





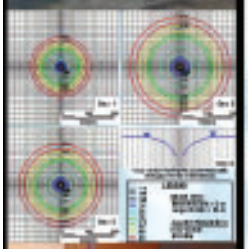

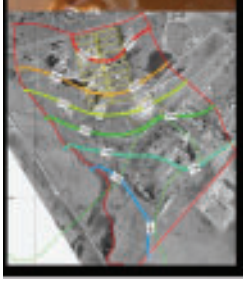

JMA (Jasper Müller Associates) was founded on 1 October 1988, as a 1 man Professional Practice, specializing in environmental geohydrology. It has since grown into one of the biggest geohydrological specialist firms in South Africa, and currently employs 17 people, 9 of which are professionally qualified, and registered, earth and environmental scientists with SACNASP.

Jasper Müller Associates CC

"at the edge of ground water innovation"

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THE WATER WHEEL 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.

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EDITOR'S NOTE

In this issue of the *Water Wheel* we are breaking new ground. Not only will our circulation figure exceed the 7 000 mark, but for the first time we will be publishing a fiction story (see page 14).

WHY THIS DEVELOPMENT?

Firstly, the needs and involvement of stakeholders could be mentioned. In the world of accounting, corporations are nowadays encouraged to move beyond the traditional single financial bottom line reporting to what is known as the "triple bottom line". The three lines represent the economy, the environment and society and focus corporations not just on the economic value they add, but also on the environmental and social value they add – and destroy. Society depends on the economy – and the economy depends on the global ecosystem whose health represents the ultimate bottom line. This broadens the company's stakeholders to almost everybody in society.

In the water field, where everybody is also a stakeholder, especially in a country like South Africa where drought and waterborne disease are rampant, there is a dire need to make the public more aware of this important stakeholder relationship that they have with water. Traditionally, water scientists and managers have used facts and figures to try and create awareness, understanding and appreciation for water. Now fiction is added to broaden the communication spectrum, and we the trust that - side by side - fact and fiction will mutually accentuate and reinforce one another, as well as the broader message – the importance of water.

Secondly, the Water Research Commission is taking the initiative to move beyond its traditional sphere of influence and build capacity in a field where so much talent is just waiting to be stimulated.

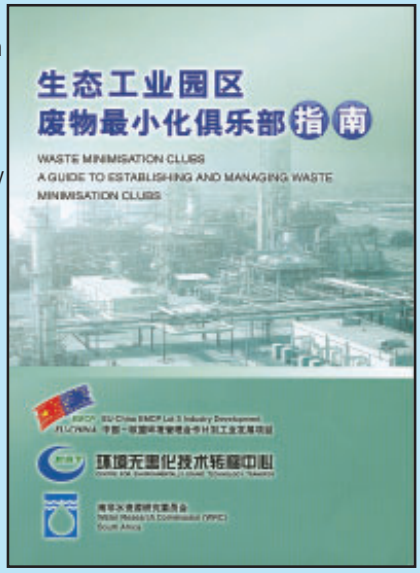
Therefore, if you feel you would like to make a contribution, we herewith invite you to submit your work to the *Water Wheel*.

Looking forward to your comments and contributions.

WRC MANUAL IN CHINESE

A Guide for establishing waste minimization clubs in South Africa, has been translated into Chinese. The Guide was originally compiled for the Water Research Commission by Susan Barclay of the Pollution Research Group, University of KwaZulu-Natal, Durban.

The translation and free distribution of the Guide is sponsored by the EU-China Environmental Management Cooperation Programme. For more information visit their website: www.cestt.org.cn/emcp/eindex.htm



WORLD WATER DAY

The theme for next year's World Water Day, which will be held on 22 March 2005, is "Water for Life 2005 – 2015".

According to Dick de Jong from IRC International Water and Sanitation Centre in the Netherlands, the theme highlights the fact that water is critical for sustainable development, including environmental integrity and the alleviation of poverty and hunger.

De Jong says the United Nations General Assembly agreed in December 2003 to proclaim the years 2005 to 2015 as the International Decade for Action – Water for Life, starting on World Water Day.

He says the Water for Life decade will help to achieve the water-related goals of the Millennium Declaration, the Johannesburg Plan of Implementation of the World Summit for Sustainable Development as well as Agenda 21.

The first water decade from 1981 to 1990 brought water to more than a billion people and safer sanitation to almost 770 million.

AMIWASH ANNOUNCED

Entebbe, 6 November 2004 - a new program called the African Ministerial Initiative for Water, Sanitation and Hygiene" or AMIWASH, was announced at the opening session of the 5th general meeting of the African Ministers' Council on Water (AMCOW) today.

AMIWASH will be formally launched, with the support of the Water Supply and Sanitation Collaborative Council (WSSCC) at the forthcoming Global WASH Forum in Dakar, Senegal, from 29 November to 3 December 2004.

The AMIWASH programme is intended to be a political advocacy for Sanitation and Hygiene on the African Continent. It will assist African countries to achieve their Millennium Declaration goals through coalition building, WASH advocacy, policy development and implementation.

Mr Jay Bhagwan from the Water Research Commission was elected to the steering committee.

Brought Back from the Brink of Extinction

The Working for Water Programme has benefited biodiversity enormously. Its positive effects have gone beyond job creation and rehabilitating hydrology, and have rescued species that were on the brink of extinction.

It was not realized just how damaging invasive alien riparian trees were until they were removed. The problem rests with the fact that invasive alien plants have a pernicious effect that over the years has crept up to blot out indigenous biodiversity.

Some dragonfly species were thought to be extinct as they had not been seen for years, with one being rediscovered having last been recorded in 1920. The point is that by removing invasive alien plants in wetland systems, there can be an enormous and immediate benefit. In particular, it is the very rare and localized endemics that have benefited most, with almost instant recovery of the endemic species where the invasive alien trees have been removed. The removal allows adequate sunlight to penetrate the system once more, and for streamside bushes to recover.

One of the most striking findings is that river braids are under such threat. Alarm bells have been ringing in Europe that pressure on river braids is having a major effect on local biodiversity. This seems now to be also the case for South African river systems. It seems that river braids are highly susceptible to invasion, simply because they are wet, warm and aerated. Yet they are also of great conservation value. The message from this is that pools in river braids ("kuile"), particularly in the Western Cape, need special attention.

Report and photographs by Michael Samways: Centre for Agricultural Biodiversity, Dept of Entomology, Faculty of Agricultural and Forestry Sciences, University of Stellenbosch.
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Basking malachite damselfly Chlorolestes apricans *was on the verge of extinction, but raising its profile is now leading to conservation action.*

The Ceres Stream damsel Metacnemis angusta, *formerly only known from two females, and not seen since 1920, was feared extinct. It has made a dramatic comeback as a result of removal of invasive alien trees under the Working for Water Programme.*

Harlequin sprite damselfly Pseudagrion newtoni; *disappeared from its type locality but has appeared at one site where cattle grazing of river banks and alien trees have been curbed.*

Travel back in time to the last century: One hundred years ago, the Anglo-Boer War was drawing to its conclusion, and people's thoughts turned back to pastoral activities associated with day-to-day life. In the valleys around the town of Brits, planners and agronomists cast an eye toward the rich soils of the Crocodile River Valley and began to dream of the agricultural production that such soils could generate...if only there was water!

Jump forward in time to the 1920s: The Great War had drawn to its bloody conclusion, and people's thoughts again turned to more peaceful pursuits. This time, the plans made and left dormant while the peoples of the world engaged in mortal combat are dusted off and construction of the great concrete wall at the Antelope Gorge upstream of the fertile Brits Valley on the Crocodile River was begun, culminating in the completion of the Hartbeespoort Dam in 1925.

Some twenty five years later another global conflagration had ended. In South Africa urban growth centered on the Golden City of Johannesburg. The influx of people into the valleys of what is now Gauteng Province inevitably spilled over into the Crocodile River watershed.

With these people came roadways, homesteads, and waste. Because of the value of water, recognized even in those optimistic days, provision was made for the construction of a wastewater treatment plant on the northern side of Johannesburg which would discharge into the Crocodile River basin. These effluents entered Hartbeespoort Dam and stimulated the growth of aquatic plants to the extent that the first reports of impaired water quality entered the scientific literature. Humans had indeed effected a change to the landscape, and, in terms of Hartbeespoort Dam, initiated a process of enrichment and water quality decline that culminated some 25 years ago with the conduct of extensive scientific investigations into the causes and consequences of water quality degradation in Hartbeespoort Dam.

Forward again to the present, in fact March 2004 to be precise: A barge slowly makes its way around the perimeter of Hartbeespoort Dam.

A variety of voices are heard...South African accents mingle with those of Finns and Yanks. The New South Africa has engendered a new era of global cooperation, with the focus, again, on Hartbeespoort Dam. The new age of prosperity is bringing new investment to the area, and, with it, new demands for action to rehabilitate the waters of the impoundment, now home to a thriving community of residents and holiday-makers alike.

On the barge are a team of international specialists assembled by DH Environmental Consulting, prime contractors tasked with the preparation of an action plan to restore balance to the Hartbeespoort Dam ecosystem. Also present are specialists and technical advisors from

"…..understanding the public wishes, and integrating their vision for Hartbeespoort Dam with the science and public policy of both provincial and national agencies, was the cornerstone of our efforts."

the North West Province Administration, the national Department of Water Affairs and Forestry, the Government of Finland, International Environmental Management Services Ltd.—DH Environmental Consulting's partner in the development of an action plan for Hartbeespoort Dam, and the citizen members of the Hartbeespoort Water Action Group (HWAG). Discussion was animated as these citizens and specialists shared thoughts and ideas for the rehabilitation of the impoundment.

Subsequent to this site visit, and based on the results of proposals submitted during 2001, and work that commenced during August 2003, the consulting team settled down to the business of drafting a lake management and business plan for Hartbeespoort Dam. Dr Bill Harding, project leader, noted that "understanding the public wishes, and integrating their vision for Hartbeespoort Dam with the science and public policy of both provincial and national agencies, was the cornerstone of our efforts." Consequently, the project team met with representatives of the various agencies for detailed discussions of alternatives.

A lot of what enters Hartbeespoort Dam passes through this giant pipe first!

Sections of the Crocodile River could be used for the chemical removal of phosphorus.

The first phase of the Hartbeespoort Dam Remediation Project, now completed, concentrated on the identification of workable and implementable solutions to eutrophication. Integral to this approach were lessons learnt from the pioneering work of DH Environmental Consulting in advocating and implementing foodweb management approaches ("top-down" management applications as opposed to "bottom-up") and the use of enclo-

Mesocosms have provided valuable information at Harties.

A mesocosm array located in a shoreline embayment

sure trials to provide *in situ* evaluations of the efficacy of proposed treatments. The results of the latter work are now being extended to much larger scale pilot testing.

After ten days of intensive work, the team joined with the Hartbeespoort Water Action Group to present their recommendations to the public. "This was the first opportunity that we had to share the technical recommendations with the community at large," said Garry McKay, Chairperson of the Hartbeespoort Action Group. "It is gratifying to see such a good turnout for this session." Present were about 80 people representing a cross-section of the population living on and around Hartbeespoort Dam.

Bill Harding introduced the meeting by reviewing the history of the Hartbeespoort Water Action Group and the involvement of DH Environmental Consulting. "In seeking practical solutions to the concern expressed by the Hartbeespoort Dam community as a whole," he said, "DH Environmental Consulting and its international team have looked both within South Africa as well as outside to compile a realistic, doable and cost effective management programme for this water body." "A locally implemented and sustainable management plan is our goal," said Dr Harding.

Dr Pirjo Kuuppo of Finland, project oversight specialist, then shared a case study from Finland that re-enforced the fact that, with sound knowledge and good will, communities can change a degraded lake into an attractive and productive waterbody. To do so successfully, however, she noted that "the community has to be willing to make the necessary investments and even voluntarily make lifestyle changes to turn a lake back from the brink, and restore it to being a desirable feature in the community." Enhanced wastewater treatment, stormwater management, and fisheries management measures were all used to restore the ecological balance of the lake and return the lake to pride of place in the local community and its landscape.

