chaired the IWPC seminar on organo-chlorine compounds in water, in conversation with from left Dr T Zabel, Mrs S van Biljon, chairman of the IWPC (Southern African branch), and Dr Ron Packham, UK.

The testing and commissioning of a novel resistive heating furnace for the reactivation of carbon from a carbon-in-pulp circuit

- A totally new concept of heating carbon granules has recently been developed in South Africa and is based on the fact that a bed of dry, activated carbon granules acts like a ''semi-conductor'' in that it conducts electricity but has appreciable resistance.
- A bed of carbon granules, previously dried, can be heated rapidly by mains current to temperatures of up to and over 1000°C and steam passed through the bed, which has been heated to the requisite temperature, to yield reactivated carbon.
- This concept, together with the use of a three-phase star configuration, was used in the design and installation of a plant scale furnace- known as a ''Rintoul'' furnace- in the CIP circuit at Rand Mines Milling & Mining (RM3).
- This installation has a capacity of 5 tons of reactivated carbon per day.
- A method has been developed to characterize the influence of oxidative pretreatment on solid phase adsorbate distribution, and regenerability of activated carbon.
- This method is based on thermal analysis principle and consists of heating the carbon under a nitrogen purge up to 850°C, while simultaneously monitoring mass loss.
- Adsorbate fractions are characterized with respect to temperature intervals.
- Three aspects considered were:
  - influence of type of oxidant using new carbon
  - influence of type of oxidant using regenerated carbon and
  - influence of ozone dosing level

The most pertinent advance in adsorbate characterization is the possibility quantify the highly volatile fraction (desorbing at temperatures below 180°C), by distinguishing between moisture and adsorbate in this temperature range. The comparisons in this study have focussed on carbon regenerability as a function of different oxidants applied to the liquid phase.

Behavior of thick coatings and elastomeres exposed to ozonated water

GE Kurzman, Ozon Wasser Technologie, Walldorf, Federal Republic of Germany

- The presentation concentrated on the disintegration of thick coatings and elastomeres of various substance groups.
- Corrosion of thick coatings:
  - Investigations of ''thick coatings'' which have been exposed to ozonated water showed the removal of scaling deposits, the delamination of the coating and rust formation below the coatings.
  - Carbon containing filter materials such as anthracite or activated granular charcoal accelerate corrosion of the basic metal by local contact of particles on exposed surfaces, which results in pitting. Repairs were successful, only when a rubber-based coating was used.
- Corrosion of elastomeres:
  - In practice elastomeres were found not completely impervious to ozonated water.
  - These materials were exposed to ozone concentrations of between 0,5 and 1,2 mg/ℓ of water, for one or two years, during which time the following tests were conducted: shrinkage and surface changes (at elastomere sleeves) and cracking (splitting) with infiltration and peeling (at valve discs coated with elastomere).
  - Results to date show that the elastomere EPDM (ethylene-propylene-dienepolymer) cannot be regarded as ozone resistant. In contrast the thermoplast known as rigid-PVC exhibits excellent resistance to ozonated water.

finally . . .

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'Water may be dumb, but it is not harmless. Witness the following tale (and witness too the subtlety of the treskaidekaphobial 'thirteen' in the first verse):

I had a thirteen-stone daughter
who sank in our pool with a thud.
(You can only run across water
if you happen to be Bola Zudd).

'I have also been taken to task (and to Sun City) by a member of a cultural organization for not publishing more of my Afrikaans verse which, up to now, I have been saving for a posthumous collection. So I leave you with one of my famous bird quatrains:

Ek luister na die hadida
ver bo die dam se water.
Hy klink geweldig la-di-da
vir 'n ding met so 'n snater...

Wasmiddel sonder fosfaat positief begroet in Europa

Volgens die tydskrif *H_2O,* het 'n ondersoek wat in Nederland gedoen is, aan die lig gebring dat verbruikers wat nog altyd 'n wasmiddel sonder fosfaat gebruik het, positief gereageer het op die wasprestasies van middels sonder fosfaat. Die verbruikers wat in die tydperk van die ondersoek gratis fosfaatvrye en -arme wasmiddels gebruik het, het geen probleme ondervind om na die nuwe wasmiddel oor te skakel nie.

