SA waterbulletin

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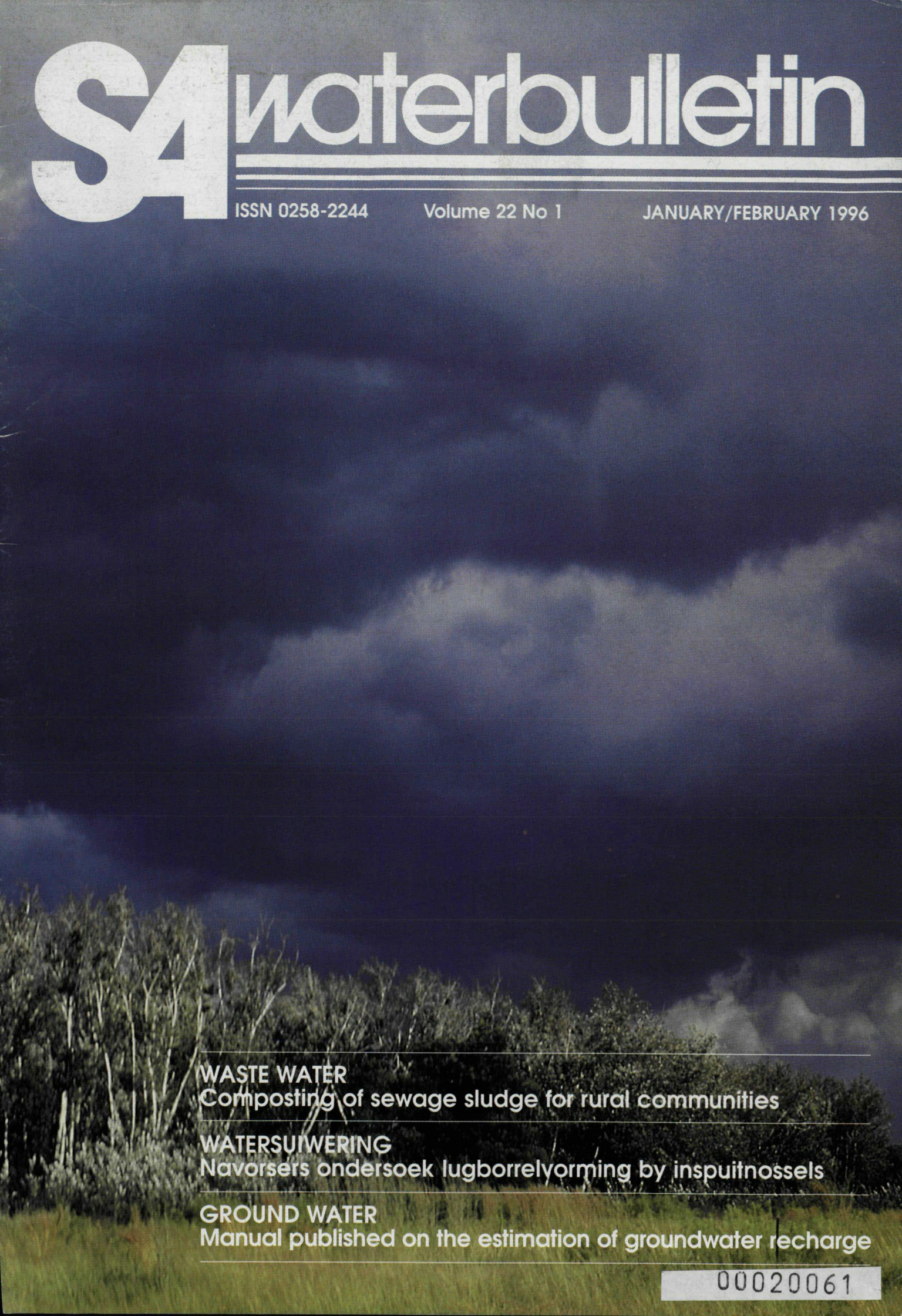

WASTE WATER
Composting of sewage sludge for rural communities

WATERSUIWERING
Navorsers ondersoek lugborrelvorming by inspuitnossels

GROUND WATER
Manual published on the estimation of groundwater recharge

S·H·O·R·T C·O·U·R·S·E

University of Pretoria

Department of Chemical Engineering

Division of Water Utilisation

WATER QUALITY MANAGEMENT

13-17 May 1996

Course contents:

- Legal and policy aspects related to water pollution control and water quality management.
- Mass and energy balances, water housekeeping, optimisation of water usage and waste minimisation.
- Treatment processes including : oxidation/reduction, chemical precipitation, membrane processes, activated carbon adsorption, ion exchange.
- Treatment and disposal of brines and concentrates.
- Mine water : minimisation and treatment of acid mine drainage

Course contents enquiries can be directed to Prof CF Schutte at tel (012) 420-3571.

Course fee

The fees for the short course is R1 950 excluding tax.

Language

The lecture notes are in English.

Registration

The short course is administrated by the Laboratory for Advanced Engineering, Centre for Continued Education, University of Pretoria. Please contact Mrs D Pienaar at tel. (012) 342-6460/43-6625 or fax (012) 342-4151 for registration and further information.

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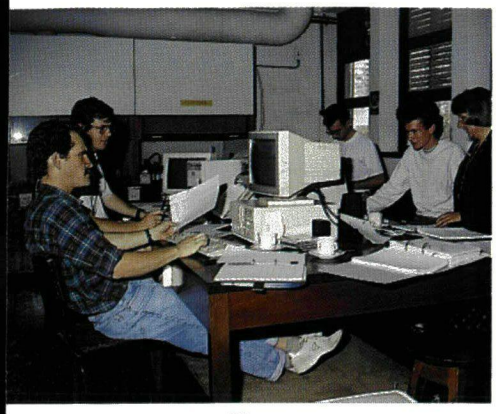


p 10

p 12

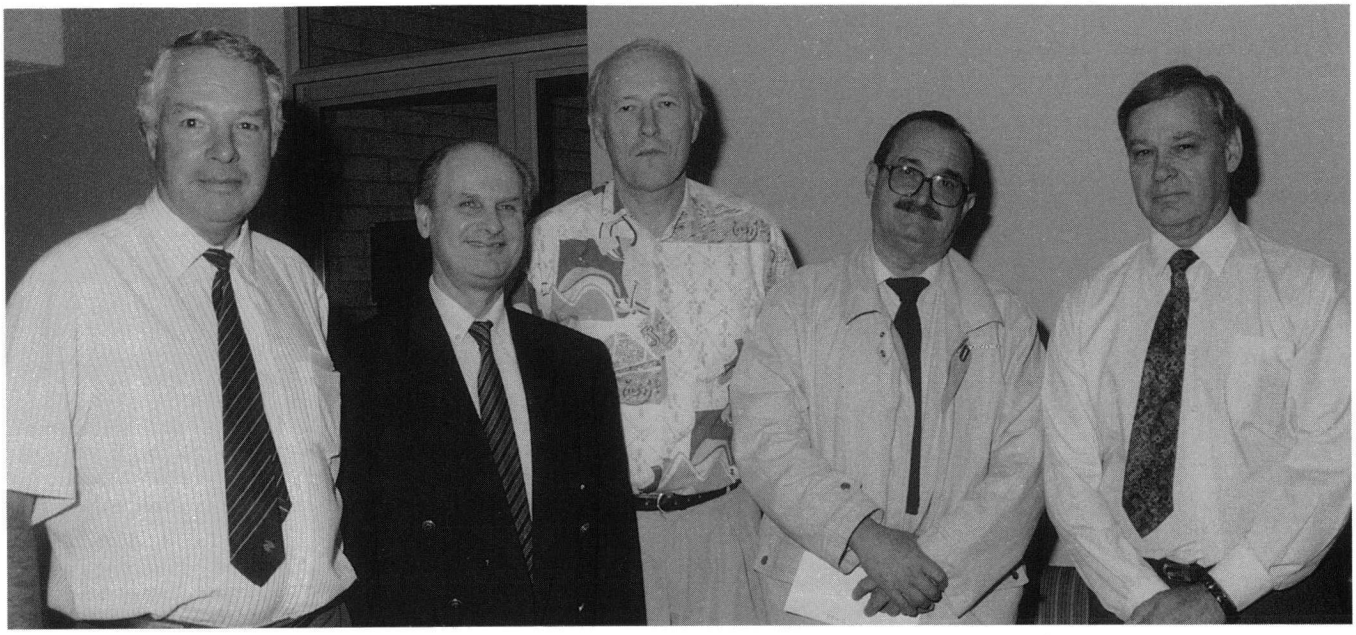
p 16

Contents

Cover: Storm clouds gathering east of Pretoria (Foto: Helene Joubert)

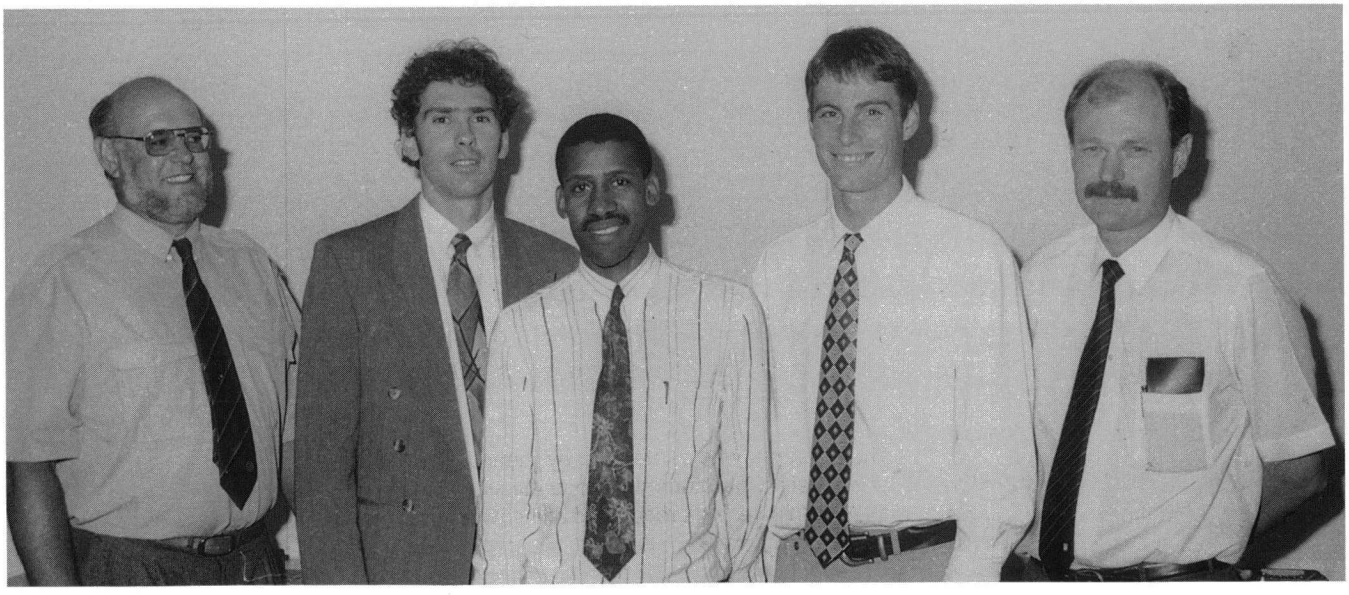
SA Waterbulletin is a two monthly magazine on water and water research published by the South African Water Research Commission (WRC), a statutory organisation established in 1971 by Act of Parliament. Subscription is free. Material in this publication does not necessarily reflect the considered opinions of the members of the WRC, and may be copied with acknowledgement of source. Editorial offices: Water Research Commission, PO Box 824, Pretoria 0001, Republic of South Africa. Tel (012) 330-0340. Fax (012) 331-2565. Editor: Jan du Plessis. Asst Editor: Helene Joubert. Ed Secretary: Rina Human. Layout: Prepress Images, Pretoria. Colour Separations: Lithotechnik. Printing: Beria Printers.

WRC assists UNESCO with meetings



During December 1995 the Water Research Commission assisted UNESCO in holding a series of meetings on the subject of Total Interdisciplinary Risk and Crisis Management. The meetings were attended by representatives of universities, municipalities, technikons, the private sector and the media. Photographed here are from left: Mr H Maaren, (Research Manager, Water Research Commission (WRC), Mr P Vasarhelyi, (UNESCO), Professor L Faugeres, (Sorbonne, Paris), Mr C Collin, (Marseilles, France) and Mr PE Odendaal, (Executive Director, WRC).

WRC awards Fellowships



The Water Research Commission recently awarded WRC Fellowships to three post-graduate students to pursue studies in resource economics in the field of water supply and utilisation. Photographed here are Prof MF Viljoen (University of the Orange Free State) far left, and Dr Gerhard Backeberg (Water Research Commission) (far right) with some of the Fellowship candidates they interviewed, Mario du Preez (left), Sibusiso Luvuno (centre) and Hugo van Zyl (right).

Researcher reviews approaches to determine leachate generation and groundwater recharge

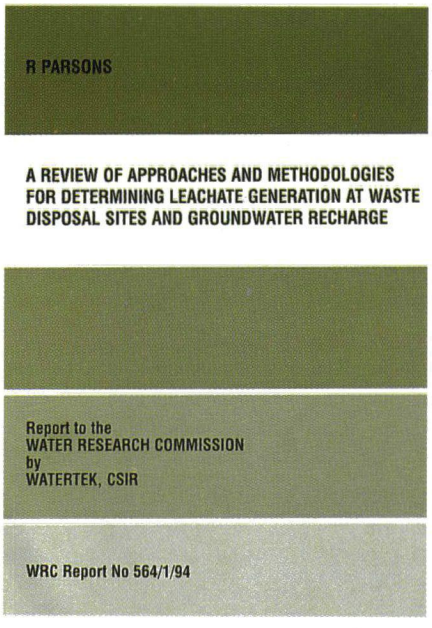
From a geohydrological point of view it is relatively simple to show that groundwater recharge occurs throughout South Africa, irrespective of climatic conditions. The quantification of recharge is, however, difficult. The classical Waste Site Water Balance (WSWB) method, on the other hand, has and is being widely applied in South Africa to determine or predict leachate generation at waste disposal sites. Following this approach it is generally accepted that in areas where the annual evapotranspiration rate exceeds the annual precipitation rate (water deficit climates) water contamination due to landfill leachate is not a problem. This would suggest that leachate only poses a threat to groundwater in 20 per cent of South Africa.