The project team then turned to the case of Hartbeespoort Dam: Five issues were identified as critical to managing the condition of Hartbeespoort Dam; namely:

- water quality—including both point and nonpoint source pollution;
- management of lands and ecologically valuable areas tributary to Hartbeespoort Dam;
- fisheries;
- recreational boating and recreational access; and
- institutional development.

WATER QUALITY MANAGEMENT

Point sources of water pollution are clearly identifiable discharge points, characterised as "end-of-pipe" discharges. Nine wastewater treatment plants discharge to the Crocodile River and its tributaries upstream or adjacent to Hartbeespoort Dam. Of these, the Johannesburg Northern Works is the largest and most effective, contributing about one-third to one-half of the total phosphorus load to the impoundment. Phosphorus is a fertilizer element that is present in least supply, thereby controlling the growth of algae and aquatic plants in the impoundment. The other eight plants are much smaller, contributing only one-quarter of the water load to the Dam, but making up two-thirds of the phosphorus load. While one of these small plants has been identified for abandonment, the others will continue to operate into the future. Clearly, reducing the nutrient content of their discharge will benefit Hartbeespoort Dam. Consequently the plan recommends reducing phosphorus effluent concentrations from over 5 milligrams per litre (mg/ℓ) to less than 1 mg/ℓ, which standard is being consistently met by the Johannesburg Northern Works. This would contribute to a 30% reduction in external phos-

phorus load to Hartbeespoort Dam.

In addition to these larger treatment plants, a number of smaller or package wastewater treatment systems exist in the areas immediately surrounding Hartbeespoort Dam. It is recommended that these plants be extended and upgraded to include a nutrient removal stage. These plants, too, should be operated and maintained to meet or indeed perform better than the 1 mg/ℓ phosphorus effluent standard. Individual households using septic tanks and "French drains" should be encouraged through an informational programme to ensure that these individual sewage treatment systems also operate efficiently and effectively.

"the community has to be willing to make the necessary investments and even voluntarily make lifestyle changes to turn a lake back from the brink, and restore it to being a desirable feature in the community."

CATCHMENT AND IN-LAKE MANAGEMENT

The catchment area of Hartbeespoort Dam is not heavily developed at present. This lack of urban intrusion into the drainage area provides an opportunity for implementing sound land use management practices in the catchment to minimise water quality impacts on the impoundment. "All human actions on the landscape generate contaminants which can be mobilised and washed off the land into our waterways," said Dr Jeff Thornton of International Environmental Management Services. "These are controllable activities which can be mitigated or moderated with sound planning and use of available management measures," he said, adding that "catchment planning begins in the riparian zone immediately adjacent to the impoundment." Actions recommended in the plan to address these issues are:

- completion of integrated and comprehensive land use and lake edge/riparian buffer plans;
- implementation of (minimum) 10 m setbacks from the water's edge and restoration of shoreland vegetation as a buffer between human activities on the land and the waters of the Dam; limitation of removal of riparian vegetation both on the landward side of the full supply level/high water level of the Dam and on the lakeward side, the latter protecting the lakeshore from erosion due to wind waves and boat wakes;
- restoration of in-lake habitat to promote both aquatic diversity and a balanced fishery;
- consideration of the use of planned unit developments or conservation subdivisions on the lands adjacent to the waterbody to maximise open space, preservation of shoreland buffers, and enhance provision of basic sanitation services;
- extension of integrated agricultural nutrient and pest management practices, including conservation tillage, to farms in the catchment with specific attention to land form, water courses, and soil characteristics for each farm; and,
- promotion of good urban housekeeping practices such as litter reduction, recycling, homestead maintenance, and garden care, as well as stormwater management within larger neighborhoods.

Water quality modelling conducted as part of the sonsultants suggested that, even with full implementation of the point, nonpoint, and catchment management practices, the mass of nutrient reaching the impoundment may continue to exceed tolerable conditions. The modeling process has supported the identification and compartmentalization of the target phosphorus reduction requirement deemed necessary to bring the dam back into balance. Achieving the identified goals within each of these compartments requires a different approach – for example in the final stage the project team has proposed the use on an in-stream or off-channel drip system using ferric sulphate be considered to ensure control of phosphorus reaching to waterbody. Iron or ferric sulphate can be locally manufactured using facilities that can be made available at NECSA, upstream of Hartbeespoort Dam, and dosed into the Crocodile River at the gauging station adjacent to the property.

FISHERIES MANAGEMENT

Professor Gert Steyn of Ecodynamics and a member of the consulting team is overseeing the fisheries management programme. Prof Steyn is proposing a commercial fishery on Hartbeespoort Dam as a means of restoring a sustainably balanced fish community in the impoundment. "Canary kurper are abundant and aggressive in the Dam," notes Prof Steyn. He notes that these fish "are hammering other species such as blue kurper and bass," and that "control of the canary kurper, carp and catfish in the Dam through an appropriate harvesting program can not only contribute to the local economy, but also fill the demands for fish protein elsewhere in Africa, as well as helping to rebalance the ecosystem of Hartbeespoort Dam." Dr Steyn's fisheries studies are ongoing.

Chetia flaviventris: *A major problem for the Hartbeespoort Dam ecosystem.*

This could be a popular fishing spot if…..

RECREATIONAL USE MANAGEMENT

The project team noted the continuing demand for lands around Hartbeespoort Dam. In the past, these demands have been met, in part, by the sale of public lands, which diminish the opportunities for the public to visit and enjoy the waterbody. The plan recommends that consideration be given to maintaining public access in the form of local and provincial parks that can be used and enjoyed by all. In addition, enforcement of boating laws and limitations on boating traffic in environmental sensitive areas of the impoundment was proposed. These latter actions should be viewed in conjunction with the proposed shoreland management actions, and as a means of helping to balance the in-lake ecosystem by protecting and preserving fish habitat and breeding areas.

INSTITUTIONAL ISSUES

"In order to make this ambitious management programme work," said Bill Harding, "the key ingredient is an appropriate and adequately equipped and financed management organization." Such an organization is provided for under the South African Water Act in the form of a Water Users Association (WUA). These agencies have the capacity to raise public funds as well as to provide a stable institutional and financial base from which to undertake an ambitious programme of reservoir management. "The Hartbeespoort Water Action Group stands ready to accept the challenge of becoming South Africa's first Water Users Association," says Garry McKay, HWAG Chairperson. "Our organization, currently incorporated as a 'grass-roots' Section 21 not-for-profit company, is in place, concerned, and actively seeking to partner with government to protect and rehabilitate Hartbeespoort Dam."

Fast forward now to the year 2020: Hartbeespoort Dam is continuing to serve the needs of the humans settled in the Crocodile River Valley, thanks to the foresight and concerted actions of a multinational, multi-ethnic group of individuals who gathered on the Dam during 2004! The outcomes of the Hartbeespoort Dam Remediation Project are being applied at a number of other SA impoundments, and the bogeyman of "little can be done about eutrophication" has been well and truly dispelled!

For further information contact Dr Bill Harding at DH Environmental Consulting (tel 021 855-2528) or visit their website at www.dhec.co.za/hbpd.

Flow and transport characteristics of groundwater in Karoo formations

When cool drink is sucked with a straw from a soft plastic bottle the shape of the bottle can be influenced by the way you suck: suck gently and slowly and the cool drink flows out smoothly while the shape of the bottle stays basically the same. Suck hard and violently and the cool drink will flow faster but the shape of the bottle will start to contract and become distorted.

Roughly, the same reaction occurs in a Karoo groundwater aquifer when water is pumped from a borehole. When the pumping rate, or discharge rate as scientists call it, exceeds a certain limit, the area in the aquifer where the water is sucked from becomes slightly "distorted" or deformed near the borehole. Depending on the force of the discharge rate and the manner in which the borehole is pumped, this deformation could permanently destroy a Karoo borehole, leading to the well-known cry: "My borehole has dried up!" - which is often heard from people who depend on Karoo aquifers for their water supply.

According to Professor JF (Jopie) Botha, from the Institute for Groundwater Studies at the University of the Free State, groundwater aquifers in Karoo formations of South Africa are usually considered as unreliable sources of water, as illustrated by the difficulties experienced by towns such as Dealesville, Dewetsdorp and Philippolis with water supply schemes based on boreholes.

However, studies have shown that these aquifers must contain considerable volumes of water otherwise it will be difficult to explain the large quantities of water pumped daily from mines and buildings located in and on the formations respectively. One reason for this seeming discrepancy is that the behaviour of a stressed Karoo aquifer is determined by its very complex geometry, consisting of multi-porous rocks interspersed by a few bedding-parallel fractures. To neglect this geometry in the management and operation of these aquifers can damage the aquifer severely or even ruin it completely.

Botha says that there is sufficient reason to believe that the inability of previous investigators to take the internal geometry of Karoo aquifers into account must be regarded as the main reason for the difficulties experienced with these aquifers and why people distrust them.

"The real problem with these aquifers might thus be more a management problem than a shortage of water."

To study this problem Professor Botha and his team at the Institute for Groundwater Studies conducted a research project, funded by the Water Research Commission, into the flow and transport characteristics of groundwater in Karoo formations. The results of the investigation were new and far reaching and included an innovative three-dimensional poro-elastic model for determining groundwater flow through the Karoo aquifers. The main purpose with the model was to investigate to what extent deformations are responsible for the observed physical behaviour of Karoo aquifers in South Africa, which cannot be explained with the conventional porous flow model. This applies in particular to the effect that linear and nonlinear deformations may have on the behaviour of the aquifer.

BACKGROUND

A common view of the Karoo formations in the past was that the rocks are very tight and that the formations can only store water in vertical and sub-vertical fractures. However, Botha says their research shows that this is not the case.

"Vertical and sub-vertical fractures do occur quite frequently in these formations, but they only serve as preferential flow paths during the recharge of the aquifers and not as storage units. The major storage units of water in Karoo aquifers are the formations themselves. Because these formations are very tight, they do not transmit water readily, but the bedding-parallel fractures can serve as the conduits and transmit water in these aquifers."

He says a borehole in a Karoo aquifer therefore only has a significant yield if it intersects one (or more, but usually one) bedding-parallel fracture. Although these fractures often extend over large areas, they can only store a limited volume of water, because of the size of their apertures, which are of the order of 10 mm. The apertures, nevertheless, are large enough to allow them to transmit water rapidly to any point in the aquifer where the fracture is present and there is a demand for water.

An American hydrologist, OE Meinzer already argued in 1928 that aquifers are compressible.

Nevertheless, the compressibility of an aquifer is habitually neglected in groundwater investigations, because the magnitudes of these phenomena are small and difficult to observe in practice. However, the magnitudes of the deformations are such that they could collapse a fracture with the aperture of a water-yielding fracture in the Karoo formations in a few decades or less, even though the deformation might not be recognized during normal field investigations of an aquifer.

MODEL

The project team concentrated their efforts on the development of a deformation model. This model showed that deformations might play a much larger role in the behaviour of aquifers in general, and not only Karoo aquifers, as was originally thought. This means that one should use a model that also takes the mechanical properties of the aquifer into account and not a model that only depends on the classical hydraulic parameters (specific storativity and hydraulic conductivity), when modelling the flow of groundwater in practice.

The deformation model was supplemented with a two-dimensional mass transport model to study mass transport in an aquifer in an aquifer subject to deformations. However, this showed that there is no significant difference between mass transport in a deformable and a rigid aquifer, provided that the discharge rate of a borehole is not so high as to cause oscillations in the water levels of the aquifer and the mass transport model becomes unstable.

Previous studies on the deformations of aquifers have usually been based on the generalized linear law of Hooke – one of the keystones of the theory of elasticity and the basic principle governing the operation of the classical spring balance (the more massive a body the longer the extension of the spring). This law, unfortunately, does not allow one to study residual deformations, (the spring in the balance will not return to its original length, if used to weigh a body whose mass exceeds the maximum mass for which the balance was designed), which could be important in Karoo aquifers.

