SA waterbulletin

ISSN 0248-2244 Volume 17 No 2 1991 April 1991

WATERBESTUUR
Elektrochemiese fosfaatverwydering toon belofte

WATER MANAGEMENT
NATSURV guides for industrial water use

SEWAGE SLUDGE
ASP process for sewage sludge evaluated

WATER INSTITUTE OF SOUTHERN AFRICA

Technical Division for Water Distribution

ONE DAY SEMINAR : JUNE 12, 1991

TITLE:	Water Distribution : Management, maintenance and measurement
VENUE:	Kempton Park: Recreation Hall at the Kempton Park Golf Club
TIME:	09:30 for 10:00
COST:	R40,00 per person (includes tea, lunch and papers)
PROGRAMME:	Keynote Address: Management of Water Supply – T.H. Proudlock Overseas practice – Prof J Haarhof
Paper 1:	Pipe Rehabilitation – E Gregor
Paper 2:	Use of Data loggers in the Management of water networks – J P Marè

The afternoon session will comprise group discussions on three areas:

1. The role of the Technical Division – what you expect from it.
2. Research needs in Water Distribution.
3. Problems being experienced.

Should you be interested in attending this one day seminar please complete the applicable post card in this bulletin.

Enquiries to: Mrs S van Biljon or Mrs M Dawson at
Tel: (011) 728-4303
Fax: (011) 483-1253

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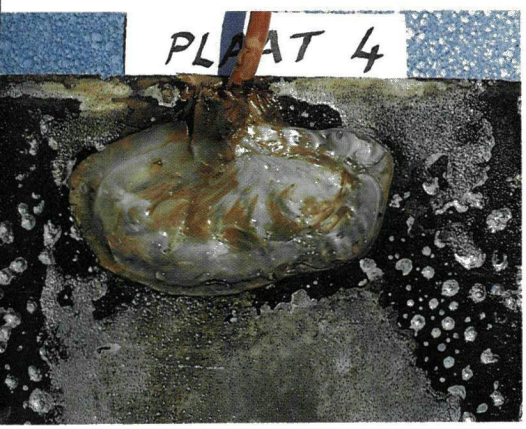

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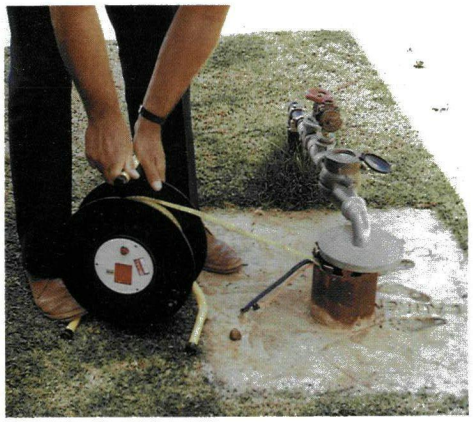

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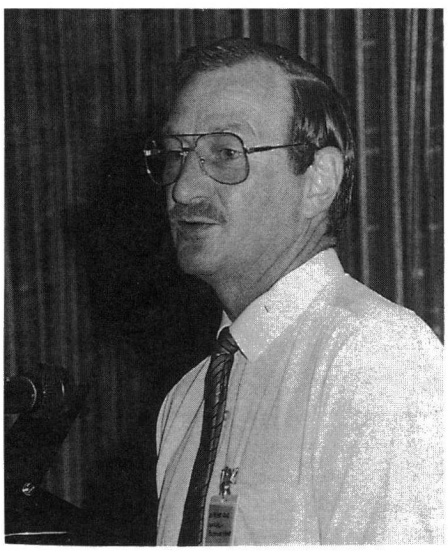
Contents

SA Waterbulletin is a two monthly magazine on water and water research published by the South African Water Research Commission (WRC), a statutory organisation established in 1971 by Act of Parliament. Subscription is free. Material in this publication does not necessarily reflect the considered opinions of the members of the WRC, and may be copied with acknowledgement of source. Editorial offices: WRC, P O Box 824, Pretoria, 0001, Republic of South Africa. Tel: (012) 330-0340. Fax: (012) 70-5925. Editor: Jan du Plessis, Asst Editor: Helene Joubert, Ed Secretary: Rina Human, Typesetting: Type Technique, Colour separations: Lithotechnik, Printing: Creda Press, Cape Town.

Mr Piet Odendaal (Executive Director, WRC) opening the annual meeting.

Dr Paul Roberts (Dept Water Affairs) addressing the meeting.



Dr Peter Reid (WRC) Rivers, Research Programme Manager.

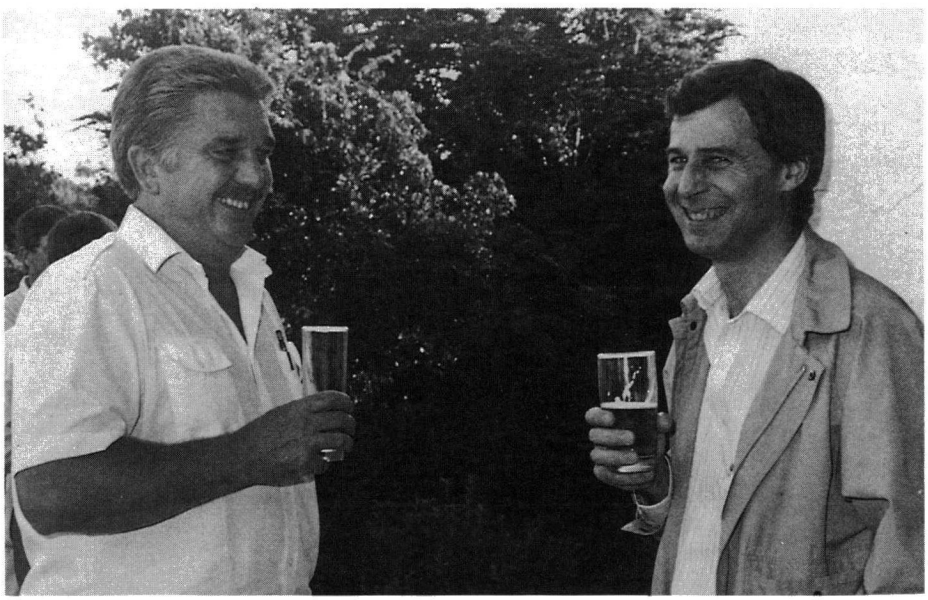
FIRST ANNUAL M
of the
KNP RIVERS RES

Recently some 50 research workers, managers, consultants and other delegates gathered at the Rhoode Valley Country Lodge near Pretoria, for a comprehensive two-day meeting of all involved in the Kruger National Park Rivers Research Programme.

Seminars and reports by the various research workers certainly emphasised the wide range of projects and the various aspects of the environment, water, ecology and even socio-economic development in the eastern Transvaal, involved in this multi-disciplinary research programme. This gave the individual researchers the opportunity to get to know one another and the various projects on which they are working.

Dr Andrew Deacon confirmed that the general feeling amongst the researchers was one of greater undersanding of the complexity of the programme, where it is headed and where each one's research fit into the programme.

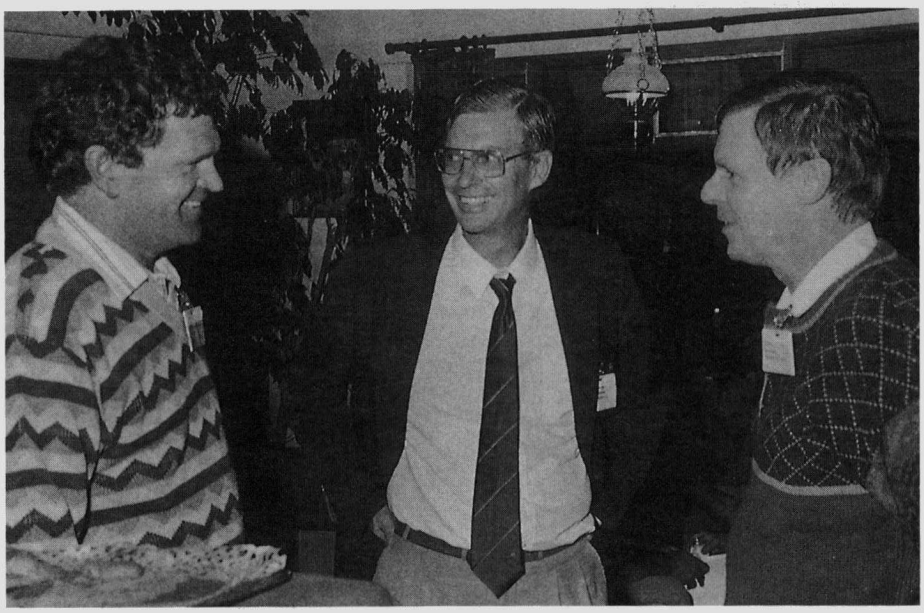
According to Dr Jay O'Keeffe the two day meeting "was a marvelous opportunity in creating a network amongst the researchers" and giving them a broader perspective of the Kruger Park rivers situation and showing the need to study any one of the rivers as a whole and not merely the section within the Park boundaries in order to eventually be able to give realistic answers on water requirements for the Park.



Prof Bernie Moon (Wits) and the colleague Dr Chris James (Wits) enjoying a beer after a day of seminars and reports.

IEETING

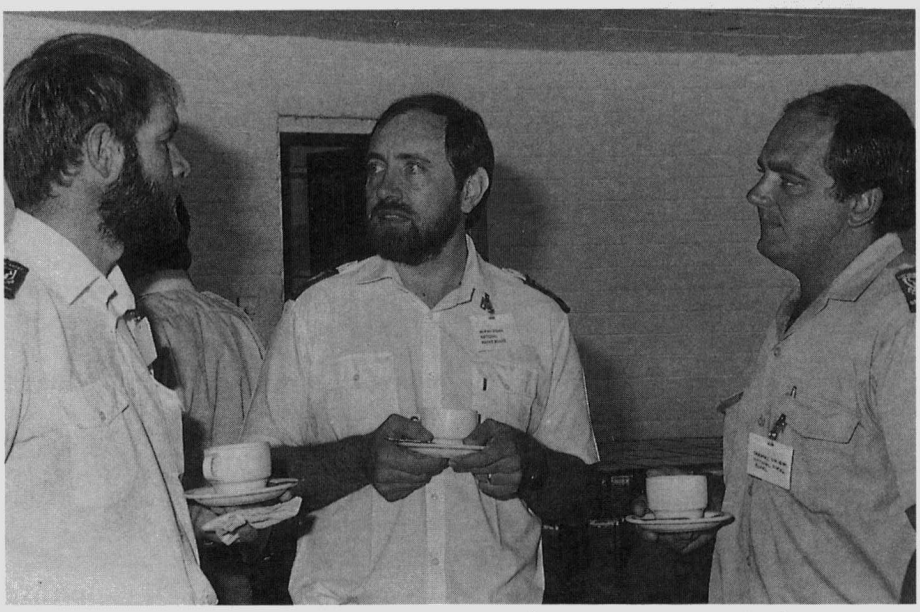
EARCH



The extent of the programme now became apparent to all present and according to Dr Peter Reid, programme manager, "almost everyone was surprised at the breadth of the programme".

Dr Reid said that with this research meeting he and the co-ordinating committee became very aware of communication gaps between administrators and researchers, emphasising the need for a strong line of communication between these two parties.

The annual meeting indeed was an opportunity to meet fellow researchers, identify problems and find out where your project fits into the "big picture"!



Top: Ecologists Dr Noel van Rooyen and Prof George Bredenkamp from the University of Pretoria having a word with Dr Willem Gertenbach (KNP).

Middle: Research officers from Kruger National Park, Dr Freek Venter, Dr Petri Viljoen and Gerhard Strydom.

Bottom: Dr Paul Mulder (Water Affairs), Mr Piet Odendaal (WRC), Mr David van der Merwe (WRC) and Dr Danny Walmsley (FRD) discussing the programme.

Elektrochemiese fosfaatverwydering kan soutlading van uitvloeisels verlig

'n Studie wat deur die Waternavorsingskommissie gefinansier is, toon dat elektrochemiese koagulantproduksie 'n lewensvatbare metode vir die verwydering van fosfate uit munisipale uitvloeisels is en die las wat chemiese fosfaatverwydering op die omgewing plaas, kan verlig. Die studie is by die Departement Chemiese Ingenieurswese aan die Universiteit van Pretoria uitgevoer deur G G Lempert en W A Pretorius en het sestien maande geduur.