Both approaches are primarily based on climatic considerations, yet they yield apparently contradictory results, says researcher R Parsons of Watertek, CSIR, in a report to the Water Research Commission. This apparent paradox between the Waste Site Water Balance and groundwater recharge approaches, prompted the proposal of the research project entitled **A review of approaches and methodologies for determining leachate generation at waste disposal sites and groundwater recharge**.

AIMS

The aims of the research project were to evaluate approaches employed locally and overseas to determine recharge and leachate generation, in order to identify the more appropriate approach. The specific aims of the research project were:

- to assess approaches and methodologies employed internationally to determine rates of recharge and leachate generation at waste disposal sites;
- to assess approaches and methodologies employed in South Africa to determine rates of recharge and leachate generation at waste disposal sites;



- to compare the identified approaches and methods, in order to evaluate the current knowledge and practices in South Africa;
- to identify further research needs in this field in South Africa.

The research was carried out by means of a detailed literature study and discussions with selected proponents of the two approaches.

CONCLUSIONS

The fundamental differences between leachate generation and groundwater recharge suggest that the two processes do not equate.

Leachate generation occurs near surface as water passes through the landfill, usually exiting at or near the base of the system. Precipitation, however, is not the only source of water in the generation of leachate, as additional moisture can be derived from the incoming waste as well as from chemical and biological activity within the waste pile.

Groundwater recharge, on the other hand, is essentially an end product, being the volume of water that can or does enter the aquifer system resulting in replenishment.

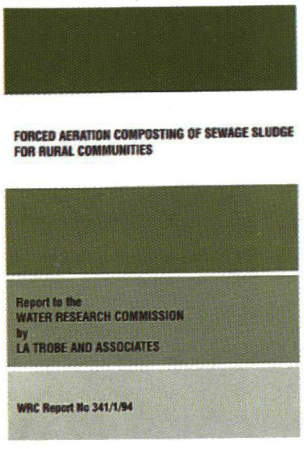
These differences indicate that a direct comparison between the two is not legitimate. Further, because of the different scales involved in trying to predict output, the estimation techniques are not interchangeable.

Therefore it cannot be said that one approach is more appropriate than the other, nor can it be said that recharge estimation techniques can be used to predict leachate generation.

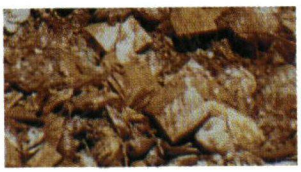
However, the comparison made between the two methods has highlighted flaws in the WSWB method, and consequently the need for further research.

Furthermore, this report accentuates the great need for the transfer of knowledge from focused disciplines, especially, into multi-disciplinary arenas such as waste management.

The report entitled **A review of approaches and methodologies for determining leachate generation at waste disposal sites and groundwater recharge** (WRC Report no 564/1/94) is available free of charge from the Water Research Commission, PO Box 824, Pretoria 0001. (Overseas price: US $20).



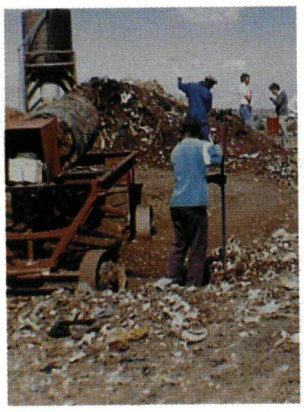
Sewage sludge and domestic wastes create jobs

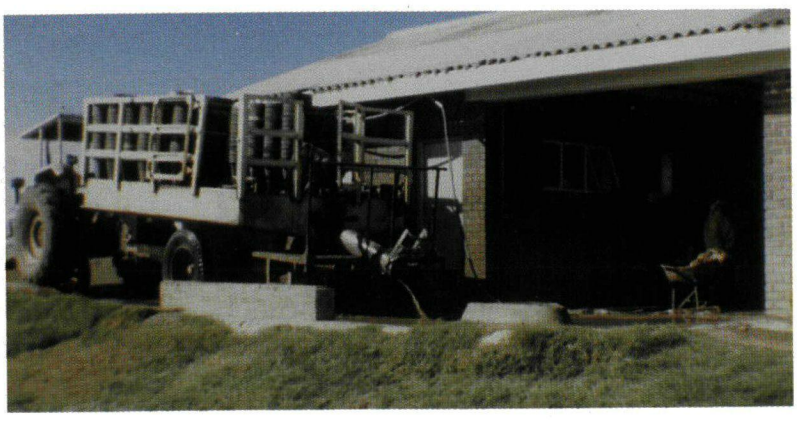


Any community, no matter how rich or poor, has two fundamental waste streams: domestic refuse and body wastes. A project report recently published by the Water Research Commission demonstrates that it is technically feasible and economically viable to stabilise large quantities of unsorted and non-pulverised domestic refuse with primary sewage, particularly night soil or activated sludge, by means of a process of forced aeration composting.

This method, developed by Dr Brian Latrobe and Associates, accelerates the composting process to a mere 21 days, by properly controlling and monitoring the internal temperatures of the windrows (static piles). The end product can be used without fear of infection or nuisance since all the weed seeds, pathogens and *Ascaris* worm cysts would have been devitalised.

The report says it is important to remember that even if all the compost produced in the process cannot be used or sold, the two obnoxious waste streams, namely domestic refuse and raw sewage and sludges, would have been effectively stabilised at a comparatively low cost, using a technique which is simple. The implementation of this composting





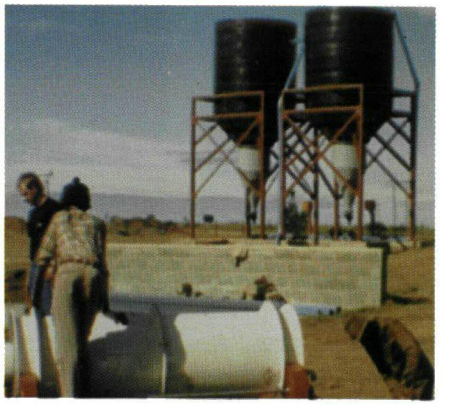
Above : *Windrow spraying with primary emascerated and thickened sludge.*
Right: *Rotary sieve for compost separation.*
Far Right: *Night soil arriving on site.*

Left:

Delivery of domestic refuse.

Below:

Settling tanks for raw sewage storage. In the fore-ground rotary screen with water jets for solids breakdown.

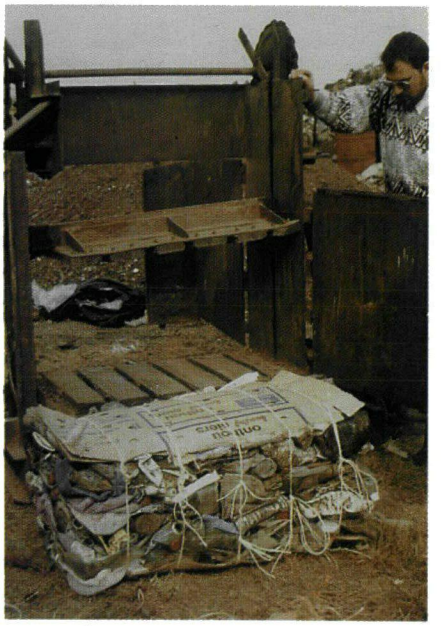


process is capable of providing job opportunities and does not need a high degree of formal education.

The end product has uses other than a soil conditioner. Large quantities can be used as a landfill cover or even as a solid fuel.

"The process is kind to our fragile and constantly battered environment. It is apt, viable and simple technology suitable for South Africa's third world conditions."

Copies of the report entitled **Forced aeration composting of sewage sludge for rural communities** (WRC Report 341/1/94) are available free of charge from:
The Librarian, PO Box 824, Pretoria 0001.
(Overseas order price: US$:20,00.)



Above right:

Baling of plastic removed from compost for recycling.

Right:

The final product from the composting plant treating night soil and domestic refuse - pathogen free compost.

Navorsers ondersoek lugborrelvorming by inspuitnossels

Die Waternavorsingskommissie het die resultate bekend gemaak van 'n ondersoek na die verfyning van inspuitnossels vir opgelostelug-flottasie.

Die navorsers, EM Rykaart en J Haarhoff, van die Randse Afrikaanse Universiteit in Johannesburg, sê in 'n verslag aan die Waternavorsingskommissie dat die proses van opgelostelugflottasie al hoe meer gebruik word by die suiwering van drinkwater, "veral aangesien die proses uiters geskik is vir hoogs eutrofe water, soos wat algemeen in Suid-Afrika voorkom".

Suksesvolle flottasie is afhanklik van 'n aantal belangrike fisiese en bedryfsbeperkinge. Een van die belangrikste redes vir die mislukking van opgelostelugflottasie volgens die navorsers is onbevredigende borrelvorming.

"Die mikroborrels word gevorm wanneer oorversadigde water afkomstig van die lugversadiger, teen 'n druk van tussen 200 en 500 kPa, deur 'n nossel vrygelaat word na atmosferiese druk. Onder druk los lug op in water en sodra die druk verlig word, presipiteer die lug uit in die vorm van klein mikroborreltjies.

Afskrifte van die verslag getiteld Die verfyning van inspuitnossels vir opgelostelugflottasie (WNK-verslag 448/1/95) is gratis verkrygbaar vanaf die Bibliotekaresse, die Waternavorsingskommissie, Posbus 824, Pretoria 0001. (Buitelandse prys: US$ 25,00.)

Dit word algemeen aanvaar dat 'n relatief homogene borrelwolk, met 'n mediaan borrelgrootte van 100 µm verlang word. Indien groot borrels tussen die kleiner borreltjies voorkom, sal hulle te vinnig styg en die dryflaag versteur, met die gepaardgaande benadeling van die skeidingsproses. Aan die ander kant, as die borreltjies weer te klein is, sal hulle stygspoed baie laag wees en sal hulle saam met die produkwater afgevoer word.

Deur die fisiese geometrie van die nossel sowel as die bedryfstoestande te manipuleer, is daar 'n moontlikheid om borrels van 'n gevraagde grootte en verspreiding te genereer.

Die vernaamste oogmerk van dié navorsingsprojek was dus om die faktore te identifiseer wat borrel-grootte beïnvloed en om daardeur die borrelgroottes te probeer manipuleer.

Die vernaamste resultaat van die navorsingsprojek was die ontwikkeling van 'n eenvoudige, konsepsuele borrelgroeimodel vir opgelostelugflottasie. Die model bestaan uit twee stappe:

❑ Die eerste stap van borrelvorming begin onmiddellik nadat die drukverlies deur die nossel 'n aanvang neem. Gedurende die eerste stap groei borrels rondom 'n konstante aantal nukleasiekerne as gevolg van die lug wat oorgedra word van die water. Nadat al die oortollige lug oorgedra is van die opgeloste na die gasfase, eindig die eerste stap en die tweede stap begin.

❑ Gedurende die tweede stap bly die volume lug konstant, maar die borrels hou aan met groei weens borrelsamevoeging.

RESULTATE

Die navorsers sê die resultate van die reeks eksperimente wat hulle gedoen het, kan kortliks soos volg opgesom word:

Versadigerdruk

Die versadigerdruk vir al die eksperimente is gewissel tussen 200 en 500 kPa. Daar word sonder uitsondering gevind dat die mediaan borrelgrootte afneem soos die druk verhoog word.

Dieselfde geld vir die persentasie growwe borrels, aangesien 'n hoër druk groter vloeisnelhede tot gevolg het. Derhalwe is die moontlikheid groter dat growwe borrels met die tref van 'n obstruksie kan opbreek.

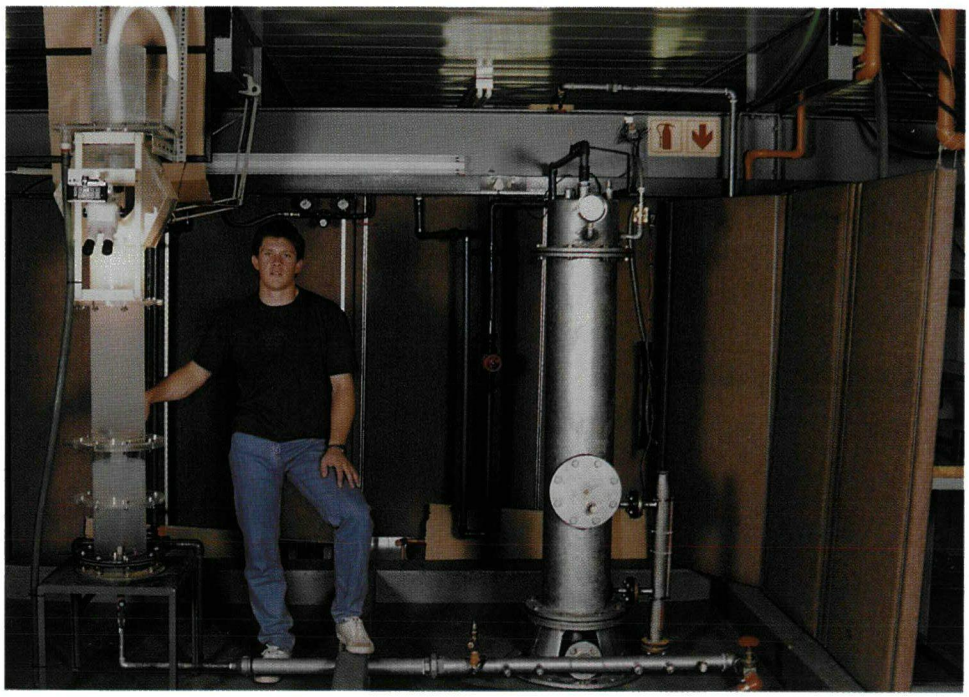
Nossellengte
Die nossellengte het geen noemenswaardige uitwerking op die mediaan by 'n hoë druk nie. Indien die druk egter verlaag word, word groter borrels gevorm as die nossellengte langer as 31 mm word. Wanneer die nossel langer as 31 mm word, het die navorsers gevind dat die persentasie growwe borrels marginaal kleiner word by hoër drukke en aansienlik groter by lae drukke. By korter nossels is daar geen merkbare effek te bespeur nie.

