

# WATER RESEARCH COMMISSION KNOWLEDGE REVIEW 2009/10



Growing knowledge  
for south africa's  
water future





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Water Research Commission (WRC)  
Knowledge Review 2009/10

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# INTRODUCTION



*Dr Rivka Kfir:  
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## STRIVING TOWARDS RESEARCH IMPACT

The knowledge created via the WRC's investment in research aimed to create a long-term impact in areas such as water and society, water and the economy, water and the environment, and water and health. These areas are closely linked to the framework for water for economic growth and sustainable development and the Department of Water Affairs' strategic objectives.

In the area of **Water and Society** the research continued to address social dynamics in the water sector and people's needs for and views of water. During 2009/10, studies led by the WRC sought to have a medium- to long-term impact on people's participation in water management and decisions about water, and on ways of using water for transformation and social justice. Research aimed at developing the basis for new approaches which will enable water users at all scales and in different localities to meet the challenges of utilising water as a shared and scarce resource, while providing access to water for the poor and disadvantaged members of society. Other studies addressed sustainable ways for the provision of water services which are socially acceptable, affordable and available to all.

As water plays a major role in South Africa's economic development, the research led by the WRC placed emphasis on another area of impact, **Water and the Economy**. This included research conducted with the view of water being an economic instrument and/or an economic good. Research explored how water could potentially provide an engine for economic growth, and how to avoid a situation where water becomes a potential economic burden. The research aimed to demonstrate the

applicability of economic principles in the water field and to provide sound knowledge and support to water management institutions and implementing authorities. Studies attempted to investigate the use of economic instruments for improved management of water and to study complex water-related economic systems. Research focused on the value of water to different sectors of the economy, the economic advantages and disadvantages of water resource development, the use of economic instruments to effect behavioural change regarding water utilisation and the use of economic instruments to promote equitable and efficient water allocation and distribution.

Linked to economic and social issues is the issue of health. Diseases due to poor water quality or lack of sanitation and hygiene are known to be costly, often creating both an economic and a social burden. Research carried out by the WRC addressed issues related to **Water and Health**. Research aimed at improving water quality and hygiene practices in order to save lives and reduce the cost and effort involved in treating diseases and their symptoms. Based on new knowledge on the origin, survival and persistence of microbial, biological and chemical agents that may pollute water and hence affect human health, improved treatment technologies and quality guidelines were suggested. Research focused on the development and utilisation of methodologies to identify and quantify the occurrence of pathogens and contaminants in water, as well as risk assessment and epidemiological studies. Studies addressed resource protection, sanitation and waste management, drinking water quality and public health and hygiene.

Since water forms a part of the overall environment, it is important that the research will address the links between water, air, soil, biota and other spheres. Issues such as pollution,

climate change and biodiversity are all parallel issues relating to water. Research carried out by the WRC addressed the above issues in an integrated manner aimed at achieving a medium- to long-term impact on **Water and the Environment**, improving the understanding of linkages between the natural environmental components (atmospheric, marine, terrestrial, aquatic, subterranean) within the hydrological cycle as well as how these link with the anthropogenic environmental components (developed infrastructure and other land uses). The research in this area seeks to establish and apply best practices in mitigation of damage to the water environment. The aim is that research will enable a situation where our governance systems and our understanding of environmental processes within the hydrological cycle are aligned to support sustainable water management that meets the needs of society.

### **Impact studies**

During the year under review the WRC has engaged a number of studies to understand and qualify the impact of WRC-supported research projects on the water sector. The studies address research programmes, which often represent a number of projects undertaken by various research organisations for a number of years. Some of these studies included the assessment of projects where strong collaboration with practitioners and decision makers was evident. This is the third year in which the WRC has undertaken such studies and special emphasis was placed on assessing the impact of research on social, health and economic issues as well as the sustainability of the environment.

Examples of such studies are:

#### ***Eutrophication Research Impact Assessment***

This impact study aimed to quantify and qualify the current and potential impacts of eutrophication-related research done since 1984. Emphasis was given to economic, environmental, social and health impacts. The study highlights the economic impact of knowledge-based solutions including treatment measures, the seeking of alternative non-eutrophic water sources, and various agricultural impacts of eutrophication. The study addressed the potential threat to biodiversity posed by the phenomenon of eutrophication and highlighted the fact that changes in species composition can indicate poor water quality and other problems. A clear need for the measurement of toxicity levels in order to prevent animal fatalities was established. The impact study also indicated that eutrophication has resulted in social impact as it is affecting both the aesthetic and recreational value of the country's water bodies. South Africa has an excellent reputation as a tourism destination, with many water-based recreational activities available, and the losses incurred from cancelling or closing such events or facilities may be substantial. The health impacts discussed revolve around the prevention of illness and fatalities as a result of exposure to toxic, eutrophic water. The research details all possible illnesses, their precise causes, and measures

for minimising the incidence of illness and potential fatalities in South Africa. In conclusion, all of the impacts identified and analysed during the impact study reflect that WRC research on eutrophication has made positive steps towards improvement of the situation. Consistent research, supported by the targeted application of the results by industry, and more efforts to increase public awareness, will do a great deal towards eradicating the problem of eutrophication and ensuring a safer, more sustainable future for people, animals and ecosystems alike.

