SA waterbulletin

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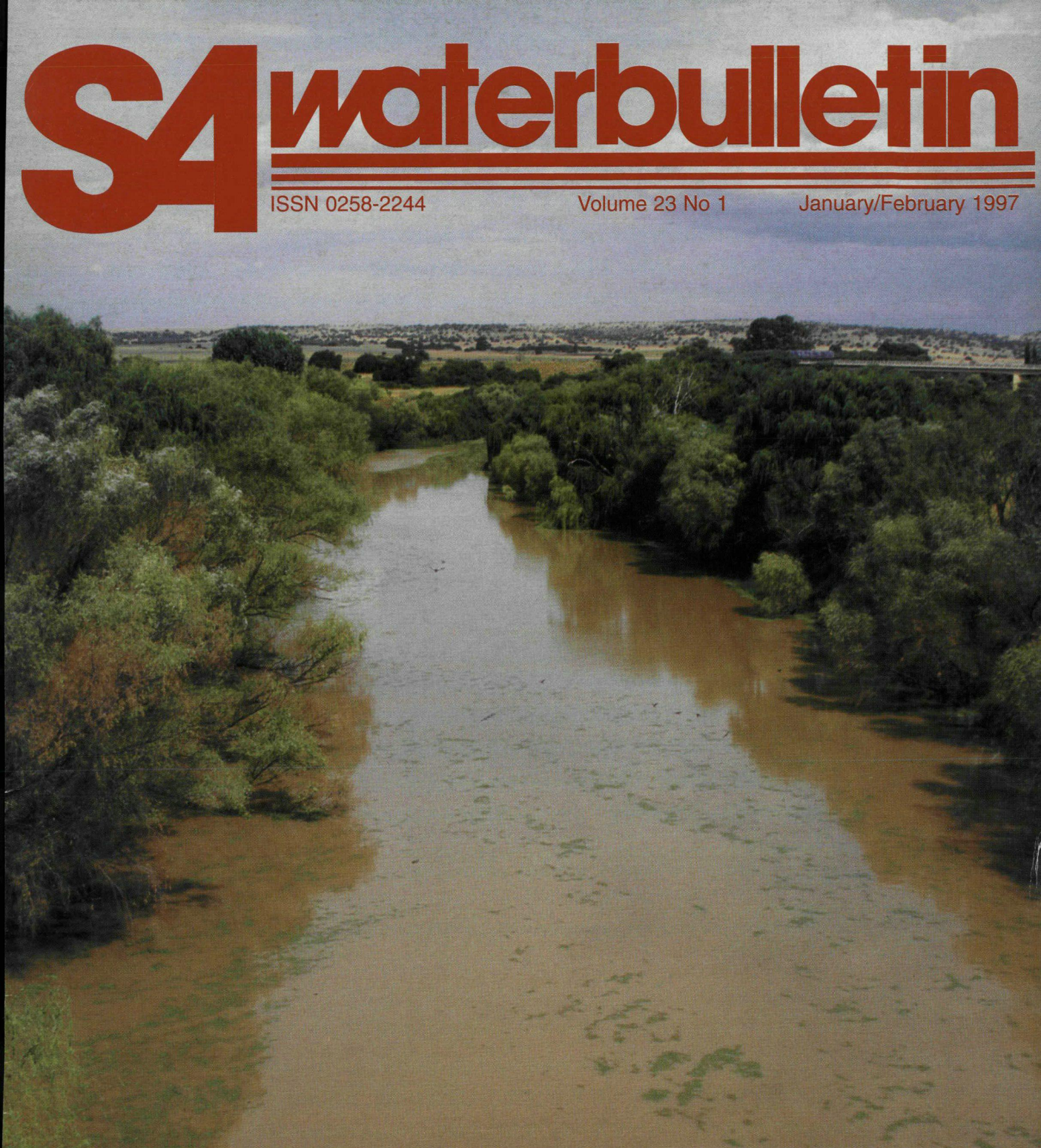

MINE WATER
New manual on water management available from WRC

BESPROEIING
Beleidsvoorstelle gepubliseer

HYDROLOGY
Researchers investigate water quality of lower Vet River

SANCIAHS/SAICE CONFERENCE '97

17 - 19 November 1997 ▼ Conference Centre ▼ ***University of Pretoria.***

Theme

Integrated hydrological sciences for sustainable water resources management in Africa.

Objectives

The need to recognize the holism of the hydrological cycle and to achieve sustainable development of water resources through integrated management (quantity and quality, all water, the water environment, catchments etc.) have become key principles in the South African water law review. This poses major challenges to hydrologists in terms of a more integrated approach towards their science in research and application.

The Conference will focus on improved understanding of the hydrological cycle and the application of this understanding towards sustainable development of our limited water resources. Of particular interest will be:

- ❑ the hydrological regime in different geographical settings (understanding and quantification);
- ❑ geographical and spatial characterization of water resources;
- ❑ hydrological networks (design, adequacy, integration, results);
- ❑ methods of water resources assessment;
- ❑ approaches to deal with uncertainty and heterogeneity;
- ❑ integration of research and decision making;
- ❑ international river basins; information requirements.

We need to refocus our research and development on the range of knowledge and information requirements for sustainable development, eg. for:

- resource assessment at different scales;
- water allocation for competing uses;
- water use control;
- catchment management;
- community water supply;
- water resource protection;
- water resource enhancement;
- environmental impact assessment; and
- conjunctive use.

Water supply and sustainable development of scarce water resources are at the top of the political agenda of many African countries. It is essential that the hydrological sciences are focused on this need and that African countries share their expertise in this regard.

Organisers

The Eighth Biennial SANCIAHS Conference will be organized jointly by SANCIAHS and the Water Division of the South African Institute of Civil Engineers. Mr Hugo Maaren of SANCIAHS and Prof Faan van Vuuren of SAICE will be on the organising committee.

Conference format

The Conference will only have plenerary sessions (no parallel sessions) to allow for integration across disciplinary fields. Presentation of posters will be strongly encouraged in order to cover the full spectrum of the hydrological sciences.

A series of courses will be run back to back with the Conference. Ideas are invited from SANCIAHS or SAICE members who would like to present a course.

A single key note address and about 40 papers will be presented during $2^1/_2$ days (Monday - Wednesday morning).

Paper deadlines

- ❑ Deadline for abstracts:
  30 April 1997
- ❑ Final papers (in electronic format):
  15 September 1997

Cost

- ❑ Registration fee:
  Approximately R500.00
  (excluding accommodation)

Enquiries to:

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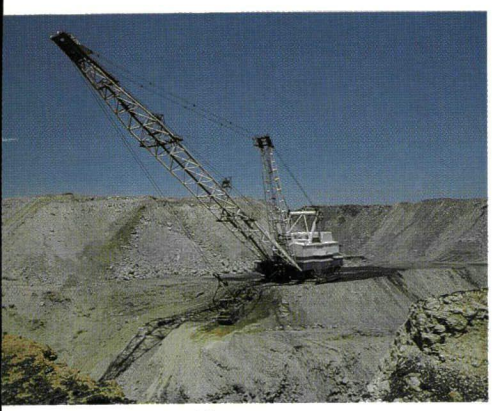

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Cover: A view of the Vet River in the Free State. (Photo: Jan du Plessis).

SA Waterbulletin is a two monthly magazine on water and water research published by the South African Water Research Commission (WRC), a statutory organisation established in 1971 by Act of Parliament. Subscription is free. Material in this publication does not necessarily reflect the considered opinions of the members of the WRC, and may be copied with acknowledgement of source. Editorial offices: Water Research Commission, PO Box 824, Pretoria 0001, Republic of South Africa. Tel (012) 330-0340. Fax (012) 331-2565. Editor: Jan du Plessis (E-mail: Jan@wrc.ccwr.ac.za). Asst Editor: Helene Joubert (E-mail: Helene@wrc.ccwr.ac.za). Ed Secretary: Rina Human (E-mail: Rina@wrc.ccwr.ac.za). Layout: Chilli Design 082 578-7257. Colour Separations: Montage Repro. Printing: Beria Printers.

Report on the IRC International Water and Sanitation Workshop

Since the early 1980s the importance of improved drinking water supplies, sanitation and health education have received increasing attention globally. However, a growing world population, rapid urbanisation, increasing agricultural and industrial production, coupled with erratic changes in climatic patterns have led to the awareness that water is a limited resource. Inefficient water use, ground and surface water pollution and conflicts surrounding water allocation abound. In the past, drinking water supply and sanitation projects gave little attention to these kinds of problems. It is clear that many issues relating to improved water resources management need to be tackled urgently and that existing sector based approaches should evolve towards integrated water resources management.

In response to these developments the IRC International Water and Sanitation Centre, an independent, non-profit organisation in the Netherlands, together with the United Nations Development Programme, initiated a project to evaluate "golden rules" or principles for effective water resources management by assessing and documenting practical international experiences. The underlying aim of the project is therefore to contribute to improvements in international water resource management practices.

A preliminary workshop was held in the Netherlands from 20 to 29 November 1996 which was attended by fifteen international participants in the project and facilitated by Peter Bury, David Saunders and Esther de Langer of IRC. Two of the promising approaches in water resource management were selected from South Africa, namely:

- The Tonga Water Supply Project, a collaborative project between the Department of Water Affairs and Forestry and the Mvula Trust to improve the water supply to eleven communities along the Nkomazi basin in the Mpumalanga Province; and
- The Mgeni Catchment Management Plan, a collaborative project between Umgeni water and the Department of Water Affairs and Forestry which develops a framework for integrated water resources management of the Mgeni catchment in KwaZulu-Natal.

Mr Cecil Chibi, the technical manager (water) at Mvula Trust, and Dr John Howard, the water quality manager at Umgeni Water attended the workshop together with participants from India, Cambodia, Guatemala, Colombia, Nepal, Ghana and Zambia. An advisory group supported the project. This included Mr Gerrit van Vuren of the Department of Irrigation and Soil and Water Conservation at Wageningen, the Netherlands; Mr Dinesh Pyakural, the Director-General of Water Supply and Sewerage in Nepal and Professor Jan Ludqvist of the Department of water and Environment Studies at the University of Linköping, Sweden.

KEY PRINCIPLES

The key principles for effective water resources management were distilled from important international meetings including the 1977 Mar del Plata conference, the 1990 New Delhi conference, the 1991 Nordic Freshwater Initiative and the 1992 United Nations conference on environment and development at Rio de Janeiro (Agenda 21).

At the workshop, these principles were evaluated and leading questions and indicators were jointly developed to assist participants to evaluate their projects. These are listed below. The first principle has been expanded upon to provide an example of how the leading questions and indicators were finally developed at the workshop for each of the principles.

Principle 1: Water source and catchment conservation and protection are essential.

Examples of leading questions and indicators:

- Has water source and catchment protection been identified as a need presently or in the longer term? Why, by whom, when, how?
- Are catchment areas negatively influenced by any activities? Is there a marked reduction in flow volume or water levels over recent years? Are floods occurring more frequently? Is there a marked deterioration of the water quality? (chemical and microbiological quality, increase in the cost of water treatment, etc.)
- What are the threats to water source and catchment area protection?
- What protection activities are being undertaken and by whom? (eg. livestock control, afforestation, land management). Is the percentage of degraded land increasing? Percentage increase of livestock; Percentage increase in irrigated areas/irrigation permits; Population growth in the catchment area.

Participants at the IRC workshop. Cecil Chibi and Dr John Howard are second and third from right.

Principle 2: Adequate water allocation needs to be agreed upon between stakeholders within a national framework.

Principle 3: Efficient water use is essential and often an important water source.

Principle 4: Management needs to be taken care of at the lowest appropriate level.

Principle 5: The involvement of all stakeholders is required.

Principle 6: Striking a gender balance is needed as activities relate to different roles of men and women.

Principle 7: Skills development and capacity building are the key to sustainability.

Principle 8: Water is treated as having an economic and social value.

THE WAY AHEAD

The participants will use the leading principles and indicators to get answers to:

- ❑ Evaluate the extent to which their project adheres to the eight formulated principles.
- ❑ Overview the processes of change taking place with regard to water resources management in their countries.
- ❑ Overview the lessons learnt (successes, mistakes and weaknesses) of their project appraisals.

A synthesis and feedback session is scheduled to take place in Holland at the end of June 1997 where participants will present the results of their evaluation. This meeting is to draw general conclusions about the applicability of the above principles, highlighting important problem areas and bottlenecks, and to identify the most promising practices and experiences. This information will be documented and widely disseminated.

CONCLUSIONS

Increasing water demands, reductions in water yield and deteriorating water quality are amongst the most pressing environmental issues facing the people of many countries, particularly those which are semi-arid such as South Africa. These issues are partly symptoms of the failure of traditional functional water management approaches. Integrated water resources and catchment management are guiding principles of the current water law review process in South Africa and indications are that in future water resource managers will adopt a more holistic approach to water management. This project establishes a draft framework of principles for effective water resources management and attempts to review these principles against practical international experiences. It is hoped that the results of this investigation will assist us in moving towards the ultimate objective of more effective global water resources management.