Since the linear law of Hooke cannot account for residual deformations, a new non-linear form of law was introduced to study residual deformations in aquifers.

Botha says there are no analytical solutions available for the coupled flow and momentum equations that arises from the application of both the linear and non-linear forms of Hooke's law to the flow of groundwater through deformable aquifers, at least not to the knowledge of the researchers. The finite element method was therefore used to approximate the equations and a computer program was developed for the numerical computations of solutions.

The computer program was first used to study a model for a hypothetical aquifer system – with the view to test and verify the present model. Thereafter the model was used to study the behaviour of the aquifer on the Campus Test Site of the University of the Free State.

TEST SITE

When the model was applied to the aquifer on the University's Campus Test Site with its bedding-parallel fracture, dramatic changes were observed. Although the simulated draw downs and displacements remained smooth for all simulations with the linear law of Hooke, the fracture experienced significant deformations if the discharge rate of the borehole exceeded a certain limit.

The same also applies in the case of the non-linear law of Hooke, except for the introduction of residual deformations with magnitudes that depend quadratically on the discharge rate of the borehole. The residual deformations ultimately led to a chaotic behaviour of both the simulated draw downs and displacements at high discharge rates.

The model thus clearly supports the view that too high discharge rates could damage a borehole and a Karoo aquifer permanently.

An interesting prediction by the model is that no deformations will form in the aquifer, even under the non-linear law of Hooke, if the discharge rate of the borehole is kept below a certain value.

However, this behaviour is typical of all deformable bodies and there is no reason to expect that aquifers should behave otherwise.

Knowledge of this limiting discharge rate of boreholes obviously would enhance the management of aquifers considerably. Unfortunately, the limiting discharge rate depends intrinsically on the hydraulic and mechanical parameters of an aquifer which vary considerably from aquifer to aquifer. The parameter can therefore only be determined through detailed field investigations.

The non-linear law of Hooke caused constrictions to develop in the fracture immediately after the pump is switched on, if the discharge rate of the borehole exceeds the limiting rate. The magnitudes of the constrictions increase very quickly at first, but then approach a pseudo steady state within a few hours of pumping (two in the case of the model).

A series of simulations was performed to try to find to what extent the pumping of the borehole will affect the fracture in the model of the Campus Site. According to the results of the simulations, a borehole on the Campus site will fail in less than six years, if pumped at a rate of 8.3 m^3 (cubic metres) per hour for 8 hours per day, every day of the year. However, the results also indicate that the fracture will suffer no significant mechanical damages if the discharge rate is kept at or below 1.4 m^3 per hour. The mechanical properties of a fractured aquifer are therefore as important as the hydraulic properties of the aquifer in designing a discharge rate for a production borehole in such an aquifer. More attention should therefore be paid to the mechanical properties of the aquifer in the management and control of well fields.

The fact that constrictions develop very quickly in the fracture at early times of pumping and then approach a pseudo state suggests that it would be more advantageous to pump a borehole for extended periods rather than intermittently. For example, pump the borehole once for 24 hours in a cycle of 72 hours rather than three times for eight hours each, as is usually done in water supply schemes. This procedure will increase the expected mechanical life of the borehole by a factor of 3 for a given discharge rate. Longer periods of pumping will increase this time proportionally.

A very important conclusion that can be drawn from this study is that a "dried-up" borehole does not imply that there is no longer water in the aquifer, but that the borehole has been damaged mechanically, in the sense that its ability to yield water has been destroyed, in most cases permanently. It is therefore often possible to drill a new successful borehole within a few metres from the damaged borehole. However, this practice should be discouraged by all means, because the new borehole will certainly also fail in future if pumped at too high a discharge rate. A repetition of the practice could therefore ruin the aquifer itself and not only a borehole. It is therefore of the utmost importance that the boreholes in water-supply schemes must be pumped at rates that will prevent mechanical damage to the borehole, to protect the aquifer for future generations.

For more information, readers can order a copy of the full report…

That I cannot say

by Rosamund Stanford

Bulu was walking round and round under the old oak tree pushing a pole. The other end of the pole was tied to a bunch of cowhide strips, suspended from a high-up branch. The little girl's eyes were on the still hairy hides. They were twisting, twisting, twisting, and growing a big lumpy bulge. As the bulge got more knotted the pole pulled Bulu's arms up and up, until they were above his head.

You know, said Bulu without looking at her, when your grandfather passes on, the buck are going to die. That herd of rhebok up there on the mountain are going to die, it will take some time, but that is what will happen.

Why will they die? asked the girl.

That I cannot say, said Bulu.

Bulu was very old and very hard to talk to. The little girl wanted to ask more but she felt unable. He had such deep dark lines in his face, and he was filled with sorrow. His sons, whom he'd raised with great care, had become cattle thieves. He said such a thing was almost enough to make him join the mission people, although not quite enough.

Get out of the way! he suddenly shouted. The little girl scattered. The pole came wildly smacking and bouncing down as the knotted riempies unwound.

Then Bulu started again, trudging round and round. My mind is like the hide of this cow, said Bulu, if I put my sinews into it and twist it up, it becomes unruly, like the water snake when it has been angered. Maybe, as they say in that church that has been built over there, I will go to hell, but there is nothing else for it.

That was very frightening for the girl. Now she was thinking, not only will Bulu one day die, but also her grandfather would die, and all the buck on the mountain too. She felt the presence of doom.

Knowing how she felt, Bulu for the first time looked straight at the girl. Not now, he said, because it is not yet the time, but when you are older, you will have to come back here no matter how difficult that will be, or how inconvenient. But come with me now I will show you something before I die.

The girl followed Bulu up into the hills. You see, he said, when they reached the heights where there was a covering of grey-green isidwadwa shrubs; the goats are destroying the grass, eating even the roots. And the cattle, he shook his head, they are thin long before the frost. And here, this spring, which is the one that sends water down to the homes below, is becoming weaker. We do not know why, but I alone have been speaking to the water snake, no one else hears him anymore. He says this mountain is shrinking from him, in shame.

The shame is on account of being left naked. No mountain wants to be without cover, but that is happening. For the first time Bulu smiled at the girl. You, he said, and me, we can put on clothes in the morning and take them off at night, but not the mountain.

They walked along the ridge and down a slope until they sighted the small herd of rhebok in the distance. There they are! said the girl, excited, because they were a rare sight for her eyes.

Now we will follow them, said Bulu, but from a distance. For nearly an hour, the two of them walked quietly behind the herd of buck. They are going, said Bulu, all the way from up here on Inungi mountain, right down down the foothills and into the valley of the Umzimvubu.

When the buck reached the Umzimvubu, the girl expected that they would drink, but no. Instead they trailed along the bank, going south with the bends of the river. They stopped at a place where the water was spreading wider and

shallow enough to wade through. One by one each buck made a small jump into the flow. With their heads held high, half wading, half swimming, they made their way to the middle of the river. Then their backs rose out of the water; there must have been a mound or a rock just beneath the surface. Standing on this they lowered their necks into the river and drank. Then one by one they returned to the bank.

All that way, said Bulu, and they could have drunk anywhere along the river. In fact they could have drunk from the stream up on the mountain. Maybe you, on those short but sturdy legs of yours, would walk such a way, from the top of the mountain to here, if there was coca cola in that water. Now you are teasing me, said the girl.

Soon after that Bulu died and the girl's grandfather died too. The family moved to the city where she was sent to school.

For the first few years the girl was alright. But as the pages and pages of facts began to mount she'd ask her brothers: How can a person remember all these things about an animal or plant, or a river without seeing it ever? The girl was scolded, she was sent for counselling, she was sent to a psychiatrist. When the psychiatrist asked her why she was refusing to learn her work she replied: There's no picture, no story to help me hold the bullet lists in my brain. I want you to take these pills, he said, they will help you remember.

I don't want pills, said the girl, I want to smell the Umzimvubu again, the water in these taps is disgusting.

The psychiatrist told the girl's family: Without medication I see little hope. It's clear as crystal that she is deluded; we all know that our city water it is absolutely sterile, you can even smell the chlorine.

Now the girl was back. Her brothers had brought her to visit the place of their early childhood. They searched for the mountain spring, but it had dried up, as Bulu predicted that it would.

Then they went down into the valley to Bulu's huts. They were long deserted. There were goats all over the place and a few cattle, bony as skeletons.

They went to the river. If only I can find the place that Bulu showed me, said the girl. I have to find the buck first. Walking around they asked whoever they came across: Have you seen any rhebok? Some people who were herding their thin cattle, said they'd last seen a small herd over there or over there, but that it was some time ago. Nobody was sure whether the buck were still around. One person said he'd heard gunshots on the mountain, and that maybe the whole herd had been hunted out. Another one said dogs had eaten the buck.

Then the girl and her brothers met a man who was tall and ropey-looking just like Bulu, but younger. You must be one of Bulu's sons, said the girl. Yes he said, they released me from prison only yesterday and I've been walking walking walking, but I no longer have a family to return to.

The spring on the mountain has dried up, said the girl. That is what my father said would happen, responded Bulu's son.

Because it was summer the Umzimvubu was swollen with earth-red water. We will never be able to find the place where the buck drank with the water so full and muddy, said the girl.

You must wait then until the rains subside if that is why you came all this way, said Bulu's son. That could take months, said the oldest brother in consternation. It's too bad, said the girl, I'll just have to wait as long as it takes. What about your schooling? asked the other brother, you will fall behind. It would make no difference if I went back now, she answered, there's no room in my brain.

Your head is too tight inside, said Bulu's son. The remedy for that is known only to the water snake. He is the one who can unravel the tightness of mind that won't allow new things to enter.

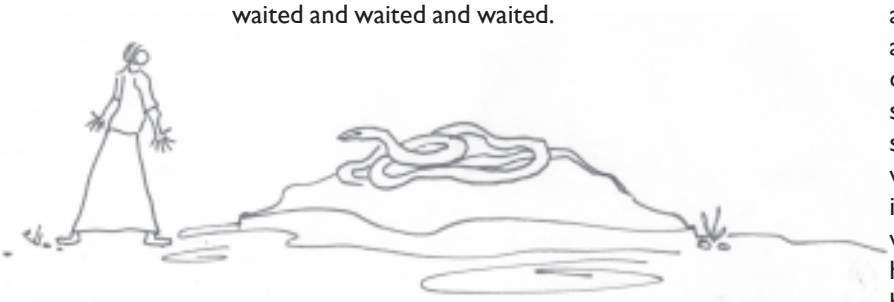
You can't stay here, said the brothers, everything's changed: look at the veld, look at how the huge old ironwoods have been hacked away. And in any case you can't drink the water of the Umzimvubu anymore, there's an enormous unserviced settlement ten kilometres upstream,

you'll have cholera in no time.

I'll stay, said the sister, Bulu's son will look after me: won't you?
I'm known as a cattle thief, he replied, but you are welcome to one of my father's huts.

For four months the girl waited. Then when the grass had broken into little white pins, the water of the Umzimvubu got shallower and clearer; and because it was late summer the snakes spent as long as possible heating up their bodies in the sun.

Then one morning next to the river the girl met the water snake. It was big and long and brownish black, almost invisible, as it lay coiled on a hot black rock.



The girl froze. The next step of her bare foot would have stood right on the snake had she not caught the glint of its eye. Her foot jerked back. Her mouth went dry, as if she'd bitten into a green banana. Her legs were trying to run her away, but she was torn in two, because her mind was saying: this is your chance; you came here because school or some other thing was squeezing your brain, now is your chance.

The girl forced her legs to be still. She faced the water snake.

I see your legs are still running inside themselves, remarked the snake. I see you are being torn apart. Follow me.

Uncurling itself the snake slid across the hot rocks and down into the grass. The girl followed it through grass and bush and deep red dongas. Then the river widened out and the water looked a bit shallower. This is the place, thought the girl, the place where the rhebok came to drink.

You are right said the snake. Now we must wait. So they waited, but soon it was dark and nothing had happened.