#### ***Biological Nutrient Removal (BNR)***

This study assesses the process of biological nitrogen and phosphate removal from domestic and industrial wastewater. The process was developed in 1974 by Dr James Barnard, who observed a reduction in phosphorus concentrations, from 8 mg/l to less than 0.2 mg/l, for periods lasting up to 6 six weeks, in a pilot plant where the experiments into the BNR process were undertaken. Ever since Barnard's first discovery, major breakthroughs in the BNR process have taken place which have resulted in the development of various BNR configurations, such as the University of Cape Town and the Johannesburg processes. The WRC has been undertaking research into the BNR process and most of these studies have focused on investigating ways of optimising the process and gaining an idea of the complex population dynamics in the systems. The BNR process is currently utilised extensively throughout the world. The successful implementation of the BNR process at local works such as the Northern Works and various other treatment plants have benefits that may be classified under economic, environmental social and health impacts.

#### ***Estuaries Research***

The purpose of the study was to determine the extent to which all relevant historical research in estuarine science, funded by the WRC, has contributed to the organisational aims of the WRC. Only preliminary analysis is available at this stage. The results of this analysis suggest that the WRC funding for research on estuaries has had very significant positive impacts. For example, the relevance of the WRC-funded research is rated highly and the WRC funding has facilitated knowledge sharing among and between research providers and research users. Also, research providers, particularly those based at universities, indicated that the WRC funding has enabled them to strive for and gain research excellence. Less positive is the observation that generally research users do not readily connect information that they use in management with research funded by the WRC.

#### ***Wetlands Research***

An impact assessment study has shown that the WRC has invested nearly R50 million (99% since 2002) in 66 research studies on wetland-related research, confirming stakeholder perceptions that the WRC plays a critical role in funding and

guiding of wetland research. The WRC has made a valuable socio-economic contribution through this research, by supporting the service providers who carried out the research and growing capacity to conduct research by supporting postgraduate student training within these projects. This approach, combined with WRC's complementary activities, has increased institutional strength by contributing to the development of a larger, more coordinated and informed wetland community of practice. Preliminary results indicate that the wetland research funded by the WRC is directly relevant to matters of policy and integrated water resource management, and to national and international environmental, economic and social (including public health and capacity) matters of global importance. Research products include useful tools for end-users, are accessible through the WRC publications and website, and are disseminated in various user-friendly forms. Initial indications are that research products are being used to guide policy and management models, make decisions regarding water-use licensing and development applications, inform management of public health issues such as wastewater treatment, and inform ecological Reserve determinations and the planning and monitoring of wetland rehabilitation. Incidental reports indicate that wetland rehabilitation is in some instances resulting in improved flows and return of biodiversity. On the whole, preliminary results indicate that there are some areas that need attention but that, within its sphere of influence as a knowledge organisation, the WRC is having a significant institutional, social, environmental and economic impact and is playing its role in realising the value of the investment into wetland research.

### ***Irrigation scheduling for efficient water use in food production***

The framework on *Water for Growth and Development* by the Department of Water Affairs contains high-level recommendations which are targeting agriculture. This includes increasing growth through savings by reducing inefficient water use for irrigation; specific mention is also made of the importance of correct irrigation scheduling. Research outputs are available for the application of models, guidelines, manuals and tools for efficient water management and effective reduction of water losses through irrigation scheduling on a field and crop level. Irrigation scheduling involves decision-making on the timing and volume of water which must be applied for crop production. The technologies and procedures already practically applied and proven as useful are amongst others the soil water balance (SWB) model, irrigation water management (BEWAB) model, and MyCanesim model for real-time irrigation scheduling; and the SAPWAT procedure for estimating irrigation requirements of crops. The impact assessment on irrigation scheduling for efficient water use in food production was initiated during 2009 and is due for completion during 2010. The focus is on WRC-funded scheduling methods and tools such as BEWAB, SWB and MyCaneSim. It will be determined whether these technologies

and methods were consciously applied by farmers, managers, extension officers or advisors, in view of competing influences of alternative approaches, to successfully improve irrigation scheduling of crops.

## INVESTING IN THE CREATION AND SHARING OF WATER- CENTRED KNOWLEDGE

During 2009/10, the WRC continued to support the water sector and all its relevant institutions and partners. This was achieved by providing them with knowledge aimed at informing their decision-making processes, improving their monitoring and assessment tools, and making available a range of new and improved technologies related to water resource management and the provision of water and sanitation services. The WRC continued to address the issue of climate change and the linked phenomena of extreme events. Research funded by the WRC will support the development of adaptive and mitigating strategies which will ensure the future sustainability of the country's water resources and services.

As the WRC aims to provide appropriate knowledge to further improve South Africa's ability and capacity to govern and manage its water resources, its research portfolio has to continue to incorporate various water uses in relation to applied land uses, with emphasis on issues of water quality, quantity and accessibility. Research projects will also focus on resource protection and its sustainability.

The research portfolio for 2009/10 was set on the basis of the WRC's strategic plan. The WRC continued to invest in the creation of knowledge via its four main key strategic areas (KSAs). These areas include **Water Resource Management, Water-Linked Ecosystems, Water Use and Waste Management, and Water Utilisation in Agriculture**. In general, the portfolio as planned for the year under review was well-received by the various stakeholders. These research KSAs are supported by the **Water-Centred Knowledge** KSA. This structure continued to form the core operating framework for WRC-funded R&D and was further consolidated during the year.