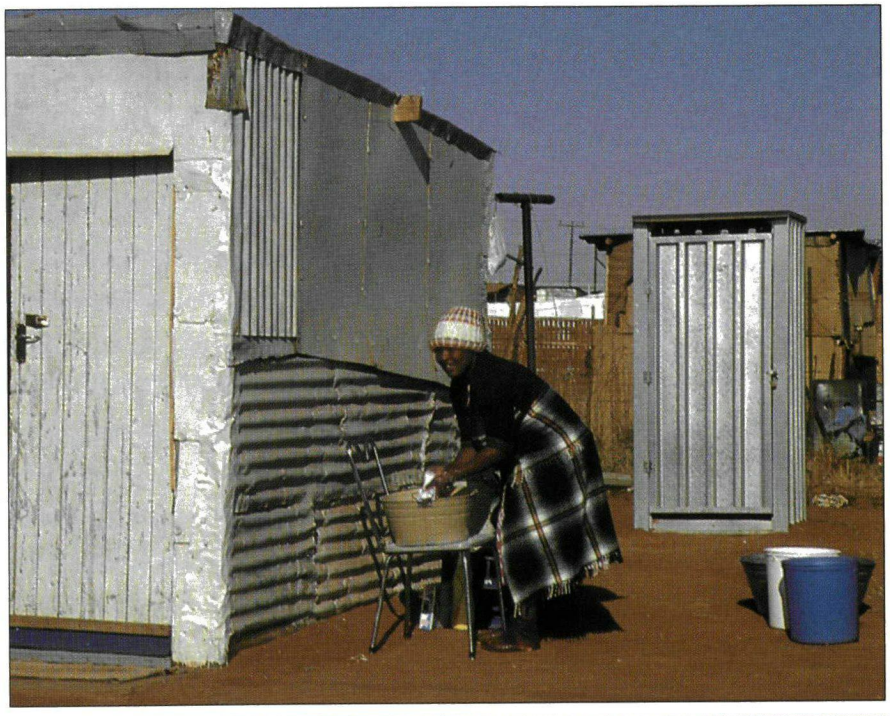
Water supply and sanitation research

with an impact on development

The Co-ordinating Committee for Research on Water Supply and Sanitation in Developing Rural and Urban Communities (CCRUC) identified the following priority research fields and topics, categorised according to three user groups.

Priorities are indicated as follows:

A = High priority
B = Normal priority
C = Low priority



GOVERNMENT USER GROUP

The government user group represents the interests of government, hence the research topics relate to policy, institutional structures, regulation, subsidy issues and so on.

1. **Regulatory and monitoring framework for service agencies. (A)**
   The research in this field will assist the government in regulating, supporting and monitoring activities of service agencies.

2. **Institutional structure for rural water supply and sanitation. (A)**

3. **Information System. (A)**
   In order to improve planning and delivery, there is an urgent need for information relating to water and sanitation, including statistics such as access to services, status of existing schemes and consumption patterns.

4. **Macro-economic and strategic issues relating to water and waste services (A)**
   Water has an impact on the economy and the need for it is also driven by economic factors. There is a need for research on economic impact of fiscal allocations to water and waste services, macro-economic constraints on water and waste expenditure. Pricing water resources for urban and rural water supplies is another urgent research need.

5. **Financing rural water supply and sanitation (A)**

6. **Education and training (A)**
   The highest priority research needs here include the following:
   - Establishing a strategy for bringing water and waste themes into the school education curriculum.
   - Development of an approach to educate the general public on water and waste issues.
   - Training programmes for practitioners at various levels of basic service provision/delivery.

7. **Water quality guidelines (B)**

8. **Implementation management (C)**

USER GROUP: RURAL SERVICE AGENCIES

This user group represents a wide variety of organisations involved in the provision of water and waste services to the rural areas. The research needs for this group include a better understanding of attitude and perceptions of the communities that are served, as well as the research needs of consultants and contractors in rural areas.

1. Attitudes of communities to water and waste issues (A)

2. Rural local authorities : institutional and management issues (A)

The research needs under this topic include the following:

- ❑ Rapid capacity building approaches.
- ❑ Arrangement for water and waste services to schools and clinics.
- ❑ Appropriate organisational structure and staffing levels.

3. Financing rural water supply and sanitation (A)

Within the framework of national finance policy in this field, rural water supply agencies will need an understanding of how to run their financial affairs. Research needs include the following:

- ❑ Viability of district authorities or water boards as service agencies.
- ❑ Cost recovery arrangements including prepayment metering.
- ❑ Studies on willingness to pay for different services.

4. User participation (A)

- ❑ Guidelines for structuring community participation in project planning, implementation and management.
- ❑ Mechanisms for dealing with illegal water connections and water theft.

5. Health issues (B)

Impact of access to water and sanitation on health/hygiene.

6. Gender issues (B)

- ❑ Impact of lack of basic services on women.
- ❑ Involving women in decision making regarding water and waste.

7. Planning (B)

- ❑ Approaches to prioritising provision of services to various communities in a district.
- ❑ Overall settlement planning.

8. Accounting for water (B)

- ❑ Consumption patterns in rural areas.

9. Sanitation (B)

- ❑ Methods for marketing sanitation.
- ❑ Guidelines for technology selection and for specific technology options.

10. Project implementation (C)

11. Water supply technology (C)

- ❑ Innovative technologies.

12. Solid waste (C)

13. Environment (C)

USER GROUP : URBAN SERVICE AGENCIES (MUNICIPALITIES)

This user group includes municipalities and private sector organisations who are service providers. The group will consider research needs of urban communities and project implementers.

1. Institutional and management issues (A)

- ❑ Private sector participation.
- ❑ Methods and options for staff training and upgrading.
- ❑ Reporting procedures.

2. Finance issues (A)

- ❑ Tariff setting procedures.
- ❑ Options for raising finance.
- ❑ Investment planning.

3. Storm water (A)

- ❑ Design of storm water systems for low income areas.
- ❑ Maintaining urban run-off water quality standards.

4. Sanitation and waste water (A)

- ❑ Innovative sanitation systems.

5. Socio-economic issues (B)

- ❑ Determining needs and demands for service, taking into account economic needs and associated development.

6. Water supply (B)

- ❑ Water demand management.
- ❑ Accounting for water and water loss control.

7. Municipal solid waste (B)

- ❑ Management of solid waste collection systems.
- ❑ Recycling, composting and reduction options.

8. Project implementation (B)

- ❑ Achieving a balance between participation and delivery.
- ❑ Costing methodology.

Enquiries to:

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Water Research Commission.

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SUBMISSION OF RESEARCH PROPOSALS TO THE WATER RESEARCH COMMISSION (WRC)

Voorlegging van navorsingsvoorstelle aan die Waternavorsingskommissie (WNK)

Soos in die verlede rig die WNK weer 'n uitnodiging aan navorsingsinstansies om met die oog op finansiering van die navorsing vanaf 1998, voorstelle vir waternavorsingsprojekte by die WNK in te dien. Volledige gedetailleerde navorsingsvoorstelle moet die WNK voor 30 April 1997 bereik.

LET ASSEBLIEF DAAROP DAT LAAT INDIENINGS ONDER GEEN OMSTANDIGHEDE AANVAAR SAL WORD NIE.

Vir die afgelope drie jaar word die indiening van voorleggings in 'n elektroniese formaat, deur die WNK aangemoedig. 'n Voorleggingsvorm op rekenaardisket word vanaf die middel van Januarie 1997 vir hierdie doel beskikbaar gestel. 'n Positiewe reaksie op die elektroniese indiening van voorleggings is weer eens hierdie jaar ontvang en dit het die evaluering van navorsingsvoorstelle grootliks vergemaklik.

Verseker asseblief dat u die opgedateerde weergawe van die 1997 sagteware gebruik wanneer u navorsingsvoorstelle indien. Die sagteware is ongelukkig slegs beskikbaar vir WINDOWS. Navorsingsorganisasies wat nie toegang tot WINDOWS het nie, moet asseblief hulle voorstelle in WordPerfect of MS WORD indien, in ooreenstemming met die WNK se gids: "Riglyne vir die opstelling van navorsingsvoorstelle". Hierdie Gids is op aanvraag vanaf die WNK verkrygbaar.

Alle voorstelle sal gesamentlik na 30 April 1997 oorweeg word. Indien nodig, sal die betrokke WNK-navorsingsbestuurder na die sluitingsdatum met die indiener van die voorstel in verbinding tree ten einde onduidelikhede op te klaar en die voorstel af te rond. Uiteindelik sal hierdie finale voorlegging tydens 'n vergadering van die Kommissie oorweeg en 'n aanbeveling oor die finansiering daarvan aan die Minister van Waterwese en Bosbou gemaak word. Instansies wat navorsingsvoorstelle indien, moet asseblief daarop let dat die voorstelle gedurende die evalueringsproses voor 'n koördinerende komitee van kundiges op dié gebied, ter tafel gelê sal word.

Navorsers in die waterveld word aangemoedig om moontlike navorsingsvoorleggings met die WNK se navorsingsbestuurders te bespreek alvorens dit aan die WNK voorgelê word.

Vroeë indiening van navorsingsvoorstelle sal verwelkom word.

As is customary, the WRC is again extending an invitation to research organisations to submit water research proposals to the WRC with a view to funding thereof during 1998. Comprehensively detailed research proposals must reach the WRC by 30 April 1997.

PLEASE NOTE THAT UNDER NO CIRCUMSTANCES WILL LATE SUBMISSIONS BE ACCEPTED.

Over the past three years the WRC has encouraged the submission of research proposals in an electronic format. For this purpose, a computer disk containing a pre-compiled submission form will be made available on request, from mid-January 1997. A positive response to the submission of proposals in an electronic format was again received this year, greatly aiding the evaluation of research submissions.

You are cordially requested to ensure that all submissions made are using the updated 1997 version of the software, which is available for WINDOWS only. Those research organisations who do not have access to WINDOWS should submit their proposals in WordPerfect or MS WORD in accordance with the WRC document, "Guidelines for compiling research proposals". The document is available on request from the WRC for the information of and use by research organisations.

All proposals received will be considered jointly after 30 April 1997. Following this date, if necessary, the WRC research manager concerned will liaise with the proposer of a project in order to clarify any vagueness that may exist in the proposal, and to finalise it. The finalised proposal will then be considered at a meeting of the Commission and a recommendation will be made to the Minister of Water Affairs and Forestry regarding the funding thereof. Those submitting research proposals should note that during the evaluation process, proposals may be tabled before a coordinating committee comprising experts in that particular field.

Researchers in the water field are encouraged to discuss potential research proposals with the WRC's research managers prior to submission.

Early submission of research proposals will be welcomed.

Co-ordinating Committee for Water Ecosystems Research (CCWER)

STRATEGIC RESEARCH PLAN

The aquatic ecosystem has been recognised as a resource base. Development of water resources generally impacts negatively on the ecosystem. As a result, the need has arisen to promote the rational marshalling of scientific resources to achieve the sustainable utilisation, rational management and desired future state of these aquatic ecosystems. This also stresses the need for optimum use of existing and new information through the initiation of relevant studies and effective information and technology transfer.

Based on the above, in conjunction with the mission of the Water Research Commission (WRC), the WRC constituted the Co-ordinating Committee for Water Ecosystems Research.

Mission Statement of the Water Research Commission

To contribute effectively to the best possible quality of life for the people of South Africa, by promoting water research and the application of research findings.

Therefore, the WRC endeavours dynamically and purposefully to:

- Promote co-ordination, communication and co-operation in the field of water research
- Establish water research needs and priorities
- Fund water research on a priority basis
- Promote effective transfer of information and technology

The Co-ordinating Committee for Water Ecosystems Research (CCWER)

The brief of the CCWER is, within the context of the overall WRC mission, to identify and prioritise, in consultation with the research and resource management communities, national research needs for aquatic ecosystems, bearing in mind South Africa's commitment to the international conventions to which it is a signatory.

Mission Statement

The mission of the CCWER is:

To co-ordinate the generation, synthesis and transfer of information on the natural environment of inland water systems so as to optimise the management of water resources in the interests of all different sectors of water users.

Functions

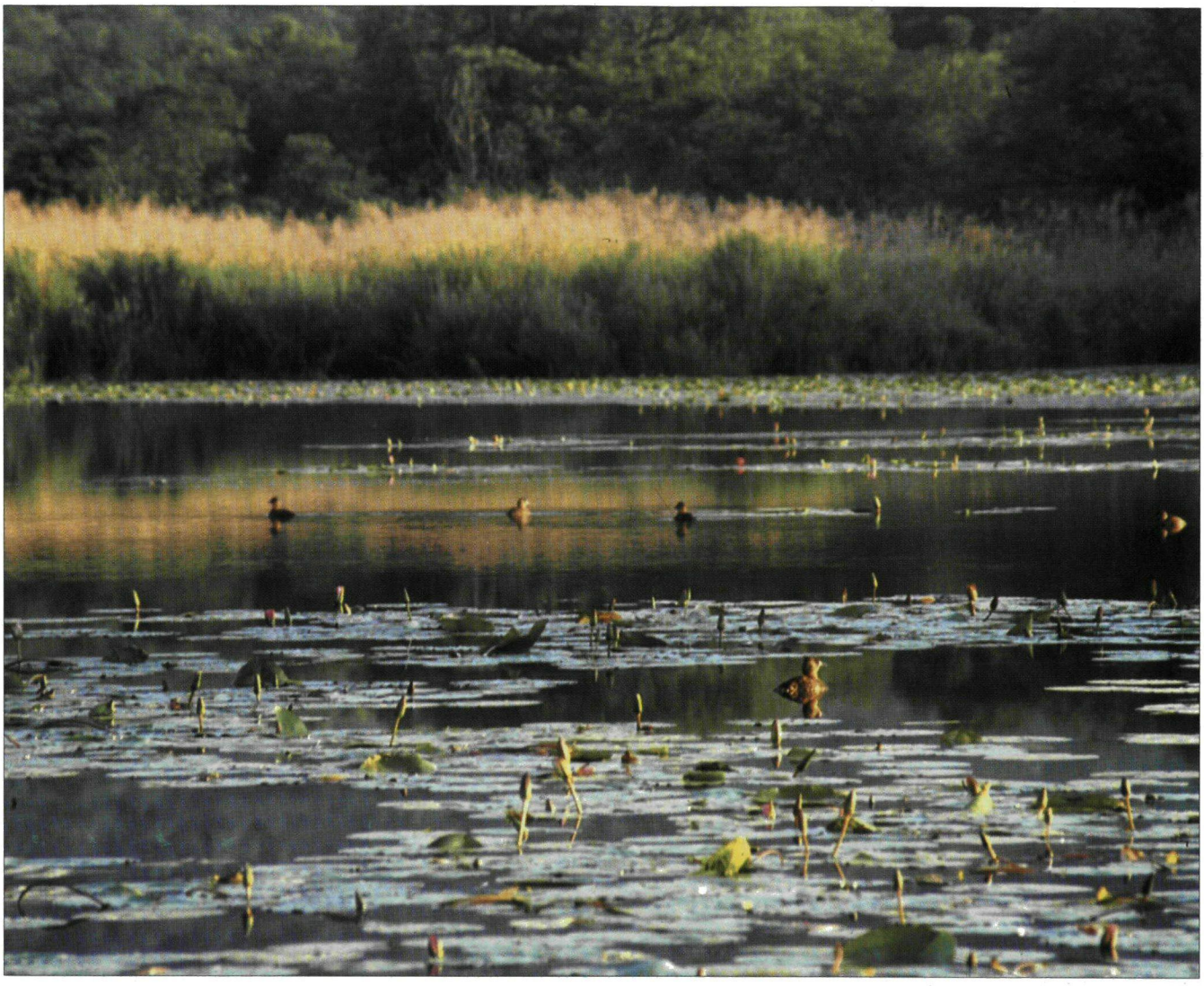
The primary functions of the CCWER are:

- to identify management and user priorities for research and development;
- encourage co-ordinated and complimentary research in priority fields;
- identify unnecessary duplication of research; and
- to foster communication and liaison within and between the management and research communities.