You will have to find me again tomorrow, said the snake, I will be back on the same rock. It slid into the water.

In the dusk the girl made her way back along the river, she went as slowly as a creeping creature so as not to injure her upright bones.

The next day as soon as it became light she walked back to the black rocks. There was no snake. She waited and waited and waited.

Then a movement caught her eye. It was the snake gliding up the rocks.

Again she followed it along the bank to the place where the river was slightly wider and shallow enough to wade through. They sat all day there. Nothing happened. The girl felt thin and hungry and very thirsty. She lay on a flat rock and sucked water up like a cow or an antelope.

The snake disappeared without saying a word to her, so again she walked very slowly back to Bulu's huts.

What was she to do? She spoke to Bulu's son: I have followed the water snake today and yesterday and waited and waited, I'm sure it's the same place that Bulu took me to, where the buck drank.

Bulu's son was unable to hear her because he was vomiting his guts out. For days he'd been unable to keep anything in his stomach. He'd heard that many people along the river were throwing everything up in the same way. The girl didn't know what to do to help him. They knew it was the water making everyone sick. If only the spring on the mountain hadn't dried up, she said. She boiled pots of water for Bulu's son, and he drank and drank. Then he said: maybe it is better that we all live in prison, at least there we are fed, and the water does not make us die.

Again the next day the girl went to find the water snake. For many hours she sat on the rock, but there were clouds passing over the sun, and every time another cloud darkened the sun her heart sank. Maybe winter has set in and the water snake has gone into hibernation, she thought.

Then she thought: but what is the point in any case, I must truly be mad, those teachers were right, if anyone saw me here spending my days sitting on a rock like a primitive person waiting for a snake, they would say yes indeed this is madness. This was a terrifying thought for the girl. She could neither get up and leave nor stay where she was: what was going to happen? What can happen if you can neither stay where you are nor leave?

It was then that she noticed that the snake was on the rock, as if it had been there all the time and she'd been unable to detect its presence. But what was happening? It was writhing and swelling. Its skin

was beginning to burst. A slow tear was splitting along the length of the snake's body.

Now, said the snake, take my old skin and grind it up with a stone, then walk along the river bank and you will know exactly which place in the water to throw it. That's all you need to do, nothing further. I will be gone now. With its golden-brown skin, like the skin of a young snake, it slid off the rock and disappeared into the running water.

The girl picked up the skin, which was thin as plastic and slightly translucent. She crumpled it into one hand then began to follow the river as she'd done the two previous days. She saw a round rock, the size of her hand, which she picked up and took with her to the place where the river widened out.

There, she sat down and ground up the water snake's skin. Then she gathered up every bit, every scale in her palms and stepped to the water's edge. This was the place she knew; but her hands wouldn't open, they were afraid to let go of the snakeskin. As long as she held it in her hands she could hope: but what if she let it go and that was the end of that, what if she never found whatever it was she'd come back for? What if she went back to school and was still unable to store more than three facts in her tight brain?

She found herself weeping: this was the first time that she'd allowed her tears to flow since returning to the place of her birth. But after only five sobs the girl took in a very deep breath. These tears, she said, will have to help me: I will not shed them for no good use. She stood up and flung the crushed water snake scales into the stream.

As she did this, she heard a soft sound like hooves on rooigras. She looked up and there was a small herd of rhebok. She remained absolutely still, as still as the snake had been when she had failed to detect it on the rock. The buck reached the bank, then one by one they made a jump and entered the water. First they swam out a bit, then they allowed the current to take them slightly downstream, to a place where the water was swirling like a knot in a tree. There the buck rose out of the water; they were standing on a rock or a mound, with just their lower legs covered. One by one they bent down and sucked up water from the river. Then they swam back to the bank.

When the rhebok had gone the girl took off her clothes and waded and swam to the same place. Just under the water was a large rock where she rested, looking into the river on the far side. The water there looked as if it had rust in it and smelt slightly sulphurous. She put her face in and let her eyes look down into the river. She felt with her arms. Under the river there must be a spring, she could feel the bubbling coming up.

The next day the girl returned with empty two-litre coke bottles. She swam to the same place, then she dived to the bottom of the river. Spring water was welling up from a hole. She filled the bottles, trying as best as possible to keep the river water out.

Then she took the bottles back to Bulu's huts. At first when she drank this water, it tasted awful, but soon she wanted nothing else to drink or eat. For five days she took in nothing but the water of this underwater spring.

On the fifth day she began to feel that her tight brain was softening, and the knotted rope in her belly was turning into a thousand flowing strands all moving together, it was as if all her energies, instead of zooming this way and that way like taxis in rush hour, were just meandering like water or thin strands of cloud on a breeze.

The girl breathed freely again. She said to Bulu's son. I'm going back now. I think those buck were same ones that came down from the mountain when your father was still alive, the snake allowed me to slip back to that time. Before I go I will show you the place under the Umzimvubu, where the water is still full of life.

(The author can be contacted at mindys@global.co.za)

Software Tools to Help Reduce Leakage in Water Distribution Systems

The previous issue of Water Wheel reported on the significant reduction in water leakage from distribution systems that is possible through pressure reduction at night. Readers were promised abridged information on four water demand management (WDM) models available to South African local authorities, on which municipal leaders and financial and water supply managers will be briefed at a short course to be offered in five centres around the country in November. The following descriptions of these models are abridged from a Water Research Commission (WRC) brochure on the tools, (including software) available to promote water demand management in South Africa[1].

Although comprehensive and sophisticated WDM software is available internationally and locally, it may be beyond the financial reach of smaller municipalities. The WRC thus focused on providing free software solutions to assist water suppliers in understanding and managing their non-revenue water. Four packages were developed for the WRC by WRP (Pty) Ltd based on the UK-developed Burst and Background Estimate (BABE) methodology. The software was customised for South African conditions, made more user-friendly where necessary, and is available free of charge to domestic water suppliers.

[1] Brochure produced by RS McKenzie of Water Resource Planning and Conservation (WRP) (Pty) Ltd and JN Bhagwan of the WRC.

THE WRC'S FOUR BABE-BASED MODELS

Model and details	ISBN No	WRC No
SANFLOW Model designed to provide an indication of the unexplained burst leakage in a zone from the analysis of the minimum night flow.	1 86845 490 8	TT 109/99
PRESMAC Model designed to estimate the potential for Pressure Management in a pressure zone based on logged flow and pressures over a representative 24-hour period.	1 86845 772 2	TT 152/01
BENCHLEAK Model designed to establish the levels of non-revenue water in a water utility or zone metered area, based on the latest IWA recommendations regarding the Minimum Level of Leakage.	1 86845 773 7	TT 159/01
ECONOLEAK Model to evaluate the most appropriate frequency for undertaking Active Leakage Control	1 86845 832 6	TT 169/02

The rationale for the development of the various models is as follows:

ECONOLEAK

The purpose of ECONOLEAK is to assist water suppliers in understanding the economics of active leakage control and the economic level of leakage. Most water distribution managers and engineers are aware that they can achieve significant savings through reduced leakage. But it is often difficult to convince financial managers to allocate the required funding for specific leakage-reduction activities even when it is well known that the costs will be recovered in less than a year.

Reduction of leakage in a water distribution system can be achieved by various measures including retro-fitting, metering, pressure management, active leakage control and mains replacement. The major problem facing water distribution managers is to determine which measures are the most beneficial and how much can be saved in real terms from each measure.

It is thus important to analyse the leakage properly and to identify and quantify the major problem areas. After the problems have been identified and quantified, the most appropriate leakage reduction measures can be determined and accompanied by sound financial motivation.

The ECONOLEAK model is not designed to address the economic issues associated with all of the various types of leakage-reduction activities mentioned above. ***Instead, it is aimed specifically at determining when a water supplier should invest in active leakage control for a specific zone metered area.*** The model complements the SANFLOW, PRESMAC and BENCHLEAK models which together provide water suppliers with key tools to assist them with their leakage management.

In order to use the ECONOLEAK model, the user must supply considerable factual system data on the frequency of burst pipes and the costs of repair. Such information is often difficult to obtain and in many cases the water supplier is unable to provide even the most basic leakage data. ***While this is clearly a problem in the short term, it does create an awareness of what information is required to undertake an economic analysis of leakage control.*** This in turn, should encourage water suppliers to start capturing and processing the necessary data so that they may be able to carry out some form of economic analysis in future. The model is very useful in creating awareness of ***the key information that all water suppliers should be capturing and monitoring on a continuous basis***.

SANFLOW

Measurement of minimum night-flow into a zone-metered area is possibly one of the simplest and most valuable actions that a water supplier can take in order to identify whether or not it has a serious leakage problem. The purpose of the SANFLOW Night Flow Analysis Model is to provide a standardised approach to evaluating burst and background losses in water distribution systems in South Africa.

The South African model stems from one of the UK-developed Burst and Background Estimate (BABE) techniques, with key improvements. It is extremely simple to use and all of the detailed calculations are hidden from the main screen. The main screen therefore provides a clear and concise overview of the leakage in a particular zone. Details of any of the calculated values can however be viewed by simply selecting one of a number of variables.

In summary, the SANFLOW model starts at the point where the UK basic research left off in 1996 and has taken the development to a new level of presentation and reliability. Through this model, the WRC hopes to encourage water suppliers to make use of a standard package for the assessment and interpretation of night-flow data as the basis for reducing unaccounted-for water.

PRESMAC

In the continual battle to reduce leakage from potable water distribution systems, the influence of pressure is often overlooked. The purpose of PRESMAC is to serve as a pressure management model for South African water suppliers.

Since distribution systems are designed to supply the minimum level of pressure during peak demand periods, it is clear that the pressure will increase during the periods of low demand. The pressures in potable water distribution systems are therefore significantly higher than required much of the time, particularly at night when demand is low. Since losses and leakage from a system are highly dependant upon pressure, it is also clear that leakage rates will be highest during the periods when few consumers are using water.

By using pressure reducing valves (PRV) according to time (time-modulation) or demand (flow-modulation), it is possible to reduce the pressure during periods of low demand and thus reduce leakage without adversely affecting the level of service to consumers. Software and hardware solutions can be used together to tackle pressure in potable water distribution systems.

Time modulated control offers the simplest form of Advanced Pressure Control and also the least expensive. It has certain limitations, however, one of which concerns the influence on fire fighting flows. If fire fighting flows present a problem, the time-modulated option may not be suitable, in which case the more advanced flow-modulated control, which provides greater flexibility and control, may be required.

The flow-modulated controller controls the pressure at the inlet point in accordance with the demand being placed on the system. During low demand periods the pressure is reduced to minimise excess pressure and the associated leakage.

The Water Research Commission initiated a project in 1999 to develop a South African pressure management model (PRESMAC) based on the BABE principles but modified to suit South African conditions where necessary.
It was clear from the eight pilot studies undertaken that pressure management was an effective tool for water demand management – in certain cases, by far the most effective form of leakage control that can be undertaken. If implemented properly it can provide very significant and cost effective savings which are both immediate and sustainable.

The PRESMAC pressure management model is used to assess the likely savings (in monetary terms) of various pressure reduction options (fixed outlet and time-modulated PRV's) in a selected zone metered area. The analysis is undertaken in a relatively simple and pragmatic manner and allows the user of the program to gauge the potential for pressure management very quickly and effectively without requiring a full detailed pipe network analysis.

Although the methodology is based on a number of simplifications and assumptions, in practice the predicted savings are generally within 10% to 20% of those achieved in practice.

It was this system, applied to Khayelitsha in the Western Cape as reported in the previous issue of *Waterwheel*, that paid for its installation costs in the first month of operation.

BENCHLEAK

The purpose of the BENCHLEAK model is to benchmark leakage in water distribution systems in South Africa.

Figures for 'Unaccounted-for Water' are often expressed as a simple percentage of system input volume. Such figures tend to be accepted blindly as a meaningful indicator of performance. Over the past decade, however, it has been recognised that percentages are often unsuitable and can be very misleading when used to assess the operational efficiency of management of real losses in distribution systems.