**Water Resource Management** – During the year under review, research led by this KSA shifted focus from supporting policy-making to providing guidance for policy implementation and the development of policy instruments. The research carried out was done with the aim of providing the necessary information systems, guidelines, decision-support systems, prediction tools and technologies/methodologies that support planning, development and protection of water resources in practical ways. Climate change has received considerable focus in this past year making sure that a number of studies have started to

support the country in facing the imminent impacts of climate change. The decentralisation of the management of water resources, which is still in its infancy, has been supported by information systems mainly supporting local decision-making, and a number of research projects have addressed this specific need. The strong emphasis of the National Water Act (NWA) on stakeholder participation in water resource management has resulted in a number of studies supporting mainly the decentralisation of governance arrangements. Ground-breaking research on pricing, value chain and service delivery in the water resource management arena has been initiated to support the above at a national level. Research in this KSA has highlighted the emerging trends and reflections from the implementation of the NWA to date: what has worked and what has not. This was addressed by exploring scenarios and by making future projections for policy review and bench-marking. During the year under review, internationally shared rivers and their role in regional cooperation and stability resulted in the initiation of research defining the suitable pathways for engaging local management institutions in such international agreements.

**Water-Linked Ecosystems** – Research in this KSA put strong emphasis on the creation of knowledge aimed at protection and ensuring the utilisation and sustainable management of water-linked ecosystems in our water-scarce country during a time of demographic and climate change. Research portfolios within this KSA promote relevant and critical issues about conservation of aquatic ecosystems in order to provide the knowledge for their sustainable functioning in terms of the national legislation, commitments to international conventions, and the ongoing provision of goods and services which ecosystems deliver. This research develops the understanding of the ecological processes underlying the delivery of goods and services and provides the knowledge to sustainably manage, protect and utilise aquatic ecosystems. Three main research areas were addressed during 2009/10, including research on ecosystem processes, i.e., the biophysical processes, form and function of ecosystems; ecosystem management and utilisation, including issues such as the ecological Reserve; and ecosystem health and ecosystem rehabilitation (estuaries, rivers and wetlands).

**Water Use and Waste Management** – During the year under review, this KSA focused mainly on research for the domestic, industrial and mining water sectors. The aim was to proactively and effectively lead and support the advancement of technology, science, management and policy relevant to water supply, waste and effluent management, for these sectors. The KSA continued to support studies on appropriate technologies for improving the quality and quantity of our water supplies for domestic use, with a focus on water supply and treatment technology serving urban, rural, large and small systems. Greater emphasis has been put on aspects related to energy efficiency and generation in the supply of services, reuse and beneficiation from water supply and wastewater treatment, as

well as adaptation and mitigation strategies at a water services level to deal with future challenges associated with climate change. Waste and effluent, as well as reuse technologies that can support and improve management in the municipal, mining and industrial sectors, were also addressed, and innovative as well as integrated solutions for water and waste management in the industrial and mining sectors were studied. The research areas included water services (institutional and management issues); water supply and treatment technology; sustainable municipal wastewater and sanitation; industrial and mine-water management; and sanitation and hygiene education.

**Water Utilisation in Agriculture** – Research carried out in this KSA aimed at increasing household food security and improving the livelihoods of people at farming, community and regional levels, through efficient and sustainable utilisation and development of water resources in agriculture. More specifically, this research focused on increased biological, technical and economic efficiency of water use, the reduction of poverty through water-based agricultural activities, increases in profitability of water-based farming systems, and the sustainable use of water resources through protection and restoration practices. All agricultural sub-sectors are addressed including irrigated and dry-land agriculture; woodlands and forestry; grasslands and livestock watering; fisheries and aquaculture. During 2009/10 emphasis was placed, through new projects, on the water use of trees/crops and on what areas are suitable for biofuel production, based on bio-climatic criteria; impacts of micro-organisms found in irrigation water on food safety; modelling of water use, biomass production and economic value of indigenous trees under plantation conditions; incentives and organisational structures for empowerment of women and including emerging farmers in rain-fed and irrigated agriculture in the mainstream of the economy; GIS-based methods to monitor the extent of salinisation; precautionary measures for wastewater use; and adaptive practices to reduce vulnerability of farming systems to climate change. This research output will support development and application of approaches, models, techniques and guidelines for efficient and beneficial agricultural water management.

### Supporting research projects

During the year under review, the WRC supported 284 research projects, of which about 80% (227 projects) were active projects (ongoing and new) and about 20% (57 projects) were finalised. The active projects comprised 165 ongoing projects and 62 newly-initiated projects that commenced during 2009/10. The various mechanisms of funding included both non-solicited projects, accommodating projects within the broad research strategy of each KSA, and solicited projects, where research projects are developed in accordance with clear terms of reference, aimed at solving specific problems. The WRC supported 105 solicited projects, which translates to about

46% of active projects. During the year 20% of the projects (57 projects) were finalised.