Responsibilities and authority of the CCWER

The committee will have no executive authority and will thus function solely in an advisory capacity to both the research and policy making communities. It will report annually through the chair to the WRC.

Following are goals and objectives which form the framework for establishing research priorities for the natural environment of inland water systems:



CCWER Strategic Research Plan Goals

Primary Goal 1: Ecosystem Research

To develop an understanding of the structure, functioning and resilience of the natural environment[1] of inland water systems[2] that is relevant for optimising the management of water resources and the anthropogenic effects thereon.

Secondary Goals

1.1 Develop predictive models of the response of aquatic ecosystems to changes in catchment management practices.

1.2 Identify and gather the information on the key components, including species, communities and processes, and their functioning and variability over time which is required to improve the predictive capabilities of the models.

1.3 Develop or use/adapt existing information management and exchange systems within the research community to support and enhance our understanding of the structure and functioning of the natural environment of inland water ecosystems.

1.4 Develop an understanding of the ecological relationship between groundwater and surface water.

For more information about this research plan, please contact: Dr S A Mitchell, Research Manager at the Water Research Commission. Tel: (012) 330-0340. Fax: (012) 331-2565.

1 The natural environment is defined, in this instance, as the natural aquatic environment and those processes that impinge on it.
2 Inland water systems include streams, rivers, marshes,swamps, pans, mires, estuaries, lakes, impoundments and canals.

Primary Goal 2: Conservation

To establish and monitor the ecological character, conservation status and importance of inland water systems (both lotic and lentic waters) to optimise their management under natural or modified regimes.

Secondary Goals

2.1 Develop classifications of inland water ecosystems so that existing information on one system can be applied to similar systems (types of classification eg. ecological, hydrological, geomorphological, water quality and quantity, degree of impairment, user priorities).

2.2 Develop methods of predicting and assessing the change in conservation status of inland water ecosystems.

2.3 Develop methods for assessing the effect of disturbance[3] on the conservation status of inland water ecosystems.

2.4 Develop practical methods for the long term monitoring of the status and variability of inland water systems.

2.5 Develop tools for water quality management (eg ecotoxicology, biomonitoring).

2.6 Develop an historical (recorded or longer where possible) perspective on the status and variability of inland water systems.

2.7 Develop methods for the assessment of the management importance of different systems for different types of users.

2.8 Develop methods for the mitigation and restoration of the effects of anthropogenic disturbances.

2.9 Develop methods for differentiating between the impacts of natural and anthropogenic disturbances.

2.10 Develop, synthesise and update inventories of species and community composition of inland water ecosystems and their responses to anthropogenic disturbances (eg bridges, dams, etc.).

Primary Goal 3: Information Synthesis

To synthesise and interpret information for the specific purpose of promoting co-ordination, communication and co-operation in the management of inland water ecosystems.

Secondary Goals

3.1 Synthesise information required for Integrated Catchment Management.

3.2 Produce and revise research priorities/guidelines (eg. Noble and Hemens, 1978) for the natural environment of inland water ecosystems.

3.3 Encourage the use of, and the incorporation of new data into, existing databases.

3.4 Promote the compatibility of methods of information generation, storage and dissemination, between researchers, managers and users.

3.5 Synthesise and assess information on effluents.

Primary Goal 4: Information and Technology Transfer

To establish methods for the successful transfer of information on the natural environment of inland water ecosystems through iteration, practice and feedback, for their sustainable management.

Secondary Goals

4.1 Promote the joint participation of researchers, managers and users (including the public) at appropriate levels of ecosystem research, planning and development.

4.2 Develop and refine decision support systems[4] which will contribute to the optimal management of ecosystems.

4.3 Integrate the results of individual research projects in order to ascertain and meet the needs of ecosystem management.

4.4 Facilitate interaction, communication and trust between researchers, managers, users and policy makers.

Primary Goal 5: Socio-economic Principle

To develop an understanding of the socio-economic principles which are required to optimise the management of the natural environment of inland water ecosystems.

Secondary Goals

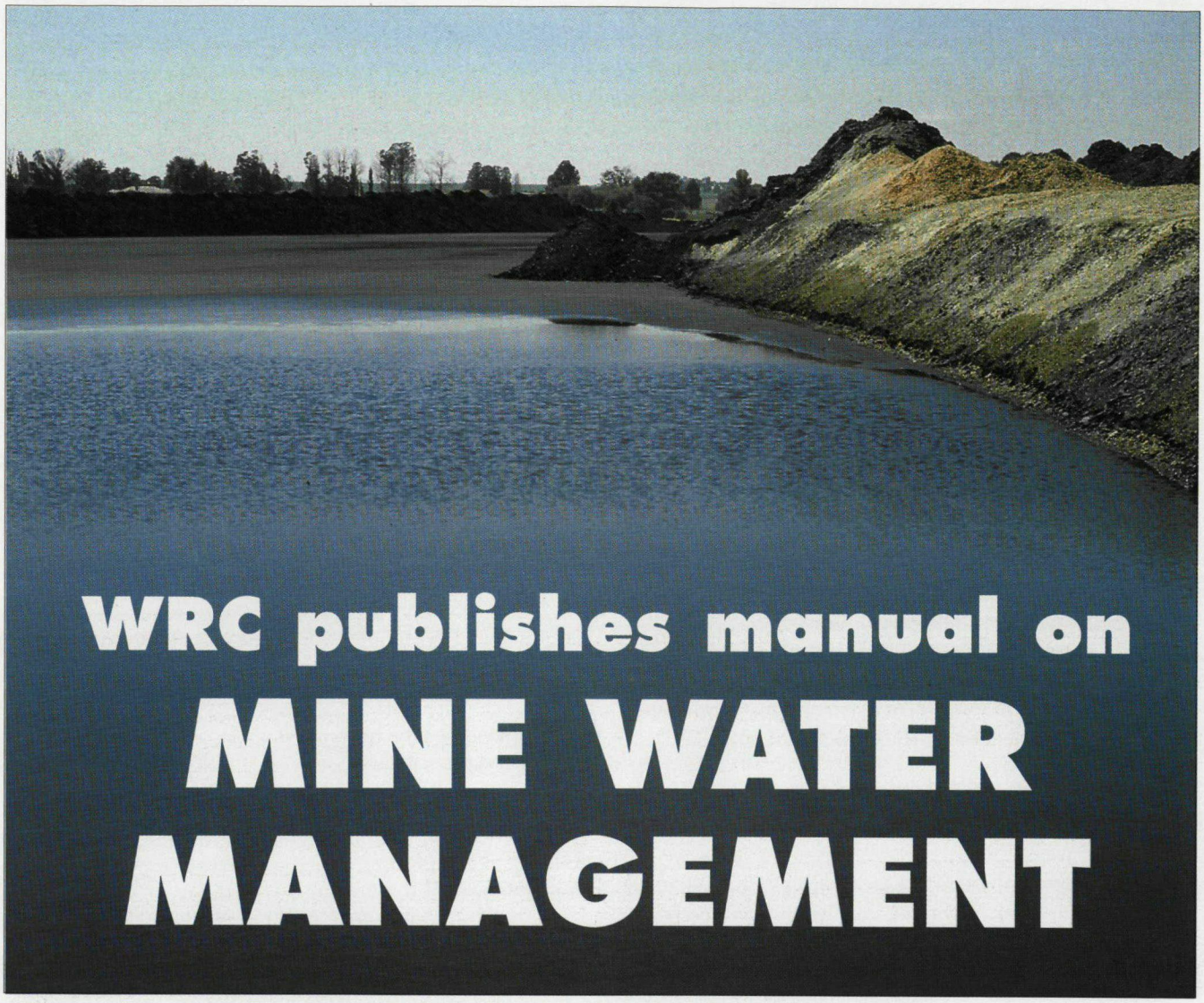
5.1 To forge and foster links with appropriate experts and institutions in the field.

5.2 Improve economic well-being of people through sustainable conservation and allocation of natural and environmental resources.

5.3 Determine the functional and economic values of inland water systems.

5.4 Ascertain methods to set objectives for sustainable management (economic, social, ecological) of the ecosystem.

3 Disturbance includes natural and anthropogenic disturbance.
4 Decision Support Systems are designed using available and appropriate information, technology and wisdom to assist in making the best possible decisions.



WRC publishes manual on MINE WATER MANAGEMENT

The results of a project aimed at defining the current water management and treatment practices and developments in the South African gold and coal mining industries have been published by the Water Research Commission in Pretoria.

The publication is structured along the lines of a manual, and not a research report, to make the information more practical, easily accessible and useful to the end users, which will include mine management, mine engineering staff, mine water management practitioners and specialists, say the researchers, W Pulles, D Howie, D Otto and J Easton from the firm Pulles Howard & De Lange Inc and the Chamber of Mines of South Africa (Environmental Management Services).

The publication consists of the main report, the Manual (WRC Report TT 80/96) for all users, as well as **five appendices** for mine water management practitioners and specialists, namely, Report 527/1/96 (Literature Reviews), Report 527/2/96 (Coal Mine Visits), Report 527/3/96 (Gold Mine Visits), Report 527/4/96 (Overseas Study Tour) and Report 527/5/96 (WRC Research Projects).

Copies of the reports are sold in South Africa by the Water Research Commission, PO Box 824, Pretoria 0001, at **R114.00 per set** (manual plus five appendices). The price includes sales tax and postage. (Overseas price: US$ 60 per set, inclusive of surface mail).

The South African mining industry is made up of a large number of independent mines covering a vast geographical area. The different mining sectors (gold and coal), as well as individual mines within each sector, experience different water management problems in terms of both quality and quantity. Some mines experience problems with large inflows of fissure water, which may be of a good or poor quality depending on the mine location, while other mines have little or no fissure water ingress. Some mines experience severe problems with the generation of sulphuric acid in the underground water systems while other mines have little or no acid problems.

Over the last number of years, the mines have applied a number of different water management strategies which are aimed at reducing their fresh water intake, reducing the volumes of effluent discharged to the environment, minimising the deterioration in water quality in the mine circuits and treating the water to the required level for reuse or discharge.

The recent introduction of the Environmental Management Programme Report (EMPR) as the vehicle for environmental and water management on the mines has also resulted in major advances in the understanding of water management issues on the mines. One of the fundamental issues embodied in the EMPR is that the mines should be applying the Best Available Technology Not Entailing Excessive Cost (BATNEEC) in their water management programmes.

The researchers say for this study 17 coal mines and 12 gold mines were assessed in terms of their water management and treatment practices. In addition, 21 operational and defunct gold, coal and base metal mines were visited in Australia, the USA, Canada and the United Kingdom and visits were made to 12 research organisations, consultants and environmental regulatory authorities in these same countries.

RESULTS

The results of the investigation are very broad in scope and are not easily summarised. However, in terms of the main contaminants which need to be removed and the main water management issues which apply at South African coal and gold mines, the researchers say certain summary statements can be made.

❑ Acidity

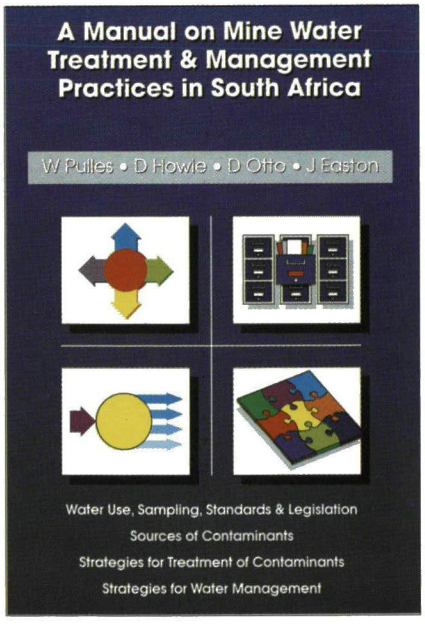
The standard neutralisation practice in South African mines, both on surface and underground, is the addition of chemicals (predominantly slaked or unslaked lime), in a poorly or manually controlled manner.

❑ Arsenic

The standard practice in the mines is to apply no treatment for arsenic removal - essentially because arsenic is not considered a problem.

❑ Calcium and Magnesium

The standard practice is to apply anti-scalants to condenser circuits and to apply ion exchange/demineralisation for boiler feed water. With the exception of Gold Fields' mines which use soda ash as a neutralising agent, no treatment is undertaken for calcium and magnesium removal in mine service water circuits - other than dilution with fresh make-up water.



❑ Chloride and Sodium

The standard practice is to apply no treatment for the removal of chloride or sodium. Waters high in these contaminants and which cannot be discharged are generally evaporated.