Die navorsers sê vanweë probleme wat met biologiese fosfaatverwyderingsprosesse ondervind word, naamlik om deurentyd aan die uitvloeiselstandaard vir fosfaat te voldoen, word daar by die meeste rioolsuiweringswerke addisionele chemiese fosfaatverwydering toegepas.

Tans word metaalsoute vir hierdie doel gebruik. Dit veroorsaak egter dat die opgeloste soutkonsentrasie van die uitvloeisel verhoog word, omdat slegs die metaalkatioon gebruik word vir fosfaatverwydering, terwyl die anioon (die sout) in die water vrygestel word. By water wat hergebruik word, soos byvoorbeeld by die Vaalrivierbarrage, lei hierdie praktyk tot die stelselmatige versouting van die water.

Die navorsers sê daar is in hierdie studie na 'n alternatiewe proses gekyk waar slegs die katioon wat benodig word as koagulant, tot die uitvloeisel toegevoeg word. 'n Elektrochemiese proses met 'n bipolêre selkonfigurasie en ysterelektrodes is gekies vir die eksperimente.

Laboratoriumondersoeke het getoon dat die stroomdigtheid die enkele parameter is wat die grootste invloed op die doeltreffendheid van die sel uitoefen. Die navorsers sê 'n lineêre verband kon gevind word tussen stroomdigtheid en seldoeltreffendheid wat, tesame met Faraday se "wet", gebruik kan word om die hoeveelheid yster te bepaal wat sal oplos vir 'n bepaalde stroom wat deur die selle vloei.

Volgens die navorsers is die elektrolitiese sel in 'n geaktiveerdeslykloodsaanleg, wat as biologiese fosfaat- en/of stikstofverwyderingsproses bedryf kon word, getoets. Goeie fosfaatverwydering kon verkry word met die opstelling wat die doeltreffendste was, naamlik, waar yster tot die uitvloeisel, na sekondêre besinking, toegevoeg is. Dit vereis bykomstige tersiêre behandeling en lewer 'n hoëkwaliteit uitvloeisel met orto-fosfaatkonsentrasies laer as 0,3 mg/ℓ (as P). Die ander kwaliteitsparameters wat van belang is by uitvloeiselsuiwering soos chemiese suurstofbehoefte (CSB), totale Kjehldal stikstof (TKN), kleur en troebelheid, het ook met hierdie opstelling verbeter.

Die navorsers sê probleme is ondervind met lae selfdoeltreffendheid (54 persent) onder kontinue bedryf wat veroorsaak word deur aanpaksels op die elektrodeplate.

Die eksperimentele resultate is in 'n ekonomiese gangbaarheidstudie gebruik om elektrochemiese fosfaatverwydering met konvensionele chemiese fosfaatverwydering te vergelyk. Daar is gevind dat die chemiese koagulantproduksie goedkoper as elektrochemiese koagulantproduksie is, maar dat die verskil in produksiekostes, veral by groot aanlegte, gering is.

Eksemplare van die verslag getiteld *Fosfaatverwydering uit munisipale uitvloeisels deur middel van elektrochemiese koagulantproduksie,* (WNK-verslagnr 287/1/90) is gratis verkrygbaar vanaf die Uitvoerende Direkteur, Waternavorsingskommissie, Posbus 824, Pretoria 0001.

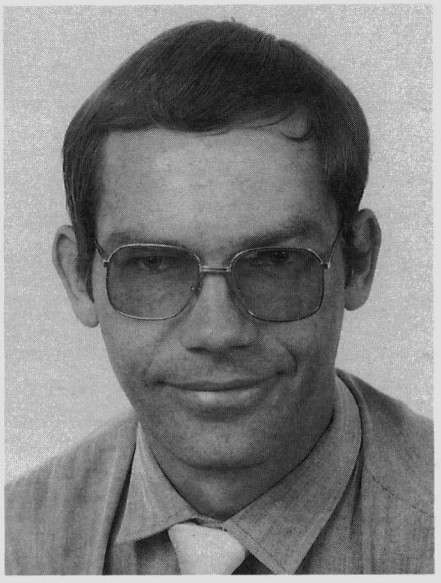
G G LEMPERT
W A PRETORIUS

FOSFAATVERWYDERING UIT MUNISIPALE UITVLOEISELS DEUR MIDDEL VAN ELEKTROCHEMIESE KOAGULANTPRODUKSIE

Verslag aan die
WATERNAVORSINGSKOMMISSIE
deur die
DEPARTEMENT CHEMIESE INGENIEURSWESE
UNIVERSITEIT VAN PRETORIA

WNK Verslag No 287/1/90

Prof W A Pretorius.



Mnr G G Lempert

In Suid-Afrika, sê die navorsers in die verslag, is navorsing oor fosfaatverwydering hoofsaaklik op biologiese fosfaatverwydering toegespits, in teenstelling met oorsese lande wat chemiese fosfaatverwydering verkies omdat dit talle voordele inhou, naamlik:

- Geen addisionele chemikalieë word benodig nie, wat die bedryf van die rioolsuiweringswerke vergemaklik;
- Bedryfskostes is laer omdat aluminium- of ystersoute, wat betreklik duur is, nie bygevoeg hoef te word nie;
- Die opgeloste soutkonsentrasie van die uitvloeisel word nie deur die anioon van die metaalsout, wat tydens die watersuiweringsproses vrygestel word, verhoog nie.

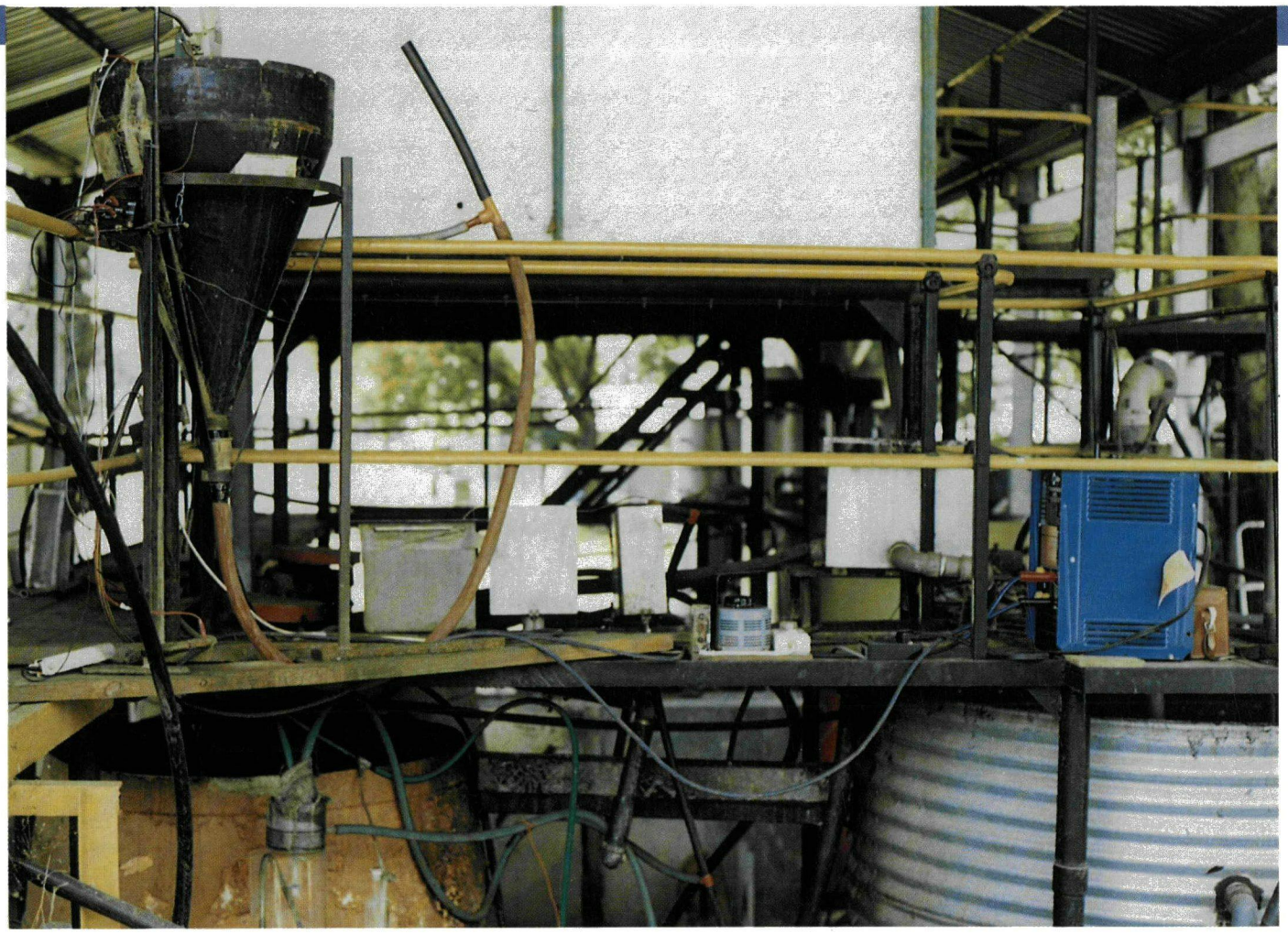
Ontwikkelde lande oorsee het feitlik almal lopende riviere met lae opgeloste soutkonsentrasies wat in die see uitmond. Dit speel dus geen rol as die opgeloste soutkonsentrasies in hul riviere effens verhoog word as gevolg van die chemiese watersuiweringsproses nie. In Suid-Afrika word fosfaat uit munisipale uitvloeisels in rioolwerke nog verwyder deur van beide prosesse (chemiese en biologiese), gebruik te maak. 'n Kombinasie van hierdie twee prosesse word ook by talle rioolwerke toegepas ten einde 'n bevredigende uitvloeisel te lewer wat te alle tye aan die fosfaatstandaard voldoen. Verskeie metodes vir fosfaatverwydering is egter moontlik:

Katode met 'n laag kalsiumkarbonaat wat op plaat vorm as gevolg van te lae elektrolietvloeitempo's.

• CHEMIESE FOSFAAT-VERWYDERING

Met hierdie prosesse word rioolwater gesuiwer deur chemikalieë te gebruik om koagulasie en flokkulasie van die kolloïdale partikels te verkry. Die vlokke word dan fisies uit die water verwyder, byvoorbeeld deur besinking, flottasie of filtrasie.

Fosfaatverwydering word bewerkstellig deur chemiese presipitering van fosfate met 'n metaalioon. In Suid-Afrika word veral ystersoute (ferrichloried, ferrisulfaat of ferrosulfaat), aluminiumsulfaat en tot 'n mindere mate kalk (kalsiumhidroksied) vir dié doel gebruik. Die nadeel van hierdie prosesse is dat by die gebruik van metaalsoute slegs die metaalkatioon wat met die fosfaat verbind om 'n presipitaat te vorm uit die water verwyder word, terwyl die anioon, wat 'n anorganiese sout is, in die uitvloeisel agterbly en veroorsaak dat die soutgehalte van die water styg. 'n Verdere nadeel is dat die alkaliniteit in die water deur metaalsoute verlaag word wat addisionele kalkdosering sal vereis indien die pH van die water te laag daal.



Eksperimentele opstelling van die laboratorium loodsaanleg.

Indien kalk vir fosfaatpresipitasie gebruik word, styg die pH van die water en moet dit weer met 'n suur afgebring word om binne die neegelegde uitvloeiselstandaard te val.

• BIOLOGIESE FOSFAAT-VERWYDERING

In hierdie prosesse word mikro-organismes gebruik wat fosfaat vir selsintese benodig. Deur bepaalde groeitoestande in die biologiese prosesse te handhaaf, word die mikro-organismes so gemanipuleer dat hulle meer fosfaat opneem as wat vir hulle normale groei benodig word.

Daar is sekere nadele verbonde aan biologiese fosfaatverwydering:

- Die prosesse kan slegs optimaal kan funksioneer indien die bedryfstoestande in die reaktors konstant gehou word. Die samestelling en temperatuur van riool wissel egter aansienlik gedurende 'n 24-uur periode en kan moeilik ekonomies konstant gehou word.
- Aangesien nutriëntverwydering slegs deur mikro-organismes geskied, is hierdie stelsels ook redelik kwesbaar vir gifstowwe wat in die riool gestort mag word en vereis 'n aansienlik hersteltyd indien die mikrobiologiese ewewig versteur word.
- Biologiese fosfaatverwyderingsprosesse is ook meer energie-intensief as chemiese prosesse.
- Ten einde 'n vloeisel te kan verseker wat te alle tye aan die standaard voldoen, is 'n chemiese bystandstelsel vir noodsituasies by alle biologiese aanlegte noodsaaklik en word deur die Departement van Waterwese aanbeveel.