As gekyk word na die uniformheidsindeks (wat 'n aanduiding gee van die verspreiding van borrels), sien 'n mens dat die marginale toename in die uniformheidsindeks konsekwent is vir beide hoë en lae drukke vir nossels korter as 31 mm. By langer nossels bly die uniformheidsindeks konstant vir hoë drukke, maar neem drasties af vir lae drukke.

Die borrelgroeimodel maak nie voorsiening vir die hoeveelheid tyd wat die waterstraal in die nossel beweeg nie, maar as 'n mens aanvaar dat die drukverlaging plaasvind vandat die waterstraal by die nossel inkom, kan dit aanvaar word dat in 'n lang nossel feitlik volkome borrelgroeiing kan plaasvind binne die nosselkanaal as die druk aanvanklik laag genoeg is. Dit verduidelik die vergroting van die mediaan sowel as die toename in growwe borrels in lang nosselkanale, aangesien daar in alle waarskynlikheidborrelsamevoeging in die kanaal sal plaasvind.

Nosseldeursnit
Die eksperiment het getoon dat vir alle nosseldeursneë, behalwe kleiner as 1 mm, die invloed op mediaanborrelgrootte nie betekenisvol was nie. 'n Deursnee van kleiner as 1 mm het egter 'n drastiese toename in die mediaan tot gevolg gehad.

Die aantal growwe borrels is meer by 'n hoër druk as by 'n lae druk, ongeag die nosseldeursnee, maar daar blyk 'n optimum punt te wees vir die tendens. By 'n lae druk moet die nosseldeursnit 2,5 mm wees vir die growweborrelindeks om 'n minimum te wees, en by hoër drukke 2 mm.



Een van die navorsers, mnr EM Rykaart, staan by die apparaat wat in hierdie projek van die Waternavorsingskommissie en die RAU gebruik is.

Knak in die nosselkanaal
Die toevoeging van 'n knak in die nosselkanaal het tot gevolg gehad dat die aantal growwe borrels afgeneem het, ongeag van die versadigerdruk, terwyl die mediaan drasties afgeneem het namate die versadigerdruk verhoog is. By 'n laer druk is die mediaan nie geaffekteer nie.

Die navorsers sê volgens die model kan dit dus vertolk word dat indien die knak op 'n afstand geplaas word waar volkome borrelvorming nog nie plaasgevind het nie, en die snelheid hoog genoeg is, sal die halfgevormde borrels teen die obstruksie bots en meer borrels vorm, wat noodgedwonge 'n kleiner mediaan sal hê.

Ongeag of die obstruksie voor volkome borrelvorming geplaas word of nie, sal die borrels wat daar is nogtans teen die obstruksie bots en kleiner borrels vorm, wat 'n laer persentasie growwe borrels tot gevolg het.

Afskerming
Die mediaanborrelgrootte het 'n noemenswaardige afname getoon indien afskerming voor die nosselkanaaluitlaat nader as 10 mm van die opening af geplaas is, ongeag die druk.

By hoër drukke is ook gevind dat die persentasie growwe borrels drasties toeneem sodra die skerm verder as 10 mm beweeg word. Vir lae drukke is geen effek bespeur nie.

Soos met die knak in die nosselkanaal kan die resultaat aan die hand van die model verduidelik word. Indien die afskerming naby genoeg is sodat die waterstraal dit tref voordat volkome borrelvorming plaasgevind het, sal die halfgevormde borrels teen die obstruksie bots en verder opbreek om meer borrels met 'n laer mediaan tot gevolg te hê.

As die borrelvorming reeds voltooi is wanneer die obstruksie getref word, sal die klaargevormde borrels opbreek om 'n kleiner persentasie growwe borrels te veroorsaak.

Uitstroomtuit
Vir beide hoë en lae drukke het die toevoeging van 'n uitstroomtuit voor die nosselopening tot gevolg dat die mediaan drasties afneem. By hoë drukke neem die persentasie growwe borrels ook verder drasties af.

Chemical speciation modelling promoted

Knowledge of the chemical composition of a water system and its interaction with its surroundings is essential for the understanding of phenomena as diverse as corrosion and scaling, groundwater quality, leachate attenuation, bioavailability and nutrient cycling, biotoxicity, water treatment and chemical dosing, desalination and effluent treatment. However, the complexity of water systems is such that the use of basic chemical equilibrium theory is inhibited by the lack of complete equilibrium data and the ability to solve mathematically the individual equilibrium equations.

This is said in a report to the Water Research Commission by CA Kerr from the Pollution Research Group in the Department of Chemical Engineering, University of Natal. The report called **Technology transfer of aquatic chemical speciation modelling** resulted from a technology transfer project to promote the use of chemical speciation in South Africa.

The report says the need to transfer this technology arose from a previous Water Research Commission project (No 319: Phase diagrams of complex precipitates - with special emphasis on the use of chemical speciation modelling). During that project the use of a computer model to obtain a speciated chemical analysis was introduced to a number of individuals and organisations concerned with the water industry.

"For many people the concept of chemical speciation was new, while others, although familiar with the principles of chemical speciation, lacked a practical tool to obtain speciation information. A need was thus identified to inform people about the benefits of having a fully speciated chemical analysis and to provide them with a tool to obtain such data."

The aim of the project was achieved by:
❑ Disseminating of the capabilities of the chemical equilibrium speciation computer program MINTEQA2. (This program can be used to calculate the equilibrium composition of laboratory solutions or natural aquatic systems.);
❑ Holding workshops on the theoretical basis and practical use of MINTEQA2;
❑ Providing back-up support for MINTEQA2 users, through the establishment of a help-desk or electronic bulletin board;
❑ Acting as a link between the United States Environmental Protection Agency (US EPA), who developed the program, and South African users, and
❑ Supporting other Water Research Commission projects which require a knowledge of chemical speciation.

Possible areas of application for MINTEQA2

Areas of Application	Type of Information
Soil science and irrigation	The ability of different soil types to adsorb metals can be evaluated. This has implications for metal cycling and bio-uptake of potential pollutants.
Acid rain attenuation	The effects of acid rain on ground water composition or soil adsorbing capacity can be modelled enabling attenuation plumes to be delineated.
Solid waste disposal; groundwater modelling; acid mine run-off	The interaction between ground waters and leachates from waste disposal sites or mine dumps can be evaluated.
Receiving water quality assessment and pollution risk assessment	The potential for pollution can be evaluated through a knowledge of dominant chemical species present. The effect of receiving water properties such as: pH, Eh and water hardness on the distribution of species can be modelled.
Water and wastewater treatment	New treatment processes can be modelled and their effectiveness assessed. The effect of proposed changes to an existing treatment process can be evaluated.
Aquatic ecosystem modelling Desalination	Where sufficient data exists, the entire aquatic ecosystem can be modelled. Combined with areas such as plant physiology, zoology, epidemiology, chemical speciation modelling would provide the means of establishing base line data for environmental monitoring.
Desalination	The effects of increasing ionic strength on species mobility, precipitation potential and osmotic pressure can be evaluated. Such information has implications for plant design and operation and can be used to assess priorities and courses of action.
Sewage treatment	The uptake of heavy metals on biomass and struvite precipitation can be modelled.

Copies of the report (WRC report 530/1/95) are obtainable from the Water Research Commission, PO Box 824, Pretoria 0001. (Overseas price: US$ 20,00.)Copies of the report (WRC report 530/1/95) are obtainable from the Water Research Commission, PO Box 824, Pretoria 0001. (Overseas price: US$ 20,00.)

Control methods developed for ameliorating bulking sludges

Results emanating from a previous research contract between the Water Research Commission and the University of Cape Town's Department of Civil Engineering into bulking sewage sludges showed that the selector effect did not control the low "food to micro-organism ratio" (F/M) filament bulking in nitrogen and nitrogen and phosphorus removal systems. Consequently, new approaches for dealing with this common problem needed to be developed.

In a follow-up contract researchers from the Water Research Group at the University of Cape Town, TG Casey, MC Wentzel, GA Ekama, MT Lakay and GvR Marais, explored a number of directions to try to identify the cause for the low F/M filament bulking. If the cause could be understood, then it becomes possible to devise strategies for the control of the low F/M filament proliferation, says the research group in their final report to the Water Research Commission who financed the investigation.

Copies of the report entitled Causes and control of anoxic aerobic (AA) (or low F/M) filament bulking in long sludge age nutrient removal activated sludge systems **(WRC reports 286/1/94 and 286/2/94) are available free of charge from the Librarian, Water Research Commission, PO Box 824, Pretoria 0001. (Overseas price: US$ 35,00.)**

The researchers say that an experimental investigation was carried out over three years in which various laboratory nitrogen and nitrogen and phosphorus removal plants were operated (all at 20°C) to examine the effect of:

- readily biodegradable or slowly biodegradable COD only as feed;
- the aerobic mass fraction;
- frequency of exposure to anoxic and aerobic conditions;
- nitrate and nitrite concentrations in the anoxic zone or during the anoxic period;
- dissolved oxygen concentration in the aerobic zone or during the aerobic period;
- sludge age;
- fully aerobic and fully anoxic conditions, and
- differences in the anoxic-aerobic condition in intermittently aerated single reactor and two-reactor anoxic aerobic systems.

CONCLUSIONS

From the results it was concluded that the single most important factor influencing low F/M filament proliferation was alternating anoxic-aerobic conditions with significant concentrations of nitrate or nitrite present at the commencement of aerobic conditions. Under these conditions the activated sludge is forced to switch between aerobic and anoxic metabolic pathways in which nitrate/nitrite and oxygen respectively serve as terminal electron acceptors.

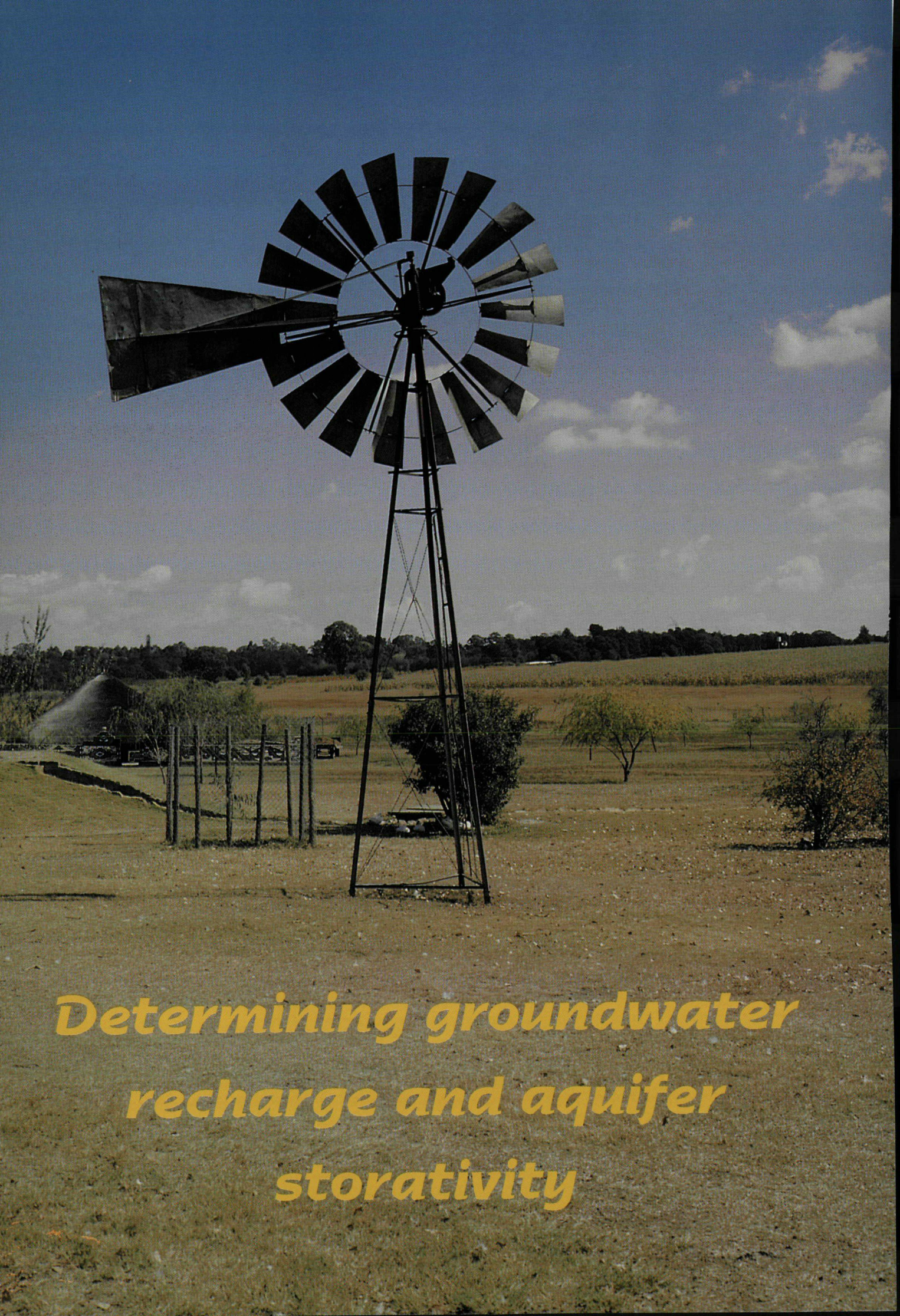
This switching confers some competitive advantage onto the filaments or some disadvantage onto the floc-formers. As a consequence of the direct influence of anoxic-aerobic conditions on low F/M filament proliferation irrespective of sludge age and a virtual absence of these filaments under fully aerobic or fully anoxic conditions, the researchers renamed these filaments anoxic-aerobic (AA) filaments - a name more descriptive of the conditions under which they proliferate.