The problem to be overcome was that of how to express real losses in such terms that the leakage in one system could be meaningfully compared to the leakage in other systems. The WRC commissioned a study to develop a benchmarking system to enable the leakage rates in the many water supply systems throughout South Africa to be defined, calculated and compared in a standard and more meaningful manner.

The success or failure of the proposed methodology obviously depends on how diligently water suppliers complete the various forms and obtain the required information. A key objective of the BENCHLEAK software is to ensure that the information requested is relatively simple to provide. At the same time, the results and details provided from the software should be of use to water suppliers by detailing their water balances in a simple and pragmatic manner.

The potential problems of 'too much detail', or 'not enough detail' were tackled by developing colour-coded software – BENCHLEAK, which provides all the optional details that are likely to be required. Most of the items in the software are calculated fields with the result that the user need only provide some very basic information that should be readily available from its information system, or can be determined with minimal effort.

The BENCHLEAK software is designed in such a manner that it can easily be condensed into a single worksheet for all data entry once the water supplier is accustomed to the data requirements and use of the software.

It should be noted that while percentage values are not recommended for comparing leakage rates from one system to another, they are useful for comparing the leakage rates for the same system from one year to another. They can be used for 'internal benchmarking', but should not be used for 'external benchmarking'.

The Water Research Commission commissioned the development of the above models to assist local authorities in their drive to improve the efficiency of their water distribution systems. This is in line with the Government's imperative to make best use of this essential but increasingly scarce commodity and avert a serious water crisis in coming decades.

Water Analysis Kit Promotes a Healthy Environment

The water education project SWAP – kick-started in 1992 with funding from the Water Research Commission – is still going strong in the Western Cape.
***Sue Matthews** reports.*

The Schools Water Project (SWAP) makes use of a simple water analysis kit to raise children's awareness about the need for a healthy environment. At the same time, it promotes other important outcomes such as critical thinking, problem-solving, effective communication and team work to achieve a desired result.

"The kit is actually a resource for both learners and teachers," says project leader Dr Chris Reddy, of Stellenbosch University's Faculty of Education. "The SWAP tests are learner-centered, hands-on and investigative, but we're also interested in the professional development of science teachers to enable the new curriculum."

NATIONAL CURRICULUM ENVIRONMENTAL EDUCATION

The Revised National Curriculum Statement has a strong focus on environmental education, and also requires more learner-centred approaches to teaching. However, its implementation may be hampered by the lack of capacity of many teachers, and a shortage of learning support materials. Dr Reddy and his team hope to address this by helping teachers to understand the curriculum statements and providing them with support material for environmental education.

SWAP

The SWAP kit consists of a 'jam-tin' containing items such as sampling vials, litmus paper, a plastic pipette, a turbidity disc and a bottle of methylene blue, as well as a series of A1 posters that can be folded and set up as 'labs' in the classroom. These cover aspects such as basic scientific tests for nitrates, turbidity, oxygen and pH; historical research with tips on interviewing skills; an assessment of the catchment area and the health risk posed by the river's water quality, and water life observations, with a bug-dial to identify invertebrates that can be used as biological indicators. In addition there is a teachers' guide containing user-friendly worksheets that can be photocopied and taken on field trips to nearby rivers or canals.

The teachers - currently representing 18 disadvantaged primary schools in the Steenberg, Grassy Park and Retreat areas of Cape Town – are also given training and additional support by the SWAP team.

"After conducting initial workshops on how to use SWAP as a learning support material, we take the teachers on river visits so that they can do a trial run, and then provide further support by accompanying them with their class to the river. Once the year is over, schools should be able to run with the project themselves," explains Dr Reddy.

SHUTTLEWORTH FOUNDATION

This year the project is being funded entirely by the Shuttleworth Foundation, established by South

Learners (top) proudly show their SWAP "jam-tins". The SWAP kits are used for water quality monitoring. Bottom: Searching for bugs that could indicate a river's "health".

Africa's home-grown astronaut, Mark Shuttleworth, in October 2001. The Foundation aims to improve the quality of education in South Africa, particularly in the subject areas of maths, science and technology at school level. Funded projects must be curriculum-aligned, and provide innovative solutions to educational challenges in an African context.

"We're making explicit curriculum links with SWAP, particularly the science curriculum," says Dr Reddy. "The project is endorsed by the Western Cape Education Department's EMDC South – the district under which the 18 schools fall – and having this formal legitimacy gives it added credibility with teachers."

He explains that Fadli Wagiet, the natural science curriculum advisor for EMDC South, highlighted the links between SWAP activities and the science curriculum at a workshop in May attended by 65 teachers. He showed them how to use the resource as part of their normal teaching, rather than seeing it as 'add on' task.

"SWAP activities can also be made applicable to other learning areas too, such as art, language and social sciences, so it's really cross-curricular," adds project facilitator, Andre Rowan.

The current version of SWAP dates back to about 1997, when the potential use of this resource in implementing Curriculum 2005 became apparent.

Since first being established in 1992 by Prof Danie Schreuder of the University of Stellenbosch and Dr Rob O'Donoghue of the then-Natal Parks Board, the SWAP kit has undergone a continuous process of evolution. Spawned from the low-cost water quality monitoring procedures developed by the Global Rivers Environmental Education Network (GREEN) founded by Prof Bill Stapp in Ann Arbor, Michigan, it was initially aimed at high-school level. In fact, SWAP originally stood for the Stellenbosch Water Analysis Project, as it all began with seven high schools in the town's Eerste River catchment.

WRC

The WRC funded the project for the first three years, but other roleplayers like WESSA, Umgeni Water and Rand Water later came on board. With wider implementation came a name change to Schools Water Action Project, and resource materials were soon being distributed countrywide as Share-Net publications.

The first SWAP kit enabled learners to test for chemical indicators such as nitrates, phosphates, organic solids and biochemical oxygen demand, physical indicators like turbidity, temperature fluctuations, stream velocity and flow patterns, and biological indicators such as invertebrates, alien vegetation and faecal coliforms.

SAFETY

Later, Rob O'Donoghue developed a simpler version for primary schools, using plant and animal life in the river to assess water quality by 'reading nature', rather than conducting actual measurements.
"I became concerned about the safety of the original kits," explains Dr O'Donoghue. "The test for dissolved oxygen used some fairly

Swap facilitator, Andre Rowan, demonstrates one of the SWAP water tests to learners from the Constantia Primary School in the Western Cape.

noxious chemicals, and we often found some nasty bacteria growing in the Petri dishes alongside the coliforms."

Somerset Educational later produced a compact MicroChem kit for high schools that was much safer that the original kits, while the primary school version of today's SWAP incorporates the innocuous 'oxy-bac' test using methylene blue. "The methylene blue test is fantastic – it's very safe and extremely useful for illustrating a contaminated river," says Dr O'Donoghue. "It measures the extent to which there are plants and animals in the water that are using up oxygen. If there's lots of microbial activity in the water it goes clear – the kids love it because it's like magic!"

In the meantime, Dr O'Donoghue has maintained his focus on environmental education tools that use biotic indicators to monitor water quality, while also incorporating indigenous knowledge.

MINISASS

Working with Umgeni Water, Dr O'Donoghue played an instrumental role in developing miniSASS, a simplified version of the South African Scoring System technique used by aquatic scientists to measure the 'health' of rivers.

A paper published recently in the *African Journal of Aquatic Science* (Graham et al., 2004) showed a high level of correlation between miniSASS and the full version, which is very expensive and labour-intensive. This means that the results of miniSASS can be used with some confidence, producing data that is sufficiently accurate to be of value to anyone with an interest in river health.

"Potentially every school, environmental or community group in the country could become a monitoring cell, and with this geographical spread use the miniSASS tool as a 'red flag' for the identification of aquatic pollution sources and events in their immediate environment", the authors state.

Schools will be able to enter their data on an internet web-based mapping programme, giving them the opportunity to make a real contribution to environmental management.

"It's likely that we'll see a tendency towards catchment observation using miniSASS in future," says Dr O'Donoghue. "But over the years a whole variety of activities - taken up by schools in different ways - have blossomed out of SWAP!"

Pivot Irrigation-
The Never-Ending Quest for Improvement

We visit Louis Wilken in the world of Teebus and Koffiebus

Wilken Boerdery is located within sight of Teebus and Koffiebus near the outlet of the Orange-Fish tunnel.

"On any farm one is constantly looking for better yields, savings on mechanisation costs etc. Farming is a constant cycle of investigations into the effectiveness of the practices you are applying, how you do things." This is the view expressed by Mr Louis Wilken, chairman of the Orange-Vaal Water Users' Association, when we visited him to discuss the role that the irrigation-planning program SAPWAT is playing in his farming operation, Wilken Boerdery, in the Karoo.

Louis Wilken

"Scheduling and the effectiveness of irrigation systems in use are one of the first phases you consider, you carry on until you feel you have the situation under control and then you move on to the next phase. You start looking at cultivars and planting densities and this leads you to planters and their suitability for the various soil conditions that apply on the farm. Inevitably this raises the issues of soil cultivation methods and implement suitability and the impact on soil compaction and root development. Fertilisers are an important factor, how much, what sort, when and how should they be applied? As improvements are implemented they have an impact on irrigation management and this means revisiting scheduling and the suitability of irrigation equipment and management. This cycle of investigations followed by improvements may extend over a year or two but all the time you are striving for progress, always returning to the factors that make a difference."

Wilken's involvement with the Orange-Vaal Water User's Association goes back to 1984 when he became the manager of what was then the Irrigation Board. He initi-

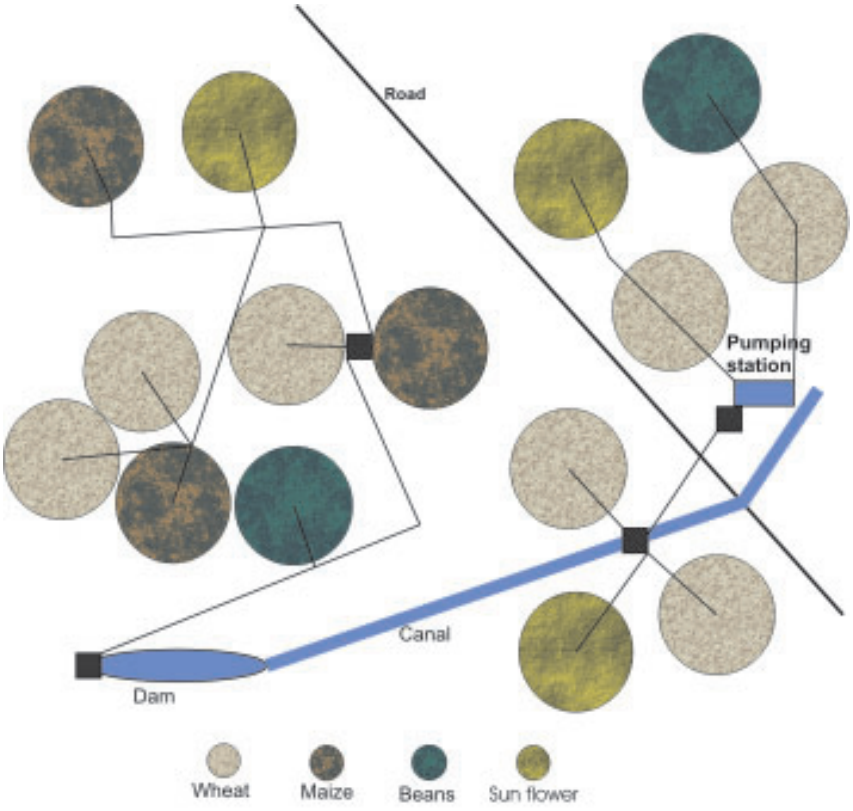
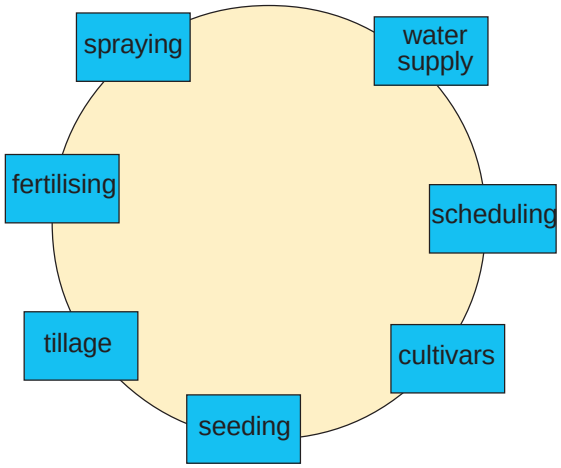


Diagram to illustrate the complexities of the irrigation planning and management task. The layout and the crop selection do not represent any specific farm.

ated the innovative approach of water management based on scientifically estimated crop irrigation requirements that is still successfully applied and has also been adopted by the Orange-Riet Water User Association.