❑ Cyanide

The standard practice in South African mines is to apply the ferrous sulphate process to immobilise cyanide in backfill. No chemical oxidation or cyanide recovery is practised. Natural degradation is applied at one mine. Normally waters containing elevated levels of cyanide are not discharged.

❑ Fluoride

The standard practice is to apply no treatment for the removal of fluoride. Fluoride is only a potential problem at certain of the coal mines.

❑ Iron and Manganese

The standard practice is to apply no treatment for the removal of iron and manganese. There appears to be one exception, ERPM gold mine, which applies lime precipitation in the form of the High Density Sludge (HDS) process.

❑ Metals

The standard practice in the mines is to apply no treatment specifically for the removal of metals. However, the neutralisation of effluents to pH 7 or thereabouts, will result in the removal of a certain amount of metals. ERPM gold mine which applies lime precipitation in the form of the High Density Sludge (HDS) process will obtain even greater removal of heavy metals.

❑ Micro-organisms

The standard practice in South African mines is to apply chlorine disinfection for underground circuits, although chlorine/bromine programmes are rapidly superseding straight chlorine programmes. For sewage works, chlorine disinfection programmes are most common, although in certain instances, maturation ponds are being used.

❑ Nitrogen Compounds

The standard practice is to apply no treatment for the removal or management of nitrogen compounds.

❑ Phosphate

The standard practice is to do no phosphate removal from the sewage effluents.

❑ Radionuclides

The standard practice is to apply no treatment for the removal of radionuclides from mine water. There is, however, one gold mine which applies a weekly lime precipitation treatment with the specific purpose of removing radionuclides. At least one mining group, with high levels of uranium in its water circuits, has a policy of applying tight pH control (pH 7-8) at its under-

ground settlers with the purpose of precipitating the uranium nuclides. In practice, however, most mines are not capable of applying tight pH control at their underground settlers.

❑ **Sulphate**

The standard practice is to apply no treatment for the removal of sulphates. Where effluent problems are experienced, the most common practice is evaporation on tailings dams and/or in evaporation dams. The rehabilitation of residue deposits and opencast coal mines is a strategy which is universally practised. This practice has, as one of its objectives, the reduction in the production of acid mine drainage (and sulphate).

❑ **Suspended Solids**

The standard practice in South African gold mines is to apply flocculation and settling to spent mine service water in the underground settling installations, followed by separate pumping circuits for clear water and mud. These settlers are typically poorly operated and are often inappropriately designed to deal with flow and quality fluctuations experienced underground. In isolated cases, the settled water is filtered in sand filters (typically on surface) before being reused. In some mines, the mud removed in the underground settlers is filtered to produce a cake which is then hoisted, rather than pumped, out of the mine. For surface water circuits, the prime source of suspended solids is the tailings from the reduction works and these solids are deposited in tailings dams with the drainage water being returned to the reduction plant.

In coal mines, gravity separation is used in the coal beneficiation process and the fine solids are removed in slurry dams, with the drainage water being reused within the beneficiation plants. Filtration is not typically applied in coal mine water circuits.

❑ **Water and Salt Balances**

Mines have been preparing water balances for permit purposes for the Department of Water Affairs and Forestry for many years. These balances are generally inaccurate and based on estimates and assumptions. In terms of the EMPR requirements, mines have recently prepared more detailed and accurate water and salt balances. Generally, however, these balances still contain estimates and assumptions due to the historical lack of proper monitoring systems (particularly with regard to flow measurement) and are not being used properly for management purposes. In many cases, once the EMPR has been prepared, the water and salt balances remain the same and are not updated to keep them useful. There is a general lack of understanding of the utility of water and salt balances for water management purposes.

❑ **Stormwater Management**

The standard practice on South African mines varies considerably from mine to mine although all of them do apply at least certain elements of stormwater control, particularly at those sites, such as active residue deposits, where the most polluted runoff occurs. However, many mines do not apply the fundamental principles of keeping clean and dirty water separate and preventing clean water from becoming contaminated. Although most mines will capture the most polluted runoff, this is often diluted with clean runoff water.

❑ **Residue Deposits**

Residue deposits can generally be considered to be one of the most important sources of diffuse water pollution from the mining industry. In the coal mining industry, many of the older residue deposits were badly sited and constructed and considerable effort is being expended at present to upgrade and rehabilitate these facilities. However, in many cases, the pollution resulting from ongoing seepage cannot be stopped and pollution collection and treatment systems will be required. These residue deposits also contribute significantly to the pollution problems at old defunct mines where the State has pollution control responsibility.

In the gold mining industry, the problems experienced with residue deposits is perhaps more severe in that these facilities cover vast areas and that many were constructed in totally inappropriate areas from a water management viewpoint. Many of these facilities are still in operation today and continue to present major problems with regard to ground and surface water pollution. Defunct operations, particularly on the Witwatersrand, also contribute substantially to pollution of the regional water resources.

Current practice at gold mines today is to institute seepage and runoff control measures as far as possible. Most return water dams supply water back to the reduction works for reuse, although a number of these dams are incapable of dealing with the input flow and regularly overflow to surface water courses.

❑ **Underground Water Management**

The most common practice in the mines is neither to attempt to separate clean and dirty water nor to prevent clean water from becoming contaminated - all water entering the underground workings is simply collected and routed to the underground settlers - most typically by gravity drains along the footwalls. Typically, no flow balancing is carried out. There are one or two exceptions where an attempt is made to separate the major flows of clean fissure water and to keep them from becoming contaminated. Some mines do pump their spent service water to the settlers, while at least one mine has underground dirty water flow balancing dams.

In the underground coal mines, the general practice appears to be to allow the water to drain to the natural low points from where it is either pumped to surface or reused underground. No major attempt appears to be made to prevent water from becoming contaminated by intercepting clean water and pumping it directly out of the mine.

❑ **Water Reclamation**

Water reclamation is applied to varying degrees at different mines and for different water circuits. In general, however, the gold and coal mines still exhibit enormous potential for improving their water reclamation strategies and, at the some time, reducing their effluent discharges and fresh water intakes. Most mines do not appear to understand the negative effects which poor water quality may have on their processes and few, if any, user fitness-for-use requirements have been set.

❑ **Monitoring and Instrumentation**

The standard practice at many South African mines in the past was fairly poor with regard to water quality and flow monitoring and many mines have almost no historical records. A number of the mines, however, have had fairly detailed water quality monitoring programmes in place for many years, although water flow records are almost universally inadequate.

The emergence of the EMPR and its

In the last few years many mines, particularly in coal mining areas, have or are developing management strategies to protect groundwater resources.

inherent need to determine impacts and to monitor impacts and the effect of management strategies has resulted in a major review of monitoring programmes at almost all the mines, to the point where fairly intensive and comprehensive monitoring systems are being implemented.

One of the most important deficiencies in the use of instrumentation in mines is with regard to the monitoring and control of water treatment installations - particularly those located underground in the gold mines. The vast majority of the pH control installations where lime or soda ash is being dosed upstream of the underground settlers, have no pH monitoring or control equipment installed. Incorrect concepts of pH control abound and, as a result, attempts are made to dose neutralising chemicals from declining head dosing tanks, with no consideration of changing pH or flowrate. The same applies to the control of flocculant dosing and settler desludging and, as a result many settlers operate very inefficiently and have to cope with pH values of between 3 and 12.

❑ Ground Water

Most South African mines, till recently, had a very limited knowledge and understanding of the local and regional ground water systems and the impact of their mining operations thereon. This situation was particularly true for most of the gold mines, whereas many of the coal mines, by having a more direct impact on the shallow aquifers, had a better understanding of their impact thereon. There are exceptions on both sides and their are a number of gold mines, particularly those in the dolomites, who have a long and detailed understanding of their impact on the aquifers, while there are also various coal mines who have not paid adequate attention to their impacts on ground water.

This situation has changed quite dramatically in the last few years, particularly in the coal mining areas, with the arrival of the EMPR many mines already have or are developing fairly detailed groundwater models and management strategies for the protection of the groundwater resources.

❑ River Diversions

A number of the opencast coal mines in the Mpumalanga have undertaken river diversions in order to mine through the watercourse, the most recent and well publicised example of which is Optimum Colliery. Extensive river diversions and canals have been constructed in the West Rand from Randfontein through to Carletonville in order to divert the rivers over and around the sinkhole areas.

The Water Research Commission has financed a study to evaluate the surface water salinity status of the Lower Vet River catchment in the Free State. Researchers also had to identify the main factors affecting water quality in the catchment.

Wat of th River

The major water quality management goal of the Department of Water Affairs and Forestry is to maintain fitness for use of South Africa's water resources on a sustained basis. Attainment of this management goal requires the setting of source water quality objectives. A water quality situation analysis is the first step in the process of setting these objectives.

The Department is in the process of setting water quality objectives for water sources on a prioritised basis. Owing to the water quality problems being experienced, the lower Vet River catchment was given a high priority and selected as one of the first sources for the setting of water quality objectives.

STUDY

The main focus of the study, carried out by CE Herold, WV Pitman, AK Bailey and I Taviv, all from Stewart Scott Inc consulting engineers, was on that portion of the catchment influenced by pollution sources in the Goldfields mining area. The water quality situation analysis was confined to the study of Total Dissolved Salts (TDS) and its main inorganic constituents in the surface water.

Only data available up to the end of September 1992 was included in the analysis. Hence subsequent changes in the water quality status will not be reflected.

The main findings of the study are discussed under the report chapter headings in the following sections.

WATER USE (Chapter 2)

There is a high degree of inter-dependence between the different water users in the Free State Goldfields region. The following is an overview of water use and water balances in the study area.

Water supply

The main water suppliers are the Sand-Vet Government Water Scheme (GWS), which draws water from Allemanskraal and Erfenis Dams, and Goldfields Water, which draws most of its raw water from the Vaal River. A number of towns abstract water from local water sources.

The Sand-Vet GWS provides water mostly for irrigation use, part of which is supplied by canals and part directly from the lower Vet River. It is only the latter part that could be affected by pollution emanating from the Free State Goldfields area.

Of the towns supplied from the Sand-Vet river system, only Hoopstad, adjacent to the lower Vet River, is likely to be affected by pollution sources in the Goldfields region.

The main crops irrigated from the Sand-Vet system are wheat, maize, fodder crops, potatoes, other vegetables, ground-nuts and sunflowers.

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e lower Vet
nvestigated

Several contradictions and deficiencies were found in the water use data for the Sand-Vet GWS. The most serious of these is apparently the large under-estimation of the actual irrigation supply from the canals.

Effluent discharge

Most of the purified sewage effluent generated in the study area is either re-used by local mines or used to irrigate parks, gardens and sports fields. Until recently most of the remainder was disposed of in natural pans. At present only Joel, Beatrix and Oryx mines and Welkom's new Thabong STW make significant direct contributions to the runoff from the Goldfields study area.

Water balances

The water balance for the main water users in the Goldfields region is very complex, with water being transferred between several mines, municipalities and storage facilities. Unfortunately the water balance data provided by the different organisations is often contradictory. The water balances for individual pans and evaporation ponds are generally deficient.

PROVISIONAL WATER QUALITY USER REQUIREMENTS (Chapter 3)

The main findings with regard to water quality user requirements are as follows:

- Those water users most likely to be affected by activities taking place in the Goldfields mining area are the town of Hoopstad, riparian irrigation farmers along the lower Vet River and farmers using water from polluted local rivers for livestock watering.

- Water quality were derived from requirements of different user categories based on the S.A. Water Quality Guidelines, taking account of information obtained regarding local conditions and specific water uses within each category.

- The S.A. Water Quality Guidelines for nature conservation had not yet been released at the time when this investigation was carried out. Nor were the Free State Nature Conservation able to come up with any water quality user requirements. As an interim measure the S.A. Water Quality Guidelines for aquaculture were used to approximate the needs of fish life. Other literature sources were also drawn upon to provide interim user requirements for the natural environment.

- The provisional water quality user requirements for the lower Sand and Vet Rivers and the Goldfields area are summarised in the report.

POLLUTION SOURCES (Chapter 4)

- Groundwater pollution: Pollution sources in the Goldfields region have led to salinisation of the groundwater over a large area.