From the observations and a review of the microbiological and biochemical literature on facultative heterotrophic denitrification pathways, a hypothesis for the cause of the AA filaments was deve- loped, namely:

If denitrification is not complete upon commencement of aerobic conditions then the facultative heterotrophic floc-formers, which denitrify nitrate to dinitrogen gas, are inhibited. This inhibition occurs in the oxygen uptake oxidase cytochromes under the aerobic conditions by denitrification intermediates, particularly nitric oxide, accumulated under the previous anoxic conditions. In contrast the AA filaments, which reduce nitrate only as far as nitrite, will not be inhibited in their oxygen uptake cytochromes because they do not generate the inhibiting intermediate nitric oxide.

The researchers say that because the hypothesis is at a microbiological and biochemical level, it could not be directly experimentally verified in this investigation, that is, it could not be tested that floc-formers denitrify to dinitrogen gas whereas the AA filaments only as far as nitrite. This aspect will need to be taken up by microbiologists and biochemists in specialist pure culture work.

The implications of the conclusions regarding AA filament bulking on the design and operation of nitrogen and nitrogen and phosphorus removal plants still need to be examined, but the researchers say it would appear that these plants need to be designed and operated such that the nitrate/nitrite recycled to the anoxic reactors should be fully denitrified before re-entering to the aerobic zone or period.



Determining groundwater recharge and aquifer storativity

A manual covering the full range of methods which can be used to determine groundwater recharge and aquifer storativity is now available from the Water Research Commission in Pretoria.

It was compiled and written by DB Bredenkamp and LJ Botha of the Department of Water Affairs and Forestry in collaboration with GJ van Tonder of the University of the Orange Free State and HJ van Rensburg of the Anglo American Corporation.

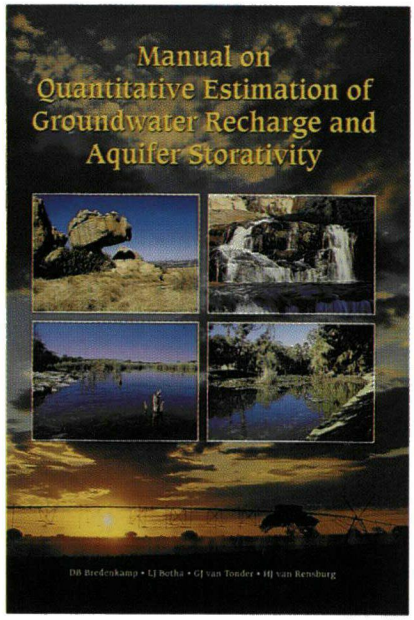
According to Eberhard Braune, Director: Geohydrology at the Department of Water Affairs and Forestry, the manual represents a major step forward in the practical quantification and regionalisation of groundwater recharge in South Africa at a time when better management of limited resources has become essential.

"The manual is not only a practical guide, but also has clear regional and international significance - regional because data sets from different regions were integrated into the analysis and international because the methodology used in the manual is strongly linked to and also advances, on a previous manual originating from the landmark groundwater recharge workshop in Turkey during 1987."

To the groundwater specialist the manual presents not only a well tested set of semi-empirical methods but also considerable food for thought on the complex hydrological processes that contribute to groundwater recharge. Mr Braune says a great advantage of the results contained in this manual is that they are based on real data.

He says the co-operative nature of the project has brought together into one team academic, government and private sector institutions, as well as experience, youth and innovation.

"This is largely due to the continuity which the Water Research Commission has provided for water research in South Africa for more than 20 years."



Copies of this publication entitled **Manual on quantitative estimation of groundwater recharge and aquifer storativity** (TT 73/95) are obtainable free of charge from the Water Research Commission, PO Box 824, Pretoria 0001. (Overseas price: US$ 50,00.)

For judicious management of groundwater resources not only in South Africa and similar semi-arid areas, but also in more humid regions of the world, reliable assessment of the exploitable groundwater resources is essential. Future economic development and sustainable growth in all semi-arid regions of the world are closely linked to the availability of groundwater. Although in many regions groundwater is less utilised than surface water, it often provides the bulk of the water used by rural communities. During droughts groundwater is often the sole exploitable and reliable resource available for the survival of man and the environment.

Although there are various well-established methods for the quantitative estimation of recharge, few can be applied successfully to semi-arid environments or even to other climatic regions. This lack of proper estimation of groundwater recharge is the main reason why groundwater exploitation and management have not reached the same level of sophistication as in the case of surface water.

The researchers say that contrary to the general assumption that estimation of groundwater recharge is more complex in a semi-arid region than in others, it appears that periods of prolonged drought interrupted by sufficient rain to provide recharge, can actually enhance the reliability of assessments of recharge and aquifer storativity. The large volumes of groundwater abstracted during mining operations also facilitate assessment of aquifer behaviour and recharge, as these groundwater systems are usually over-exploited.

The manual also aims to improve insight into hydrological interactions. It not only enhances appreciation of the simplistic approach but provides practical solutions for water resources evaluation and management. The best indication of the relationship between run-off and recharge is provided by high rainfall mountainous catchments where more than 50 per cent of the total run-off may be derived from low-flow, fed by groundwater.

The researchers say that at present no single method can yield a reliable estimate of groundwater recharge and therefore it was considered preferable to average the results of the different methods. However, because of the uncertainty inherent in each of the methods, mere averaging would be inappropriate.

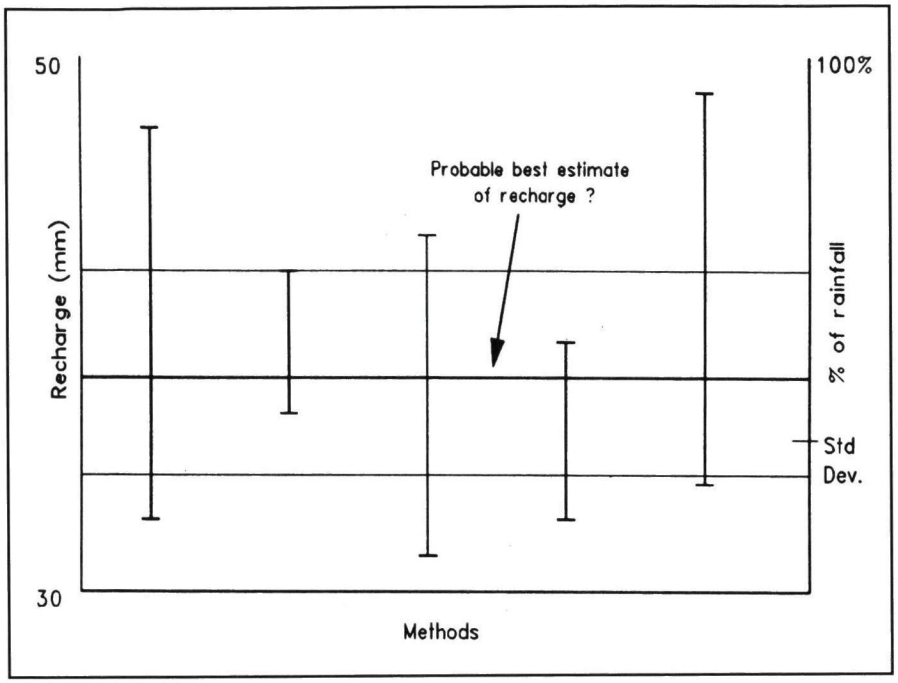


Figure 1: *Vertical lines represent estimates of groundwater recharge yielded by different methods. The horizontal line represents the best compromise between them.*

Figure 1 shows one how to obtain a better estimate using several techniques. By following this approach the range of recharge variations stemming from the inherent unreliability of the different methods or insufficient and suspect data, is also portrayed. The researchers state that uncertainty of the integrated recharge estimate is a function of the combined uncertainties of the various methods.

In view of the difficulties in obtaining a reliable estimate of recharge at every locality, such as budget constraints that restrict the application of certain methods, the researchers say expression of recharge as a function of rainfall seems the only practical way to obtain an initial value of recharge, in respect to both its long-term replenishment and annual variability. This was the view of Dr JF Enslin, a South African geologist, who already in 1970 in a paper put forward a rainfall/recharge relationship with which to estimate the replenishment of groundwater resources of the country.

Contrary to the general view that groundwater estimation is extremely complex, the golden thread in this manual is that for large time intervals the recharge conforms to simple relationships, by means of which most problems in the appraisal and management of groundwater resources can be adequately addressed.

METHODOLOGIES

The different methods that were examined in this study can be classified in various ways to provide a logical structure, and in this manual they have been grouped into categories relating to:

❑ The unsaturated zone, which includes lysimeter studies, soil moisture flow and balances, and use of tritium and chloride profiles in the soil overlying an aquifer.

❑ The saturated zone, which encompasses an analysis of groundwater hydrographs, water balances of delineated aquifers, the analysis of spring flow, the saturated volume fluctuation method and the cumulative rainfall departure method.

❑ Modelling of groundwater flow and the water balance.

❑ Steady state flow approximations.

❑ Rainfall-recharge relationships expressed by a regression-type simulation of the groundwater recharge in accordance with some conceptual logic built into the formulae.

❑ Natural radio-isotopes used to reveal mixing and transient flow within an aquifer system.

❑ Natural stable isotopes.

AQUIFER STORATIVITY

Because the water-level response depends on both recharge and storativity of an aquifer, the lack of reliable estimations of storativity is one of the main reasons why recharge cannot be derived reliably and uniquely. Evidence provided in the manual indicates that the classic methods of interpreting pumping tests in hard-rock and dolomitic aquifers cannot yield a reliable estimate of the storativity of an aquifer. The disparity appears to occur when fracture flow predominates, as this does not comply with isotropic conditions in the aquifer that is a prerequisite if standard methods of interpretation are to yield an acceptable result. Transmissivity values inferred from pumping tests appear to be reliable, however, despite the heterogeneity of the aquifer. The use of dyes to derive the storativity from the reappearance of an injected tracer and its spread over time, has been dealt with on a limited scale, mainly to elucidate the propagation of water flowing through a fractured aquifer.

Contrary to the general view that groundwater estimation is extremely complex, the golden thread in this manual is that for large time intervals recharge conforms to simple relationships, by means of which most problems in the appraisal and management of groundwater resources can be adequately addressed.

The authors say that the storativity of an aquifer is an essential parameter in the estimation of groundwater recharge and cannot be determined easily because of the interdependence between storativity and recharge in the water-level response.

It may come as a surprise to those favouring a more exact deterministic approach which fully incorporates the complexities of the hydrological processes and catchment and rainfall variability, that conceptual modelling is not highly rated. Instead, a simple lumped systems approach features more prominently in this study. Both recharge and aquifer storativity are estimated as average parameters for the aquifer as a whole. Annual variability of recharge is determined from a rainfall/recharge relationship but no estimates of the spatial variation in recharge and storativity are incorporated, except for the variability induced by the rainfall fluctuations.

Simple relationships between the annual runoff and precipitation were found to apply in all the mountainous catchments studied. This also holds for dolomitic springs: these show a linear response to the groundwater levels in the aquifer and to the cumulative rainfall departures from the average precipitation.

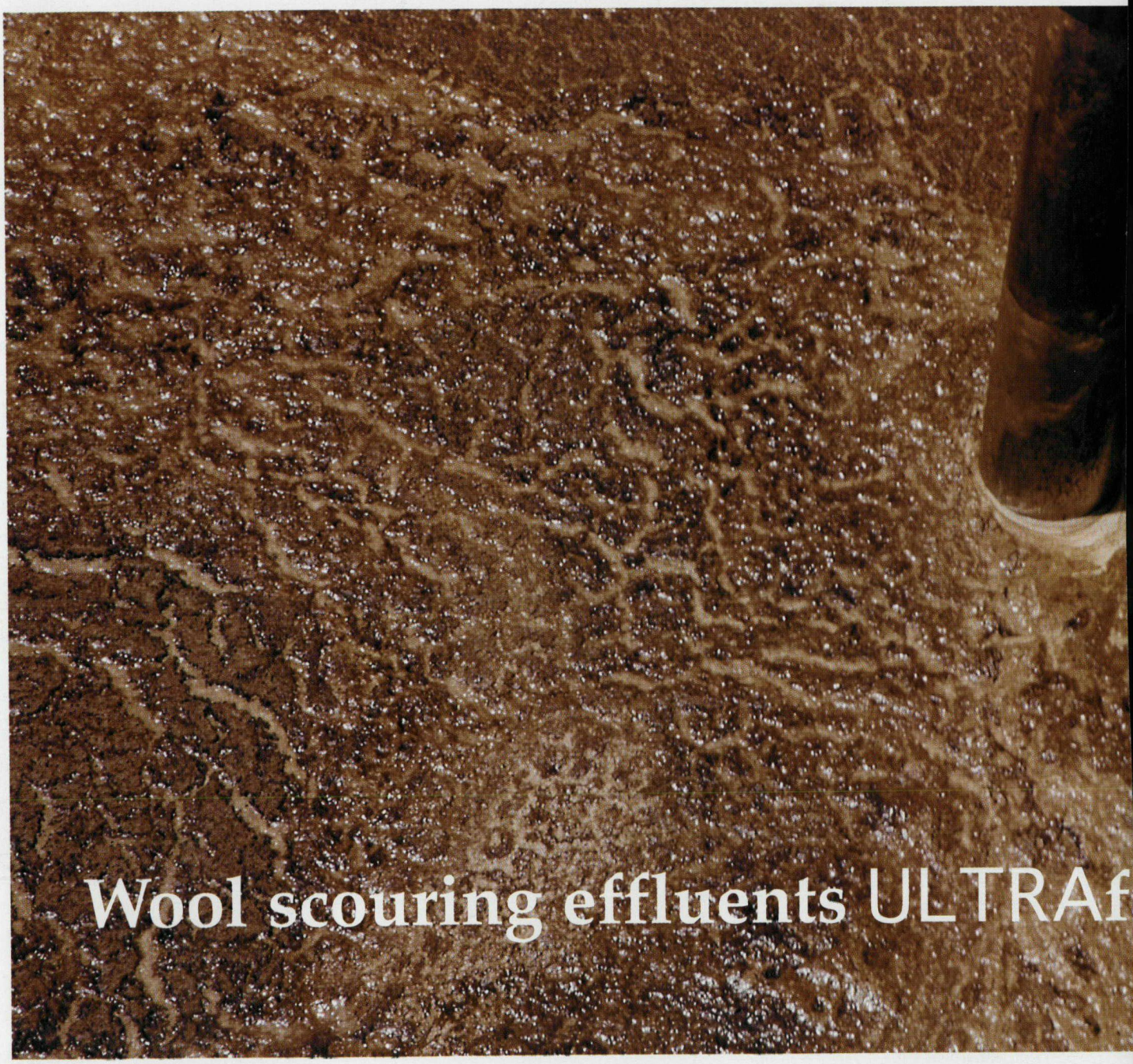
COASTAL LAKES

A simple hydrological water balance approach, based on periods of 12 months, has revealed a great deal about groundwater level response and its relationship to runoff in the north-eastern coastal area of Kwazulu-Natal. Much of the river flow appears to result from groundwater contributions to the streams. The levels of the coastal lakes are also largely controlled by the groundwater levels in the area.