• ALTERNATIEWE METODES VAN FOSFAAT-VERWYDERING

Die alternatiewe metodes om fosfate uit uitvloeisels te verwyder is almal biologiese, chemiese of elektrochemiese prosesse wat nog nie op groot skaal toegepas word nie.

■ Biologiese prosesse: twee verskillende biologiese prosesse wat tans op eksperimentele basis beproef word, is fosfaatverwydering deur assimilasie met óf groen alge óf rietbeddings. Beide metodes is onekonomies indien groot volumes uitvloeiselwater behandel moet word omdat groot oppervlaktes benodig word om die alge of riete te kweek. Die alge benodig ook lig om te groei, wat die groeiperiode beperk tot ongeveer 12 uur per dag en groot oppervlaktes noodsaak wat aan sonlig blootgestel moet word. By rietbeddings dra die tipe grond wat gebruik word om die riete in te plant ook by tot die hoeveelheid fosfaatverwydering wat in die praktyk verkry word. Beide prosesse word dus beperk tot gebiede waar die prys van grond laag is in verhouding tot die prys van energie.

■ Chemiese prosesse: Hier is dit veral een redelik nuwe metode waarmee tans nog geëksperimenteer word, wat belofte inhou, naamlik, die kristallisering van fosfaat in korrelbedreaktore. Tydens hierdie proses word die pH van die uitvloeisel verhoog ten einde 'n oorver-

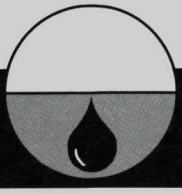
REPLY FORM

GROUND WATER QUALITY AND POLLUTION

TECHNICAL SYMPOSIUM

21-23 AUGUST 1991

ESKOM COLLEGE MIDRAND



First Biennial Ground Water Convention of
The Ground Water Division of the
Geological Society of South Africa and
The Borehole Water Association of South Africa

Please complete and return to the Symposium Secretary:

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Name _____
Organisation _____
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Tick whichever is applicable:

- I wish to attend the technical sessions of the symposium @ R500 ☐
- I will take part in the field excursion which is included in the registration fee _____ ☐
- I wish to attend the banquet _____ ☐
- I would like information on hotel accommodation _____ ☐

sadiging van kalsiumfosfaat te kry. In 'n reaktor wat gevul is met sandkorrels en waarvan die bed vervloei word, vind kristallisasie van die kalsiumfosfaat dan op die sandkorrels plaas wat maklik verwyder kan word. Geen slyk word gevorm nie en die produk, kalsiumfosfaat, kom in die vorm van korrels voor wat deur die fosfaatnywerheid hergebruik kan word. Dit maak die proses baie aantreklik vir watersuiweringsdoeleindes.

■ Elektrochemiese prosesse: Hoewel daar al navorsing op hierdie gebied gedoen is, word elektrochemiese watersuiwering nog nie op groot skaal toegepas nie. Die elektrolitiese proses is tot dusver slegs gebruik om uitvloeisels te suiwer wat hoog in kolloïdale partikels is, soos byvoorbeeld uitvloeisels van die papier-en-pulpbedryf, plateringsbedrywe, leerlooierye, inmaakfabrieke, slagplase, verfvervaardiging en uitvloeisels wat chroom, lood en kwik bevat. Tydens watersuiwering word die metaalkatione, wat as flokkulant benodig word, elektrochemies geproduseer deur metaalelektrodes in die water te oksideer met behulp van 'n gelykstroom wat deur die plate gestuur word.

VERSLAG

Die teoretiese agtergrond tot elektrochemie word in die WNK-verslag breedvoerig in hoofstuk 2 bespreek.

In hoofstukke 3 en 4 word na die elektrolitiese sel gekyk. In hoofstuk 3 word veral op seleffektiwiteit en die eienskappe van die gevormde vlok, soos wat dit tydens die laboratoriumstudie verkry is, gekonsentreer, terwyl die probleme wat met die sel onder bedryfstoestande opgeduik het asook die ontwikkeling daarvan vir kontinue gebruik in hoofstuk 4 aan die orde kom.

Hoofstuk 5 handel oor die loodsaanleg waarmee fosfaatverwydering uit munisipale uitvloeisels met elektrochemiese flokkulantproduksie op loodsskaal ondersoek is om te toets of die proses praktiese aangewend kan word en in hoofstuk 6 is die resultate wat met die loodsskaalaanleg verkry is, gebruik in 'n gangbaarheidstudie waarin die navorsers elektrochemiese en chemiese fosfaatverwydering met mekaar vergelyk het.

Hoofstuk 7 is 'n samevatting van die probleme wat met elektrochemiese fosfaatverwydering verwag kan word indien die proses op volskaal aangewend word asook aspekte van die proses wat verdere navorsing vereis.

NATSURV GUIDES FOR INDUS

Four new Guides with valuable information on the reduction of water intake and waste-water disposal in the Dairy, Sugar, Poultry and Tanning industries have been released by the Water Research Commission (WRC). The publications stem from a WRC research project entitled National Industrial Water and Waste-water Survey (NATSURV) which was carried out by a firm of consulting engineers in

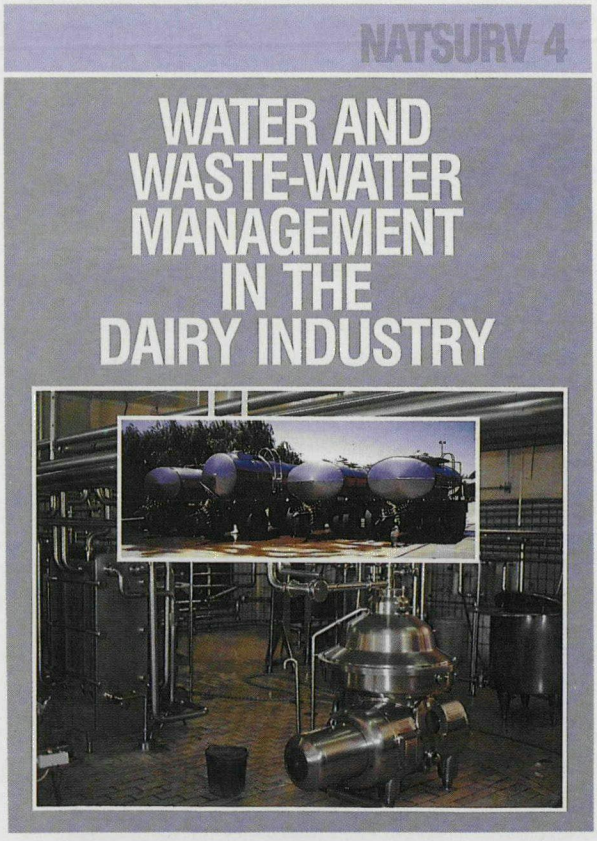
Water and waste-water management in the dairy industry

The South African dairy industry actually accounts for a group of industries with a wide range of different products such as fresh milk, butter, cheese, yoghurt, milk powder, ice-cream, condensed milk and various milk-based desserts. Overall, the industry consumes approximately 4,5 million m^3 of water per annum in more than 150 dairies.

Dairies are responsible for discharging large quantities of effluent (between 75 per cent and 95 per cent of the water intake) arising from either the process itself or cleaning processes, the ratio being dependent on the particular products made at the dairy. In the case of the pasteurised milk sector, the effluent discharge is often 85 to 90 per cent of intake, while for milk powder and condensed milk production this may rise to over 100 per cent. For butter and cheese factories, effluent discharge varies from 90 to 95 per cent of water intake.

According to the Guide the greater part of water usage in the dairy industry is associated with the various cleaning processes. Two major sources of improvement in this area are the optimal design and operation of purpose-built vehicle washing facilities and the improvement of water management and control in the bottle and crate washing facilities.

The surveyors suggest in the Guide that from a water usage point of view the use of plastic sachets for the sale of milk be encouraged. With the mean specific water intake for sachet milk being considerably lower than that for bottled milk, a significant reduction in water consumption, effluent volume and load would occur.



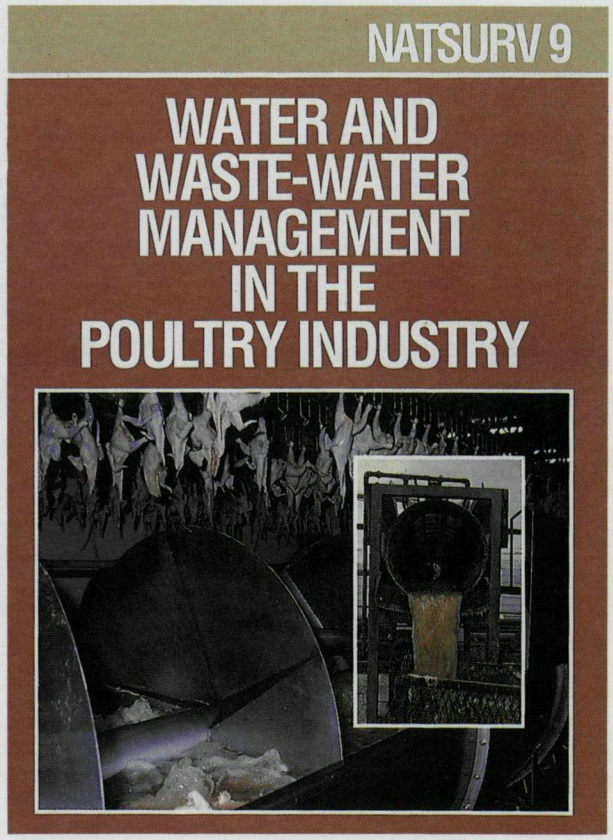
TRIAL WATER MANAGEMENT

collaboration with the Department of Water Affairs. Some of the main survey results are summarised on the next few pages. Full copies of the reports are available free of charge from the WRC. Please write to the Executive Director, WRC, P O Box 824, Pretoria 0001.

Water and waste-water management in the poultry industry

South Africa's poultry slaughtering requirements are carried out by approximately 140 abattoirs of which about 100 can be considered as being of a commercial size. These abattoirs slaughter some 330 million birds annually and thereby provide approximately 40 per cent of the nation's meat by mass. The poultry industry is growing at a rate of six to seven per cent per annum and is assuming an increasingly important role in the South African abattoir industry. The annual water consumption of the poultry industry is in the region of 6 million m^3. According to the Guide the weighted average specific water intake (SWI) was found to be 17 ℓ/bird for AP grade abattoirs, i.e. where the maximum daily slaughter that is allowed, exceeds 10 000 birds, while the SWI for other grades was 20 ℓ/bird. The ranges of SWI figures found were 15 to 20 ℓ/bird for AP grade abattoirs and 15 to 13 ℓ/bird for other grades. A target SWI of 15 ℓ/bird is proposed for AP grades and 20 ℓ/bird for other grades. According to the Guide approximately 90 per cent of the water used in an abattoir is discharged as waste water and will contain several contaminants such as blood, skin, fat, feathers, viscera and faeces. Each of these contributes to a high organic load as well as a considerable quantity of suspended matter.

The weighted average specific pollution load (SPL) was found to be 29 g COD/bird and 7 g SS (suspended solids) per bird for AP grade abattoirs and 64 g COD/bird and 14 g SS/bird for other abattoirs. Target specific pollution load (SPL) figures of 29 g COD/bird and 7 SS/bird for AP grade abattoirs and 64 g COD/bird and 14 SS/bird for other abattoirs are proposed in the Guide.