- Surface water pollution: A number of natural rivers and streams, pans and wetlands in the region have suffered severe salinisation. Affected rivers include: Sand River, Mahemspruit, Doring River, Theronspruit, Bosluisspruit, probably the Rietspruit and possibly the Merriespruit (the water quality data is too sparse to make definite statements about the latter two streams). The following pans are also salinised: Dankbaar, Riet, Wolwe, Stuurmans, Doring, Blesbok, Toronto,

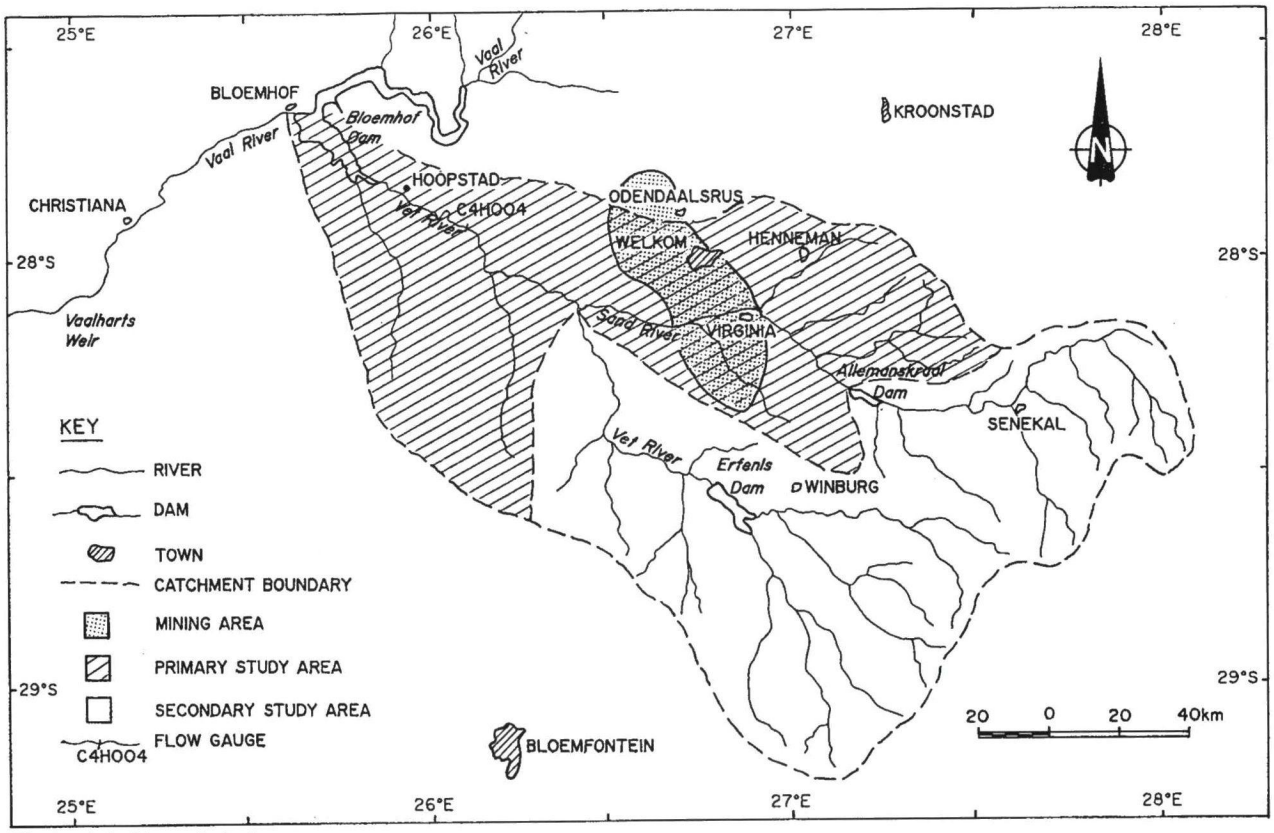


Figure 1.1: Map of study area

Flamingo, Wit, Swart.

- Nature of pollution: The most dominant ions present in the polluted river water are chloride, sodium and sulphate.

- Salinisation of the Sand River. In the case of the Sand River the median electrical conductivity (EC) was found to increase seven-fold, from 30 mS/m to 216 mS/m from east to west across the mining area. Median chloride concentrations increased twenty-fold from 18 to 390 mg/*l*.

- Mining pollution: Gold mining in the Goldfields area was identified as the main cause of the salinisation of the ground-water, pans and rivers.

- Industrial pollution: The wetland system near Blesbokpan was seriously polluted by yeast effluent from a factory, which was later closed.

- Municipal pollution: Other than that disposed of in Witpan and discharged to the Sand River Canal from the new Theronia STW, there is little sewage effluent that is not re-used within the Goldfields area. Witpan also suffers occasional pollution episodes due to contaminated storm water.

- Effect of irrigation: Irrigation from the Sand-Vet GWS appears to add little to the salinisation of the river system. On the contrary, it plays an important beneficial role in diluting the pollution in the lower Sand and Vet rivers.

- Solid waste sites: Municipal solid waste sites do not appear to have a significant effect on surface water quality. Groundwater contamination also seems to be confined to areas close to the sites.

- Nutrients: Nitrate, ammonia and phosphate concentrations in the Sand River are elevated throughout the area affected by mining and urbanisation. This holds the potential for eutrophication of slow moving portions of the river, such as in the pool backed up by Virginia weir. It is difficult to identify any one source of the nutrients, since they can originate from municipal, industrial and agricultural activities, all of which are closely inter-twined in the study area.

ASSESSMENT OF MONITORING SYSTEMS (Chapter 5)

The catchment monitoring system was found to be deficient in a number of respects:

- Insufficient coverage of catchment: Portions of the catchment, such as the Rietspruit and the Bosluisspruit are not regularly monitored.

- Lack of flow gauging: There is a total lack of flow gauging at all water quality sampling points in the most polluted portion of the catchment (i.e. the Goldfields area).

- Lack of water balance monitoring: A lack of storage state, inflow and outflow data for most of the polluted water storage facilities makes it almost impossible to evaluate either the overall water balance for the mining area or the balances for individual facilities.

- Sampling frequencies: At most regular monitoring stations within the study area, the current monthly sampling frequency is inadequate for estimating pollution loads or even detecting all pollution events.

- Choice of water quality variables: In some instances important water quality variables (such as sodium) are not measured in surface water courses.

- Site identification: In many instances the identification of monitoring sites was ambiguous or inconsistent.

Consistency of water quality data:

- External consistency problems: Large discrepancies were sometimes observed between water quality data collected by different organisations at the same (or nearby) points. Since the sampling frequency is so low, it could not be ascertained if these discrepancies arose from data errors or changes in flow regime between sampling dates.

- Internal consistency problems: The mines' data in particular showed large internal inconsistencies. For example, contradictions between EC and TDS values resulting in impossible TDS/EC ratios of 20 or more were common. Large imbalances between anions and cations were also often found. This implies poor laboratory control.

NATURALISATION OF STREAMFLOW (Chapter 6)

❑ Natural mean annual runoff (MAR): The natural MAR of the Vet River catchment (at gauge C4H004) is estimated to be 404 million m^3 (based on 1920 to 1991 hydrology). This is about 10 per cent of the MAR of the entire Vaal River catchment.

❑ Present day (1992) MAR: Under present-day conditions the MAR of the catchment has decreased to about 271 million m^3.

HYDRO-SALINITY MODEL CALIBRATION (Chapter 7)

Comparisons of modelled and observed monthly flows, TDS concentrations and TDS loads are given in the report.

❑ Allemanskraal Dam and Erfenis Dam catchments: The model calibration results for these two dams are satisfactory.

❑ Sand River in Goldfields area: Although far from ideal, the calibration results for the Sand River between Allemanskraal and Blaaudrift bridge are good enough to provide a reasonable first order representation of the system.

❑ Lower Vet River: The fit between modelled and observed results at station C4H004 in the lower Vet River is poor.

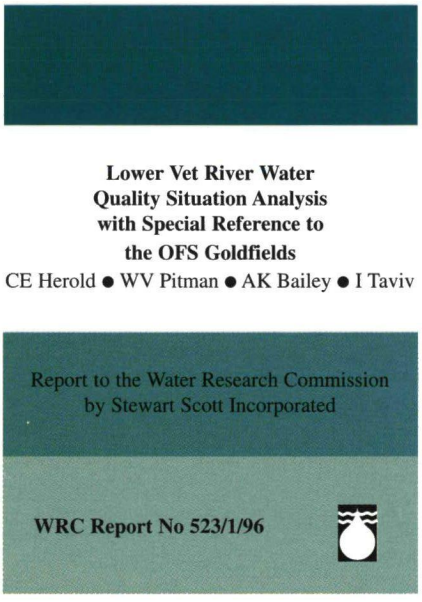
❑ Overall evaluation of salinity modelling: Despite the limitations, the model calibration for the two dams and the Sand River to Blaaudrift bridge provides a reasonable representation of the salinity regime.

ESTIMATION OF TDS LOADS (Chapter 8)

❑ Free State Goldfields TDS load contribution

- During the last fifteen years pollution sources in the Goldfields region are estimated to have added about 16 000 t per annum to the TDS washoff from the Vet River catchment. This represents an increase in the Vet River catchment TDS export of about 35 per cent.

- During wet years the contribution of the Goldfields region is significantly higher. For example, during the 1987/88 and 1988/89 hydrological years the pollution increased the Vet River TDS export by 40 and 68 per cent respectively.



❑ Net TDS export to Lower Vaal System

- During dry weather there appears to be a net retention of salt in the Vet River system. Under these conditions there should be little runoff entering Bloemhof Dam and consequently little effect on downstream water quality.

- During wet conditions the increase in the net TDS export from the Vet River (relative to natural conditions) is estimated to have increased the TDS load entering Bloemhof Dam by up to 9 per cent.

❑ Impact on downstream water users: The impact of increased TDS load export from the Vet River on users in the Lower Vaal System is dependent on the relative magnitude of the monthly runoff and TDS inputs to Bloemhof Dam from the Vet and Vaal Rivers. Modelling of the Vaal River System will be required to assess these impacts.

❑ Data deficiencies: The absence of flow gauging stations and the low water quality sampling frequency prevented reliable estimation of pollutant loads anywhere within the most polluted portion of the catchment, or even immediately downstream of it.

EVALUATION OF SALINITY STATUS (Chapter 9)

Salinity trends

❑ The only points in the system where significant salinity trends were detected over the last two decades are in Harmony Mine's "Waste Dump Stream" and "Donga Dump Stream", east of Virginia, and in the Sand River immediately downstream of these two streams. In more recent years the salinity regime at these stations appears to have reached some sort of a plateau.

❑ At all other stations there was no significant trend in EC or any of the major ions comprising the TDS. This is consistent with the predominance of older long established gold mines in the Goldfields region. However, as some of the new gold mines to the south of the Sand River come into full production, it is possible that further deterioration in water quality will occur.

Copies of the report summarising the results and entitled **Lower Vet River water quality situation analysis with special reference to the OFS Goldfields** (WRC Report 523/1/96) are available free of charge from the Water Research Commission, PO Box 824, Pretoria 0001. (Overseas price: US$ 30, inclusive of surface mail).

Policy proposals published for irrigated agriculture in South Africa

The Water Research Commission has published a discussion paper to inform interested and affected persons on relevant issues regarding irrigation policy in South Africa. The document was compiled by GR Backeberg, TJ Bembridge, ATP Bennie, JA Groenewald, PS Hammes, RA Pullen and H Thompson, and indicates what its authors would regard as appropriate policy directions.

The main proposals in the paper could be summarised as follows:

POLICY OBJECTIVES

Water is scarce and should be used optimally. The general objective of public policy is improvement of general social and economic welfare. Available policy instruments, e.g. legal prescription, economic pricing, education and administrative control should be directed at this objective. A balance must however be struck between instruments.

GENERAL POLICY RECOMMENDATIONS

❑ Water legislation and institutional reforms should be formulated and implemented in conjunction with accepted policies and objectives.

❑ Appropriate pricing and charging systems that reflect real opportunity costs need to be established, and decentralised decision-making is to be encouraged.

WATER RESOURCES

❑ Increased use of groundwater resources should be supported by strict scientifically formulated operating rules.

❑ Irrigation development is an expensive way to handle socio-economic objectives. It should only be done after extensive investigation.

❑ In times of scarcity, water use for certain uses can be restricted either through operating rules or through voluntary transfer.

❑ Water resources management should be done on a river basin basis and should include all stakeholders.

WATER-SOIL-CROP RELATIONSHIPS

❑ Better soils should receive priority for irrigation.

❑ Environmental damage must be minimised through sustainable irrigation practices; ecological and social responsibility must be developed among irrigators.

❑ Water use should be moved from crops with low physical and economic water use efficiencies to those which perform better.

❑ Water saving practices should be encouraged.

COMMERCIAL IRRIGATION FARMING AND MODERNISATION

❑ More irrigators engaged in subsistence and near-subsistence irrigation should be introduced to commercial irrigation, using appropriate technology, i.e. labour absorbing, capital and water saving and sustainable technology. Research and extension should be directed at such technology.

❑ Irrigation farms must be of viable size and successful irrigators must have the right to expand.

❑ New irrigation development should preferably occur in areas with a favourable economic location. In previously neglected areas, transport and communications infrastructure should be supplied to improve economic location.

❑ Subsidies should be limited and tied to time scales.

❑ Rehabilitation of existing schemes should be prioritised above development of new schemes.

❑ Proper and thorough studies on economic, financial, fiscal, social and ecological impacts should precede expenditure of public funds.

SMALL-SCALE FARMER IRRIGATION SCHEMES

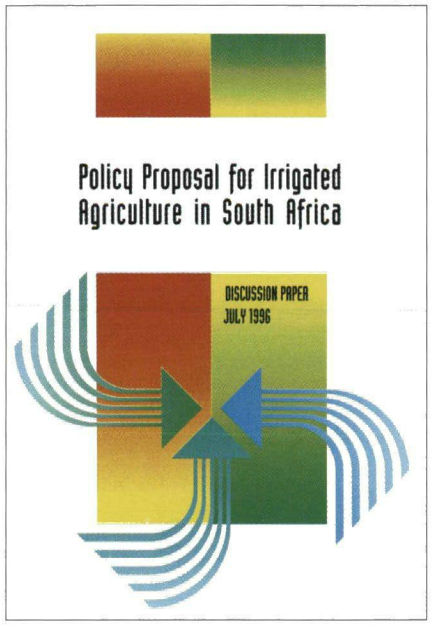
Very few small-scale farmer irrigation schemes have succeeded, due largely to poor scheme management and a lack of communication with the intended beneficiaries.

A multi-disciplinary task team should investigate the causes of failure, make innovative changes and develop training programmes for both project managers and farmers.

"Top down" and autocratic administration and management of many small-scale farmer schemes must be remedied by devolution of responsibility; rural communities should be empowered to take more responsibility and Water User Associations (WUAs) formation should be stimulated. They will initially require institutional support, and they will also require legal powers and status. Extension agents can act as catalysts for the initial organisation of WUAs, but they are not to be allowed to dominate them. A needs approach is indicated.

Infrastructure should be part of area development programmes.

❑ Irrigation technology on schemes should be evaluated in terms of appropriateness. Back-up services, e.g. in extension, credit, marketing, storage and project management need to be adequate. Government extension services should thus be reformed. A multi-



disciplinary approach should be adopted in the planning of new irrigation schemes, including intended farmer participants.

❑ Settlement of projects where no settlement has yet taken place should receive priority. Farmer selection should be done in an objective, scientific manner.

❑ Policy regarding farm size should be flexible, and liaison is needed among all government departments involved.