Some salient features of the periodic salinisation of the coastal estuarine lake of St Lucia were revealed by the lumped approach adopted to study the behaviour of the lake. The response of the system suggests that a significant portion of the inflow is derived directly or indirectly from groundwater.

The similarities between the average total runoff response of different mountainous catchments, demonstrate convincingly that the hydrological balance of these areas conforms to a simple function of the total precipitation. Non-linear runoff response seems to occur mainly over short periods of high rainfall - but on an annual basis linear relationships above threshold value of rainfall apply.

Clear ground water flowing from the "Kuruman Oog" in the Northern Cape.



Wool scouring effluents ULTRAf

Before the raw wool of the sheep or the raw hair of the angora goat (mohair) can be carded and spun into yarn on an industrial scale, it has to be cleansed (scoured) of its natural impurities. When the scouring is carried out in an aqueous medium it leads to the production of an extraordinarily stable effluent which is both unsuitable for discharge to the environment and very difficult to deal with. The components of the waste water are highly variable by virtue of their origins and an effluent is thus produced having different ratios of its constituents from hour to hour.

While almost all conceivable methods of treating waste waters have been applied to scouring wastes at one time or another, with varying degrees of success, most are highly capital intensive or are associated with high running costs or are not feasible in certain locations or countries for one reason or another. Research into the treatment of such effluents is, therefore, on-going in various parts of the world.

According to a report compiled by researchers from the Pollution Research Group (Department of Chemical Engineering) at the University of Natal in collaboration with the firm Gubb & Inggs in Uitenhage, a relatively new approach pioneered by the University of Natal, and involving the application of dynamic ultrafiltration, appeared to hold promise as a new alternative technology for the treatment of wool scouring effluent. It was necessary, however, to evaluate this technology in an industrial environment. In this context the firm of Gubb & Inngs Limited was ideally placed. Not only did it have one of the largest mills for the processing of raw fibre in the Southern

Hemisphere and an involvement in scouring a very wide selection of fibres, but it was prepared to cooperate and collaborate with the University of Natal in trying out this new technology.

The Water Research Commission was prepared to sponsor the project financially and, accordingly, a contract was entered into in 1985 to pursue this new approach, involving the Water Research Commission, the University of Natal, Binnie & Partners (as consultants) (later Steffen, Robertson & Kirsten) and Gubb & Inggs.

OBJECTIVES

The objectives of the project were as follows:

- ❑ To determine the technical feasibility of dynamic ultrafiltration in the treatment of scouring effluent for water re-use at high water recoveries.
- ❑ To evaluate the reuse of the reclaimed water in the production environment.
- ❑ To evaluate the processing performance and the cost effectiveness of the system.
- ❑ To evaluate the mechanical performance of the system.
- ❑ To develop estimates of the nett savings in water recycle, energy conservation, waste treatment and possible chemical recovery.
- ❑ To develop a design for the full-scale treatment of wool scouring effluents.

The report says that while much useful data emerged during the first few years of the project, the system was not considered viable when conducted on scouring effluent. Therefore, in 1990 it was agreed by all parties to suspend research in this direction and to change over to the treatment of dirty rinse water from the rinse bowls. At the same time it was agreed to integrate the firm's biological degradation ponds into the water and effluent loop.

RESULTS

❑ Laboratory and pilot-plant trials

Dynamic membranes of the hydrous zirconium (iv) oxide type could be used successfully to treat the difficult scour effluent. Rejections of 100 per cent, over 92 per cent and over 85 per cent could be obtained for grease, total organic carbon and total solids respectively. Furthermore, 85 per cent of the original feed could be recovered for potential re-cycle.

❑ Trials with modular demonstration plant on scour effluent

These trials illustrated the need for membrane re-formation as the modules became progressively fouled. While fluxes could be maintained in the short term while plant operations was continuous, unscheduled stoppages had a marked effect on performance. It was concluded that cooling of the liquor in the modules resulted in module fouling. Removal of the foulants and stripping of the dynamic membrane was accomplished by circulating one-molar solutions of sodium hydroxide, sodium hydroxide/hydrogen peroxide mixture, and nitric acid, in turn, through the module at 80°C. Because the foulant was embedded or chemically bonded in the matrix of the membrane/substratum significant flux restoration was not possible without stripping followed by membrane re-formation.

Unfortunately, the quality of the permeate was at all times too poor to be acceptable by management for re-use in the rinsing of the scoured wool product, and consideration of a tertiary treatment plant was ruled out on economic grounds.

❑ Trials with modular demonstration plant on rinse effluent

In the treatment mode which involved treatment of the dirty rinse effluent as opposed to the effluent produced from the earlier, highly contaminated scouring bowls, not only was the treatment itself successfully accomplished from a technical point of view, but re-use of the processed water enabled the factory to reduce its normal water use by half and the quality of the wool product passed all the firm's requirements.

Individual flux rates for the membranes varied widely and were shown to decline rapidly with time. Membranes needed to be stripped around once every 10 days to maintain fluxes at a reasonable figure. As a consequence it was decided to design and build an automatic membrane formation plant.

With the automated membrane formation plant in operation several studies were carried out: It was found that there was a relatively high between-module flux variability. Furthermore, some modules required cleaning more frequently than others. In contrast to observations on the

scour effluent, no deterioration in flux could be observed during a specific concentration cycle, in spite of a four-fold increase in the levels of grease and suint and a seven-fold increase in dirt.

The membranes rejected all the dirt and about two thirds of the grease and suint. Conductivity was reduced by 44 per cent, turbidity by 99 per cent, COD by 89 per cent and absorbance from 92 to 96 per cent at wavelengths of 350nm to 700 nm. The high colour rejection was considered of special importance in the context of wool washing.

Municipal Water consumption was monitored on the specific washline on which the project was carried out for some 50 operational days. The results showed that, as a result of the recycling of permeate to the rinse bowls, in the context of the integration of water from the firm's biological ponds into the scouring loop, municipal water use was reduced by approximately 50 per cent. (The report says the high residual detergency and alkalinity of the water from the biological ponds has found excellent use both in the firm's scouring and carbonising operations while at the same time reducing the firm's total use of soda ash by approximately 40 per cent.)

Membrane fouling again became serious during 1991/92 and although relatively high fluxes could be obtained by pretreatment with sulphuric acid, they plunged to low levels in a short period. The reason for this can be traced to the firm's increased use of water from the biodegradation ponds during the height of the drought in the Eastern Cape which, through carry-over into the rinse bowls by the wool, resulted in a deterioration of the dirty rinse water quality. Under normal conditions the carry-over of any water from the ponds would, however, be minimal.

Part of the demonstration plant for the treatment of wool scouring effluent and rinse water at Gubb & Inngs in Uitenhage.

COSTS

During the first year of operation serious breakdowns were frequent and costs of maintenance, electricity and steam were very high. It was estimated that it cost some R16 to treat one kilolitre of water and recycle it to the plant. During the next year of operation there were significant improvements in the costs of maintenance, repairs and labour. The report says latest estimates, allowing for savings in municipal water and effluent handling and potential energy recovery, are that it costs approximately R8,60 to treat one kilolitre of water and recycle it to the plant. This cost is, however, considered too high to be commercially viable at the present time.

Copies of the report entitled **Research into the treatment of wool scouring effluents** (WRC Report 161/1/94) are obtainable free of charge from the Water Research Commission, PO Box 824, Pretoria 0001. (Overseas price: US$ 20,00.)

Treating metal-cutting fluid waste with ADUF

The disposal of metal-cutting-fluid waste water from machining operations in the automotive industry is becoming a concern due to environmental considerations.

At a manufacturer of diesel engines in the Western Cape, for instance, this difficult effluent is currently removed and treated by a waste disposal company. (The treatment involves pH-adjustment to a value between 7 and 9, followed by co-disposal with other waste to a toxic waste dump.) It is doubtful whether co-disposal will be allowed in the near future because of increasingly stringent environmental regulations. Alternative treatment methods for this waste must therefore be found.

Since it has already been proven that water based metal-cutting-fluids can be treated successfully by anaerobic digestion, the expectation was that this process combined with membrane separation should result in a final treated metal-cutting fluid effluent of acceptable quality.

A laboratory study to investigate the application of the ADUF process (Anaerobic Digestion combined with Ultrafiltration) to this type of effluent was, therefore, conducted to investigate the process. The study was financed by the Water Research Commission and carried out by NKH Strohwald of Membratek (Pty) Ltd.

ADUF PROCESS

ADUF is a South African developed membrane-assisted process for the treatment of industrial effluents which eliminates the sludge concentration and retention problems associated with conventional systems. The process utilises locally manufactured tubular ultrafiltration membranes instead of imported technology.

To date successful laboratory and pilot-scale studies have been carried out on wine distillery, malting, egg, brewery, chemical, fruit and maize-processing effluents. These investigations have culminated in the commissioning and operation of a full-scale ADUF plant for the treatment of a maize-processing effluent at Meyerton in Gauteng.

PROJECT OBJECTIVES

The laboratory investigation into the treatability of metal-cutting-fluid waste water was carried out to determine the following:

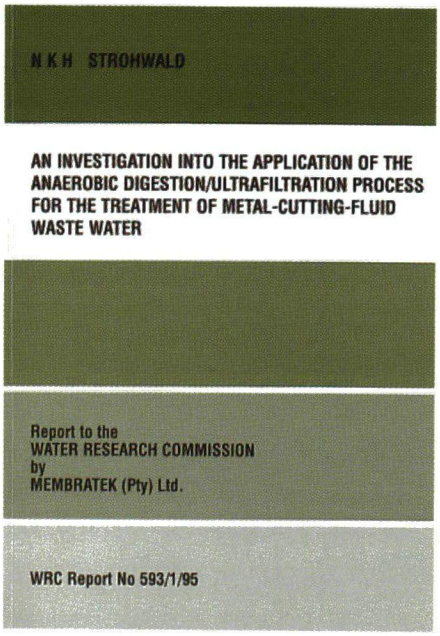
- the biodegradability of the factory effluent by means of mesophilic anaerobic digestion;
- the flux values for ultrafiltration at stabilised digester conditions;
- the maximum digester load rate and limits of general operating parameters; and
- the quality of the final treated effluent at stabilised digester conditions.

CONCLUSIONS

COD reduction percentages of more than 85 per cent could be obtained. Final treated effluent COD values were dependant on influent COD level. The ultrafiltration membranes were expected to contribute to this reduction since the organics in metal-cutting fluid waste are reported to be 65 per cent anaerobically biodegradable.

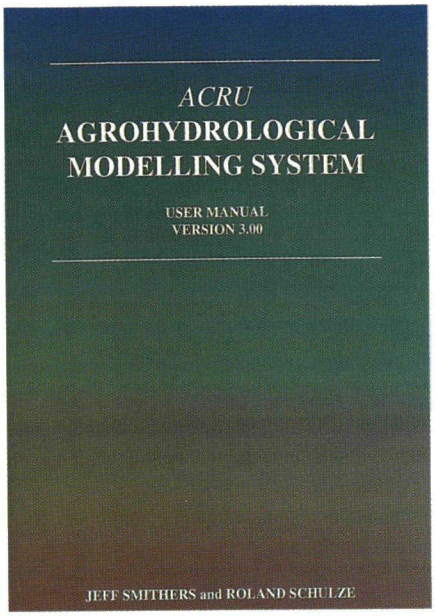
The lack of nutrients and alkalinity in the waste water resulted in poor digester buffer capacity and low load rates. A maximum sludge load rate of 1,05 g COD per gram volatile suspended solids per day could be achieved.

Long term stability of membrane flux was demonstrated and no cleaning was done throughout the 3 000 h trial period.



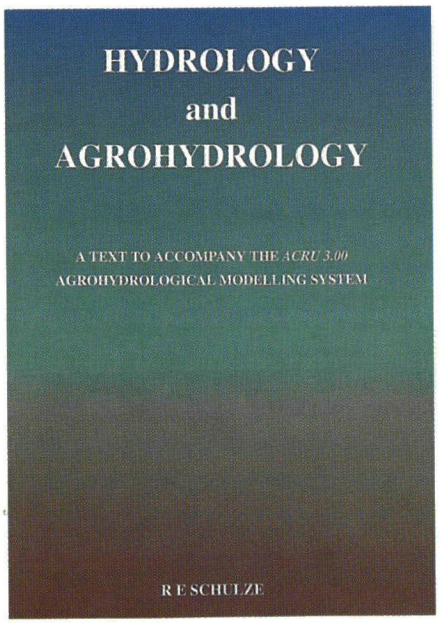
Copies of the report summarising the final results of the study and entitled **An investigation into the application of the anaerobic disgestion/ultrafiltration process for the treatment of metal-cutting-fluid waste water** (WRC Report 593/1/95) are available free of charge from the Water Research Commission, PO Box 824, Pretoria 0001. (Overseas price: US$ 5.00)

The project objectives were satisfied in the sense that the biodegradability of the effluent by anaerobic digestion was established and that stable membrane flux could be demonstrated for the duration of the experiment without resorting to chemical cleaning. A negative aspect proved to be the low digester load rates which were achieved. The experimental results presented in this project report should be seen as an initial phase in the optimisation of the ADUF process for this particular application. Additional treatment or a combination of processes may be required in order to address the fraction of the effluent which is not biodegradable.