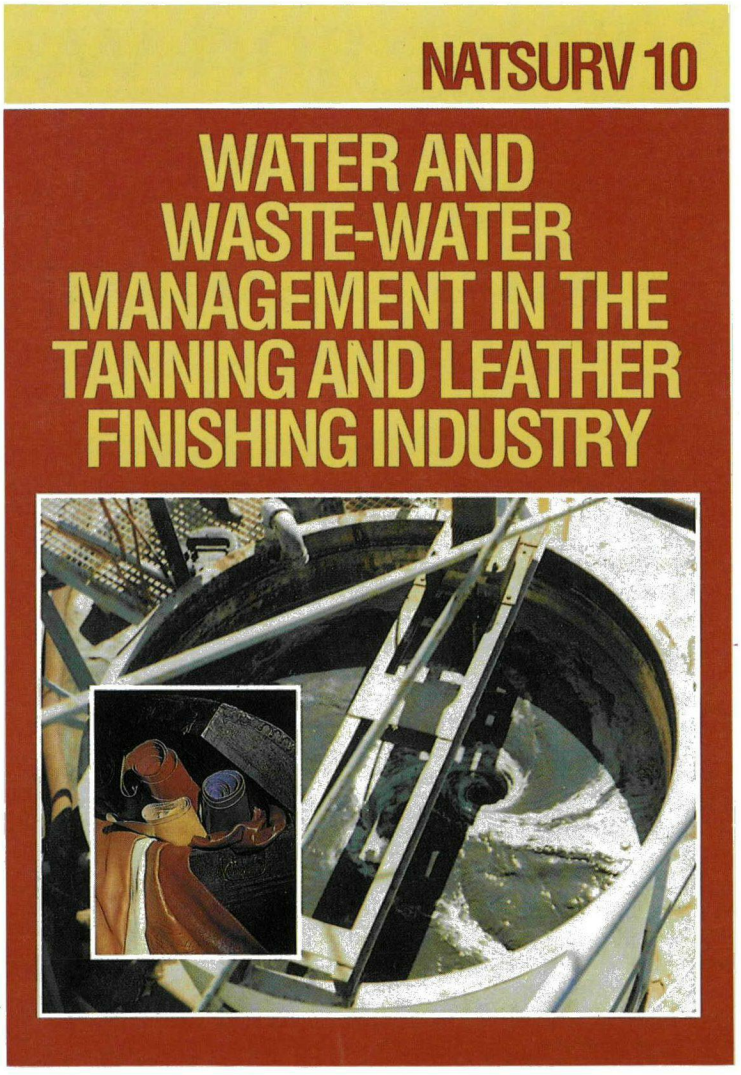
Water and waste-water in the tanning and leather industry

There are twenty tanneries in the Republic of South Africa which process approximately two million hides annually. Water usage by these tanneries is approximately two million hides annually. Water usage by these tanneries is approximately 600 000 m^3 per annum and almost all of this water becomes waste water. The range of specific water intake (SWI) for full tanning was found to be 320 to 744 ℓ/hide with the average being 432 ℓ/hide. A target SWI figure of 432 ℓ/hide has been proposed in the Guide.

The water requirement of a tannery is dependent on the specific tanning process. In most cases potable domestic water is used, but some tanneries depend on good quality river water, and for selected processes purified domestic sewage effluent can be utilised where available. Furthermore, if tannery effluent is treated sufficiently, it can be blended with other water for specific applications in the tannery.

The range of specific pollution load (SPL) was found to be 0,9 to 6,8 kg COD/hide with a mean of 3,7 kg COD/hide, 2,6 to 8,9 kg TDS/hide, with a mean of 7,7 kg TDS/hide, 0,5 to 1,4 kg suspended solids (SS)/hide with a mean of 0,8 kg SS/hide and 0,01 to 0,2 kg Cr/hide with a mean of 0,1 kg Cr/hide. Target figures have been proposed of 1,0 kg COD/hide, 3,0 kg TDS/hide, 0,5 kg SS/hide and <0,01 kg Cr/hide.

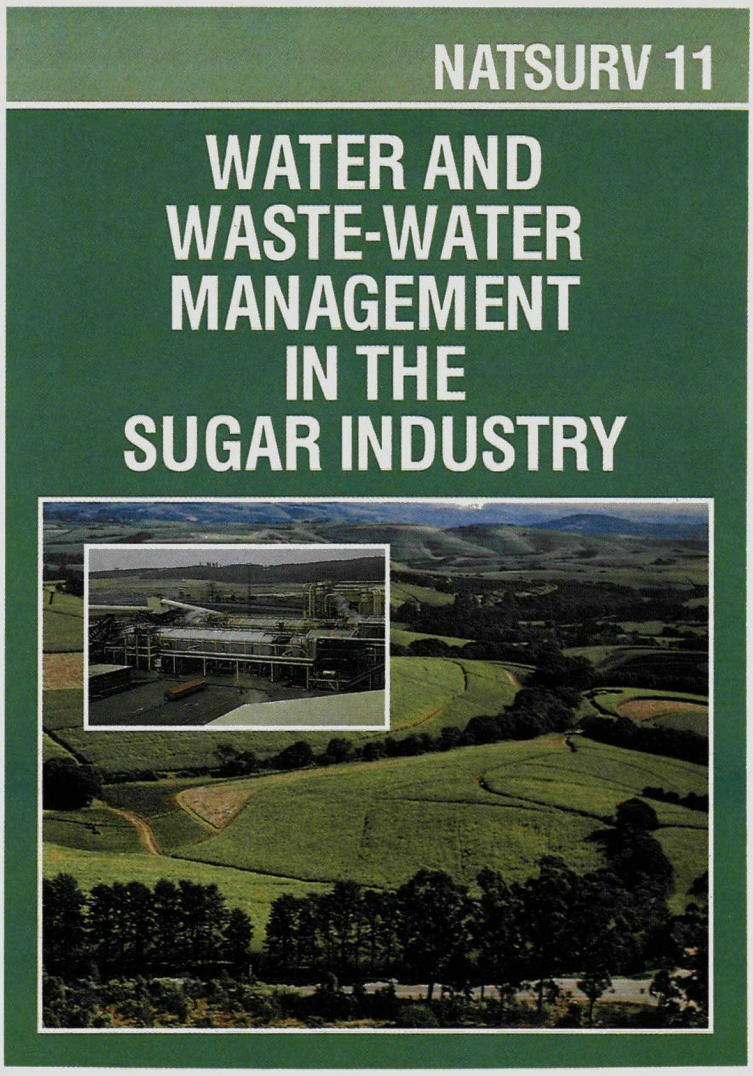
Investigations have shown that the technology for economic effluent purification to river water standards does not exist and that the systems used by tanneries depend on the requirements of the Department of Water Affairs and local authorities. Where dilution with domestic sewage and subsequent treatment by local authorities are inadequate, the alternatives are irrigation or evaporation ponds, with pre-treatment to remove sulphide and settleable solids. For greater detail of the main systems used for waste-water and solid waste disposal at tanneries as well as the biological and physico-chemical treatment methods investigated, readers are referred in the Guide to another Water Research Commission publication entitled "Guide to waste-water management in the tanning and fellmongering industries" (TT 27/87).



Water and waste-water management in the sugar industry

There are 16 sugar cane processing plants and one stand-alone refinery in South Africa which produce about two million tonnes of sugar per annum according to the 1985 figures. The surveyors say in the Guide that more recent production figures for the sugar industry are not available. Of the 16 processing plants ten are mills only and six are mills with a so-called 'back-end' refinery. The latter situation is increasingly becoming the trend in the sugar industry worldwide.

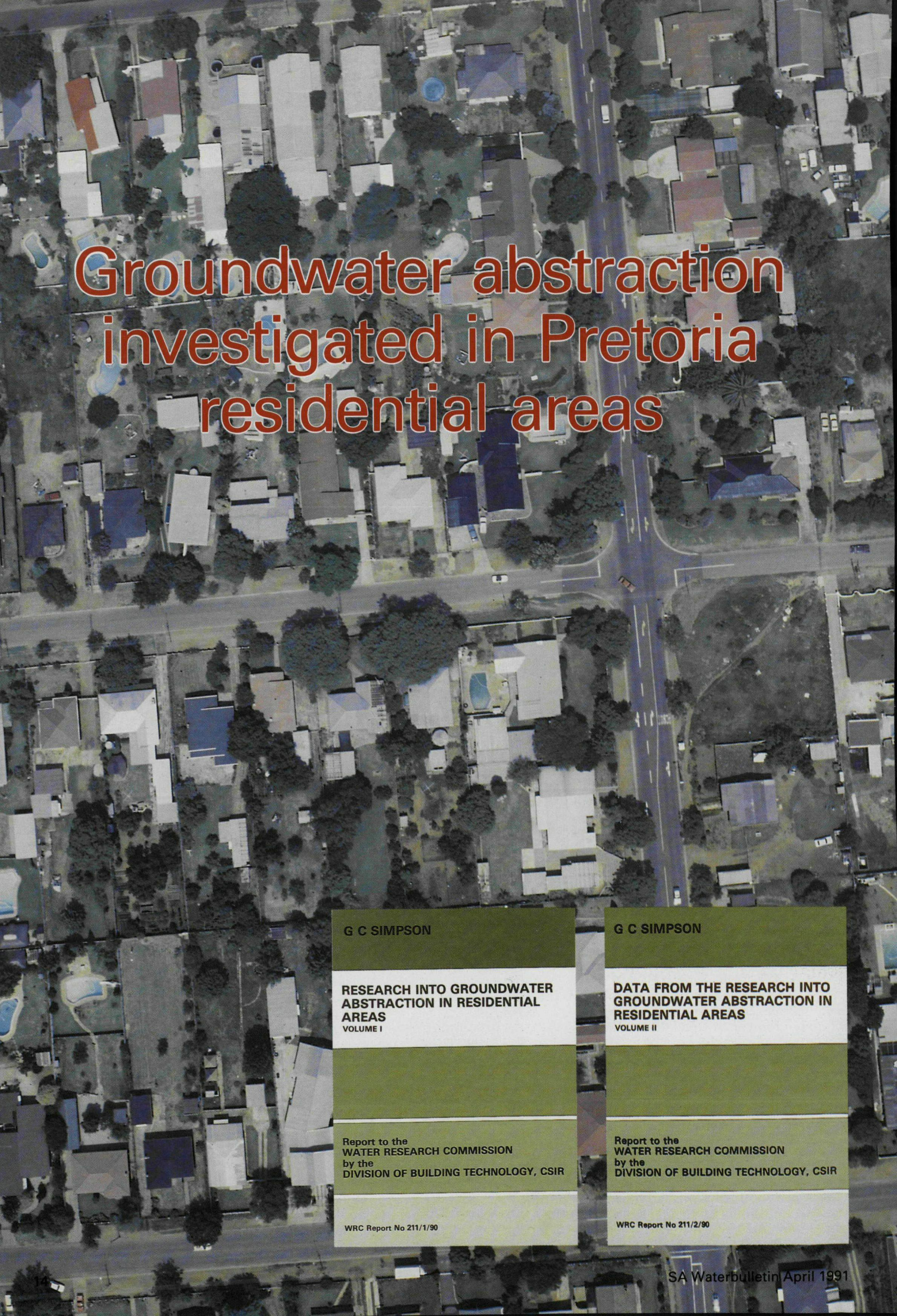
The sugar industry is unusual in that the main raw material (sugar cane) contains very large quantities of water (about 70 per cent by mass). As the main process in both a mill and a refinery is concerned with extracting sugar crystals from solution, the vast majority of this and any other water entering a plant is evaporated and can be recovered as condensate. Water from other sources (typically boreholes or river abstraction) is used only in applications such as cooling for condensation of vapours or domestic consumption. Specific water intake (SWI) was found to be 30 to 100 m^3/100 t of cane processed with a mean SWI of 60 $m^3$100 t. Waste water volumes are relatively small compared to the total volumes of water in circulation at any one time. Typically 750 to 1 500 m^3/d of waste water (about 30 per cent of the water intake) is generated with a chemical oxygen demand (COD) of 1 500 to 2 000 mg/ℓ. The main source of this COD is sugar lost in washing and in cooling water overflows. Sugar plant waste waters are problematic in that the COD load present is almost totally soluble leading to sludge bulking and sludge loss problems in conventional biological treatment systems. They also tend to be deficient in nitrogen and phosphorus.



By-products from a sugar processing plant are molasses, which goes to animal feed or further processing to fermentation products, and bagasse which is burnt in the sugar plant boilers or can be further processed to paper and chemical products.

Solids wastes arising from sugar processing are boiler ash and smuts which go to landfill and filter cake (from the milling process) which may be used as fertiliser in some areas or alternatively is disposed of as landfill.

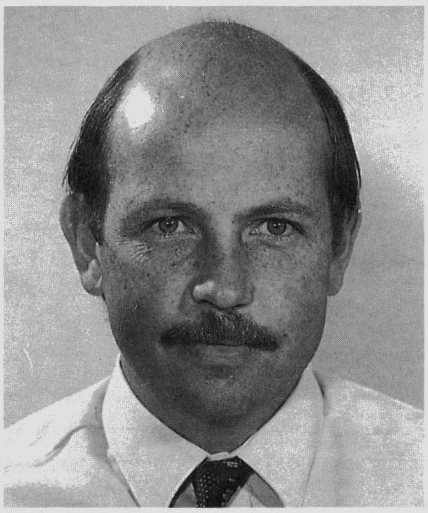
Groundwater abstraction investigated in Pretoria residential areas



A Report based on results emanating from a study to assess the annual quantity of water abstracted from private boreholes in Pretoria has been released by the Water Research Commission. The research work which was funded by the Water Research Commission, was done by the Division of Building Technology of the CSIR. The researchers tried to determine the variation in groundwater levels over the period of the project as well as the quality of the groundwater pumped from the boreholes.