Over the past four financial years there has been a clear trend of an increase in solicited projects, reaching about 100 projects for the year under review, i.e. about a third of all research projects. The increase in number of solicited projects is due to both a strategic drive by the various KSAs and the multi-year nature of such projects. Solicited research projects are medium- to long-term, consortia-based, and address complex issues, often calling for more than one research discipline and a substantial budget.

During the past 5 years the WRC has finalised 353 research projects, indicating a significant contribution to knowledge in the water sector. Over the same five-year period 317 new projects were initiated, ensuring the continuous contribution of new knowledge to the sector. In the year under review as well as in the previous financial year the number of finalised projects reported on was very similar to the number of new projects started in these specific years, indicating a stable number of active projects of about 227-230 which can be effectively managed by the organisation.

Total investment in the support of knowledge creation, sharing and dissemination amounted to R115.3 m. This represents a decrease of less than 1% from the previous year (R115.7 m. total investment was reported in 2008/09). This investment includes about R2.0 m. for the Water Information Network (WIN-SA), R6.2 m. for the Framework for Education and Training in Water (FETWater), and other income leveraged for research projects during the year under review. Both the investments in research projects and in research support, expressed as a percentage of total expenditure, were close to the set budgeted ratios and almost identical to that of previous years. The ratio addressing funding of the creation of new knowledge (research projects only) is 62%, compared to 65% in 2008/09, and is 1% lower than the planned ratio of 63%. The ratio for research support is 73%, compared to 75% in 2008/09, and is about 1% lower than the planned ratio of 74%.

### **Leveraging income for the creation, sharing and dissemination of water-centred knowledge**

During the year under review the WRC continued to leverage levy income by striving to obtain funds from other sources to support water research. During 2009/10 this drive has been highly successful. The WRC income originating from sources other than the levy for 2009/10 amounted to R18.5 m. Leveraged income included funds allocated to a number of KSAs for direct support of research projects and funds provided for capacity building, knowledge sharing and dissemination (e.g. WIN-SA and FETWater). Leveraged income was obtained from both local and international sources, where the main source of income was due to support by various government departments for specific research and other knowledge-sharing

projects. Sources of income other than the levy for 2009/10 amount to about 17% of the total income.

## **BUILDING CAPACITY**

The WRC aims at providing South Africa with future researchers as well as a source of skilled human capital for other institutions within the water sector. This is done by accommodating students conducting water research through the various projects supported by the WRC. During the year under review, the WRC continued to place strong emphasis on building research capacity in South Africa as well as supporting a number of related capacity-building initiatives in Africa. In many areas of research supported by the WRC, it is evident that students who participated in earlier WRC projects are currently leading WRC-funded research projects and are serving as members of steering committees as well as reviewers of new proposals.

### **Capacity building in 2009/10**

During the year under review the WRC continued to excel in its support to students, with special emphasis on historically disadvantaged students. In 2009/10, 562 students were supported by WRC projects, of whom 356 or 62% were from disadvantaged backgrounds. The percentage of students from a disadvantaged background remained stable at 62% compared to 61% in the 2008/09 financial year. Table 1 below reflects the number of students reported by the lead organisations contracted by the WRC in the 2009/10 financial year.

**TABLE 1****Number of students involved in WRC projects in 2009/10**

<b>Contract Lead Organisation</b>	<b>No. of historically disadvantaged (HD) students</b>	<b>Total no. of students</b>
African Centre for Water Research	4	4
Agricultural Research Council	10	14
Althydro	3	3
Aquagreen Consulting	2	5
Arcus Gibb (Pty.) Ltd.	2	4
ASSET Research	3	13
Association for Water and Rural Development (AWARD)	0	3
Biostream	2	3
Bunker Hills Investment	1	3
Cape Peninsula University of Technology	9	10
Council for Scientific and Industrial Research	21	34
CPH Water	0	1
DH Environmental Consulting CC	3	9
Digby Wells and Associates	4	5
Emanti Management	1	1
GEOSS (Geohydrological and Spatial Solutions)	0	2
Golder Associates Africa (Pty.) Ltd.	4	6
Groundwater Africa	0	1
Institute of Natural Resources	3	5
Jeffares & Green (Pty.) Ltd.	1	3
Maluti Water and Community Engineering Services	1	1
Nelson Mandela Metropolitan University	4	14
Nemai Consulting	1	1
Ninham Shand Consulting Engineers	1	1
North-West University, Potchefstroom Campus	0	3
Onderstepoort Veterinary Institute	1	1
Partners in Development (PID)	4	6
Pegasys Strategy and Development (Pty.) Ltd.	1	2
Pegram and Associates (Pty.) Ltd.	2	3
Prime Africa Consultants (previously CIC International)	1	2
Process Optimisation and Resource Management	2	2
Proxa (Pty.) Ltd.	1	3
Pulles, Howard and de Lange Inc.	3	3
Rhodes University	6	9
Rural Integrated Engineering (Pty.) Ltd.	10	12
SASRI	1	2
Sigma Beta	6	10
Sinelwati Scientific Research & Management	1	1
South African National Biodiversity Institute (SANBI)	2	2