ACRU USER MANUAL

To order the new ACRU 3.00 package please complete the Order Form in this Bulletin.



"ACRU Theory"

ACRU 3.00 Agrohydrological modelling system

The latest updated version of this popular multi-purpose model has recently been released. The new package includes software programs, utilities, the ACRU user manual and ACRU text.
Courses on the ACRU system are also given by the Department of Agricultural Engineering, University of Natal.

The acronym ACRU is derived from the Agricultural Catchments Research Unit within the Department of Agricultural Engineering of the University of Natal in Pietermaritzburg. The model has its hydrological origins in a distributed catchment evapotranspiration based study carried out in the Natal Drakensberg in the early 1970s. The agrohydrological component of the model first came to the fore during research in the early 80s on an agrohydrological and agroclimatological atlas for Natal. Since then the model has developed, through co-operation with many colleagues and graduate students, and with generous funding primarily from the Water Research Commission to its present status.

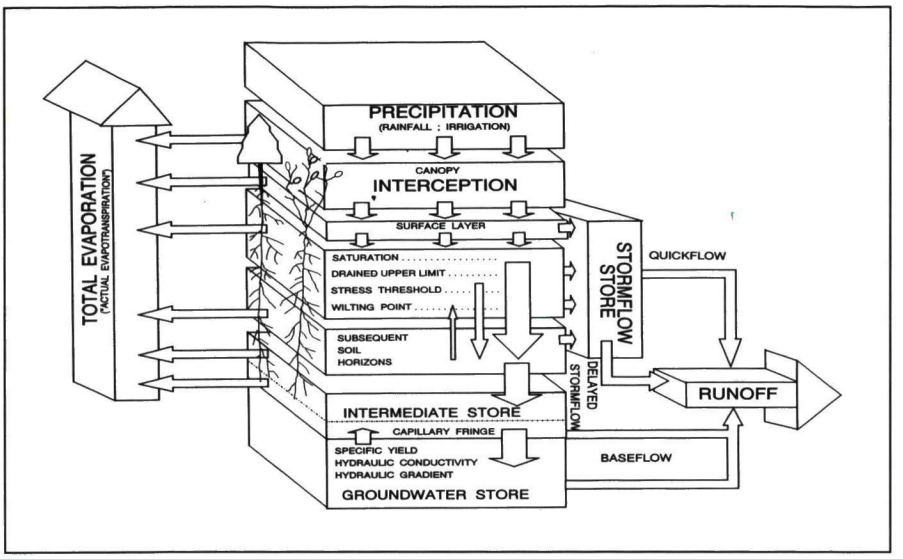
The major current reference to the ACRU model is the companion volume to the user manual, viz. "Hydrology and Agrohydrology : A Text to Accompany the ACRU 3.00 Agrohydrological Modelling System" also referred to as "ACRU Theory", and which supersedes the 1989 "ACRU: Background, Concepts and Theory" documentation.

The model has been verified widely on data from southem Africa and the USA, used extensively in decision making in southern Africa and by 1995 the model has been applied internationally in hydrological design, the simulation of water resources and research in Botswana, Chile, Germany, Lesotho, Mozambique, Namibia, Swaziland, the USA and Zimbabwe.

CONCEPTS OF THE MODEL

The ACRU agrohydrological modelling system is centred around the following aims:

❑ It is a physical conceptual model, i.e. it is conceptual in that it conceives of a system in which important processes and couplings are idealised, and physical to the degree that physical processes are represented explicitly.



The general structure of the ACRU agrohydrological modelling system.

❑ ACRU is not a parameter fitting or optimising model and variables (rather than optimised parameters values) are, as a rule, estimated from physical characteristics of the catchment.

❑ It is a multi-purpose model which integrates the various water budgeting and runoff producing components of the terrestrial hydrological system with risk analysis, and can be applied in design hydrology, crop yield modelling, reservoir yield simulation, irrigation water demand/supply, water resources assessment, planning optimum water resource utilisation and resolving conflicting demands on water resources.

❑ The model uses daily time steps and thus daily climate data, thereby making optimal use of available data. Certain more cyclic, conservative and less sensitive variables, (e.g. temperature, reference potential evaporation), for which values may have to be input at monthly level (if daily values are not available) are transformed internally in ACRU to daily values by Fourier Analysis. More sensitive intra-daily information (e.g. of rainfall distribution) is obtained by synthetic disaggregation of daily input within the model.

❑ The ACRU model revolves around daily multi-layer soil water budgeting and the model has been developed essentially into a versatile total evaporation model. It has therefore been structured to be highly sensitive to climate and to land cover/use changes on the soil water and runoff regimes, and its water budget is responsive to supplementary watering by irrigation, to changes in tillage practices or to the onset and degree of plant stress.

❑ ACRU has been designed as a multi-level model, with either multiple options or alternative pathways (or a hierarchy of pathways) available in many of its routines, depending on the level of input data available or the detail of output required. Thus, for example, reference potential evaporation, interception losses, values of soil water retention constants, maximum (i.e. "potential") as well as total evaporation ("actual evapotranspiration"), leaf area index, components of peak discharge estimation, hydrograph routing, reservoir storage: area relationships or the length of phonological periods in crop growth, may all be estimated by different methods according to the level of input data at hand or the relative accuracy of simulation required.

❑ ACRU can operate as a point model, as a lumped small catchments model or on large (to date 4 000 km^2) catchments. For large catchments or in areas of complex land uses and soils, ACRU operates as a distributed cell-type model. In distributed mode individual subcatchments (ideally not exceeding 30 km^2) are identified, discretised and flows can take place from "exterior" through "interior" cells according to a predetermined scheme, with each subcatchment able to generate individually requested outputs which may be different to those of other subcatchments or with different levels of input/information.

❑ The model includes a dynamic input option to facilitate modelling the hydrological response to climate or land use or management changes in a time series, be they long term/gradual changes (e.g. forest growth, urbanisation, expansion of irrigation scheme or climate trends), or abrupt changes.(e.g. clearfelling, fire impacts, construction of a dam, development of an irrigation project, or introduction of new land management strategies such as tillage practices), or changes of an intra-annual nature (e.g. crops with non-annual cycles, such as sugarcane). A dynamic input file is then accessed each year with the new variable inputs to be used from that year onwards, e.g. crop coefficients, root mass distributions, planting dates or soils properties (for new tillage practices).

❑ ACRU operates in conjunction with the interactive ACRU Menubuilder and Outputbuilder and the associated ACRU Input Utilities. These are suites of software programs to aid in the preparation of input data and information. The ACRU Menubuilder prompts the user with unambiguous questions, leading the user into inputting, for example, complex distributed catchment information easily. The Menubuilder contains alternative decision paths with preprogrammed Decision Support Systems. Furthermore, the Menubuilder includes a help facility, built-in default values as well as warning and error messages. The Outputbuilder allows the user to select, from a predefined list, which variables are to be stored during a simulation for subsequent output and analysis.

❑ The ACRU Output Utilities enable the user to print out, and to analyse, the simulated results. The types of analyses include frequency analysis, extreme value analysis and comparative statistics in order to determine the goodness of fit between simulated and observed data.

Making an Impact: Top Ten Hints for Successfull Watershed Management

Our work with local, voluntary watershed partnerships across the USA has helped us compile a "Top Ten Hints List" for successful watershed management efforts, says Karol Keppy, Project Manager for the Conservation Technology Information Centre (CTIC) in sharing the lessons they have learnt.

10. Think small. The smaller the watershed, the easier the partners can "relate" or "connect" to it. In addition, the smaller the water shed the faster it will react to changes in management practices such as precision farming, or land uses such as green strips.

9. Bring everyone to the table. Everyone who has a stake in thewatershed should be included from the beginning. This helps the group to build consensus on what needs to be done and how to do it. Leaving a critical stakeholder out of the process at any step may cause problems later.

8. Great leaders plant seeds and nurture them. They facilitate the group to reach consensus, plant new or different ideas when necessary, and assist the group in nurturing those new ideas. Effective watershed leaders are good communicaotrs because they listen to others' ideas, make sure the idea is explored, and ensure that all stakeholders are heard.

7. Ask for free advice and in-kind services. For example, if you need a video, ask the local television station for script and production assistance, work with your local water department and your local school system. Ask retailers for assistance on demonstration projects. Don't forget to say "thank you" in public. It will go a long way to getting help the next time around. (Tip: People give money to groups that offer a plan on how they intend using it.)

6. Encourage teaching Allow watershed atakeholders to teach each other. No idea is too simple to discuss. For example, a farmer can teach the basics of watering, fertilizer application and pest management to suburban homeowners.

5. Seek common interests, not positions. By working to find the common interests of all stakeholders, you'll establish a strong foundation for an effective watershed management plan. One way to do this is to get past opposing positions by asking why a stakeholder has taken a particular position. Keep asking again and again.It usually takes seven layers of "why?" to uncover an interest that is common to other stakeholders.

4. Celebrate your successes. Regardless of how small celebrate progress. Whether your group measures progress by the number of canoe trips, miles of buffer strips, acres of no-till, or depth of a secchi disc dipped into the lake, recognising milestones is important. (Bonus tip: Bekind to each other; you may need that person to agree with you later.)

3. Ask not "do you like it?" but ask "can you live with it?" Remember, you probably will propose many ideas before the group reaches a common point of agreement. WHat's important in reaching consensus is that everyone can agree to live with a decision.

2. Conflict can be healthy - if managed positively ! Conflicting views or ideas often become a third view or idea that can be healthy for the group's efforts and the watershed's health.

1. Patience. Patience. Patience. We didn't get to where we are today overnight, and we won't get to where we're going by tomorrow. When you set a lofty goal, break it down into smaller steps. Before you know you will have reached your goal.

The original little article of "Top Ten Hints List" was printed in ***Water Impacts*** *(Volume 16 no 10, October 1995), the newsletter of the Institute of Water Research, Michigan State University, USA.*

Research Projects Database update

The South African Water Information Centre (SAWIC) is presently busy with a major update of the SA Water-related Research Projects database. SAWIC has built and maintained this database on behalf of the Water Research Commission, since 1992. To date 528 projects have been entered. The Centre is launching a major drive to identify all new projects, as well as existing projects not yet recorded, on a national scale. The success of this initiative relies entirely on the support offered by both funding organisations and researchers. The database has also been given a new look to mark the occasion of SAWIC celebrating its 21st birthday this year! Another major goal during this commemorative year is to make the database more widely available and much more readily accessible to all interested parties.

Aim

The database is intended to make information on current water-related research projects in South Africa available to all researchers, as well as decision-makers and funding organisations. Access to this information should provide valuable assistance in the allocation of funds for research. In addition such information will be invaluable during the initial stages of project planning. Projects can therefore be more focussed and duplication of effort substantially minimized. An added benefit is that the researcher will also be made aware of others working in similar fields.

Subject scope

The research projects included in the database cover a wide range of topics, such as: irrigation scheduling, catchment management studies, anaerobic digestion of wastewater, landfill leachate, groundwater resources, potable water treatment, water quality guidelines, sanitation, forest hydrology and micrometeorology .

Database access routes

Currently access to the database is available in the following three formats:

- Copies of the database on computer disc (in ASCII format) are available from SAWIC. Presently there is a limitation on the number of records that can be transferred to disc. Users will also need their own database management software in order to manipulate the data and search the records.
- Directly via the Computing Centre for Water Research (CCWR) at the University of Natal (Pietermaritzburg) as a read-only text file. Contact the CCWR at tel. (0331) 63-320 for further details.
- SAWIC can provide a printed, subject specific report on request. See contact information below.

As part of the drive to improve database access, SAWIC will be making the database available for searching via the SAWIC Internet homepage (http://africa.cis.co.za/wna/html/env/sawic). Due to the present limitation on the number of records that can be transferred on computer disc, the Centre is also investigating options to compress the database file which should make it possible to copy the entire database onto a disc.

Project Database Questionaire

Your contribution to help us update the Project Database will be greatly appreciated.

Kindly contact the SAWIC staff at the following address for a Project Information Form:

Paulette Millard/Jenny Shelwell
South African Water Information Centre
PO Box 395
Pretoria 0001

Fax: (012) 349-1154
Tel: (012) 841-2048

WRC RESEARCH PLAN FOR MUNICIPAL WASTEWATER MANAGEMENT

Revised 1995

by SA Mitchell
Research Manager, Water Research Commission

Mission statement for research on sanitation

Research on sanitation aims to improve the utilisation of the country's scarce funding, material and skilled manpower resources to manage sanitation-related effluents, wastes and runoffs in the most efficient and cost-effective way and to the best interest of the RSA and all its inhabitants.

The Master Plan for Future Research on Sanitation in South Africa, drawn up from a series of workshops in 1991, needed substantial revision for two reasons. The first was that at that time the Water Research Commission had no dedicated forum to address the needs of the rapidly developing communities. As a result, the two most important goals addressed issues related to this emergent problem. The convening of the new Coordinating Committee for Research on Water Supply and Sanitation in developing Rural and Urban Communities (CCRUC) after a series of workshops during 1994 and 1995 allowed these goals to be moved from the 1991 research plan on sanitation to the CCRUC. Thus, only three of the five primary goals identified in 1991 remained within the jurisdiction of this Coordinating Committee.

The second reason for the substantial revision being necessary was that research within the country had not stood still and some new issues had been identified. The process was deliberately stopped at the level of the tertiary goals. Individual projects were not identified. The reason for this was that within the research and practitioners community at large, individual geographic areas have their own specific problems, and the chairman took the decision that, rather than identify these at the meeting, the identification of projects should be left to individual researchers who were familiar with the field.