The results indicate that on average a property with a borehole uses 1,78 kℓ water per day from the borehole and 0,82 kℓ per day from the municipal supply. Based on 37,5% of all residential properties having a borehole, the annual quantity of groundwater abstracted from private boreholes in Pretoria was estimated to be 20 063 Mℓ per year. The chemical quality of the groundwater compared favourably with the municipal water quality and did not change significantly with time. However, the microbiological quality of the groundwater varied unpredictably and the researchers advise in the report that all borehole water for human consumption should be sterilised by boiling or chlorination.

Copies of the report entitled *Research into groundwater abstraction in residential areas* (WRC Report No 211/1/90, Volumes 1 and 2) are available free of charge from the Executive Director, Water Research Commission, P O Box 824, Pretoria, 0001.



Mr Graham Simpson

Until about 1983 the quantity of water abstracted from private boreholes in urban areas was considered insignificant in comparison to the water abstracted from the municipal water supply, says Mr Graham Simpson of the Division of Building Technology at the CSIR and leader of the research team.

He says in the executive summary to the report that under the drought conditions which prevailed until 1988, the shortage of surface water resources led to the imposition of rationing and punitive tariffs. The result was a proliferation of new boreholes in the suburban areas as property owners, driven by the success of their neighbours, kept the borehole industry busy.

The newspapers were equally busy reporting on and adding to the controversy that the suburban drilling activity caused among the have-nots and the existing borehole owners. People were concerned that the rapid growth in demand on the groundwater resource could seriously diminish their borehole yields, or at worst, destroy the resource. In November 1985, the Division of Building Technology, CSIR, (then called the National Building Research Institute) started a pilot study on seven boreholes in the eastern suburbs of Pretoria. Sixteen months later in April 1987, funds were made available by the Water Research Commission to expand the project to cover the whole of the Pretoria area. The main aim of the project was to quantify the amount of groundwater abstracted from private boreholes. Secondary aims included monitoring variations in the water tables as well as the quality of the groundwater and assessing the potential for a significant increase of the demand on groundwater resources in the future.

The research was carried out in Pretoria where the density and extent of the boreholes in the urban area is probably the highest in the country, although a similar situation is thought to exist in the Johannesburg areas. According to their local authorities, coastal cities do not have a significant number of private boreholes. In smaller centres there can be a very high proportion of properties with a borehole, but because of the much smaller size of the town the impact on the groundwater resource will be less when compared to a similar urban area in Pretoria.

Data collection stopped at the end of January 1990 when the water consumption records and water depth measurements covered a period of at least 24 months for the 106 monitored boreholes. Water quality analyses were carried out twice a year over the last two years and surveys were undertaken to determine the number of boreholes in the residential areas.

In February 1989, the levels of oxygen 18 isotope in twenty groundwater samples were measured to see if this parameter could be used to trace the origin of the groundwater. The results, while interesting, were inconclusive possibly because the sample size was small and aerially too widely spaced. Mr Simpson says it is possible that a more selective and concentrated exercise would yield better results. Aerial photography was used to provide groundcover data so that the irrigation rates for gardens could be assessed. Rainfall and temperature data were obtained from the Weather Bureau for

correlation with the changes in abstraction rates and water tables. A reasonable estimate of the annual quantity of water abstracted from private boreholes in Pretoria was taken as the product of the mean borehole water consumption and the estimated number of properties with boreholes. A comparison was made with the quantity of water supplied by the municipal water supply system. The report "Estimating the annual quantity of groundwater abstracted in the Pretoria municipal area and its effect on municipal water consumption", by N J van der Linde and C Elphinstone describes how this was done. (This report is included as an addendum to the final report.)

The actual depth of a number of boreholes in an area was determined in order to find the average watertable level in that area.

A highly accurate water probe was used to determine the depth of the water level in collecting borehole data.

RESULTS

It was found that the proportion of residential properties with boreholes was 0,375 of the total number of 80 536. A property with a borehole used an average quantity of water of 1,78 from the borehole and 0,82 kℓ/day from the municipal supply. From a sample of 439 properties without boreholes, the average municipal water consumption was 1,04 kℓ/day.

The average annual quantity of groundwater abstracted from private boreholes was estimated to be 20 063 Mℓ per year. This is roughly equal to the quantity of municipal water used per year at residential properties in Pretoria. Given that the average reduction in municipal water consumption is 0,21 kℓ/day for a property that acquires a borehole, the annual reduction in municipal water sales due to groundwater usage was 2 350 Mℓ per year.

Mr Simpson says it was noted that although the reduction in municipal water use was approximately 0,21 kℓ/day, this was replaced by groundwater abstraction of 1,78 kℓ/day for external purposes. He says this leads to two observations. Firstly, the supply of municipal water was severely constrained by availability and price during most of the period of the study. Secondly, although municipal water restrictions were lifted and the tariff structure reversed in September 1988, properties without boreholes have not increased their water consumption significantly, in fact the mean increased by only 50 litres per day.

WATER TABLE

Changes in the elevations of the groundwater tables were influenced by the aquifer characteristics, but in general were seasonal and no long term trends were observed, due to the short duration of the data record. Longitudinal sections taken across the city illustrated that the water table tends to follow the ground contours, but is influenced by the local geology.

The depth to the water varied from less than a metre to about 100 metres but the water was within 30 metres from the surface in most boreholes.

Mr Simpson says the chemical quality of the ground water was found to compare favourably with the municipal water quality and did not change signi-

A well-watered suburban garden maintained with borehole water.

ficantly with time. In some areas, local minerals containing elements such as manganese and iron are dissolved in the groundwater in relatively high proportions. Two of the monitored sites were found to use only groundwater for all domestic purposes. However, Mr Simpson says it was found that the microbiological quality of the groundwater varied unpredictably. Variation in quality is attributed to stormwater runoff, either at or near the borehole site and sewer ex-filtration at connections and broken pipes. He says it is advisable to sterilise all borehole water to be used for human consumption by boiling or by chlorination.

In an attempt to establish the potential for significant increase in groundwater abstraction from private boreholes in the future, borehole contractors who operate in the Pretoria area were contacted for information on the number of boreholes drilled per year. This information could have formed the basis for developing a forecasting technique for the number of new boreholes likely to be drilled per year. Unfortunately, the contractors were very evasive and no historical data of value were obtained. Mr Simpson says it was also established that the Pretoria municipal records were not reliable enough to use for extrapolations, since many people had not registered their borehole.

DROUGHT INCENTIVE

A qualitative assessment, based on observation of the trends since 1985, suggests that the incentive for an individual to sink a borehole depends on the following factors, more or less in priority:

- Restrictions on quantity of municipal water available;
- The price differential at the demanded quantity between the groundwater and the municipal water;
- The probability of obtaining a good supply from a borehole on the individual's property, and
- The availability of capital to finance the borehole installation.

Mr Simpson says the incentive to sink a borehole is therefore primarily drought driven, since it is during a drought that the surface water supply shrinks, leading to the imposition of restrictions on consumer demand and an increase in the price.

He says it is thought that the limit to which private residential properties will utilise the groundwater in the Pretoria area can be based on the degree of utilisation observed in the older areas, where further development is unlikely. On this basis, the central area of Pretoria has probably stabilised at a point where 60 per cent of the residential properties have a borehole. Mr Simpson says it is assumed that in due course the demand on the groundwater resource could be expected to increase by about 60 per cent within other areas, due to the increase in the proportion of properties with boreholes from 0,375 to 0,60.

RECHARGE

The main limiting factor however is the rate of recharge, which is not known. Mr Simpson says it would appear that a significant proportion of the recharge is occurring from areas which are outside the geographic boundaries monitored during the project. Should significant abstraction of groundwater occur from these areas, for whatever reasons, the effect on the Pretoria area could be a serious one for the residential borehole owners. Further research would be required to test this hypothesis. Should this be the case, the failure of a large proportion of the private boreholes should not affect the burden on the municipal water supply, since the demand from this source would be controlled by restrictions and the tariffing structure. The environment would however suffer and this could have a demorialising effect on the inhabitants, says Mr Simpson.

Scientists evaluate the ASP process

For sewage sludge to be classified as suitable for unrestricted horticultural and agricultural usage, it must contain low levels of heavy metals and must be "further" treated, that is, either heat treated (e.g. pasteurised), irradiated, chemically treated or composted to eliminate or significantly reduce pathogen levels.

Until recently these treatment methods were, apart from incineration, the only feasible options available to the sanitary engineer. The introduction of the Active Sewage Pasteurisation (ASP) process, however, not only extended the range of "further" treatment alternatives, but made possible the enrichment of two of the macro plant nutrient levels of sludge, nitrogen and phosphorus, to the extent that the end-product may correctly be called a fertilizer, and has been registered as such recently.

Recognising the potential merits of the ASP process such as low capital cost, small area requirements, controllability, substantially reduced risk of heavy metal toxicity and revenue generation potential, the Water Research Commission funded a research project at the Division of Water Technology of the CSIR whereby the ASP process would be evaluated in terms of the degree of stabilisation and pasteurisation achieved. Leaching studies were sub-contracted to the Deptartment of Soil Science and Plant Nutrition at the University of Pretoria.

A final report entitled *Evaluation of the Active Sewage Pasteurisation (ASP) Process for the Treatment of Sewage Sludges (WRC Report No 327/1/90) written by J H Nell, M van der Merwe and RO Barnard, and based on the research results of this project has been released by the Water Research Commission. Copies of the report are available from the Executive Director, Water Research Commission, P O Box 824, Pretoria 0001.*

In the ASP process primary or digested sewage sludge is dewatered by means of conventional methods. The dewatered sludge then enters a stainless steel pipe reactor with a variable retention time depending on the flow rate. (See fig 1.) A retention time of ten minutes is, however, normally used. At the point of entrance anhydrous ammonia gas is injected into the sludge at a pressure anywhere between 100 and 300 kPa, although 200 kPa is typical.

Due to the exothermic reaction between ammonia and sludge, the temperature rises to between 40 and 50°C depending on inlet temperature, pressure, quantity of ammonia injected and flow rate. The pH rises to a level of 11,6. Concentrated phosphoric acid is pumped into the ammoniated sludge just before leaving the pipe reactor at a rate sufficient to reduce the pH of the mixture to 7,0.

Depending on residual temperature and ammonia concentration, a further temperature rise to between 65 and 75°C is obtained. The treated sludge then enters a heat exchanger where heat is transferred to the incoming, untreated sludge and ammonia. Pasteurisation is achieved by a combination of pressure, temperature, pH and ammonia toxicity. Pressure in the pipe reactor is controlled by throttling the outflow, while retention time is determined by the throughput rate. Final pH depends on the ratio of ammonia to phosphoric acid pumped into the system. Temperature control is less straight forward, since it is dependent on both the total mass of ammonia injected and the ammonia to phosphoric acid ratio.

The end-product is syrupy, grey to black liquid with a slight ammonia smell. The intensity of the latter is obviously dependent on pH, the concentration of free ammonia and the ratio between the ammonium phosphate species present. As more phosphoric acid enters the system the ratio of di- to mono-ammonium phosphate decreases with a concomitant decrease in free ammonia, pH and ammonium phosphate solubility.

The WRC funded evaluation of the ASP process was conducted, under the supervision of DWT staff, at the pilot ASP plant situated at the Klipgat sewage works near Pretoria.

Primary and anaerobically digested sludges were evaluated. Each run lasted for at least one working day and composite samples of each run was prepared by mixing half-hourly samples taken after the process

Right: The ASP pilot plant at the Klipgat sewage works near Pretoria.

stabilised (less than two hours after start-up). In addition, samples of untreated sludge were also taken.

Samples were cooled to 4°C before being air-freighted in insulated cooler bags to the Bellville laboratory of the DWT for analysis and evaluation. In addition to the process evaluation, untreated primary sludge was used to assess the degree of stability.

What is meant by a stable sludge?

According to the report it should be evident that the definition depends on a knowledge of what the ultimate disposal of the sludge will involve. Since ASP treated sludges will eventually be disposed of by spreading on land (with or without ploughing in) or subsurface injection, it was concluded that the stability requirements for these sludges should be determined in terms of hazards presented to soil and plant, risk of damage to the environment and the nuisance potential it could present to humans.