Contract lead organisation	No. of historically disadvantaged (HD) students	Total no. of students
Sustento Development Services	0	1
The Council for Geoscience	1	1
The Impact-Free Water Group	1	2
The Mvula Trust	1	1
Tshwane University of Technology	12	12
Umgeni Water	5	5
Umvoto Africa	0	1
University of Cape Town	24	45
University of Fort Hare	17	17
University of Johannesburg	1	1
University of KwaZulu-Natal (all campuses)	40	72
University of Limpopo	5	6
University of Pretoria	37	52
University of Stellenbosch	22	50
University of the Free State	11	27
University of the Western Cape	30	31
University of the Witwatersrand	6	14
University of Venda	9	10
Water for Africa	3	6
Zitholele Consultants (Pty.) Ltd.	0	1
<b>TOTAL</b>	<b>346</b>	<b>562</b>

### Capacity building initiatives

In addition to its support for the training of students the WRC has initiated and supported a number of national capacity building initiatives. These include support to national and local government as well as the development of new training material for different levels of learners and for academic institutions. Examples of such initiatives are given below:

The WRC serves on the **Skills Development Strategic Task Team** of the **Water Sector Leadership Group**. The task team consists of representatives of the LG and E-SETAs (Sector Education and Training Authorities), Department of Cooperative Governance and Traditional Affairs (CoGTA), Development Bank of Southern Africa (DBSA), South African Local Government Association (SALGA), National Treasury, key consultants, the WRC and the Department of Water Affairs (DWA).

The WRC continues to lead the establishment of a **Technical Assistance Centre (TAC)** to assist rural water service providers. The establishment and piloting of the first national TAC for small wastewater treatment works arose from a need to provide technical expertise and management assistance to small- to medium-sized water treatment plants which experience serious

challenges with compliance and sustainability. Pilot projects are currently being undertaken in the Eastern Cape Province (where major challenges exist) and the Western Cape Province (as parallel best practice support) to help build an understanding of the frameworks and mechanisms required for a sustainable large-scale national rollout of such a centre.

A national drive was undertaken to support the implementation of the **Water Administration System (WAS)** for effective water loss control and increased water savings on irrigation schemes. This involved formal discussions with, and sending letters to, amongst others, officials of DWA and AgriSA; funding a consultancy to develop training material for presenting courses on WAS to water control officers; finalising and publishing the report on the impact assessment of the research for development of WAS; and publishing articles in *The Water Wheel* (November/December 2009), *SABI Magazine* (February/March 2010) and the magazine *Agri* (Winter 2010), to demonstrate the practical relevance of WAS.

During the year under review, the WRC continued to act as the DWA implementing agent for **Framework for Education and Training in Water (FETWater)**. This is a key national capacity-building initiative aimed at the development of competencies

and capacity regarding water resource management. FETWater is a joint UNESCO, Belgian and South African programme which is currently in its second phase. Phase II of this programme has progressed well under the custodianship of the WRC. During 2010, an assessment study on the impact of the FETWater programme on South Africa's water sector was conducted. The assessment showed that the FETWater programme was well managed by the WRC and that the programme realised outstanding achievements (output and outcome) under the guidance of the WRC.

The WRC continued to serve as the implementing agent for DWA for the **Water Information Network (WIN-SA)**. This is in response to the recognition that competence at local government level is critical. WIN-SA is aimed at knowledge sharing and capacity building for local government. The 2009/10 financial year was a difficult year for WIN-SA due to unclear funding sustainability. However, even against the sudden shock of lack of funding commitment for the year, WIN-SA continued to generate knowledge targeted at local government. The activities of WIN-SA were reduced in light of the situation. The group continued to develop lesson plans and delivered several other knowledge-sharing products on:

- Water conservation and demand management
- Asset management
- HIV/AIDS, sector collaboration and water quality
- Free basic water
- Mine-water reclamation within the national benchmarking initiative
- Wastewater treatment plants and capacity building
- Collaboration, partnership, leveraging in infrastructure development

WIN-SA has also launched a social network (<http://waterinformationnetworking.com>) which continues to grow. Since its establishment in July 2009, there are 193 members. Members of the network are taking ownership of the platform and use it to raise issues and facilitate discussions.

## INNOVATION AND KNOWLEDGE APPLICATION

The WRC supports the protection and transfer of innovative methods and technologies that may result from WRC-funded research, where and if required. Some technologies, processes and products require commercial involvement in order to make them publicly available and some academic organisations have required WRC support in this regard.

During 2009, the WRC filed three patent applications, two of which are national phase applications (South Africa and Australia) based on the PCT (Patent Cooperation Treaty),

entitled 'Treatment of wastewaters using dual stage membrane bioreactors'. A third patent was only filed in South Africa and is entitled 'Reverse flow microfiltration'. This technology emanates from an innovation from a recently completed WRC project undertaken by the Durban University of Technology. The main aim of this project was to develop a robust, inexpensive and sustainable water treatment unit for rural areas, based on the woven fibre microfiltration fabric. The treatment unit is being piloted in the northern part of the Eastern Cape and has been demonstrated to approximately 30 local and district municipalities in a WRC workshop held at one of the villages undertaking the pilot trials.