THE LEGAL ENVIRONMENT

Water resources management should involve the effective allocation, use and protection of water rights. This could involve the following:

An effective institutional and regulatory management structure that will incorporate stakeholder participation.

Priority to basic human needs and ecological matters.

❑ Effective criteria, procedures and structures to allocate water resources and rights fairly.

❑ Clear definition of water rights, effective registration and protection thereof.

❑ Prohibition of significant pollution.

❑ Transferability of water rights on a willing-buyer-willing-seller basis, and facilitation of procedures and facilities for such a process.

❑ Limiting expropriation to cases where higher priority or higher valued uses are contemplated, and fair compensation for such expropriation.

❑ Legal means to prevent water rights being exceeded; this will also involve measurement of water use.

INSTITUTIONAL CHOICES

❑ Water markets are more efficient and flexible allocators of water rights than administrative decisions. The establishment of water markets subject to limited but well specified regulation is recommended.

❑ Certain poorer sections of the community will however need additional protection against exploitation by other parties.

❑ Water delivery prices should in the long run cover at least operational and maintenance (O & M) costs; initial subsidisation of poorer, disadvantaged communities should however also be contemplated.

❑ Volumetric water supply pricing is preferable, and where this cannot be done, supply pricing should be based on area cultivated.

❑ Water rights should be separated from ownership of land.

❑ The administration, control and management of water schemes must be made more effective through decentralisation and improved local community participation. WUAs can play a crucial role in this regard.

INFORMATION

There is a serious shortage of information regarding irrigation farming in South Africa. Such information is crucial for the formulation of proper policy. A comprehensive wide-scale agro-economic-social survey is needed. This can form an initial data base which should be updated in the course of time.

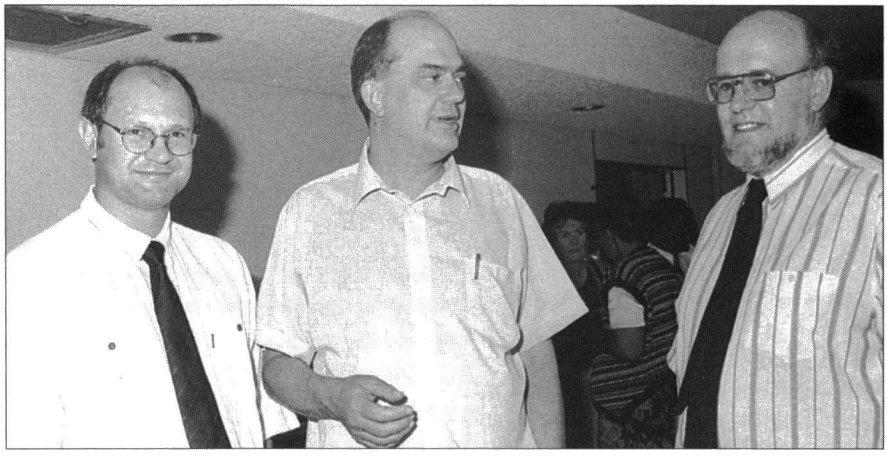
Copies of the document titled **Policy Proposal for Irrigated Agriculture** are available free of charge from the Water Research Commission, PO Box 824, Pretoria 0001. (Overseas price: US$ 25 - via surface mail).

Irrigation Research scrutinised at workshop

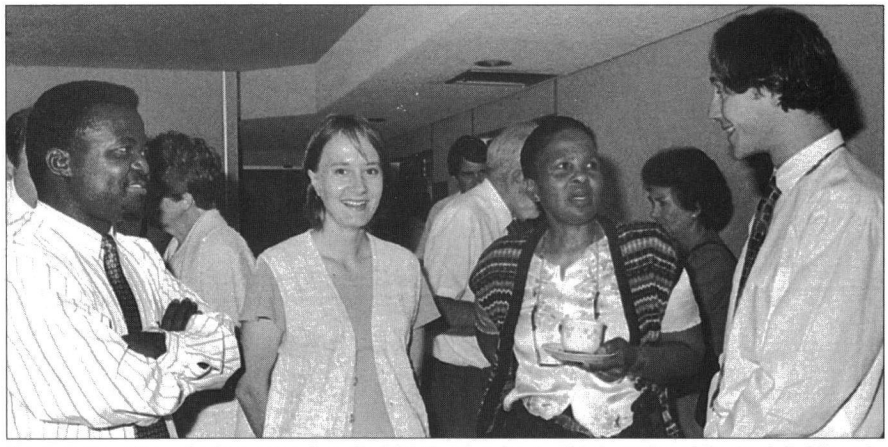
Recently the Coordinating Committee for Irrigation Research (CCIR) held a workshop for researchers active in the field of irrigation and drainage. The workshop was welcomed and well attended by a number of researchers, mainly from universities and the Agricultural Research Council (ARC).

An overview of the existing framework of the Master Plan for Irrigation Research was given along with priorities for research according to disciplinary and multi-disciplinary perspectives. With regard to priorities, group discussions where held on five focus areas namely crops, soils, engineering, resource economics and rural sociology. Further aspects that were given attention to were crop modelling approaches and the necessity of a data basis, as well as the purpose of the proposed 'Provincial Discussion Forums on an Agenda for Sustainable Agricultural Water Management'.

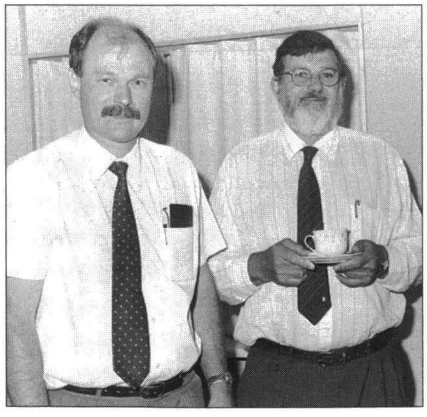
The researchers agreed that it was certainly most worthwhile to set aside time to discuss research priorities and they found the exchange of ideas amongst different researchers within the same broad research field of irrigation very fruitful and challenging, says Dr Gerhard Backeberg, Research Manager for the research field Agricultural Water Management (Water Research Commission).



Jimmy Botes (Clover SA), Pieter van Heerden (Dept of Agriculture, Free State) and Giel Viljoen (University of the Free State) attended the CCIR workshop, which was held at the Water Research Commission, in Pretoria.



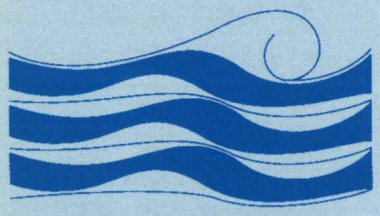
In conversation during a tea-break: MP Nepfumbada (University of Pretoria), Elmarie van Zyl (ARC, Nietvoorbij), Sibongile Nene (Post Graduate School of Agricultural and Rural Development, UP) and Mark Glaysher (Afrosearch Index).



Dr Gerhard Backeberg (Workshop Convenor) with Prof Jimmy de Jager (University of the Free State).

Dr A Belete (University of Fort Hare), Dr R Hassan (CSIR) and Dr M Mekuria (University of the North) having a cup of tea together during the CCIR workshop.

NEW ROLE FOR SAWIC STAFF AT WRC



Launching the WRC on the Internet

With the growing importance of information in the world, the Water Research Commission (WRC) has decided to transfer the South African Water Information Centre (SAWIC) staff to assist the WRC in making its publication and other information resources available to users worldwide. This step is in line with the organisation's policy to promote the effective transfer of information and technology.

The main task of the new group will be to develop and manage the WRC's site on the World Wide Web (WWW) on the Internet. Access to the site will provide users with detailed information on the organization, its people and activities. Free access to publications, the annual report as well as research project reports will be provided. Another feature of the site is that it will serve as a hub facilitating information exchange and discussions between researchers and other concerned parties.

The WRC site will be launched towards the end of March 1997 and the Internet address for the site will be:
http://www-wrc.ccwr.ac.za

SAWIC now obsolete

Following the decision to transfer and incorporate the SAWIC information specialists in the WRC, it was decided to terminate SAWIC's existence. Therefore the SA Water Information Centre, as such, no longer exists.

Waterlit database continued

Although SAWIC no longer exists, a contract for the continued development of the Waterlit bibliographic database was closed between the WRC and the CSIR. All services derived from Waterlit will, however, in future be handled by the staff at the WRC. Requests for literature searches and regular information updates may be directed to the address below. The database will still be available in CD-ROM format, published by SilverPlatter and NISC. The cost structure will also remain the same, i.e. R110,00 (+ VAT) for an individual literature search and R150,00 per annum (+ VAT) for the monthly information update service. Prices for the CD-ROMs are available from the local agents of the publishers.

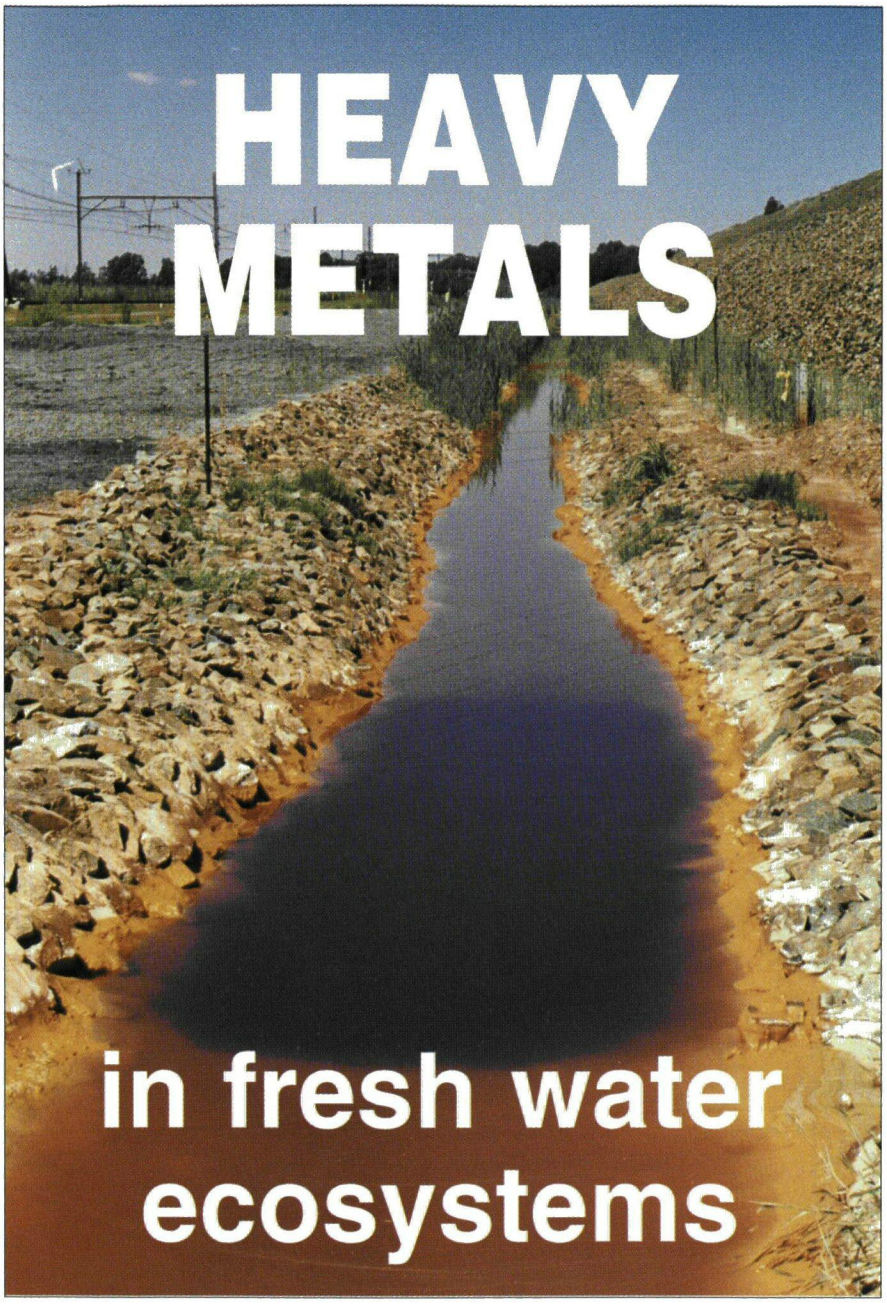
Waterlit and the Water-related Research Projects database on the Internet

As part of the process to make the information generated by the WRC available to users all over the world, the database on Water-related Research Projects will also be hosted on the Internet. Access to this database will be free, with the facility to download the information.

The WRC site on the WWW will make provision for users to request literature searches and other services from the Waterlit database. Even general water-related enquiries may be channelled via this route.

For enquiries about the WRC's WWW site, requests for Waterlit services and general water-related enquiries, please contact:

Martha Pretorius or
Francette Myburgh
Water Research Commission
PO Box 824
PRETORIA 0001
Tel: (012) 330-0340
Fax: (012) 331-2565
e-mail: mpretori@wrc.ccwr.ac.za
fmyburgh @wrc.ccwr.ac.za



In view of the increasing threat of metal-containing effluents to the water quality of wetland areas on the Witwatersrand in particular, the Water Research Commission funded a project undertaken by researchers of the Rand Afrikaans University to evaluate stream conditions and the problem of metal pollution of the aquatic environment on the Witwatersrand.

The report **The occurrence and accumulation of selected heavy metals in fresh water ecosystems affected by mine and industrial polluted effluent** (WRC Report no 312/1/96), emanating from the research by HJ Scoombee, A Adendorff, LM de Wet, CL Fleischer, CG van der Merwe, PH van Eeden and AJA Venter, is available from the Water Research Commission, PO Box 824, Pretoria 0001. (Overseas price: US $25).