He has recently extended his farming activities to an irrigation farm at Schoombee in the Karroo that is served by a canal that originates at the outlet of the Orange-Fish tunnel. The irrigation system comprises ten centre pivots, several pumping stations and storage/ balancing dams.



Louis Wilken's irrigation improvements cycle

It will be appreciated that on a farm of the size and diversity of Wilken Boerdery this cycle is implemented for each land, crop rotation and pivot and integrated when developing the water management procedures for the farm as a whole. At the end of the day each change or improvement will influence irrigation requirements in terms of both volumes and timing. SAPWAT has a significant role to play in this process. It is a tool for evaluating and re-evaluating, on a continuing basis, the impact of changes in practices on irrigation management as well as the management of water resources and supply.

DEVELOPING CROP IRRIGATION REQUIREMENTS ESTIMATES

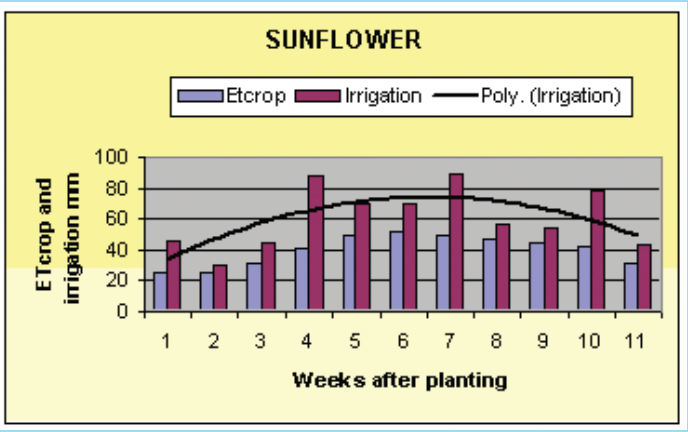
In the case of a farm such as Wilken Boerdery with 10 pivots served by several pumping stations and operating on varying soil types crop production planning can be complex. The impact on water supply and irrigation scheduling is facilitated if various alternative options can be weighed up interactively on a computer screen.

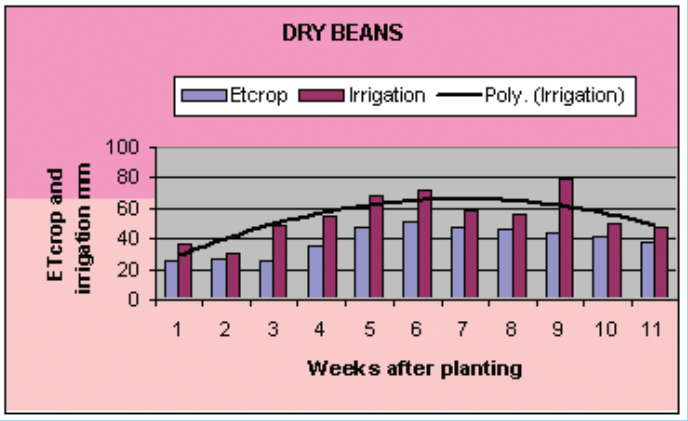
SAPWAT reflects directly the impact of the various crop production factors such as cultivar selection and planting date on weekly evapotranspiration (ETcrop), the blue columns in the graphs. This is the amount of water required by the crop for stress free production. This is to a large extent determined by climatic factors out of the control of the farmer.

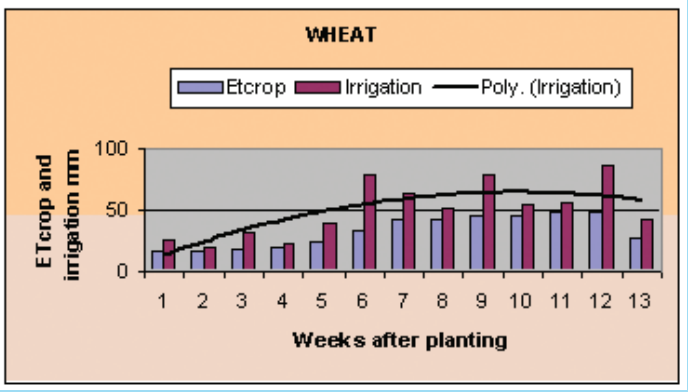
The dark red columns reflect weekly irrigation requirements and are influenced by the amount and frequency of irrigation applications and particularly by the water holding capacity of the soil profile.

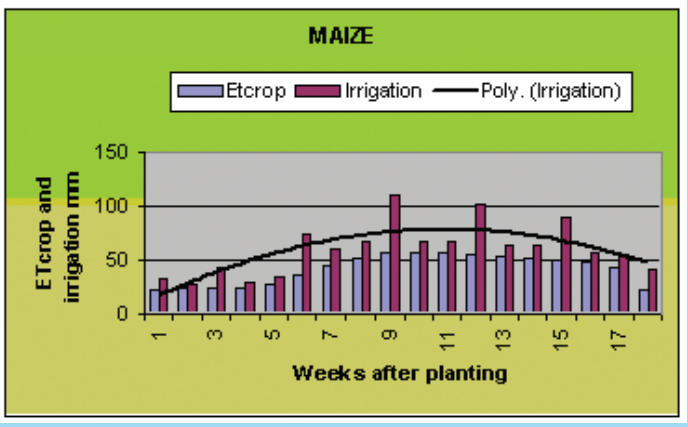
The graphs are based on the soil profile being refilled every three days to field capacity. The unexpected jumps in predicted weekly irrigations are largely caused by the three-day irrigation cycle not being in phase with a seven-day week! Estimates should be based on the black trend line that smooths these differences.

The simulations are conservative and do not take rain into account in this very dry area and the irrigation quantities are the amount of water pumped to the pivots, not "water on the ground".









THE AFFORDABILITY OF CENTRE PIVOTS

(Table and discussion based on data from *Cost Guide for crops produced under irrigation in the GWK area, June 2004.* Produsentedienste-GWK beperk.)

Crop	"Water factor" R/mm	Yield tons/ha	Gross margin R/50 ha	Irrigation Costs %	Irrigation Applied - mm
Wheat	4.31	6.50	142 050	13.8	660
Groundnuts	5.68	3.50	198 800	8.1	700
Cotton	5.97	5.00	253 550	10.3	850
Soya beans	7.00	3.50	193 250	17.8	550
Maize	7.96	12.0	299 250	14.2	750
Dry beans	8.04	3.00	181 000	8.1	450
Lucerne	9.13	22.0	593 600	25.4	1300
Sunflower	16.53	0.80	454 600	18.4	550
Potatoes	32.32	32.5	969 550	1.4	600
Onions	58.70	55.0	2 494 700	2.5	850
Cabbage	129.82	80.0	3 894 550	3.5	600

Crop gross margin is one indicator of the "affordability" of a pivot and is presented for a 50 ha pivot costing complete with pumps, piping mains and electricity supply some R700 000. The "irrigation costs" include only the cost of water and electricity. Affordability is very dependent on the crops grown.

This is a fascinating table. There is a world of difference between irrigating lucerne and onions although both can be produced profitably under pivot irrigation. Onions demand high-cost inputs and dedicated management to ensure quality, high yields and the safety of the crop and here the smaller automated pivots have advantages. They are proportionately more expensive than the large pivots but this will not be a consideration. Two 25 ha pivots would cost about 40% more then one 50 ha pivot.

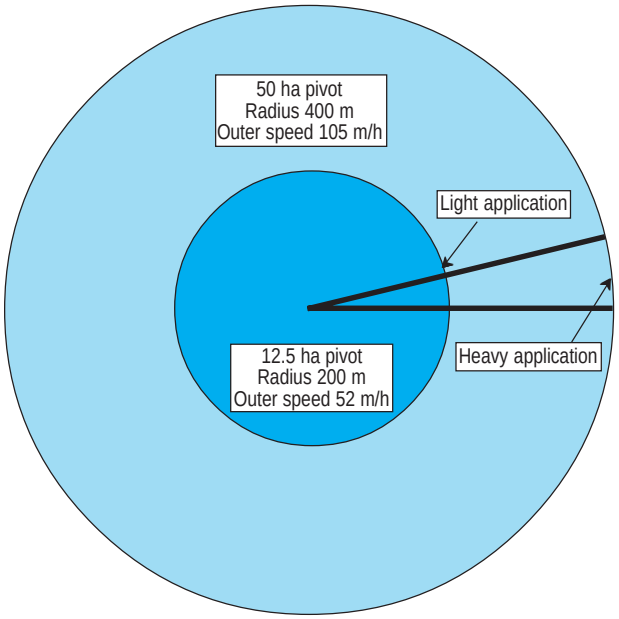
PIVOT IRRIGATION AND THE SOIL

When flood and hand-move sprinkler irrigation systems were the norm irrigation scheduling relationships were relatively straightforward. The objective was to replenish the water extracted by plant roots when the soil profile water content had reached the point where plants were starting to experience stress. The frequency of irrigation depended on how long it took the crop to extract the water from the profile and how much water could be stored. Typically this might be 60 mm so that if the evapotranspiration rate were 5 mm per day the irrigation cycle would be 12 days.

The introduction of the short cycle irrigation systems has greatly simplified management and made irrigation less dependent on soil depth and water holding capacity. It is even possible to work on a one-day cycle although this is not desirable. Each day the crop is given its daily water and, at times, fertiliser.

At Wilken Boerdery they are only too well aware of the need to improve the infiltration rate of the 50 ha pivots. Ploughing in a green manure crop helped but the next step is to fit spreaders and a double row of drop hoses and sprayers on the outer spans to improve infiltration by increasing the spray width. Once a higher rate of application has been confirmed SAPWAT will be applied to assess alternative strategies.

A centre pivot in common with all irrigation systems is required to apply water evenly over the full area of the field. The outer span of the pivot describes a circle while at the pivot there is no movement. The sprayer package is computer designed to compensate for this and the further out from the centre the higher the application rate. In many soils this limits the overall application to about 12 mm at each pass so that pivots are then designed to apply up to 12 mm per day. During peak periods this means that water must be applied at a rate of 12 mm per day, every day. This limits management options. Smaller pivots have the advantage of higher application rates.



REDUCING IRRIGATION PEAKS

One of the major problems occurring when the application rate is limited to 12 millimetres per day because of soil and pivot size constraints is coping with peak demand situations. An important strategy is to utilise the storage capacity of the profile to help cope with peaks. This technique has the additional advantage that management can be simplified by applying a constant volume of irrigation water every week throughout the major part of the growing season. If such a strategy is adopted it is important to physically check that the process is on track by having the water status of the profile checked weekly.

This method can only be effective if the profile is fairly deep and there is nothing to restrict root penetration. Usually the profile will be reasonably dry at the start of the season so that if more water is applied than would normally be required by the small plants it percolates down into the profile and is stored for later use by the maturing plant. At mid season the weekly irrigation application will be augmented from these deeper layers.

This strategy requires reasonably good water holding capacity in the soil profile but because water is being added continuously to the roots in the feeding zone the deeper water sources only come into the picture if the applications are inadequate. This reserve is not only of value if a breakdown should occur but because the peak demand has been reduced greater use can be made of the Ruraflex off-peak electricity tariffs.