In addition, the WRC has a number of patented innovations that are already licensed out. Currently, the WRC has licence agreements with 13 reputable South African companies. These include one royalty-earning innovation, i.e. **The Secondary Metabolites**, a cluster of 13 patents, currently licensed to Synexa-Life Sciences; the WRC has been receiving royalties since 2006. Two other licensed innovations are currently undergoing further development: the **BioSURE™ Process**, a cluster of 36 patents which is licensed to ERWAT, and the **Ambient Temperature Ferrite Process (ATFP)** for removing iron from acid mine drainage, which is currently licensed to Environmental Technology Agencies (ETA). The newly patented technology, **Treatment of waste water using dual-stage membranes**, is being piloted. This technology was licensed to AtHydro in March 2010. The **Olive Wastewater Treatment Technology** was assigned to the University of Cape Town (UCT) and a benefit-sharing agreement was concluded.

Large-scale manufacturing and commercialisation of one of the WRC's licensed technologies, namely the **Capillary Ultra Filtration (CUF)**, is progressing well. On 29 October 2009, Ikusasa Water launched the capillary ultrafiltration membrane technology manufacturing plant in Somerset West. The ultrafiltration membrane technology produces high quality water by conventional treatment without the use of chemicals. Most membranes used in South Africa are imported at great cost. This innovation provides suitable and cost-effective, locally-produced, ultrafiltration membranes and filtration systems for use in water treatment and industrial water management.

## KNOWLEDGE REVIEW 2009/10

What follows is a summary of the WRC's investment in the creation and sharing of water-centred knowledge, over the 2009/10 financial year. This reflects the organisation's strategic focus based on assessment and integration of the needs, opportunities and priorities presented by the current context and challenges facing the water sector in South Africa, and globally.

# KSA 1: WATER RESOURCE MANAGEMENT



*Ms Eiman Karar:  
Director*

## SCOPE

The **Water Resource Management** KSA will take account of pertinent developments taking place in the implementation of the National Water Act of 1998. As such, the focus will continue to be guided by the Bill of Rights, the Constitution of South Africa, Section 27 (1)(b): 'everyone has the right to have access to sufficient water', and by the principles and objectives of the said Act (NWA). The primary principle of the Act is that water resources should be managed to achieve optimum long-term social and economic benefits for all without compromising environmental integrity. This implies maintaining an optimum balance between protection of the environment and use of water for human welfare. The supporting principles are incorporated strategically in the DWA strategy for water for sustainable growth and development and as reflected below:

- The basic human needs of present and future generations
- The need to protect water resources
- The need to share some water resources with other countries
- The need to promote social and economic development through the use of water
- The need to establish suitable institutions

This KSA supports the implementation of the NWA by:

- Developing tools and technologies for overall water resource management
- Supporting decision making by reviewing existing policies and strategies
- Providing quick responses to immediate and specific research questions in support of national initiatives
- Providing platforms for debate
- Building capacity in project teams and steering committees

- Disseminating resultant information as widely as possible
- Encouraging partnerships through joint projects with key stakeholders

In recent years, the research focus in this KSA has been shifting from supporting policy-making to providing guidance for policy implementation and the development of policy instruments in accordance with the needs of the sector. The challenge for research in this KSA is to provide the necessary information systems, guidelines, decision-support systems, prediction tools and technologies/methodologies that support planning, development and protection of water resources. The human capital challenges have necessitated more focus on applied research and hands-on experience sharing for research teams and research steering committees. The NWA places emphasis on stakeholder participation in water resource management which forms a blend between the decentralisation and democratisation for decision making. Vast resources have been used in ensuring that adequate consultation takes place without necessarily reflecting value returned from those investments. International literature confirms that empowerment is a long path which is progressive in nature and highly non-linear. Since the focus, primarily, is to make an impact on the lives of people, the KSA has commissioned studies to test the lowest appropriate level for decision making in water management, the benefits derived from such engagements and their impact on women and the poor. The role of local government as the democratic representative of South Africa in water-related decision making has also received attention. Ground-breaking research on pricing, value chain and service delivery in the water resource management arena is required for financial sustainability at a national level in support of economic growth and development. Research in this KSA is interrogating the emerging trends and reflections from the implementation of the NWA to date,

pertaining to the four impact areas – environment, economy, health, society: what has worked and what has not. This is envisaged to be achieved from the running scenarios and by making future projections for policy review and bench-marking. Furthermore, the need for comprehensive and integrated monitoring and regulatory framework is being benchmarked against international practices. Compliance and enforcement of provisions in the Act exacerbate an already stretched sector whose absorptive capacity for research findings is limited. Internationally-shared water remains a strategic focus with particular research needs, and with emphasis on defining the suitable pathways for engaging local management institutions without compromising the sovereignty rule.

The support to the review of the National Water Resource Strategy continues unabated. New and improved methodologies for water resources assessments, development and protection continue to warrant a fair share of this KSA's investments. Other key aspects informing the research addressed by this KSA are issues related to climate change. Climate change and hydroclimatic variability can have serious implications on the triple bottom line (environmental sustainability, economic growth and social justice) and on sustainable development. The conjunctive use of surface water and groundwater should filter down to addressing seamless research needs for both social and economic development.