According to the report the following parameters were selected for the determination of the relative degree of stability of ASP treated sludges:

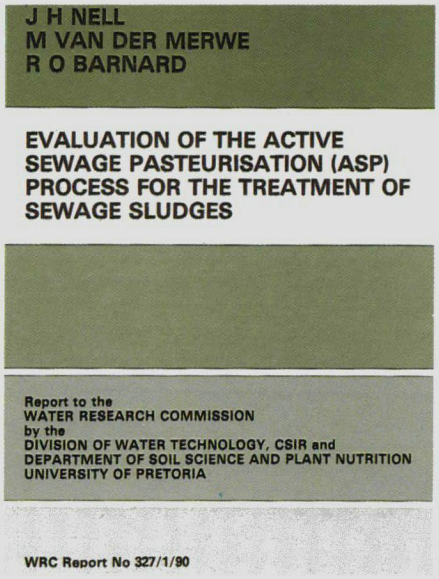
- Odour generation potential
- Pathogen levels
- Rate of leaching of nitrogen and phosphorus from treated sludge mixed with soil
- Volatile acids concentration
- Oxygen uptake rates

Investigations of the first three parameters have been completed while the latter two were postponed for economic reasons.

Results

The results were evaluated in terms of:

- Effect of the type of sludge, retention time, temperature, and pressure during treatment on the degree of pasteurisation achieved;
- Level of enrichment (nitrogen and phosphorus) obtained under different operational conditions, and
- Stability of the end product as reflected by the absence or presence of nuisance conditions during land spreading and the rate of leaching of nitrogen and phosphorus relative to equivalent inorganic fertilisers.



At the rate of chemical additions tested, temperatures of 70°C appears to be the only additional requirement for achieving pathogen destruction. There were no odour nuisance conditions caused by ammonia, hydrogen sulphide or fatty acids during land spreading, but these compounds were present at low concentrations in the untreated sludge used as input to the plant. Treated sludge retained considerably more nitrogen, and also phosphorus, than inorganic ammonium phosphate fertiliser upon leaching.

Recommendations

The report says that although the ASP process appears to be an innovative process which produces a disinfected end product that will not give rise to nuisance conditions, it is recommended that further experiments be conducted with sludges from different sewage works containing levels of odour causing compounds higher than those prevalent during this study. It is further recommended that experiments be conducted to evaluate the availability to plants and retention in soil, of the nitrogen and phosphorus in the treated sludge.

NATSURV guide for water management in the sorghum malt and beer industries.

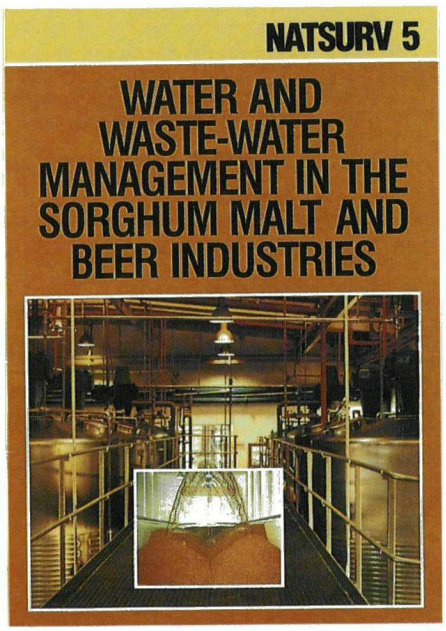
The Water Research Commission has released a Guide for water and waste-water management in the sorghum malt and beer industries. The aim of the Guide is to establish norms for water intake and waste-water disposal in this industry which forms part of the National Industrial Water and Waste-water Survey (NATSURV) currently being conducted by a team of consulting engineers under contract to the Water Research Commission.

The Guide will be of value to all interested parties in the water and effluent fields.

Sorghum beer is produced at 36 breweries in South Africa and the national and self-governing states and some 3.4 million m^3 of sorghum beer is drunk in the country each year. This is more than twice the volume of South Africa's annual barley beer consumption. The industry is characterised by numerous small capacity plants in both industrial and rural areas. This is largely due to the short shelf life of the product.

Sorghum beer is made from maize or sorghum grits, sorghum malt, yeast and water. The beer is highly nutritious containing large quantities of minerals, proteins, carbohydrates and vitamin B and has a low alcoholic content of approximately three per cent.

The beer from the production lines of the breweries is normally not pasteurised and either packaged directly and marketed in an active fermentation state, or allowed to ferment for 24 hours. It may then be transferred to beer halls or other customers as bulk beer for consumption. Sorghum beer's market price is roughly a quarter of the price of lager beer. The difference between the consumption and the industrial production represents a future market for the brewing and malting industries. Recent efforts to rationalise and privatise the industry and the continuing development of pasteurisation as well as new beers by the CSIR indicate the possibility of high growth trends in the long term.



MALTING

Malting of sorghum grains forms an integral part of the sorghum beer industry. The malting industry may be divided into two categories: industrial and commercial. Industrial maltsters provide the brewing industry with malt for the brewing process. Commercial maltsters produce packet malt powder which is sold directly to the consumers. In some instances, packet malt are also produced by industrial maltsters. Industrial and commercial malting installations are in general different, commercial malting usually being less mechanized.

The sorghum malting and brewing industries are significant with respect to water and effluent use. This is especially true when considering that the breweries are located largely in water scarce regions and often fall within the jurisdiction of small rural municipalities.

The industry, however, sells its products at a low market price to customers who are often living at sub-economic levels and expensive water saving and effluent treatment systems are therefore generally unsuitable for these plants. Also, skilled operators may be required which the industry often does not have available. The treatment processes that are required should therefor be cheap to purchase, install and maintain and be cost effective in relation to the individual brewery's turnover.

Sorghum maltsters vary enormously in terms of their productions. Similarly the water and effluent treatment systems that are suitable vary in cost, but there are simple measures which can be instituted throughout the industry.

In 1984 the Water Act of 1956 was extensively amended, effectively tightening up legislation and control on water consumption and effluent quality. This was in response to the critical drought conditions experienced in southern Africa. Industry's response to the revised Act requires inproved water management techniques using the latest available technology parallel with revised staff training in water conservation and pollution matters.

Water and waste-water management must be seen as complimentary and should not be undertaken in isolation from each other if satisfactory results are to be achieved.

A sorghum beer brewery in Venda. Some 2,5 m^3 water is neeeder per m^3 of beer produced.

According to the Guide the sorghum malting and sorghum beer brewing industries presently account for an estimated water consumption of 3,4 million m^3 annually. For malting sorghum grain, 630 000 m^3 of water are consumed in producing 185 400 tonnes of malt annually. The specific water intake for malting is approximately 3,4 m^3 of water per tonne of malt.

Breweries use a total of 2,75 million m^3 of water and produce 1,1 million m^3 of beer. This gives a specific water intake of 2,5 m^3 of water per m^3 of beer produced.

The average specific water intake was found to be 3,4 m^3 of water per ton of malt and 2,5 m^3 of water per m^3 of beer produced. Target water intakes have been proposed as 3,0 m^3 per t for large and mechanised maltsters, 7 m^3 per t for small maltsters (less than 300 t per month) and 2,0 m^3 per cubic metre of beer for breweries.

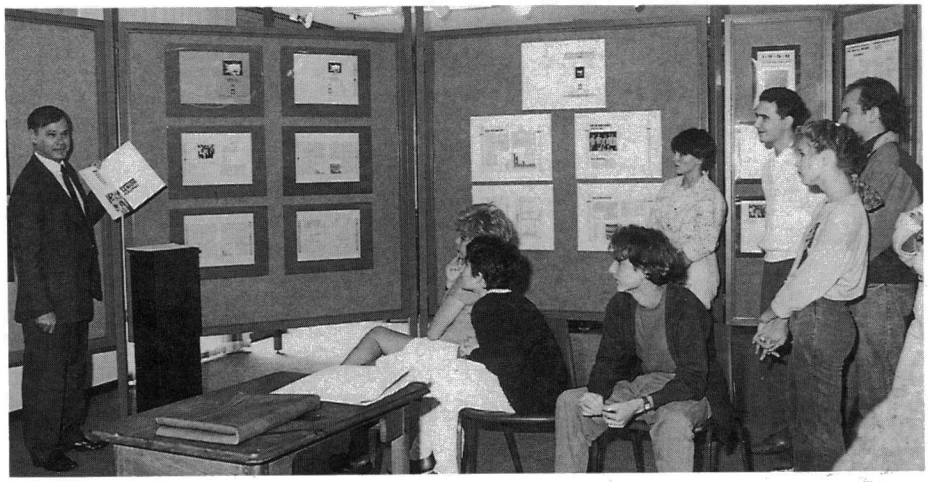
EFFLUENT

The effluent generated in the sorghum malting and brewing industries has a low ph with a high content of organic solids. Breweries discharge quantities of sorghum malt and grain, maize and sorghum grits, spent grain, dust, intermediate phases of brewing mixtures, sorghum beer, cleaning compounds and boiler treatment chemicals. For sorghum malting and sorghum brewing, approximately 84 per cent and 52 per cent respectively of the total incoming water is discharged as industrial effluent.

Specific pollution loads were found to be 8,6 kg chemical oxygen demand (COD) per ton of malt and 5,2 kg COD per cubic metre beer produced. The research team proposed target pollution loads of 7,0 kg COD per ton and 5,0 kg COD per cubic metre respectively.

Suggestions on methods of reducing the overall water consumptions and pollution loads have been outlined in the Guide. Further research on all aspects covered in the survey is also recommended.

Copies of the guide, NATSURV 5, Water and waste-water management in the sorghum malt and beer industries, are available free of charge from the Water Research Commission, P O Box 824, Pretoria 0001.



Mnr Piet Odendaal , Uitvoerende Direkteur van die Waternavorsingskommissie, bespreek aspekte van die individuele ontwerpe met die studente.

STUDENTE ONTWERP VIR WNK JAARVERSLAG

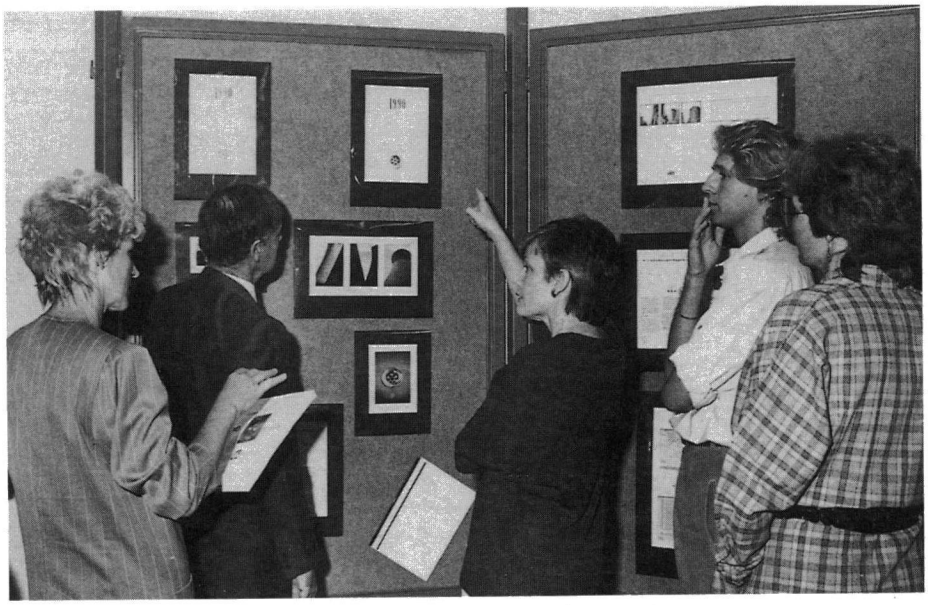
Kunsstudente in Inligtingsontwerp aan die Universiteit van Pretoria het onlangs geleentheid gehad om hul slag te wys met konsepontwerpe van buite- en binneblaaie vir 'n WNK jaarverslag as deel van hul opleidingsprojekte.

Prof Marion Sauthoff het mev Ingrid Buchan, Wetenskaplike Redakteur van die WNK genader omtrent dié projek waarmee gepoog word om die studente blootstelling te gee aan die vereistes van die bedryf en verwagtinge van klieńte.

Mev Buchan het met 'n gaslesing die studente ingelig oor die WNK en WNK-aktiwiteite, asook die basiese vereistes vir 'n WNK jaarverslagontwerp.