Electricity is charged at prices that vary during the week for peak (20 h), standard (74 h) and low demand (Ruraflex) (74 h) periods. If the irrigation system follows normal practice in the area it will have the capacity to apply 12 mm in 24 h or 0.5 mm/h. This means that the system could provide 74x0.5 = 37mm/week at the low tariff (Ruraflex) rate. It is probable that during the peak period 60 mm/week would be required and the shortfall of 60-37 = 23 mm would have to be augmented by some 23/0.5 = 46 h of operation at standard tariffs. Should it be possible to even out the peak requirement by utilising the storage potential of the profile it might be feasible to reduce the need to pump during

standard hours to negligible volumes? The Ruraflex rates apply during the late hours of the night and over the weekend so that some degree of automated control would be desirable! The exploitation of Ruraflex rates appeals when water and electricity are a significant percentage of operational costs (lucerne) but are less significant in the case of the high value/high input crops.

WHAT OF THE FUTURE?

Louis Wilken has been an important role player in the development of the Orange Vaal WUA both as manager and subsequently as farmer and chairman. He has been responsible for innovative developments in water management and he knows irrigation farming in the area intimately.

He has now taken on the challenge of developing irrigated cash crop production in an area that has tended to use irrigation more for fodder production. The climate of Douglas and Schoombee has much in common as far as rain and evaporative demand is concerned but Schoombee is significantly colder and this influences crop selection, planting dates and season lengths. The soils tend to be moderately heavy and some areas are stoney.

One can see that he is following the approach of applying the improvement cycle he outlined earlier. He has given particular attention this past season to tillage (particularly seedbed preparation) and the acquisition of suitable implements for the area. Green manuring has been successful and pivots are being modified to promote better infiltration. Next in line for attention is scheduling based on the GWK Douglas model and it can be expected that there will be innovative developments in the near future. The future role of SAPWAT will be to quantify and facilitate the assessment of these developments on irrigation.

Louis Wilken is a SAPWAT practitioner and is familiar with its applications at Douglas. We are looking forward to further cooperation in the future and know this will contribute to the further development of SAPWAT.

DOMESTIC WATER FILTERS: ARE THEY NECESSARY in SA?

An increasing number of consumers are installing domestic water filters at home but scientists say South Africa's tap water is top quality

Viktor Schauberger, the Austrian forester who invented the technology to transport logs in water sluices, is quoted as saying that one day a good bottle of water would cost more than a good bottle of wine.

Schauberger worked in the ancient forests of Europe in the first half of the 20th century and, despite the apparent timelessness of this environment, he recognised water was being indiscriminately polluted. Today a "good bottle of water" is still within reach of the ordinary man's pocket but Schauberger makes a strong point – will clean drinking water eventually be so rare that it costs more than other bottled drinks?

CHEMICALS

The question an increasing number of consumers want answered is whether or not chemicals, like chlorine, added to water at municipal treatment facilities to produce potable water are helping or harming our health?

Is it safe to drink tap water or should we all install a domestic water filter in our home to remove the cancer-causing THMs present in chlorinated water?

THMs, by the way, stands for trihalomethanes which is a class of chemical compounds that occur when chlorine combines with organic matter in water.

All water that comes through municipal treatment plants have THMs present – chlorine is added as part of the disinfection process to kill the bacteria, viruses and parasites that cause water-borne diseases like cholera, gastro-enteritis, typhoid and dysentery.

Sue Freese, senior scientist: research and development for Umgeni Water in KwaZulu Natal says she drinks tap water, especially in the major urban centres, without hesitation.

"A non-smoker probably stands about a one in four chance of contracting cancer – the THMs in purified water are not going to make a difference."

Freese says these THMs increase the risk of cancer by only a fraction of a percent.

"You could say then that your chance of cancer increases to 3,9 (recurring)%. There is no documented proof that chlorinated water causes cancer." (Freese has made the point that the figures she is quoting are by way of example and are unsubstantiated). Much worse is smoking which doubles the risk of cancer.

"THMs are more of a health hazard when inhaled than when ingested from the water we drink," she says. Without chlorine in water the risk of dying from a water-borne disease is high. Freese quotes an example from Peru where, in the 1990s, officials were so afraid THMs would cause cancer that they stopped chlorinating water in some areas. "Within weeks 4000 people were dead from water-borne diseases."

WATER PURIFIER

Lyndal Diedericks, marketing representative for EVA Water Purifiers promoted and used by the holistic health company Nature's Technologies, only drinks water that comes through a domestic water purifier. She became interested in purifying tap water after her mother discovered higher than normal traces of lead in her blood caused by old plumbing in their Pretoria home. "I grew up on tap water but now that I understand the technology behind domestic water purifiers and

how they improve water I won't drink anything else."

Diedericks explains how, in the EVA filter, the water first passes through a ceramic filter that traps bacteria and parasites, after this a sterilising agent, built into the carbon filter, prevents water from re-polluting. Silica sand removes acidic components, while magnets ensure the water retains the free moving molecules of mineral spring water. Mineral stones impart 45 minerals into the water including germanium which improves the oxygen level in the water and is anti-carcinogenic. Silver activated carbon removes chlorine, organic chemicals and THMs while Zeolite removes heavy metals like lead and mercury. Mineral sand adjusts the pH of the water and finally silver impregnated coral stones ensure the water in the storage tank stays fresh indefinitely.

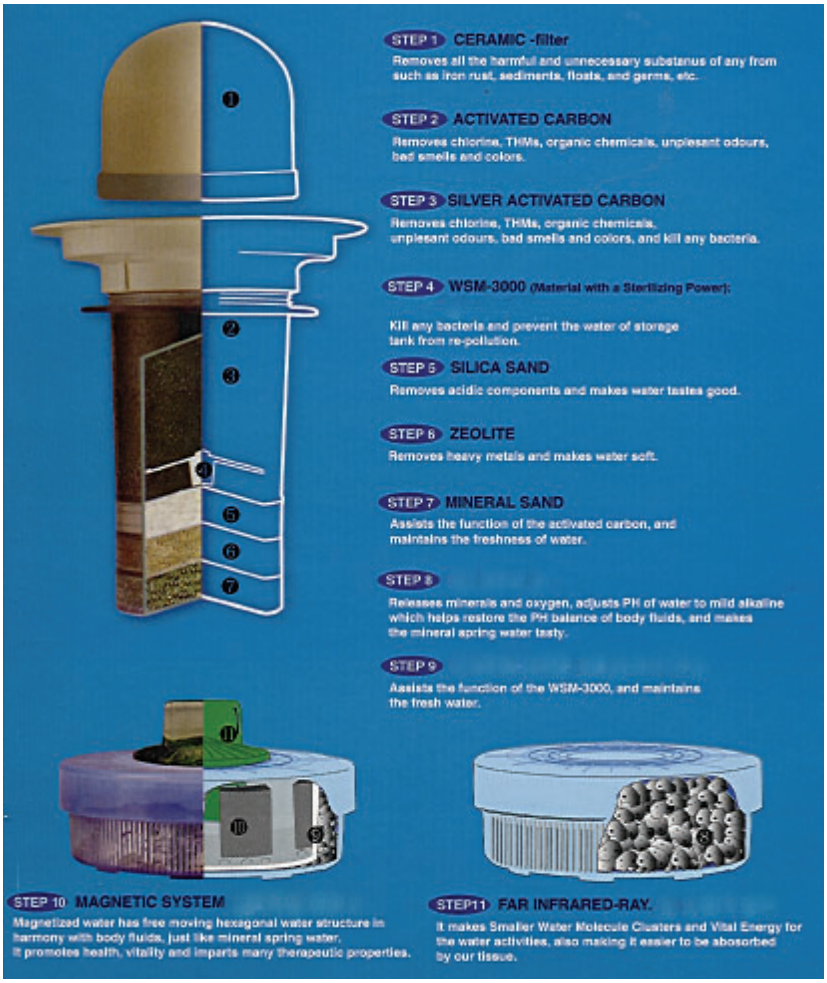
"At a demonstration in Sandton recently I was shocked to see how much chlorine had accumulated in the filter by the end of the presentation.

"It can't possibly be good for one to drink all those chemicals never mind the awful taste."

The non-chemical taste of domestically purified water is what keeps Diedericks, and most other domestic-water purifier users, coming back for more.

Sue Freese is not anti domestic water purifiers but, she points out, consumers should not be taken in by persuasive salesmen who don't have the scientific knowledge to explain how the product they are selling works.

"Many of these water filters need ongoing maintenance," she says, "if the filters are not properly and regularly cleaned bacteria accumulate and contaminate the water coming through the filter." This means that the tap water going into the filter can be safer than the water coming out of it."



The construction of a modern domestic water filter.

RAND WATER

Rand Water's Manager of Process Technology John Geldenhuys was commissioned by the Water Research Commission three years ago to investigate the feasibility and safety of domestic water purifiers. His conclusion was that water quality in South Africa's major urban centres is of the best in the world and does not need extra filtration. "Where I would consider using a filter is in some smaller communities where municipal water treatment is not up to standard." Take the case of one rural municipality where a dead baboon was found floating in the reservoir.

Geldenhuys says buying an off-the-shelf domestic water filter is a risk. "Before spending money on a product find out about the water in your area and then find a suitable purifier. Also a consumer must understand how to keep the purifier properly maintained and clean."

ACTIVATED CARBON

He explains that most domestic water purifiers contain activated carbon that absorbs organic compounds improving the taste and smell of water. However the acti-

vated carbon also neutralises the chlorine that kills bacteria, viruses and parasites.

"Activated carbon has a porous structure that allows it to harbour micro-organisms but, when it becomes saturated, these harmful compounds are released back into the water."

In one test, conducted by researchers for the WRC report, an office domestic water purifier, left to stand over a weekend, had to be flushed 10 times before the water was considered safe to drink. Sometimes the organic compounds absorbed by the activated carbon are displaced by other compounds that are more easily absorbed. "This means high concentrations of these compounds can be released back into the water without warning," says Geldenhuys, "and some of them could be dangerous."

Information made available to the Water Research Commission indicate that domestic water purifiers are being marketed aggressively in old age homes where salesmen promise the purified water can cure a range of ailments.

In a letter to the WRC Mr HP Beyers, a retired analytical chemist living in the Kokanje Retirement Resort near Modimolle (formerly Nylstroom) in the Limpopo Province wrote that he was concerned that "unscrupulous salesmen" promoting domestic water purifiers were targeting the elderly living in old age homes and retirement villages.

"I live in a retirement resort with about 800 elderly residents who because of their age invariably suffer from some malady. As a result, in desperation, some who attempt to find a cure become victims of these fortune seekers."

Geldenhuys' research made it clear: "Given that large water suppliers meet all accepted health criteria for water for domestic consumption and that the small amount of activated charcoal used in most home treatment devices is subject to saturation and breakthrough the shelf-life of these devices render them little more useful that placebos for the unduly concerned."

Domestic water purifiers are being marketed aggressively in old age homes where salesmen promise the purified water can cure a range of ailments

Lyndal Diedericks, spokesman from EVA, says it's wise for consumers to do their homework and understand the technicalities of a domestic water filter before making a purchase.

"We are selling a holistic, healthy way of living and find that the EVA purifier is the right product for what we want to achieve."

CLEAN WATER

For the public, confused as to what is best for one's health, it is worth looking at history to see how mankind has overcome the problem of sourcing clean drinking water. First were the Ancient Egyptians who developed an apparatus to remove solids suspended in the drinking water from the Nile. Nearly 1000 years later, in 500BC, Hippocrates, the father of modern medicine, realising something in water was making his patients ill, invented the Hippocrates Sleeve to strain rainwater for drinking. Not long afterwards the Romans began developing aqueducts to supply their homes with water and, by 300BC, the Greeks, Romans and Egyptians were using large settling cisterns to remove sedimentation from their water.

In the Dark Ages there was little scientific exploration and water purification was not considered a priority – as a result water-borne disease killed millions.