## OBJECTIVES

The main objective of research in this KSA is to ensure that the water resources of South Africa are protected, utilised, developed, conserved and managed to achieve environmental, social and economic sustainability. The revised aims to support the main objective are to:

- Develop a scientific understanding of the hydrological cycle (and inter-linkages) in order to promote a systematic assessment and variability of the quantity and quality of water available for development in South Africa
- Build up appropriate quantitative understanding, tools and adaptive strategies for managing the impacts of extreme climatic events (floods and droughts) due to global warming and human-induced impacts on water resources (including the understanding of the impact on human health)
- Provide control measures for improving the prevention, mitigation and control of pollution of water resources
- Support and improve policy reforms for promoting equitable, efficient and sustainable conservation and allocation of water resources among competing needs

These objectives are achieved in support of the desired impacts on the lives and health of people, on the economy and on the environment. In view of the above revised aims, the thrusts have been realigned as follows:

- Thrust 1: Water Resource Assessment and Planning
- Thrust 2: Management of Natural and Human-Induced Impacts on Water Resources
- Thrust 3: Water Resource Protection
- Thrust 4: Water Resource Institutional Arrangements

## THRUSTS AND PROGRAMMES

In the interests of fully articulating climate change research and grouping the water management research family under one thrust, Programmes 5 and 6 in Thrust 1 dealing with climate variability and water quality management have been moved to Thrust 2 as a consequence of human-induced impacts. Thrusts 3 and 4 remain unchanged.

### THRUST 1: WATER RESOURCE ASSESSMENT AND PLANNING

**Scope:** This thrust focuses on developing a scientific understanding of the hydrological cycle (and inter-linkages) in order to promote systematic water assessment and planning. The thrust will promote better understanding of the variability of the quantity and quality of water available for use and development in South Africa. Recent changes in national water resource infrastructure management, the awareness of the poor state of water resource infrastructure and increased knowledge of water resource planning needs are expected to receive attention, through the support of competent and sustainable solutions. Sound water resource assessment and planning can only be achieved with reasonably accurate and consistently recorded and processed data and information. The thrust will support the implementation and use of a national water resource information system.

- Catchment data and information systems
- Surface water / groundwater hydrology
- Water resource planning
- New water

### THRUST 2: MANAGEMENT OF NATURAL AND HUMAN-INDUCED IMPACTS ON WATER RESOURCES

**Scope:** Research in this thrust focuses on developing appropriate understanding, tools and strategies for managing the impacts of climate variability and change as well as human interventions on the hydrological cycle and related water resources, with the aim of supporting the development of policy responses, at regional, national or catchment scale, to existing and emerging problems. This includes development of systems (e.g. river flow and inundation forecast models, drought-impact monitoring systems) for the management of floods and droughts.

- Developing mitigation and adaptive measures for global climate change
- Land-use management planning
- Hydroclimatic variability
- Integrated flood and drought management

### THRUST 3: WATER RESOURCE PROTECTION

**Scope:** Research in this thrust focuses on the generation of information and understanding in order to improve water resource management, with reference to point sources and diffuse sources, and addressing chemical, microbial, and biological pollution impacts on surface water and groundwater. This thrust will also address water resource protection from flow-reduction processes as well as other physical processes such as sediment accumulation. Scientific and technological approaches that will assist in characterising and addressing these problems include: (1) Assessment, prediction and decision support; (2) Basic science (e.g. data and methods for evaluation of multi-scale interdependencies, uncertainty, etc.); (3) Technological innovation and (4) Implementation approaches and technology transfer options.

- Protection and management of surface water and groundwater quality
- Urban and rural water resource management
- Integrated river flow and catchment hydraulics

### THRUST 4: WATER RESOURCE INSTITUTIONAL ARRANGEMENTS

**Scope:** This thrust focuses on articulating the thinking for the new roles and responsibilities of the various stakeholders based on catchment and water management area boundaries. The marked shift from central management of resources to a more localised scale is critical to the main founding concepts of integrated water resource management (IWRM). The defined management boundary based on watershed boundaries is another fundamental provision in IWRM as a concept. This thrust supports research on tools and methodologies for IWRM decision support which aims to provide strategic intervention for new policy development and to improve the understanding regarding the effective functioning of institutional structures for implementing IWRM through:

- Institutional governance and reforms
- Regulation, compliance and enforcement
- Pricing and financing of IWRM
- Transboundary water resources
- Future scenarios

## RESEARCH PORTFOLIO FOR 2009/10

From the needs analysis, the KSA has and will continue to actively pursue the full articulation of the coming new challenges in water resource management. These challenges are not necessarily new but can be viewed in different combinations each year and with newly-defined priorities. Continuing to monitor the impact of the KSA's research investments on society, environment, health and economy is a means to maintain a focus on the ultimate objective of research – making a difference. Competition over scarce or inequitably allocated resources can lead to tension and insecurities. Strategies for

reducing demand, increasing efficiency, and tapping into new water resources from targeted recycling, reuse, artificial recharge, etc., will be important research topics fully aligned to the fledgling DWA strategy of *Water for Growth and Development* (Version 6). Water as an economic good and aspects of valuing water in the South African context can be complicated, due to the prevalent inequities in distribution of the resource and the large proportion of the population whose ability to pay for water is limited. In all of the above, the need to safeguard society and the economy through early warning systems has been identified. Research results need to be shared and communicated effectively to be optimally used for the benefit of South Africa and further afield. Finally, water governance, which has received a lot of attention recently, continues to occupy centre stage in the water sector, bringing with it tremendous uncertainty and also optimism, from a continued desire for improvement and self reflection. This KSA will continue to be willing to support these processes for a more locally suitable and resilient institutional landscape in the water sector.