Goldmining on the Witwatersrand and elsewhere in the former Transvaal, and the deposition of processed and unprocessed waste material above ground, have led to continuous and persistent leaching of dissolved minerals and metals, over decades, from these sites into streams, lakes and rivers. These mining activities were accompanied by the establishment of secondary industries, in particular metal-processing plants, only adding to the problem with a variety of industrial effluents being discharged into these water bodies. Such effluents and seepage waters have contributed substantially to the acidification, eutrophication and metal contamination of aquatic habitats in this region.

Changes in physical and chemical conditions such as pH and dissolved oxygen have also affected the speciation and biological availability of certain metals in the water and substrates of the affected waters, enabling organisms such as aquatic plants and benthic macro-invertebrate organisms to bioaccumulate certain metals directly or indirectly via aquatic food chains. Transfer of these metals occurs via several possible pathways to amphibia and fish (via food, gills, through drinking the water and via absorbtion through the skin) as well as aquatic birds and even to man. Changes in the physical and chemical conditions of the aquatic environment may also affect the degree of toxicity of such metals to these organisms.

During the period 1986 to 1993 a number of investigations were conducted on the presence and concentration of selected metals in wetland ecosystems of the Elsburg-Natalspruit, Klip River and Blesbokspruit catchment areas. Specific attention was given to the presence of Zn, Mn, Cu, Ni, Fe, Pb, Cr and to a lesser extent Cd, as these metals were largely associated with effluents and seepage waters from mines and

industries in this region. In addition to the metal concentrations in the abiotic environment, analyses were also done on selected aquatic and semi-aquatic plants, macro-invertebrate organisms, a number of fish species, amphibia (*Xenopus laevis*) and aquatic and semi-aquatic birds.

OBJECTIVES AND SCOPE

The investigations conducted during 1988-1994 had the following objectives:

❑ Selection of representative localities in lakes and rivers affected by metal-containing effluents and seepage water from mines and metal-processing industries.

❑ To determine the occurrence and concentration of selected metals in mine- and industry-polluted waters and sediments in catchments of the Natalspruit-Elsburgspruit, Blesbokspruit and in the headwaters of the Klip River in the Roodepoort municipal area.

❑ To establish metal concentrations in semi-aquatic and aquatic weeds in these mine and industrially polluted waters with observations on the ability of some plants to accumulate certain metals in their roots and/or shoots.

❑ To evaluate some benthic macro-invertebrate organisms as possible indicators of metal pollution in streams with special reference to the freshwater crab, *Potamonautes warreni*.

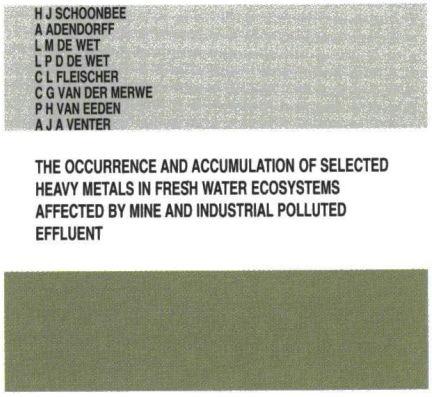
❑ To study the occurrence of metals in target organs and tissues of fish from mine- and industry-polluted aquatic habitats. Nine indigenous and exotic fish species were considered for investigation from one or more of six different sampling localities on the East and West Rand. The report deals with two of the fish species concerned, namely the southern mouthbrooder *Pseudocrenilabrus philander* and the perch *Perca fluviatilis*

❑ To evaluate the clawed frog or platanna, *Xenopis laevis*, as a potential indicator of metal pollution in aquatic ecosystems.

❑ To compare concentrations in organs and tissues of some aquatic and semi-aquatic birds. Attention was specifically given to the redknobbed coot, *Fulica cristata*, the sacred ibis *Threskornis aethiopicus* and the reed cormorant, *Phalacrocorax africanus*.

The localities where the investigation took place were mainly in wetland regions on the East and West Rand, Gauteng, where the water of the polluted streams traverse expansive wetlands consisting of floating, emergent and submerged aquatic vegetation and where these plants play an important role in the recovery from pollution of the affected waters.

All the above objectives have largely been met.



RESULTS AND CONCLUSION

Physical and chemical conditions of the water and sediments of the different localities

Research showed that the Germiston Lake had recovered substantially from mine and industrial pollution following the first steps taken to rehabilitate this lake in the early 1970's. Since then, there was a consistent decline in the mineral loads of the lake water. However, metal concentrations in the lake sediments remained high and metals released into the water column appear to be gradual under the prevailing alkaline conditions. Transfer of metals through the biological component of the lake ecosystem takes place without any signs of metal toxicity to organisms studied. The lake water is discharged into the Elsburgspruit where serious metal pollution of its water by both the mines and industries took place. Seepage of water from industrial, ash and mine dumps further complicated the situation. Although the Elsburgspruit has shown considerable recovery from organic and inorganic pollution, despite the ability of the wetlands to assist in the recovery of the stream, considerable metal loads still pass through the dense mats of submerged and emergent weeds into the Natalspruit. A similar situation was found to exist in the main Blesbokspruit ecosystem where abnormal concentrations of Fe, Zn, Ni and at places Cu were found. Water in both the Cowles and Nigel dams contained appreciable loads of most of the metals investigated, with Fe and Mn in particular, occurring in relatively high concentrations in the water and sediments of both dams. Florida Lake showed the best recovery from past mine pollution in its catchment area.

❑ **Metal uptake by some emergent and floating aquatic weeds**

The emergent aquatic weeds *Typha capensis, Arundo donax* and the water fern *Azolla filliculoides* were evaluated for their ability to retain metals in their organs and tissues, and estimates were made on their ability to remove metals from polluted aquatic environments under local environmental conditions.

❑ **Metal uptake by the freshwater crab** *Potamonautes warreni*

The concentrations in which the metals occurred in the Natalspruit and in the crab *P. warreni* followed similar trends. Indications are that the accumulation of the metals Pb, Cr and Fe, in particular, in the body of the crab may be regulated successfully in the metalpolluted waters of the Natalspruit and probably also in other similarly polluted waters where it occurs.

❑ **Metal uptake by fish**

Investigations showed that the southern mouthbrooder *Pseudocronilabrus philander* appears to be reasonably tolerant to various concentrations of the metals Fe, Mn, Zn, Cu, Ni and Pb in the Spaarwater dam and that a possible mechanism exists whereby concentrations of these metals are bioregulated by this fish species. Bioregulation improves with the age and size of the fish.

Wetlands of the Blesbokspruit with mine dumps in the background.

Concentrations of Fe, Ni and Zn were the highest of all the metals analysed in the organs and tissues of the perch *Perca fluviatilis* and closely reflected the ratio of the metals in the lake sediments. Comparatively high concentrations of Pb in most organs were mainly related to surface run-off waters from the streets which enter the lake via various storm-water drains.

❑ **Metal uptake by the platanna** *Xenopus laevis*

The concentration of metals by the frogs and tadpoles of *X. laevis* show that certain organs and tissues were able to accumulate certain metals in much higher concentrations than others. This can be linked to sites of metal uptake, storage and excretion in the frogs and also the possibility that metal bioregulation may take place. Whole body metal analysis more closely reflects the metal loads present in the water and sediments. Metal analysis of the river frog *Rana angolensis* larvae yielded similar results as those for *X. laevis.*

❑ **Metal uptake by the redknobbed coot** *Fulica cristata,* **the reed cormorant** *Phalacrocorax africanus* **and the sacred ibis** *Threskiornis aethiopicus*

The concentrations of cadmium, copper, nickel and lead were determined in the liver, kidney, bone and blood of all three species which occurred in the Natalspruit wetlands. The investigation suggests that the dietary preferences of these birds and the metal contents of their diets as such, may be the two most important factors which determined the metal concentrations in the bodies of these birds.

❑ **Concentration ratios**

The concentration ratios for the metals investigated suffer the same weaknesses and limitations as pointed out by Bain *et al.* (1994) for the radionuclide radium in mine polluted aquatic ecosystems. Both the CR_w (water) and CR_s (sediments) of the metals were calculated to evaluate the possible efficiency of particular aquatic flora and fauna to accumulate the metals under different environmental conditions. In the present study more importance is attached to the CR_s values as they represent the history of metal pollution at a given site whereas the CR_w values evaluate the concentrations of metals in streams at a specific period and which may differ considerably within hours depending on the periodic release of effluents from mines and industries during the day.

❑ **Water quality criteria for metals**

Results obtained during the present survey compared to the maximum limits suggested for the protection of aquatic life in rivers and lakes, showed that all the different ecosystems investigated were being endangered by excessive loads of the seven metals under consideration, in both the water and sediments. This tendency is usually not reflected by the prevailing general physical and chemical conditions at the various sites.

WRC receives merit award

The SA Insitute of Agricultural Engineers (SAIAE) recently honoured the Water Research Commission (WRC) with a Merit Award for the WRC's outstanding contribution to agricultural engineering in South Africa. Mr David van der Merwe, Deputy Executive Director, received the award on behalf of the WRC from Mr Chris Combrinck, President of SAIAE.

The citation read at the presentation lauded the WRC for the sound and productive relationships which have been established between the WRC and the South African agricultural engineering fraternity in particular, over the past 25 years. A number of products and services have resulted from the WRC's association with agricultural engineers in the academic and private sectors as well as the government sector. The research has spanned hydrology, irrigation, agro-hydrology and climatology as well as computor modelling and programs in these fields.

According to the citation the WRC's "steady guiding hand" is to be found all over the agricultural water scene in South Africa and has also helped agricultural engineers to contribute meaningfully to the water aspect of industries such as forestry and sugar. Furthermore, a large number of papers published over the past two decades in the SAIAE national journal, Agricultural Engineering in South Africa, have their origins in WRC-funded projects.

Dr Saayman retires

Dr Henry Saayman

Dr H M Saayman, Research Manager: Membrane Technology, has retired after almost eight years as one of the team of research managers of the Water Research Commission.

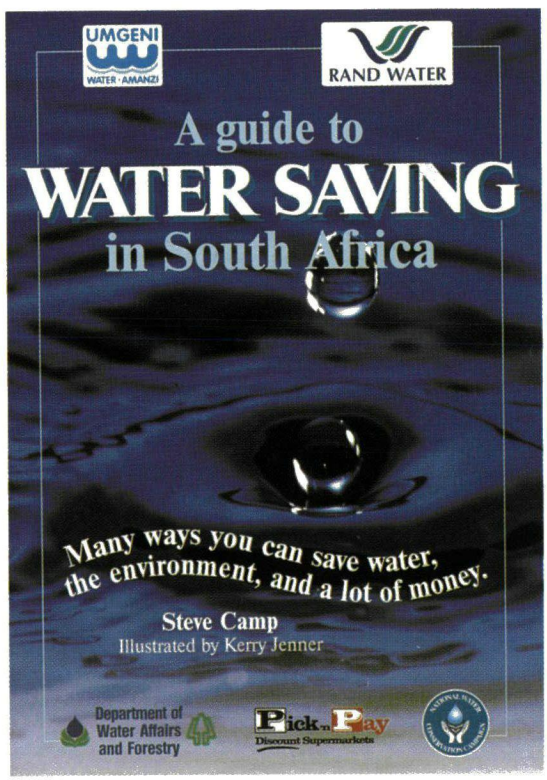
He has been involved with sixty WRC projects which comprehended membrane technology, biotechnology, microbiology, biochemistry, as well as the chemistry of toxic and heavy metals.

Dr Gerhard Offringa will now be responsible for membrane technology projects.

How to save water!

An excellent booklet with helpful hints on saving water in your house and around your garden has recently been published. The cartoon-style illustrations make this worthwhile booklet most appealing and user-friendly.

Copies are now available, at R5.00 per copy, from:
Umgeni Water,
PO Box 9,
Pietermaritzburg 3200.



Legionella Action Group

The Legionella Action Group (LAG) aims to collect and disseminate information on Legionella, to evaluate detection methods in biofilms, bulk water and aerosols to recommend procedures for analysis and sampling, and to recommend appropriate treatment methods for water systems contaminated with Legionella.

LAG intends building a database of available information and to hold workshops and seminars in various centres around the country, focussing on both industrial and medical issues. For further enquiries please contact:

Delene Bartie
National Centre for Occupational Health (NCOH)
PO Box 4788
Johannesburg
2000
Tel: (011) 720-5734
Fax: (011) 720-6608
E-mail: delene@ncoh.pwv.gov.za

SA WATERKALENDER

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

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

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

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

See conferences and symposia pages for events.

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

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

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

Gids:
- ❍ Een SA Watergeleentheid vir hierdie dae.
- ❑ 'n Tweede SA Watergeleentheid vir dié datums.
- × 'n Derde SA Watergeleentheid vir dié datums.

Sien Konferensies- en Simposiumbladsy vir aangeduide geleenthede.

1997

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SOUTHERN AFRICA

1997

METEOROLOGY
APRIL 7 - 11
The 5th international conference on **southern hemisphere meteorology and oceanography** will be held at the University of Pretoria.
Enquiries: Conference Planners: Amie Wissing. Tel and Fax: (012) 46-0170.

FORESTS
MAY 11 - 17
A workshop with the theme: **Forests at the limit: Environmental constraints on forest function** will be held at Skukuza in the Kruger National Park, Mpumalanga.
Enquiries: Ms Tisha Greyling, IUFRO Workshop Secretariat PO Box 95823, Waterkloof 0145. Tel: (012) 346-1517 Fax: (012) 46-7909 E-mail: liaison@cis.co.za

IRRIGATION
MAY 13 - 15
The South African Irrigation Institute's congress IRRIGATION 2001 will be held at the Aventura Resort, Blydepoort, Mpumalanga.
Enquiries: Mrs René de Wet. Tel: (051) 430 7697 or Mr PH Lombard. Tel: (013) 75 22997. Fax: (013) 75 22841

WATER UTILISATION
MAY 19 - 23
A post-graduate training course in water utilisation: operation of activated sludge plants will be held in Pretoria.
Enquiries: The Head, Water Utilisation Division, University of Pretoria, Pretoria 0002. Email: dtoi-h@faanella.ee.up.ac.za Fax: (012) 43-6683.