It was 200 years after Anton van Leeuwenhoek invented the microscope (in 1680) and Lu Antonio Porzio invented a multiple level water filter (1685) that scientists eventually put the two together and realised there was a link between what they were seeing under the microscope, water and health. Nevertheless by then Parisian Joseph Amy had already patented the first domestic water filter (1746) – a contraption made of sponge, charcoal and wood. Scottish factory owner John Gibb was the first person to develop a system to supply water to a whole town. He needed filtered water for his bleachery in Paisley and, within three years, his system was being used to pipe water to customers in the industrial centre of Glasgow. Modern water purification is a sophisticated science developed to protect the health of the entire population. While deadly chemicals are added to water to kill germs it is in carefully calculated doses that will not interfere with the general health of its users.

Says Geldenhuys: "Where I would consider additional treatment is in small communities where the local water treatment practises are possibly not up to standard. His conclusion is that generally water in this country complies with the South African National Standards (SANS) O241 specification and does not need additional purification. Cheers to the fact that in South Africa a good bottle of (tap) water is still cheaper than a bottle of wine!

New WRC Reports

REPORT NO 1217/2/04 A FLOOD NOWCASTING SYSTEM FOR THE ETHEKWINI METRO. VOL 2: MODELLING FLOOD INUNDATION IN THE MLAZI RIVER UNDER UNCERTAINTY

This project aimed, firstly, to pull together the outcome of previous research funded by the WRC in the areas of radar estimation of rainfall, space-time modelling and forecasting of rainfall, linear catchment modelling and river-flow modelling, and, secondly, to provide decision makers in Umgeni Water and Durban Metro (and eventually the Umgeni Catchment Management Authority) with the tools to be proactive rather than reactive in the context of flood warning. The components of the project are meteorological, hydrological and hydraulic. As a result of the project, people living near rivers now have both the potential for receiving warnings about impending floods and the knowledge that the Disaster Management Group is working towards mitigating floods in their area. Furthermore, with the new flood forecasting capability, 6 to 12 hour warning of an impending flood will enable industries to evacuate staff and perform controlled shut downs or take steps to reduce the damage to sensitive plants.

REPORT NO 998/1/04 MODELLING OF RECTANGULAR SEDIMENTATION TANKS

This project sough to evaluate the suitability of computational fluid dynamics (CFD) as a technique for design and research of rectangular sedimentation tanks; design CFD models for simulation of sedimentation tanks; validate the models with experimental data; use CFD to investigate the effects of design parameters and operational parameters and to make recommendations for improved design and operation of sedimentation tanks. It was found that CFD does provide a useful tool for modelling of sedimentation tanks. It can be used to calculate flow patterns of the water in the tanks, as well as the effect of various parameters on it. It cannot, however, be used as a routine tool by simply any operator. At present CFD is still a qualitative rather than quantitative tool for this specific application. It is necessary to develop better mathematical descriptions or measurements of these parameters and incorporate them in the CFD models in order to obtain better quantitative results.

REPORT NO 1274/1/04 LEAST COST PLANNING (LCP) FOR THE WATER SERVICES SECTOR IN SOUTH AFRICA

This project aimed at exploring LCP in general and its application in the water sector; comparing LCP with other planning approaches and exploring an algorithm for LCP in the water services sector through a hypothetical example. The aims of the study were achieved through tracing the history of LCP and the adoption of a definition which was applicable to the water services sector of South Africa. Lessons were drawn from the various sections. Although some experience from the energy sector is transferable to the water sector, certain aspects of water supply are dramatically different from energy supply. Unlike electricity, natural gas and transportation utilities, which have regional transmission networks, regional water systems are constrained by the limited application of economies of scale. The study developed an algorithm that demonstrates the effectiveness of LCP and recommends that the algorithm be tested through a "real life" case study with various stakeholders. The linkage with further research should be encouraged and the LCP approach should be communicated to as many interested parties as possible.

REPORT NO 1155/1/04 DEVELOPMENT AND EVALUATION OF AN INSTALLED HYDROLOGICAL MODELLING SYSTEM (IHMS)

The IHMS developed in this study was set to be generic for South African catchments and to involve the building up of national, regional and local hydrological data sets. The national quaternary catchments database was refined and linked to the ACRU model to develop the framework of the IHMS. The developed IHMS was then applied to case study catchments: Mkomazi and Thukela. The case study simulations involved detailed model simulations which looked at a number of catchment characteristics, some of which had never received attention before. The project produced a detailed national hydrological data and information system coupled to the first Windows-based ACRU model. The ACRUView: A model output visualisation and statistical package for model post-processing, was one important development that took place in this study. This project also generated a reasonably supported electronic model user support system which is likely to improve model use and the quality of outputs to be generated.

REPORT NO 1238/1/04 HYDROGEOLOGY OF FRACTURED-ROCK AQUIFERS AND RELATED ECOSYSTEMS WITHIN THE QOQODALA DOLERITE RING AND STILL COMPLEX, GREAT KEI CATCHMENT, EASTERN CAPE

Research has shown that the dolerite ring structures, which are prominent features in the landscape of the Karoo and Eastern Cape, are potentially fruitful drilling targets for groundwater exploitation. Continuation of this research in the Eastern Cape has thrown light on the dependency of ecosystems, springs and seepages on fractured-rock aquifers related to these dolerite rings, and their vulnerability to groundwater abstraction. A large part of the population of the Eastern Cape is dependent on springs and seeps for their water supplies. The research required a multidisciplinary approach involving structural geology, hydrostratigraphy, spring census, geomorphology, wetland and biosystems mapping, and extensive use of spatial analysis and remote sensing. In addition, a total of 12 exploration boreholes, drilled by DWAF across the SW rim of the Qoqodala dolerite ring, were needed to fine-tune a conceptual model of the ring system. The saucer-shaped intrusion contains three aquifers: shallow, unconfined; medium-depth, semi-confined; and, deep, confined. Because of the shape of the intrusion, the upper unconfined aquifer is very vulnerable to deep drilling, which would create artificial connections between aquifers. The location of wetlands or seeps at low elevation, the direction and density of fracturing, the slope of the inclined sheet, and the shape of the intrusion are factors that must be taken into account when developing groundwater from dolerite rings.

REPORT NO 1230/1/04 EVALUATION OF NANOFILTRATION FOR THE TREATMENT OF RURAL GROUNDWATER FOR POTABLE WATER USE

Many groundwater sources in the North-West Province cannot be used for potable purposes because of the saline quality of these sources – especially regarding ni-

SOUTHERN AFRICA & AFRICA 2005

WATER LAWS
JANUARY 26 – 28

An international workshop on African water laws with the theme "Plural legislative frameworks for rural water management in Africa" will be held in Gauteng. Objectives: A comparison of ongoing national policy and legal reform in Africa and their impacts on small-scale rural water development, use and management. Case studies on the impact of statutory and customary arrangements on communities' water development, use and management in particular by the poor. General and site-specific recommendations and guidelines for water management and legal pluralism.
Enquiries: http://www.unesco.org/water/water events /Detailed/819.shtml

RIVER BASINS
MARCH 7 – 9

The East African integrated river basin management conference will be held in Morogoro, Tanzania.
Enquiries: Henry F Mahoo, Soil-Water Management Research Group, Sokoine University of Agriculture, PO Box 3003, Morogoro, Tanzania. Tel: +255 (023) 260 1206. Fax: +255 (023) 260 4649.
E-mail: hmahoo@suanet.ac.tz

GROUND WATER
MARCH 7 – 9

The 2005 biennial ground water conference – "Ground Water: Stretching your Vision" will be held at the CSIR Conference Centre in Pretoria.
Enquiries: The Secretariat (Conference Planners), PO Box 82, Irene 0062. Tel: 012 667 3681. Fax: 012 667 3680.
E-mail: confplan@iafrica.com
Web: www.gwd.org.za

MEMBRANES
MARCH 14 – 15

The 6th WISA Membrane Technical Division (MTD) workshop will take place at an Eastern Cape resort.
Enquiries: Ms Marshall Solomon, Department of Chemical Engineering, Cape Technikon, PO Box 652, Cape Town 8000. Tel: 072 4853171. Fax: 021 460 3282.
E-mail: marshall@ctech.ac.za

WATER AFRICA
MARCH 16 – 18

Water Africa 2005 Sub-Sahara trade show and exhibition will be staged in Dar es Salaam, Tanzania together with a seminar programme in conjunction with the Ministry of Water & Livestock Development.
Enquiries: Jacqui Hepworth, ACE Event Management, Johannesburg.
Tel/Fax: 011 705 1648. Cell: 083 626 5882.
E-mail: jhepworth@mweb.co.za
Web: www.ace-events.com

DESALINATION
MARCH 17 – 20

A desalination technologies conference will be held in Sharm El-Sheikh, Egypt.
Enquiries: Prof Magdy Abou Rayan.
Tel/Fax: 203 5920641.
E-mail: mrayan@mans.edu.eg

SANITATION
MAY 23 – 27

The third international conference on ecological sanitation – EcoSan 2005 – will be held in Durban.
Enquiries: Conference Administrator, Betty Snodgrass, CSIR Building and Construction Technology, PO Box 395, Pretoria 0001.
Tel: 012 841 2566. Fax: 012 841 3400.
E-mail: bsnodgra@csir.co.za

WASTEWATER TREATMENT
AUGUSTUS 9 – 12

A conference on the "Sustainable management of residues emanating from water and wastewater treatment" will be held at the Sandton Convention Centre in Johannesburg.
Enquiries: Dr Heidi Snyman at e-mail: hsnyman@golder.co.za

HYDROLOGY
SEPTEMBER 5 – 7

The 12th SANCIAHS symposium with the theme "Managing water for people and the environment" will be held at the Eskom Convention Centre in Midrand.
Enquiries: Lesley Stephenson, PO Box 327 Wits 2050. Tel (011) 717 7031.
Fax: (011) 339-7835.
E-mail: stephensonl@ebe.wits.ac.za

HEALTH
SEPTEMBER 13 – 15

A regional conference on water, health and the environment will be held in Tanta, Egypt.
Enquiries: Dr Bakenaz A Zeydan, Head of the Water Engineering Dept, Tanta University, PO Box 31521, Tanta, Egypt.
Cell: +201 228 32379. Fax: +2040 331 5860.
E-mail: bakenaz@ewra.com

2006

CAMEX
MAY 8 – 12

An international conference on the application of meteorological extremes (CAMEX) will be held in South Africa in 2006. (A conference website with more information becomes operational in January 2005.)
Enquiries: Dr Willem Landman, Long-Range Forecasting Group, South African Weather Service, Private Bag X097, Pretoria 0001.
Tel: (012) 367 6003. Cell: 082 644 5304.
Fax: (012) 367 6189.
E-mail: willem@weathersa.co.za

OVERSEAS 2005

PURE WATER
MARCH 1 – 2

The 6th China summit on high-purity water treatment and recycling technology will be held in Shanghai, China.
Enquiries: Ms Cynthia Yeo.
Tel: +65 6346 9132.
Fax: +65 6345 5928.
E-mail: Cynthia@cmtsp.com.sq
Web: www.cmtevents.com

URBAN WATER
MARCH 14 – 18

A conference on the efficient use and management of urban water supply will be held in Santiago, Chile.
Enquiries: Francisco Cubillo – Scientific Committee Chairman.
E-mail: scientific@efficient2005.com
Web: http://www.efficient2005.com
or in South Africa – Mr Johannes Buckle (Rand Water).
Tel: 011 682 0814.

WATER RESOURCES
APRIL 11 – 13

The third international conference on water resources management will be held in Algarve, Portugal. The conference will present the most recent technological and scientific developments associated with the management of surface and sub-surface water.
Enquiries: Conference Secretariat: Amy D'Arcy-Burt. Wessex Institute of Technology, Ashurst Lodge, Ashurst, Southampton, SO40 7AA.
Tel: 44 (0) 238 029 3223.
Fax: 44 (0) 238 029 2853.
E-mail: adarcy-burt@wessex.ac.uk

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