The mission statement was not revised, and so remains unchanged. Likewise, the overall goal remains unchanged However, the revised masterplan now has six primary goals (Table 1). These goals were not prioritised or weighted due to lack of time. They will be discussed in the order in which they were tabled at the meeting, together with their secondary and tertiary goals (Tables 2-7).

Table 1: ***The overall aim and the six primary goals of the research plan for municipal wastewater treatment***

OVERALL AIM:

The Optimal Management of Sanitation in South Africa through Effective and Co-ordinated Research

PRIMARY GOALS:

1. DEVELOPMENT OF HIGH TECHNOLOGY. (Table 2)
2. IMPROVE SLUDGE HANDLING AND UTILIZATION. (Table 3)
3. RESOURCES RECOVERY. (Table 4)
4. ARTIFICIAL WETLANDS. (Table 5)
5. OLD TECHNOLOGIES REVISITED. (Table 6)
6. PACKAGE PLANT TECHNOLOGIES. (Table 7)

PRIMARY GOAL 1: DEVELOPMENT OF HIGH TECHNOLOGY

TABLE 2: ***Secondary and tertiary goals for primary goal 1***

1. DEVELOPMENT OF HIGH TECHNOLOGY

1. Improve existing systems
   - i. Sludge bulking (clarification)
   - ii. In-plant chemical addition
   - iii. Acid fermentation
   - iv. Develop back-up systems
   - v. Improve oxygen transfer
   - vi. Improve microbiological understanding
   - vii. Improve biochemical understanding
   - viii. Upgrade effluent for direct reuse
   - ix. Plant automation
   - x. Upgrade environment - education
     - technology

2. Develop alternative processes
   - i. To improve water quality
   - ii. To lower energy consumption
   - iii. To obtain more robust systems
   - iv. To lower direct operating costs
   - v. To lower manpower requirements

SECONDARY GOAL 1

Improve existing systems. The tertiary goals 1-7 remain unchanged from the 1991 document. Tertiary goals 8-10 are new, and address specific issues which have arisen since the previous major review.

i. **Sludge bulking (clarification).** Sludge bulking reduces the settleability of sludges from BNR plants, thus limiting both the hydraulic and the solids loading rate of the plant.

ii. **In plant chemical addition.** Optimise the use of chemicals used for removal of phosphates.

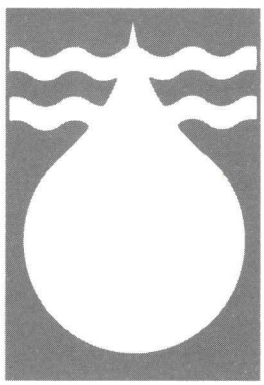
iii. **Acid fermentation.** Optimise acid fermentation and so optimise biological nutrient removal for each waste stream.

iv. **Develop back-up systems.** Currently, failure of a plant means the release of untreated or partly treated waste into the environment. How can this be prevented.

v. **Improve oxygen transfer.** Aeration of activated sludge biomass is currently a major cost factor. Improvement of the oxygen transfer efficiency will reduce this cost.

vi. **Improve microbiological understanding.** Understanding the microbiological processes involved in the various aspects of waste water treatment will enable process and reactor designs to be optimised.

vii. **Improve biochemical understanding.** This will assist in the optimisation of process design.



viii. **Upgrade effluent** for direct reuse. South Africa's water shortage is getting worse, and direct reuse is one way of increasing the quantity of water available.

ix. **Plant automation.** Effective plant automation improves the overall effluent quality of a plant, and is particularly effective on large BNR plants.

x. **Upgrade environment.** Education would address both the need to protect both the environment itself as well as the need to protect the process of sewage purification. Upgrade technology will enable upgrading of the environment.

SECONDARY GOAL 2

Develop alternate processes. The tertiary goals remain unchanged.

i. **To improve water quality**. This includes both the main and side stream processes of sewage treatment.

ii. **To lower energy consumption**. Activated sludge, a process currently favoured, is energy intensive.

iii. **To obtain more robust systems.** High technology systems currently used need careful operation without interruptions if they are to work well.

iv. **To lower direct operating costs.** These costs are borne by the rate-paying public.

v. **To lower manpower requirements.** A contributory factor towards lowering the cost of sewage treatment.

PRIMARY GOAL 2: IMPROVED SLUDGE HANDLING AND UTILISATION

TABLE 3: ***Secondary and Tertiary Goals for primary goal 2***

2. IMPROVE SLUDGE HANDLING AND UTILIZATION

1. Investigate alternative disposal methods for sludges
   - i. Disposal to ground
     - * Chemically contaminated sludge
     - * Chemically uncontaminated sludge
   - ii. Co-disposal with other wastes
     - * Chemically contaminated sludge
     - * Chemically uncontaminated sludge
   - iii. Sea disposal
     - * Chemically contaminated sludge
     - * Chemically uncontaminated sludge
   - iv. Incineration
     - * Chemically contaminated sludge
     - * Chemically uncontaminated sludge
   - v. Other
     - * Chemically contaminated sludge
     - * Chemically uncontaminated sludge
2. Develop improved treatment methods for sludge
   - i. Physical/chemical methods
   - ii. Biological methods
   - iii. Heat treatment
   - iv. Other
3. Collate and present existing information
   - i. Alternative uses of sludge
   - ii. Alternative disposal methods
   - iii. Cost-effective treatment methods
4. Keep pollutants out of the sewer systems
5. Cost effective technologies
   - i. sludge handling
   - ii. sludge disposal
6. National Strategy/Policy
   - i. sludge handling
   - ii. sludge disposal
7. Odour control
8. Sludge handling for BNR plants

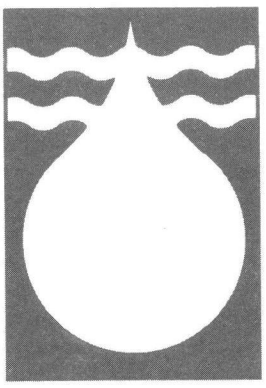
SECONDARY GOALS

Secondary goals 1-3 remain unchanged, but secondary goals 4-8 have been added.

1. **Investigate alternative disposal methods for sludges.** This series of goals is particularly relevant in the light of the recent solid waste regulations.

2. **Develop improved treatment methods for sludges.** Sludge handling represents a substantial part of sewage treatment.

3. **Collate and present existing information.** This is a low key and ongoing activity.



4. **Keep pollutants out of the sewer systems.** This is becoming increasingly important in the light of increasingly strict sludge disposal regulations.

5. **Cost effective technologies (for sludge handling and disposal).** This is part of the ongoing effort to improve sludge handling.

6. **National Strategy/Policy (for sludge handling and disposal).** The lack of a national policy or strategies for sludge handling needs to be redressed.

7. **Odour Control.** Urbanisation is approaching previously isolated treatment works, so issues such as odour control are becoming increasingly sensitive.

8. **Sludge handling for BNR.** Sludges from BNR plants are high in phosphate and if not handled properly can cause problems.

PRIMARY GOAL 3: RESOURCE RECOVERY

TABLE 4: ***Secondary and tertiary goals for primary goal 3***

3. RESOURCES RECOVERY

1. Quantify & identify potential marketable products from sewage
   - i. Energy
   - ii. Feed/food
   - iii. Agriculture
   - iv. Fine chemicals
   - v. Other chemicals
   - vi. Construction materials
   - vii. Other
2. Develop cost-effective technologies
   - i. Energy
   - ii. Feed/food
   - iii. Agricultural
   - iv. Fine chemicals
   - v. Other chemicals
   - vi. Construction materials
   - vii. Other
3. Collate & present existing products, technologies and processes
   - i. Energy
   - ii. Feed/food
   - iii. Agricultural
   - iv. Fine chemicals
   - v. Other chemicals
   - vi. Construction materials
   - vii. Other

Each of the secondary goals, namely,

- Quantify and identify potential marketable products from sewage;
- Develop cost-effective technologies;
- Collate and present existing products technologies and processes;

all have the same tertiary goals:

i. Energy. Competitive ways to harness this energy need to be developed.

ii. Feed/food. *(Pellets, protein)* Sludge has a protein, fat and carbohydrate content which could included in feed formulations.

iii. Agricultural. Use of sludge by agriculture could be expanded once certain problems have been addressed.

iv. Fine Chemicals Recovery. *(Enzymes, vitamins)* Techniques and public acceptance need to be addressed.

v. Other Chemicals Recovery. *(CO_2, CH_4, phosphates)* Techniques and public acceptance need to be addressed.

vi. Construction materials. *(Bricks)* Broaden the possibilities of using this route for sludge use.

vii. Other. We need innovation

PRIMARY GOAL 4

ARTIFICIAL WETLANDS

TABLE 5:

Secondary goals for primary goal 4

4. WETLANDS

1. Environmental upgrading
2. Longterm application and cost

1. Environmental upgrading. Optimise design and management of artificial wetlands.

2. Longterm application and cost. How do wetlands compare with other methods of wastewater treatment.

PRIMARY GOAL 5

OLD TECHNOLOGIES REVISITED

TABLE 6:

Secondary and tertiary goals for primary goal 5

5. OLD TECHNOLOGIES REVISITED

1. Biofilters
   - i. Increase efficiency
   - ii. Incorporate in plant upgrades
2. Ponds
   - i. Increase efficiency
   - ii. Incorporate in plant upgrades
   - iii. Long-term management to increase useful life
3. Anaerobic Digesters
   - i. Design
   - ii. Management - matching
     - heating
     - upgrading

1. Biofilters. Many biofilter plants are still in use and funds to replace them with more modern technologies are not available.

i. Increase efficiency. Improve the effluent from existing plants.

ii. Incorporated in plant upgrades. An alternate to replacing existing biofilters altogether.

2. Ponds. Pond systems provide an economical option for sewage treatment.

i. Increase efficiency. Improve the cost/benefit ratio and effluent quality.

ii. Incorporate in plant upgrades. An alternate to replacing existing ponds altogether.

3. Anaerobic Digesters. Widely used in South Africa, but little thought has been given to improving their functioning.

i. Design

ii. Management
How can these be improved.

PRIMARY GOAL 6

PACKAGE PLANT TECHNOLOGIES

TABLE 7:

Secondary and tertiary goals for primary goal 6

6. PACKAGE PLANT TECHNOLOGIES

1. Evaluate package plants
   - i. Total process
   - ii. Sludge generation and handling

Package plants do not always deliver the expected results.

1. Evaluate package plants

i. Total process.

ii. Sludge generation and handling. Both the process and the sludge cycle need to be improved to achieve the reliability of which they should be capable.

SA WATERKALENDER

The Water Research Commission is placing this calender in order to assist with the co-ordinating of water events in South Africa.

You are invited to send information about conferences, symposia or workshops to the SA Waterbulletin.

Address:
The Editor,
SA Waterbulletin,
P.O. Box 824,
0001 Pretoria
Tel (012) 330-0340
Fax (012) 331-2565

Legend:

- ❍ An SA Water Event arranged for these dates.
- ❑ 2nd SA Water Event scheduled for these dates.
- ✗ 3rd SA Water Event scheduled for these dates.

See conferences and symposia pages for events.

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

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

Adres:
Die Redakteur
Posbus 824
0001 Pretoria
Tel: (012) 330-0340
Fax: (012) 331-2565

Gids:

- ❍ Een SA Watergeleentheid vir hierdie dae.
- ❑ 'n Tweede SA Watergeleentheid gereël vir dié datums.
- ✗ 'n Derde SA Watergeleentheid gereël vir dié datums.

Sien Konferensies-en Simposiumbladsy vir aangeduide geleenthede.

1996

JANUARY 1996

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SOUTHERN AFRICA 1996

WATERGEHALTE
MEI 13 - 17

Die Universiteit van Pretoria bied 'n kortkursus in watergehaltebestuur aan.
Navrae: Professor WA Pretorius, Departement Chemiese Ingenieurswese, Afdeling Waterbenutting, Universiteit van Pretoria 0001. Tel: (012) 420-3566.

WISA '96
MAY 20 - 23

The WISA '96 conference will be held at the Feather Market Centre in Port Elizabeth.
Enquiries: Conference Planners, PO Box 82, Irene 1675. Tel (012) 63-1681. Fax (012) 63-1680.

SOIL SCIENCE
JUNE 25 - 27

The 20th Congress of the Soil Science Society of South Africa will be held at the University of the Orange Free State in Bloemfontein.
Theme: Sustainable soil utilisation and rural development.
Enquiries: Chris du Preez. Tel: (051) 401-2957 Fax: (051) 401-2212.

WATER AFRICA
JULY 9 - 12

An exhibition and conference called Water Africa 96 will be held at the Ghana International Trade Fair Centre in Accra.
Enquiries: Zia Howeson.
Tel (011) 792-9807
Fax: (011) 791-0571.

WATER ENGINEERING
JULY 18 - 19

The young water, environmental and geotechnical engineers' festival will be held at the Rob Roy Hotel, Botha's Hill, Natal.
Enquiries: Lesley Stephenson, Conference Secretary, PO Box 327, WITS. Tel: (011) 716-5091 Fax: (011) 339-7935.

AQUATIC SYSTEMS
JULY 15 - 19

A conference on aquatic systems will be held at the Elephant Hills Hotel, Victoria Falls, Zimbabwe.
Enquiries: Ms Lesley Stephenson, PO Box 327, WITS 2050. Tel: (011) 716-5091 Fax: (011) 339-7835. E-mail: Stephenson @ egoli.min.wits.ac.za

HYDRAULIC RESEARCH
AUGUST 5 - 7

The International Association for Hydraulic Research - African Division's biennial congress with the theme "From flood to drought" will take place at Sun City.
Enquiries: Miss Genevieve Stephenson, Conference Office, PO Box 327, WITS 2050. Tel (011) 716-5091 Fax (011) 339-7835.

AFRIWATER '96
SEPTEMBER 2 - 5

The AFRIWATER Conference and Exhibition will be held at the Gallagher Estate in Midrand.
Enquiries: Nigel Walker Tel: (011) 318-2009/1189 Fax: (011) 318 1189. International code: (+27 11).