SAICE
JUNE 2 - 4
The 2nd international mining and industrial waste conference will be held in Midrand, Gauteng.
Enquiries: Lesley Stephenson, Conference Secretary, PO Box 327, Wits 2050. Tel: (011) 716-5091 Fax: (011) 339-7835.

AQUATIC SCIENCE
JUNE 24 - 26
The Southern African Society of Aquatic Scientists will hold its 34th symposium at Mtunzini, KwaZulu-Natal. The symposium will focus on aquatic research and conservation in the context of industrial development as a special theme, but will cater for all aspects of aquatic research.
Enquiries: Rodney Owen or Victor Wepener, Coastal Research Unit, University of Zululand, Private Bag X1001, Kwadlangezwa 3886. Tel: (0351) 93911 x 2549. Fax: (0351) 93162. E-mail: cruz@pan.uzulu.ac.za

WEDC '97
SEPTEMBER 1 - 5
The 23rd WEDC conference will be held at the International Convention Centre in Durban. Theme: **Water and sanitation for all.**
Enquiries: Conference Secretariat, Congress International, 18 Rapson Road, Morningside 4001, Durban. Tel: (031) 233-494. Fax: (031) 232-405. E-mail: ci@neptune.infolink.co.za

ENVIRONMENTAL MANAGEMENT
SEPTEMBER 8 - 10
A specialised conference on **Chemical process industries and environmental management** will be held at the new five-star Table Bay Hotel, Waterfront, Cape Town.
Enquiries: Conference Secretariat: Ms Cilla Taylor, Conference Planners, PO Box 82, Irene 1675. Tel: (012) 63-1681. Fax: (012) 63-1680.

ENVIRONMENT
SEPTEMBER 8 - 11
An international conference on health and environment in Africa will be held at the CSIR Conference Centre in Pretoria.
Enquiries: The Conference Secretariat, 18 Rapson Road, Morningside, Durban 4001. Tel: (031) 233494. Fax: (031) 232405.

AQUACULTURE
SEPTEMBER 15 - 18
The 4th congress of the Aquaculture Association of Southern Africa with the theme: **Aquaculture - an opportunity based on science and technology** will be held at Stellenbosh.
Enquiries: The Chairman AASA Congress, Mr TT de Villiers, Department of Agriculture, Elsenburg 7607. Tel: (021) 808 5017. Fax: (021) 808 5120. E-mail: dier5@elsburg1.agric.za

WATER AFRICA '97
SEPTEMBER 15 - 19
The second Southern Africa Water & Wastewater conference and exhibition will be held in Harare, Zimbabwe. Theme: "Water security: guarding resources against drought and pollution".
Enquiries: Zia Howeson. Tel: (011) 792-9807. Fax: (011) 791-0571.

SEWAGE PLANTS
OCTOBER 6 - 10
A post-graduate training course in water utilisation: Operation of small water purification and sewage plants will take place in Pretoria.
Enquiries: The Head, Water Utilisation Division, University of Pretoria, Pretoria 0002. Fax: (012) 43-6683. E-mail: dtoi-h@fanella.ee.up.ac.za

HYDRAULICS
NOVEMBER 5 - 7
The third in the series of international **River Flood Hydraulics** conferences will be organised by HR Wallingford in partnership with the University of Stellenbosch at Stellenbosch. Topics to be covered include flood hydraulics and hydrology, management of developments on flood plains, flood control, sediment transport and river morphology, flow measurement: social, economic and environmental aspects.
Enquiries: Prof A Rooseboom, University of Stellenbosch. Tel: (021) 808-4353. Fax: (021) 808-4361.

DAM DESIGN
NOVEMBER 3 - 4
A course on the design of smaller dams will be offered under the auspices of SANCOLD at the University of Stellenbosch.
Enquiries: Prof A Rooseboom, University of Stellenbosch. Tel: (021) 808-4353. Fax: (021) 808-4361.

HYDROLOGY
NOVEMBER 17 - 19
The SANCIAHS/SAICE '97 conference will be held at the University of Pretoria. See advertisement on page 2 in this Bulletin.

1998

CEMSA '98
FEBRUARY 9 - 11
An international conference and exhibition on Integrated Environmental Management (IEM) in South Africa will be held in East London.
Enquiries: Professor OS Fatoki, University of Fort Hare, Analytical Chemistry, Private Bag X1314, Alice 5700. Tel: 404-22094. Fax: 404-31643. E-mail: FATOKI @UFHCC.UFH.AC.ZA

OVERSEAS

1997

MEMBRANES
APRIL 1997
The 2nd specialised conference on membranes in drinking water and industrial water will be held in Berlin, Germany.
Enquiries: IWSA Secretariat, 1 Queen Anne's Gate, London SW1H 9BT, UK. Tel: +44 171 957 4567. Fax: +44 171 222 7243.

REUSE OF WATER
APRIL 1997
A WEF conference on the beneficial reuse of water and solids will be held in Marbella, Spain.
Enquiries: Linda Blankenship, WEF. Tel: +1 703 684 2400. Fax: +1 703 684 2492.

GROUNDWATER
APRIL 7 - 11
An international conference and course on **Analytic based modeling of groundwater flow** will take place in Nunspeet, the Netherlands.
Enquiries: The Conference Secretariat, MOORGA, Buerweg 51, 1861 CH Bergen, the Netherlands. Tel: +31 7258-99062 Fax: +31 7258 99040

DAF
APRIL 16 - 18
An international conference on **Dissolved air flotation technology in water treatment - an art or a science?** will be held at the City University in London, UK.
Enquiries: Conference Secretariat, CIWEM Services Ltd, 15 John Street, London WC1N 2EB, UK. Tel: 0171 831 3110. Fax: 0171 405 4967.

OXIDATION
APRIL 21 - 23
A symposium on oxidation methods for water and wastewater treatment will be held in Berlin, Germany.
Enquiries: IOA European African Group, 83 Avenue Foch, F-75116 Paris, France.

RAINWATER
APRIL 21 - 25
The 8th international conference on **rainwater catchment systems** will be held in Tehran, Iran.
Enquiries: Mr J Ghoddousi, PO Box 13445-1136, Tehran, IR Iran. Tel: +98 21 6418335 Fax: +98 21 6407214 E-mail: RAIN@NEDA.NET.IR

WATER INDUSTRY
APRIL 21 - 25
An international water industry exhibition will be held in conjunction with **Wasser Berlin '97** in Berlin, Germany.
Enquiries: In South Africa: Mrs E Berger. Tel: (011) 486-2775. Or: Messe Berlin GmbH, IFW/M3, Messedamm 22, D-14055 Berlin. Tel: (030) 30380. Fax: (030) 3038-2079.

SANITATION
APRIL 23 - 24
A specialised conference on models for organisation and management in water supply and sanitation will be held in conjunction with Wasser Berlin '97 and IFW '97 in Berlin, Germany.
Enquiries: IWSA Secretariat, 1 Queen Anne's Gate, London SW1H 9BT, Great Britain. Fax: +44 (0) 171 222 7243. E-mail: IWSA@dial.pipex.com

IAHS 97
APRIL 23 - MAY 3
The 5th Scientific Assembly of the International Association of Hydrological Sciences will take place in Rabat, Morocco.
Enquiries: Direction Generale de l'Hyraulique, Casier Rabat, Chellah, Maroc. Tel: +212 7 769008. Fax: +212 7 778696.

SLUDGE
APRIL 30 - MAY 2
A conference on the management and fate of toxic organics in sludge applied to land will be held in Copenhagen, Denmark.
Enquiries: Mia Clausen, Building 115, Technical University of Denmark, DK-2800 Lyngby, Denmark. Tel: +45 45 251613. Fax: +45 45 932850. E-mail: mc@imt.dtu.dk

DEPOLURB '97
MAY 18 - 22
Depolurb '97 - an international conference on waste pollution control and environmental management in large metropolitan areas will be held in Sao Paulo, Brazil.
Enquiries: IAWQ Brazilian National Committee, Rua Conde de Iraja, 260/1 andar, 22271-020, Rio de Janeiro, Brazil. Tel: +55 21 537 4338. Fax: +55 21 537 7991. E-mail: depolurb@fageventos.com.br

WATER SUPPLY
MAY 19 - 22
A conference on reservoir management and water supply - an integrated system - will be held in Prague, Czech Republic.
Enquiries: Dr Petr Dolejs, IWSA/IAWQ Conference, W&ET Team, Box 27, Pisecka 2, 370 11 Ceske Budejovice, Czech Republic. Tel/Fax: +42 38 41624. E-mail: petrdol@marvin.jcu.cz

ASIAN WATERQUAL '97
MAY 20 - 23
Asian Waterqual '97 - the 6th IAWQ Asia-Pacific regional conference will be held in Seoul, Korea.
Enquiries: The Secretariat, SL Kangnam, PO Box 305, Seoul 135-603, Korea. Tel: +82 2 3476 7700. Fax: +82 2 3476 8800. E-mail: koconex@chollian.dacom.co.kr

WATER SYSTEMS
MAY 25 - 28
An IWSA and IAWQ specialised conference on the **Upgrading of water and wastewater systems** will be held in Kalmar, Sweden.
Enquiries: Dr Ulf Lidman, Dept of Natural Sciences, University of Kalmar, Box 905, S 391 29 Kalmar, Sweden. Tel: (46) 480-446235 Fax: 480-446262

AD-97
MAY 25 - 29
The 8th international conference on **anaerobic digestion** will be held in Sendai, Japan.
Enquiries (local): Prof Trevor J Britz, Department of Food Science, University of Stellenbosch, Private Bag X1, Matieland 7602. Tel: (021) 808-3578 Fax: (021) 808-3510. E-mail: voedselw@land.sun.ac.za

SEWERS
MAY 26 - 28
The 2nd international conference on **The sewer as a physical, chemical and biological reactor** will be held in Aalborg, Denmark.
Enquiries: Kirsten Andersen, Environmental Engineering Laboratory, Sohngaardsholmsvej 57, DK-9000 Aalborg, Denmark. Tel: +45 98 158522 ext 6522. Fax: +45 98 142555. E-mail: i5ka@civil.auc.dk

ACID DRAINAGE
MAY 31 - JUNE 6
The fourth international conference on rock acid drainage with the theme: "Application of Technology" will take place in Vancouver, British Columbia, Canada.
Enquiries: 4th ICARD, att. Peggy Shepard, Venue West Conference Services, 645 - The Landing, 375 Water Street, Vancouver, BC Canada V6B 5C6. Tel: (604) 681-5226. Fax: (604) 681-2503. E-mail: congress@venuewest.com

WATER & HEALTH
JUNE 1997
A conference with the theme: Innovation in water technologies - water and health, will take place in Pescara, Italy.
Enquiries: Miriam Balaban, secretary, Biomedical Research Institute, 66030 Santa Maria Imbaro, Italy. Tel: +39 872 570 316. Fax: +39 872 570 317. E-mail: Balaban@cmns.mnegri.it

GRASSLAND
JUNE 8 - 19
The 18th international grassland congress will be held in Winnipeg, Manitoba, Saskatoon, Saskatchewan, Canada.
Enquiries: Grassland '97, PO Box 4520, Station C, Calgary, Alberta, Canada T2T 5N3. Fax: 403-244-4487. E-mail: amc@forage.org Website: http://www.forage.org

DRYLANDS
JUNE 9 - 13
An event with the theme: Changing water regimes in drylands will be held at Lake Tahoe, California, USA.
Enquiries: N Lancaster, Desert Research Institute, University of Nevada, Reno NV 89512 USA. E-mail: nick@maxey.dri.edu Internet: http://www.dri.edu Fax: 702 6737304.

WATER POLLUTION
JUNE 18 - 20
The 4th international conference on water pollution - modelling, measuring and prediction will be held in Slovenia.
Enquiries: Conference Secretariat, Wessex Institute of Technology, Ashurst Lodge, Ashurst Southampton, S040 7AA, UK. Fax: 44 (0) 1703 292853. E-mail: wit@wessex.witcmi.ac.uk

WATERMATEX '97
JUNE 18 - 20
Watermatex '97 - the 4th international symposium on systems analysis and computing in water quality management will be held in Quebec City, Canada.
Enquiries: Dr Paul Lessard, Department Genie Civil, Pavillion Pouliot, Universite Laval, Quebec, QC, Canada, G1K7P4. Tel: +1 418656 7293. Fax: +1 418 656 2928. E-mail: paul.lessard@gci.ulaval.ca

HYDROLOGY
JULY 6 - 10
An international symposium on hydrology in a changing environment will be held in Exeter, United Kingdom.
Enquiries: Dr Bruce Webb, Department of Geography, University of Exeter, Rennes Drive, Exeter, EX4 4RJ, UK. E-mail: B W Webb@exeter.ac.uk Fax: +44 (0) 1392 263342.

INSTRUMENTATION
JULY 6 - 11
The 7th IAWQ workshop on **instrumentation, control and automation of water and wastewater treatment and transport systems** will be held in Brighton, UK.
Enquiries: Concorde Services, 10 Wendell Road, London, W129RT, UK. Tel: +44 181 743 3106. Fax: +44 181 743 1010. E-mail: 101611.3664@compuserve.com

ACTIVATED SLUDGE
JULY 21 - 23
The second international conference on Microorganisms in activated sludge and biofilm processes will be held at Berkeley in California, USA.
Enquiries: Prof D Jenkins, Microorganisms Conference, Department of Civil & Environmental Engineering, University of California at Berkeley, Berkeley CA 94720-1710, USA. Tel/Fax: 510 527-0672. E-mail: jenkins@ce.berkeley.edu

South African Irrigation Institute

IRRIGATION 2001 CONGRESS

For programme details, registration and accomodation information please contact René de Wet at Tel/Fax: (015) 430-7697 or Paul Lombard at Tel: (031) 752-2997 x 104, Fax: (031) 752-2841.

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