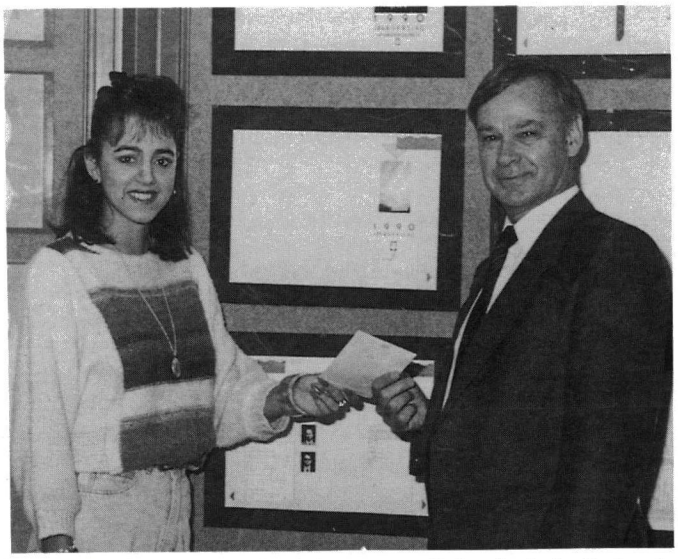
Die studente se ontwerpvoorleggings was van 'n goeie gehalte en interessant met 'n verskeidenheid ontwerpidees.

Mnr Piet Odendaal, Uitvoerende Direkteur van die WNK, het die ontwerpe en die redaksionele personeel van die WNK se kommentare met die studente bespreek. Volgens Prof Sauthoff was die studente in hul skik met die "lekker" kritiek!



Links: Mev Ingrid Buchan en mnr Piet Odendaal van die WNK bespreek 'n ontwerp met prof Marion Sauthoff, mnr Pieter Venter en mev Helga Nothoff, almal dosente in Inligtingsontwerp by UP.

Mnr Odendaal oorhandig 'n tjek aan Leánne le Roux vir die beste binnebladuitleg en ontwerp.



Susan Keuler ontvang 'n tjek van mnr Odendaal vir die beste buitebladontwerp.

SA RAIN SAMPLER PERFECTED

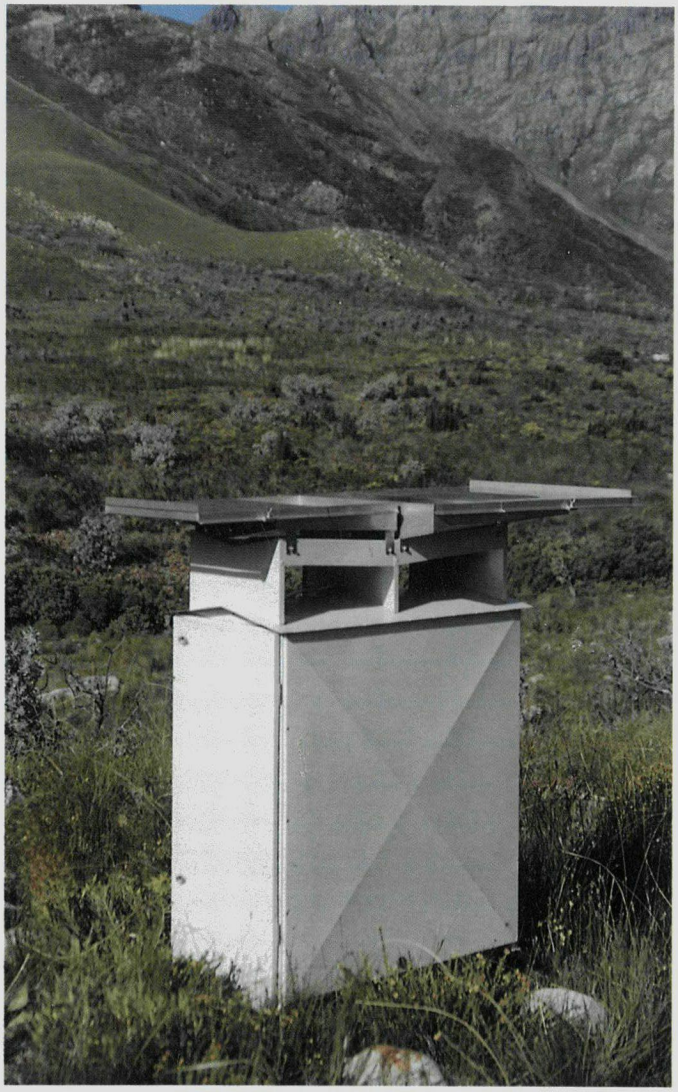
An apparatus which accurately samples rainfall in stages has been developed by the CSIR's Division of Forest Science and Technology (FORESTEK).

According to Mr Danie van Wyk of FORESTEK, who designed the sampler, the apparatus makes use of simple, easily calibrated design and is used to sample wet precipitation at regular intervals. It uses no power source other than the falling rain itself and can therefore be erected in remote locations such as mountain catchment areas. A simple adjustment allows the user to take rain samples of any chosen size and at any regular rainfall interval, for example after every 1, 2 or 5 mm of rain event etc. For each rainfall interval chosen, the apparatus takes samples of sufficient volume to allow a complete chemical analysis to be performed. The samples are of a uniform volume and they do not come into contact with each other or the air.

Slightly adapted, the precipitation sampler could be used for sampling purposes in several other situations for example for studies on the chemistry of mist, in run-off studies, nutrient cycling studies and forest ground precipitation studies.

Jonkershoek Forestry Research station where the apparatus has been erected and tested, has conducted research into the quality of atmospheric precipitation in the mountain catchment areas of the Cape since 1971.

Forestek's newly developed rain sampler that can be used in remote areas.



Such research which was previously conducted by means of wet/dry- and bulk precipitation sampling apparatus, serves a number of purposes. It allows researchers to

- learn more about the origin of chemical elements found in precipitation;
- study the different pollution characteristics of major and minor rain events;
- observe variations in precipitation concentrations during rain events, and
- determine the ratios of chemical constituents in rain during the various stages of a rain event.

All this information allows the user to make deductions regarding the effect which polluted precipitation might have on specific areas or objects.

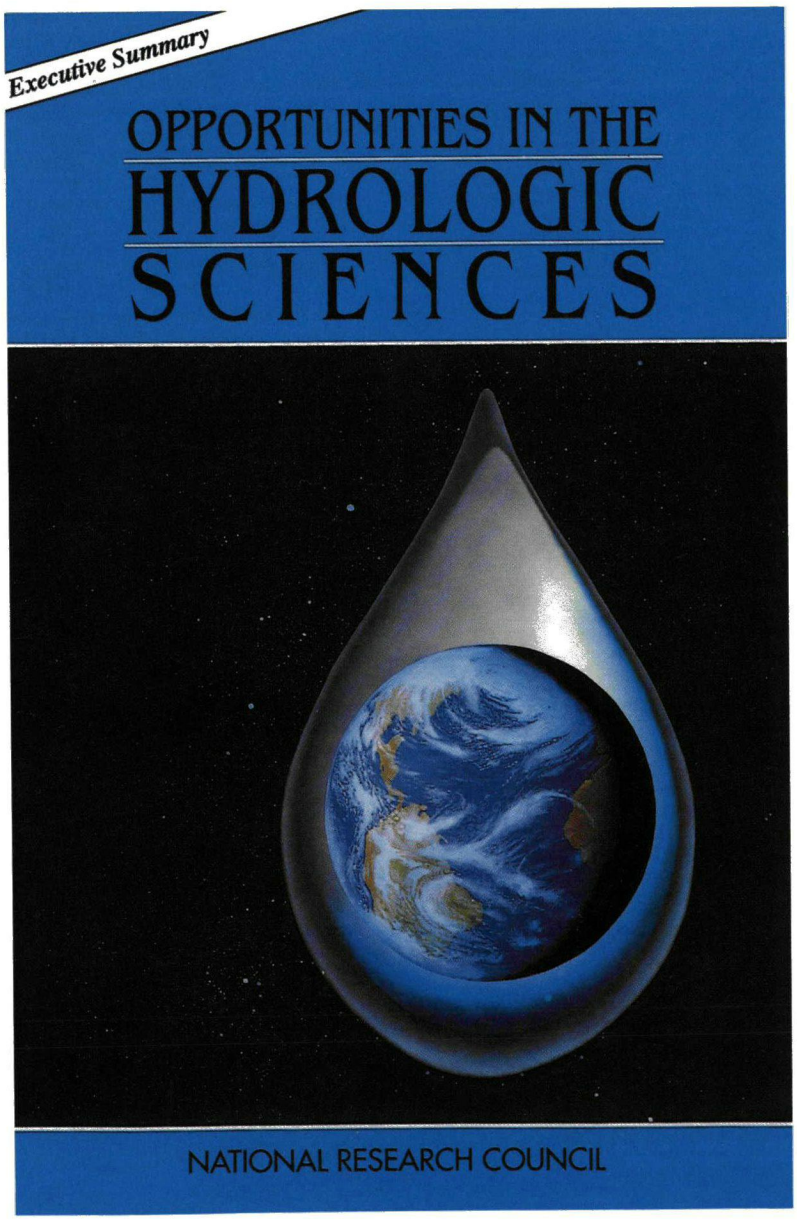
The first prototype of the apparatus was built in 1987 by one of FORESTEK's hydrological technicians, Mr Eric Prinsloo from material available in local hardware stores. The first machined version was manufactured by the Weather Bureau's workshop and a private engineering firm, under the leadership of Mr Danie van Wyk. Enquiries regarding the precipitation sampler should be directed to Mr Danie van Wyk at the Jonkershoek Forestry Research Centre, Private Bag X5011, Stellenbosch 7600. Tel 02231 - 73230 or Fax 02231 - 75142.

SPECIAL REPORT

A report on opportunities in Hydrologic Sciences, from the national Academy of Sciences, USA, has recently been published.

According to Dr Frank Press, president of the National Academy of Sciences, this report should be an important reference work on opportunitites in the hydrologic sciences. It transmits the importance of the hydrologic sciences and identifies needed improvements to the research and educational infrastructure. It its recommendations are followed the scientific base of hydrology will be strengthened and contribute directly to improved management of water and the environment.

To wet your appetite and urge you to study this report the following is an extract from the preface of the executive summary:



Hydrologic science deals with the occurrence, distribution, circulation, and properties of water on the earth. It is clearly a multidisciplinary science, as water is important to and affected by physical, chemical, and biological processes within all the compartments of the earth system: the atmosphere, glaciers and ice sheets, solid earth, rivers, lakes, and oceans. Because of this geophysical ubiquity, concern for issues of hydrologic science has been distributed among the traditional geoscience disciplines. As a result, an infrastructure of hydrologic science (i.e. distinct discipline with a clear identity and supporting educational programs, research grant programs, and research institutions) has not developed, and a coherent understanding of water's role in the planetary-scale behaviour of the earth system is missing. This report describes this problem and offers a set of recommended remedial actions.

The Problem

Water moves through the earth system in an endless cycle that forms the framework of hydrologic science. In so moving, it plays a central role in many of the physical, chemical, and biological processes regulating the earth system, where human activity is now inseparable from natural events. Water vapor is the working fluid of the atmospheric heat engine: through evaporation and condensation it drives important atmospheric and oceanic circulations and redistributes absorbed solar energy. As the primary greenhouse gas it is instrumental in setting planetary temperature. Through fluvial erosion and sedimentation, water, together with tectonics, shapes the land surface. Water is the universal solvent and the medium in which most changes of matter take place; hence it is the agent of element cycling. Finally, water is necessary for life.

Investments in water resources management over the last century have helped provide the remarkable levels of public health and safety enjoyed by the urban populations of the developed world. Although we have spent lavishly to cope with the scarcities and excesses of water and to ensure its potability , we have invested relatively little in the basic science underlying water's other roles in the planetary mechanisms. This science, hydrologic science, has a natural place as a geoscience alongside

atmospheric, ocean, and solid earth sciences; yet in the modern scientific establishment this niche is vacant.

Because of the pervasive role of water in human affairs, the development of hydrologic science has followed rather than led the applications – primarily water supply and hazard reduction – under the leadership of civil and agricultural engineers. The elaboration of the field, the education of its practitioners, and the creation of its research culture have therefore been driven by narrowly focused issues of engineering hydrology. The scale of understanding has been modest – generally limited to surface drainage basins with areas of 10 000 km^2 or less.

Hydrology has not been cultivated as a geoscience because until now there has been no practical need to build a comprehensive understanding of the global water cycle. Moreover, the patches of scientific knowledge that support traditional small-scale engineering applications do not merge into the coherent whole needed to understand the geophysical and biogeochemical functioning of water at the regional and continental scales of many emerging problems.