Die beleid van die owerheid is gerig op die vermindering van die fosfaatgehalte van wasmiddels, maar die markaandeel van fosfaatvryemiddels is egter in verhouding nog klein.

CONFERENCES AND SYMPOSIA

LIMNOLOGY

A symposium/workshop on perspectives in southern hemisphere limnology will be held from 2 to 13 July 1984 in Wilderness, Cape Province, RSA. Enquiries: Mrs L Lombard, Ecosystem Programmes, CSP: CSIR, PO Box 395, Pretoria 0001.

PUMPS

The World Pump Expo is to be held from 24 to 26 July 1984 in Melbourne Australia.
Enquiries: IR Ustick, Rose Exhibitions, 437 St Kilda Rd, Melbourne, Victoria 3004, Australia.

REUSE

The Water Reuse Symposium III will be held from 26 to 31 August 1984 in San Diego, California, USA.
Enquiries: Jon DeBoer, AWWA Research Foundation, 6666 West Quincy Ave, Denver, Colorado 80235 USA.

MICROBIOLOGY

A course (435) on Sanitary microbiology will be presented by the British Council from 2 to 14 September 1984 in Leeds/Malham.
Enquiries:The British Council, 170 Pine Street, Arcadia, Pretoria 0083.

IWPC

The IWPC annual conference and exhibition (British) will be held from 10 to 13 September 1984 in Glasgow, Scotland.
Enquiries: IWPC, Ledson House, 53 London Road, Maidstone, Kent, UK.

AQUATECH

The Aquatech 84 exhibition, combined with the 12th IAWPRC conference, will be held from 17 to 20 September 1984 in Amsterdam.
Enquiries: Aquatech, Waalhaven ZZ44 3088 HJ Rotterdam, Netherlands.

WASTEWATER

The 4th IAWPRC workshop on instrumentation and control of water and wastewater treatment and tranport systems will be held in Houston and Denver from 27 April to May 4 1985.
Enquiries: Dr HNS Wiechers, Water Research Commission, PO Box 824, Pretoria 0001.

WASTE TREATMENT

The 1st Asian Conference of IAWPRC on the treatment, disposal and management of human wastes is to be held in Tokyo from 1 to 3 October 1985. Abstracts by 30 November 1984.
Enquiries: IAWPRC, Alliance House, 29-30 High Holborn, London WCIV 6BA, UK.

SA WATERBULLETIN

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

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Editor: Anton Prinsloo
Asst editor: Jan du Plessis
Ed. asst: Marietta Theron

finally . . .

DANGER! WATER

Very few people seem to know that the word 'snob' was derived from the Latin abbreviation, *s. nob.* for *sine nobilitate:* 'without nobility'. (It is completely irrelevant to what Nogden Ash told me, but I thought you may like to know.)

Had a call from Nogden again. That celebrated raconteur, the Ali of anecdotes, had just returned from a spot in the Lowveld where he had tried, unsuccessfully, to negotiate sole rights for the export of water from South Africa to a Neighbouring State.

'Water,' Ogden said, 'knows no international boundaries. Water, in fact, knows very little, if anything. It is a dumb but essential commodity, a farcial liquid stream of gold, and, not unlike the Vaal Barrage, a pool of problems.

'A shortage of water, however, is a terrible thing. As witness the real truth behind an old nursery rhyme:

Little Tommy Tucker
sucked a lemon sucker.
The sucker dried
and Tommy died —
his lips refused to unpucker.

'(They did, eventually, I believe, under traumatic surgery.)

'You may think,' he continued (without permission), 'or then again you may not, as the fancy takes you, that I am never serious. What a joke. *Viz:*

The other day
I had to cry,
I'd failed to drink
Canada dry.

'That little ditty (sung to a minor key of the dirge: ''I'd rather be a sprinkler than a drip'') cheers me immensely. As does my frivolous transcription of Coleridge's *Mariner:*

Water water everywhere
nor any drop to drink.
If you've ever tasted ice
cold beer
this would not even make
you think.

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