WATERSUIWERING
SEPTEMBER 16 - 20

'n Kortkursus in die bedryf van watersuiweringsaanlegte sal by die Universiteit van Pretoria aangebied word.
Navrae: Professor WA Pretorius, Departement Chemiese Ingenieurswese, Afdeling Waterbenutting, Universiteit van Pretoria 0001. Tel: (012) 420-3566.

ENVIRONMENTAL MANAGEMENT
OCTOBER 7 - 8

The 2nd Environmental Management, Technology and Development Conference will be held at the Indaba Conference Centre, Fourways, Gauteng.
Enquiries: Lesley Stephenson, Conference Secretary, PO Box 327, WITS 2050. Tel: (011) 716-5091. Fax: (011) 339-7835.

WATERBEHANDELING
OKTOBER 21 - 23

'n Kortkursus oor die behandeling van nywerheids- en verkoelingswater sal by die Universiteit van Pretoria aangebied word.
Navrae: Professor WA Pretorius, Departement Chemiese Ingenieurswese, Afdeling Waterbenutting, Universiteit van Pretoria 0001. Tel: (012) 420-3566.

ISIAME '96
NOVEMBER 4 - 8

An international symposium on industrial applications of the Mössbauer effect will be held in Johannesburg.
Enquiries: Prof Herman Pollak (Chairman), Mössbauer Laboratory, Department of Physics, University of the Witwatersrand, Private Bag 3, Johannesburg 2050. Tel: (011) 716-4053 Fax: (011) 339-8262. E-mail: 005KLKS@ WITSVMA.WITS.AC.ZA

SOUTHERN AFRICA 1997

METEOROLOGY
APRIL 7 - 11

The 5th international conference on southern hemisphere meteorology and oceanography will be held at the University of Pretoria.
Enquiries: Conference Planners: Amie Wissing. Tel and Fax: (012) 46-0170.

OVERSEAS 1996

DRAINAGE
APRIL 21 - 29

The 6th drainage workshop on Drainage and the Environment will be held in Ljubljana, Slovenia.
Enquiries: SDNO-ICID Organising Committee, Biotechnical Faculty, Jamnikarjeva 101, 61000 Ljubljana, Slovenia. Tel: +386-61-123-11-61 Fax: +386-61-123-10-88.

MICROPOLLUTANTS
MAY 6 - 7

A workshop on "Natural origin inorganic micropollutants: arsenic and other constituents" will take place in Vienna, Austria.
Enquiries: Mr Pierre Schulhof, Compagnie Génèrale des Eaux, Quartier Valmy - 32, Place Ronde, 92982 Paris La Defense CEDEX. Fax: (+33) (1) 46 35 31 50.

GEOFILTERS '96
MAY 29 - 31

The second international conference on Geofilters, addressing new developments and advances in all areas of filtration and drainage will be held in Montreal, Canada.
Enquiries: Geofilters '96, Bureau des Congrés, Ecole Polytechnique de Montreal, CP 6079 succ Centre-ville, Montreal (Qc) H3C3A7, Canada. Tel: (514) 340-3215. Fax: (514) 340-4440.

MONITORING NETWORKS
JUNE 3 - 7

A short course: Design of water quality monitoring networks will be held at the Colorado State University, Fort Collins, USA.
Enquiries: TG Sanders, Environmental Engineering, Departement of Civil Engineering, Colorado State University, Fort Collins, CO 80523. Tel: (303) 491-5448 Fax: (303) 491-7727 E-mail: TGS@Lance.Colostate.Edu

FOREST INDUSTRY WASTE-WATERS
JUNE 10 - 13

The 5th IAWQ symposium on forest industry wastewaters will be held in Vancouver BC, Canada.
Enquiries: The organiser, Forest Industry Wastewaters symposium, c/o Venue West Conference Services, 645 the Landing, 375 Water Street, Vancouver BC, Canada, V6B5C6. Tel: +1 604 681 5226. Fax: +1 604 681 2503.

IAWQ
JUNE 23 - 28

The 18th biennial conference and exhibition of the International Association on Water Quality will be held on the tropical island of Singapore.
Enquiries: IAWQ, 1 Queen Anne's Gate, London SW1H9BT, England. Tel: 44-171-222-3848. Fax: 44-171-233-1197.

AQUATECH ASIA 96
JUNE 24 - 26

Asia's specialised water technology forum Aquatech '96, will be held at the International Convention & Exhibition Centre in Singapore.
Enquiries: RAI, 1 Maritime Square 09-49, World Trade Centre, Singapore 0409. Tel: 65-272-2250. Fax: 65-272-6744.

BIOFILM SYSTEMS
AUGUST 28 - 30

The 3rd international IAWQ special conference on biofilm systems will be held in Copenhagen. Call for papers.
Enquiries: Institute of Environmental Science & Engineering, Att: Mia Clausen, Building 115, Technical University of Denmark, DK-2800 Lyngby, Denmark. Tel: +45 45 9339 08 Fax: +45 45 9328 50.

MONITORING TAILOR MADE
SEPTEMBER 9 - 12

The second international workshop on information strategies in water management will be held in Nunspeet, the Netherlands.
Enquiries: Workshop Secretariat, Buerweg 51, 1861 CH Bergen, the Netherlands. Tel: +31 72 5899062 Fax: +31 72 5899040.

IRRIGATION
SEPTEMBER 15 - 22

The 16th International Congress on Irrigation and Drainage will be held in Cairo, Egypt.
Enquiries: The Organising Committee, Drainage Research Institute, National Water Research Centre, Delta Barrage, PO Box 13621/5, Cairo, Egypt. Tel: (202) 21 89 383 or (202) 21 88 941 Fax: (202) 21 89 153.

WASTEWATER TREATMENT
SEPTEMBER 23 - 25

The IAWQ-NVA conference on advanced wastewater treatment, nutrient removal and anaerobic processes will be held in Amsterdam, the Netherlands.
Enquiries: Conference Secretariat, Buerweg 51, 1861 CH Bergen, the Netherlands. Tel: +31 725 899062 Fax: +31 725 899040.

WATER QUALITY
SEPTEMBER 26 - 27

The European Water Pollution Control Association in cooperation with the Netherlands Association on Water Management is organising an international conference on The Future Water Quality Management in Europe. The conference will be held in the RAI Conference Centre in Amsterdam, the Netherlands.
Enquiries: The Conference Secretariat, Buerweg 51, 1861 CH Bergen, the Netherlands. Tel: +31 725 899062 Fax: +31 725 899040.

WATER HONG KONG '96
NOVEMBER 11 - 17

The 10th IWSA-ASPAC regional conference and exhibition will be held in Hong Kong. Call for papers.
Enquiries: Technical Sub-committee, Water Hong Kong '96, c/o Water Supplies Department, 48/F Immigration Tower, 7 Gloucester Road, Wan Chai, Hong Kong. (Attention: Ms Daisy S M HO). Fax: (852) 2824 0578 Tel: (852) 2829 4444.

HAZARDOUS MATERIALS
JUNE 11 - 13

A waste managers training course on the management of hazardous materials will be held at the Colorado State Unviversity, USA.
Enquiries: TG Sanders, Environmental Engineering, Departement of Civil Engineering, Colorado State University, Fort Collins, CO 80523. Tel: (303) 491-5448 Fax: (303) 491-7727 E-mail: TGS@Lance.Colostate.Edu

POLLUTION
JUNE 22

The US EPA will present a Pollution prevention speciality course from 8:30 to 16:30 at Singapore Polytechnic.
Enquiries: Mr Ang Fui Gan. Tel: 870 6163 Fax: 772 1973 E-mail: FGAng@sp.sc.sg

IAWQ
JUNE 23 - 28

The 18th biennial conference and exhibition of the International Association on Water Quality will be held on the tropical island of Singapore.
Enquiries: IAWQ, 1 Queen Anne's Gate, London SW1H9BT, England. Tel: 44-171-222-3848. Fax: 44-171-233-1197.

AQUATECH ASIA 96
JUNE 24 - 26

Asia's specialised water technology forum Aquatech '96, will be held at the International Convention & Exhibition Centre in Singapore.
Enquiries: RAI, 1 Maritime Square 09-49, World Trade Centre, Singapore 0409. Tel: 65-272-2250. Fax: 65-272-6744.

ACTIVATED SLUDGE
JUNE 24 - 28

The 8th annual short course on Activated sludge process control will be held at the Colorado State University, Fort Collins, USA.
Enquiries: TG Sanders, Environmental Engineering, Departement of Civil Engineering, Colorado State University, Fort Collins, CO 80523. Tel: (303) 491-5448 Fax: (303) 491-7727 E-mail: TGS@Lance.Colostate.Edu

WASTEWATER
JUNE 27 - 28

An IAWQ post-conference seminar on industrial wastewater management will be held at the Singapore Marriott Hotel. Fees: US$450.
Enquiries: Binnie & Partners (Singapore), 31 Exeter Road, #15-01/02 Singapore 239732. Tel: 738-4022 Fax: 738-2717.

BIOFILM SYSTEMS
AUGUST 28 - 30

The 3rd international IAWQ special conference on biofilm systems will be held in Copenhagen.
Enquiries: Institute of Environmental Science & Engineering, Att: Mia Clausen, Building 115, Technical University of Denmark, DK-2800 Lyngby, Denmark. Tel: +45 45 9339 08 Fax: +45 45 9328 50.

STORM DRAINAGE
SEPTEMBER 9 - 13

The 7th international conference on urban storm drainage will be held in Hannover, Germany.
Enquiries: Prof F Sieker: Institüt für Wasserwirtschaft, Universität Hannover, Appelstrasse 9a, D-3000 Hannover 1, Germany. Tel: +49-511-7623567 Fax: +49-511-762-3456

MONITORING TAILOR MADE
SEPTEMBER 9 - 12

The second international workshop on information strategies in water management will be held in Nunspeet, the Netherlands.
Enquiries: Workshop Secretariat, Buerweg 51, 1861 CH Bergen, the Netherlands. Tel: +31 72 5899062 Fax: +31 72 5899040.

WINDHOEK MUNICIPALITY

Namibia, Southern Africa

presents

SEMINAR

on

HYGIENIC WATER RE-USE AND RECLAMATION USING MEMBRANE TECHNIQUES

9 - 11 September 1996

The seminar/workshop will be held in Windhoek, Namibia, and is a joint effort of the Water Services Department of the City of Windhoek, local industries and the Federal Environmental Agency (Institute for Water, Soil and Air Hygiene) in Germany.

THEMES

- Re-use and reclamation of water
- General requirements for water: chemical and biological
- Membrane techniques available to re-use/reclaim water

Particular attention will be given to applications in the following industries: meat, tanning, mining, fishing, pulp and paper, as well as power generation.

Both local and overseas experts will speak on various topics related to membrane technology and water re-use, to be followed by group discussions. The three day seminar will include site visits and an information tour to various localities and installations such as the world renowned Goreangob reclamation plant which is currently being upgraded and extended from 200 to 1 050 kiloliters per hour.

PAPER CALL

Interested contributors are invited to submit abstracts for oral or poster presentation. Prospective authors should send a copy of a one page (300-word) abstract, not later than 11 May 1996 to one of the two contact persons. It is important that the title of the paper, the author's name, organisation, address, phone and fax numbers appear on the abstract page - and not on a separate sheet. Papers will be accepted on the understanding that the main author or a co-author will personally attend the seminar/workshop and present the paper. The following deadlines apply:

One-page abstract for consideration	11 May 1996
Authors advised of acceptance	31 May 1996
Submission of a two page extended abstract	13 July 1996
Submission of full paper	13 July 1996
Seminar/workshop	9-11 September 1996

Further information can be obtained from the following persons:

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20th Congress of the Soil Science Society of South Africa
20ste Kongres van die Grondkundevereniging van Suid-Afrika

Wanneer
25 - 27 Junie 1996

When
25 - 27 June 1996

Plek
Universiteit van die Oranje-Vrystaat, Bloemfontein

Place
University of the Orange Free State, Bloemfontein

Tema
Volhoubare grondgebruik en landelike ontwikkeling

Theme
Sustainable soil utilisation and rural development

Programinhoud
Meer as 30 mondelinge en meer as 20 plakkaatreferate sal aangebied word.

Programme content
More than 30 oral and more than 20 poster papers will be presented.

Ekskursie
'n Ekskursie word vir die Maandag 24 Junie beplan. Daar word beoog om 'n ekstensiewe mielie- en koringplaas naby Hoopstad te besoek waar die boer baie goed daarin slaag om grondverdigting op te hef, winderosie te bekamp en water op te gaar. Die fabriek van ACO, waar van die grootste trekkers in die wêreld vervaardig word, gaan ook besoek word.

Excursion
An excursion is planned for Monday 24 June. The intention is to visit an extensive maize and wheat farm near Hoopstad where the farmer succeeds in reducing soil compaction, combating wind erosion and conserving water. The factory of ACO, where some of the world's largest tractors are manufactured, will also be visited.

Sosiale funksies
Behalwe vir die formele dinee op Donderdagaand, beoog die reëlingskomitee 'n skemeronthaal vir die Dinsdagaand en 'n braai vir die Woensdagaand.

Social functions
Apart from the formal dinner on Thursday evening, the organising committee plans a cocktail for the Tuesday evening and a braai for the Wednesday evening.

Akkomodasie
Koshuisverblyf is vanaf Sondag beskikbaar vir persone wat daarvan gebruik wil maak. Besonderhede oor hotelle en gastehuise waar u u eie besprekings moet doen, kan vanaf die organiseerders verkry word.

Accommodation
Hostel accomodation is available at the University from the Sunday for persons who want to make use of it. Details of hotels and guest houses at which delegates should make their own reservations are available from the organisers.

Registrasie
Die registrasiefooi beloop R500.

Registration
The registration fee is R500.

Navrae/Enquiries:
Organisatoriese aspekte/Organisational aspects

Elize Rall Tel. (051) 4012425 Fax (051) 306714
(08:30-12:00)

Navrae/Enquiries:
Programme Content/Programinhoud

Chris du Preez Tel. (051) 4012957 Fax (051) 4012212