Furthermore, the training of hydrologic scientists cannot be accomplished efficiently in educational programs dominated either by applications-oriented constraints or by undergraduate preparation in which engineering predominates. A thorough background in mathematics, physics, chemistry, biology, and the geosciences is necessary.

A Course of action

The Committee on Opportunities in the Hydrologic Sciences (COHS) was created by the Water Science and Technology Board (USA) to conduct an assessment of the hydrologic sciences, including their definition, their current state of development, and their relationshps with related geosciences and biosciences. The committee also was asked to identify promising new frontiers and applications and to outline an appropriate framework for education and research in the hydrologic sciences.

At the outset we should understand the committee's use of the term "geoscience's vis-à-vis "earth science" and the more recently coined "earth system science." The COHS uses "geoscience" to include atmosphereric scienece, ocean science, solid earth science, glaciology, and, as argued herein, hydrologic science.

"Earth science" is interpreted as the solid earth sciences, including geology, petrology, seismology, volcanology, and so on. "Earth system science" includes all sciences relevant to the functioning of the planet earth as a set of interacting physical, chemical, and biological mechanisms. It differs from geoscience in its inclusion of important terrestrial biota and certain solar and other space physics effects on the earth, and in its emphasis on integrated planetary behaviour.

In summary, the report's contents are as follows:

Chapter 1, "Water and Life," explains the uniqueness and historical importance of water. It contains examples of the roles of water in civilization both as sustainer and hazard, and as a resource to be managed.

Chapter 2, "The Hydrologic Sciences," describes the evolution of the perception and definition of the hydrologic sciences and identifies as primary agents of change the increasing scale of applied problems and the concurrent spreading of anthropogenic influences. The hydrologic cycle is recognized to be the framework of these sciences, and its physical and chemical processes are illustrated. The status of understanding of these processes and of the biological components of the hydrologic cycle is summarized. Some major research questions are posed.

Chapter 3, "Some Critical and Emerging Areas," is the intellectual core of the report and contains a collection of essays on promising frontier research topics. in selecting these topics the committee has opted for the interesting and exciting, subjectively seeking to transmit the flavor of the science rather than to provide an exhaustive catalog of opportunities. A typical essay begins with a research question, is followed by a brief historical review, and concludes with a description of the problem and its importance to the science.

The essays are grouped in sets representing the major subdivisions of the hydrologic sciences. The quality of water is as much a part of the hydrologic cycle as is its mass or flow rate, and so chemical issues occur along with the physical in each of the geophysical subdivisions; indeed, several have been selected for presentation there. The same can be said for the mathematical topics of the final secion, and, to a more limited degree, for biology. However, the committee has chosen to concentrate its discussions on the relation of hydrology to its sibling sciences in separate sections in order to call the attention of biologists, chemists, and mathematicians to interesting hydrologic problems.

Chapter 4, "Scientific Issues of Data Collection, Distribution, and Analysis," discusses the need for, the characteristics of, and the current status of hydrologic data. It concludes with a set of brief essays concerning topics such as new technology, methods of analysis, and co-ordinated multidisciplinary experiments.

Chapter 5, "Education in the Hydrologic Sciences," contrasts education for the internally driven puzzle solving of science with that for the externally driven problem solving of engineering. It makes specific recommendations relative to hydrologic science for programs at the graduate, undergraduate, and kindergarten through twelfth grade levels.

Chapter 6, "Scientific Priorities," outlines a rational process for setting scientific priorities for funding agencies, and with strategic actions that individual scientists and their scientific societies can take to enhance the image and status of hydrologic science.

The report concludes with four appendixes. Appendix A gives an estimate of recent annual investments of U.S. federal agencies in research in hydrologic science. Appendix B profiles the hydrologic science community, contrasting the results of a 1988 human resources questionnaire with those of a similar survey published in 1962.

1991 337+ pages Price: Not available
ISBN 0 309 042445

The complete volume of *Opportunities in the Hydrological of Sciences,* is available from: National Academy Press, 2101 Constitution Avenue, N.W., Washington, D C 20418, USA.

From your secretary,

SOUTHERN AFRICA 1991

IRRIGATION
JUNE 4 – 6

A Southern African irrigation symposium will be held at the Elangeni Hotel in Durban.
Enquiries: The Organising Committee, Irrigation Symposium, P O Box 824, Pretoria 0001.

RURAL WATER SUPPLIES
JULY 1 – 5

A course on the planning, design, construction and operation of dams for rural water supplies will be held at the University of Pretoria.
Enquiries: Mrs Nellie le Roux, Department of Civil Engineering, University of Pretoria 0002. Tel (012) 420-2978 Fax (012) 43-3589.

FRESHWATER ECOSYSTEMS
JULY 9 – 11

A conference on marine, estuarine and freshwater ecosystems will be hosted by the JLB Smith Institute of Ichthyology, Rhodes University and the Albany Museum in Grahamstown.
Enquiries: Dr A K Whitfield, Convener, Local Organising Committee, JLB Smith Institute, Private Bag 1015, Grahamstown 6140. Tel. (0461) 27124.

GROUNDWATER
AUGUST 21 – 23

The first biennial groundwater convention of the Groundwater Division of the Geological Society of South Africa and the Borehole Water Association of Southern Africa will be held at Eskom College in Midrand. The theme for this technical symposium is groundwater quality and pollution.
Enquiries: The Symposium Secretary, P O Box 2178, Southdale 2135.

OCEANOGRAPHIC ECOLOGY
SEPTEMBER 8 – 12

A symposium on the Benguela trophic functioning entitled Resource Utilisation from an Ecosystem Perspective, will be held at the University of Cape Town.
Enquiries: The Symposium Secretariat, Oceanography Department, University of Cape Town, Rondebosch 7700.
Tel. (021) 650-2681.

OVERSEAS 1991

WATER RESOURCES
AUG 12 – 15

A symposium entitled Water Resources in the Next Century, will be held in Stockholm, Sweden.
Enquiries: Stockholm Water Symposium 1991, c/o Stockholm Convention Bureau, P O Box 6911, S-102 38 Stockholm, Sweden.

WASTEWATER PLANTS
AUG 26 – 30

The 6th IAWPRC conference on the design and operation of large wastewater treatment plants will be held in Prague, Czechoslovakia.
Enquiries: Prof J Wanner, Prague Institute of Chemical Technology, Department of Water Technology and Environmental Engineering, Suchbatarova 5, CS–166 28, Prague 6, Czechoslovakia.

POLLUTION
SEPTEMBER 10 – 12

The University of Bradford's Silver Jubilee Celebration Conference with the theme The Changing Face of Europe: disaster, pollution and the environment will be held in Bradford, Yorkshire.
Enquiries: Dr Z Keller, University of Bradford, Bradford, West Yorkshire BD7 1DP.

ACID DRAINAGE
SEPTEMBER 16 – 18

The second international conference on the abatement of acidic drainage will be held in Montreal, Canada.
Enquiries: Pamela Friedrich, Centre de Recherches Minerales, 1665 Boulevard Hamel, Edifice 2, First Floor, Quebec, Canada G1N3 Y7.

WASTEWATER
SEPTEMBER 24 – 26

An international symposium on wastewater reclamation and reuse will be held in Castell Platja d'Aro, Costa Brava, Spain.
Enquiries: Prof Rafael Mujeriego, Universidad Politecnica de Cataluna, ETS de Ingenieros de Caminos, Gran Capitan S/N, 08034, Barcelona, Spain.

GROUNDWATER
OCTOBER 8 – 9

A two-day international conference on groundwater protection will be held in Paris.
Enquiries: Mrs Lavinia Gittins, IWEM, 15 John Street, London WC1 N2 EB.

WATER DISTRIBUTION
OCTOBER 21 – 22

The European specialised conference on managing water distribution systems will be held at the "Centro Affari" in Florence, Italy.
Enquiries: The IWSA Secretariat, 1 Queen Anne's Gate, London, SW1 H9 BT, Great Britain. Call for papers.

PIPELINES
OCTOBER 27 – 31

The third international conference on pipeline construction will be held at the Congress Centrum, Hamburg, Germany.
Enquiries: No-Dig '91, Leitungsbau '91, c/o Hamburg Messe and Congress GmbH, Congress Organisation, P O Box 302480, D-200 Hamburg 36, Germany.

NITROGEN
NOVEMBER 26 – 27

A workshop on inorganic nitrogen compounds and water supply organised by the standing committee on water quality and treatment of the IWSA will be held in Hamburg, Germany.
Enquiries: Mr Pierre Schulhof, Compagnie Générale des Eaux, 52 rue d'Anjou, 75384 Paris Cedex 08, France. Call for papers.

ECONOMICS COURSE
SEPTEMBER – DECEMBER

A three months course on economics and management for the water industry will be held by the Developing Countries Unit at the Strathclyde Business School of the University of Strathclyde, Scotland. Tuition and accommodation fees: £6 800.
Enquiries: Dr J Love, DCRU, Department of Economics, Strathclyde Business School, University of Strathclyde, 100 Cathedral Street, Glasgow G4 OGE Scotland, UK.

SHORT COURSE

DEPARTMENT OF CIVIL ENGINEERING

UNIVERSITY OF PRETORIA

presents

Planning, Design, Construction and Operation of Dams for Rural Water Supplies

DATE

1 – 5 July 1991

PURPOSE

The water supply situation is critical in many regions of southern Africa. Financial resources are often severely limited.

The purpose of this course is to present soundly based technology with strong emphasis on minimum cost solutions. The methodology has been developed, tested and applied in South Africa and is particularly applicable in situations where the available resources are limited. The emphasis during the course will be on practical applications, supported by extensive course notes for future reference. Computer programs on disks will be provided. These include computer-aided tuition programs as well as programs for solving many of the problems covered in the course. The afternoons will be spent solving practical problems on computers in the University's computer laboratories. No knowledge of computer programming will be required.

The lectures will be presented in English and will be at a level that can be understood by engineers, experienced technicians, and informed lay persons.

PRESENTERS

Prof W J R Alexander (course leader), staff of the University of Pretoria and experienced engineers from other organisations.

COURSE FEES

R950 per person, payable to the University of Pretoria. (The fees include documentation, computer programs, teas and lunches.)

ACCOMMODATION

Accommodation at a university residence within walking distance of the venue will be available. The cost is R245 per person which includes bed and breakfast from 30 June (15:00) to 5 July (15:00).

ENQUIRIES

Mrs Nellie Roux
Department of Civil Engineering
University of Pretoria
PRETORIA 0002
Tel (012) 420-2978
Fax: (012) 43-3589

Should you be interested to attend this course please complete the applicable post card in the Bulletin and post it to the above address.

GROUND WATER QUALITY AND POLLUTION

TECHNICAL SYMPOSIUM

21-23 AUGUST 1991

ESKOM COLLEGE MIDRAND

First Biennial Ground Water Convention of The Ground Water Division of the Geological Society of South Africa and The Borehole Water Association of South Africa

VENUE & DATES

The 3 day convention will be held at **Eskom College, Midrand** on 21-23 August 1991.
A field excursion is being planned for the afternoon of 22 August 1991.

OVERVIEW

In view of the ever-increasing demand for ground water and the preservation of potable supplies, the theme for the convention is: ***"Ground Water Quality & Pollution".***

The Convention consists of:

- **A Technical Symposium**
- **An Exhibition**
- **Workshops**

TECHNICAL SYMPOSIUM

Papers on the following aspects of ground water quality will be presented: Regional ground water quality characterisation; geochemistry; pollution problems and impact studies; waste disposal and ecology related topics; monitoring; aquifer protection and quality management.

A registration fee of R500 includes technical sessions, proceedings, excursions, lunches, refreshments and cocktail party.

(A 10% discount will apply for paid-up members of the Ground Water Division and Borehole Water Association as well as full time students.)

BANQUET: Single **R35**
Double **R60**

EXHIBITIONS AND WORKSHOPS

Companies are invited to display and advertise their products and/or present workshops.

There will be indoor and outdoor exhibits of:

Drilling equipment; equipment for location of boreholes; construction equipment; testing equipment; ancillary equipment for the equipping of boreholes.

Prices of stands vary with size. Contact the Symposium Secretary for details.

ENQUIRIES:

The Symposium Secretary P O Box 2178 SOUTHDALE 2135
Tel: (011) 942-1123 or (011) 942-1402

If you wish to attend, contact the Symposium Secretary for details, or complete the reply form inside this bulletin.