During the past funding cycle the research community has been given an opportunity to respond to the water resource management challenges through both the solicited and the non-solicited proposal streams of funding. The plan for 2009/10 was informed by the needs expressed by the then Minister of Water Affairs and Forestry and the then former Director-General of DWAF, as well as the interests identified by the then former Department of Environmental Affairs and Tourism (DEAT) during the Conference of the People (COP 14) organised by the Inter Governmental Panel on Climate Change Convention (IPCCC). DEAT, which led the delegation, made up of representatives from Water Affairs and Forestry, Trade and Industry, Science and Technology, Treasury, Foreign Affairs, Transport, and the South African National Biodiversity Institute (SANBI), expressed the need for better understanding of the climate change impacts on water resources, especially in view of the Ministerial strategy of *Water for Growth and Development*. It was hence seen fit to allow for a sole solicitation of proposals in the area of climate change for the 2010/11 cycle. This will be the start of relatively large investments in this new and important area of research. This did not mean that there were no funds to support other research – the ratio between solicited and unsolicited research for 2010/11 remained equally distributed to allow continuity for supporting innovation and new ideas in other fields that are no less important to South Africa.

## BUDGET FOR 2009/10

The approved funding of the research portfolio for 2009/10 led to a committed funding budget of R22 518 664 (inclusive of roll-over). Funding of R5 943 610 was requested to support new projects within the four thrusts. The proposed new projects will continue to develop tools, technologies and guidelines that are necessary to support sustainable water resource management.

# CORE STRATEGY

## Strategic context

To address water resource challenges which are likely to emerge in the next 10 to 15 years, decision makers at all levels of government will need to make informed choices among often conflicting and uncertain alternative actions. These choices are best made with the full benefit of research and analysis. It is therefore of great importance that the nation will continue to invest not only in applied research but also in fundamental research that will form the basis for national implementation of water sector projects.

Water resource assessments are expected to benefit from improvements in the accuracy and detail of hydrological measurements, and how these are interpreted in water resource simulations and other tools for water resource decision making. The extent to which interpolations and extrapolations can be used in modelling real water regimes can only suffice if real, reliable data are available at reasonable spatial and temporal resolutions for verifications. The KSA has invested vastly in enhancing the estimates for quantifying water use and water availability. This year, the KSA also plans to contribute to the streamlining and integration of existing centralised and decentralised water resource information systems in support of the *National Water Resource Strategy* and the National Information System.

At a national level the recent momentum towards establishing economic growth and development as the main government driver has seen different sectors, including the water sector, articulating their roles in economic growth and development. In the water sector this is reflected in the DWA framework strategy *Water for Growth and Development* (Version 6), where the main objective for water resource management is set to ensure that water resources are allocated for the promotion of social and economic development. In this KSA, research has already started and will continue to address the research issues that will contribute to this government driver of *Water for Growth and Development*.

The Department of Water Affairs indicated current water quality and quantity as major strategic issues. The WRC and this KSA recognise the challenge and the need for further research and the provision of knowledge in this regard. In future these issues will be complicated further with the advent of climate change. The issue of climate change and the linked phenomena of extreme events require both understanding and adaptability. Another linked area is that of energy, including usage of energy by the water sector and production of energy through hydropower. In the light of the above, the importance of expanding the resource via additional or alternative sources of water and diversifying the 'water mix', as reflected in the

*Water for Growth and Development* strategy, is another key challenge. The KSA will continue to support innovative research on the potential use of hydropower, groundwater artificial recharge, global circulation models for better regional climate impact assessments as well as regional evapotranspiration assessments, water reuse and recycling as further sources for 'new water'.

The KSA's contribution to the national strategy for growth and development is through conducting research that can yield impacts on society, economy, health and environment as defined in the strategy and the WRC's impact areas: water and society, water and health, water and the economy, and water and the environment

## Needs analysis

The working approach for setting and overseeing the water resource research agenda is based on the following principles:

- An effective alliance with, and active participation of, water resource research stakeholders
- A systematic, strategic, and balanced agenda of both core- and problem-driven research priorities set to meet short- and long-term needs
- The national water resource research effort should be coordinated to reduce needless duplication and to ensure that gaps do not occur
- Research should be multidisciplinary and interdisciplinary
- Research should be proactive and anticipate the nation's water needs and the environmental impacts of management options
- Research should be accountable to the public to assure that the water resource research investment has been appropriately utilised to meet the nation's needs

In the current situation where demand for water is increasing, the impact of climate change is intensifying and storage sites are reaching capacity, South Africa is looking to new strategies that will reduce demand, increase efficiency, provide for reuse of wastewater and allow for water trading. The knowledge emanating from research undertaken by this KSA aims to inform the decision process regarding where and how best to invest in these options and to provide enabling technologies.

The methodologies followed in this needs analysis process are varied and include:

- Stakeholder workshops
- Documents, e.g. *National Water Resource Strategy* and the DWA strategy *Water for Growth and Development*
- Focal group and individual interviews
- Interpretation and reinterpretation of research outcomes
- International/regional forums
- Strategic studies

Some of the pertinent issues related to the development of the research portfolio are:

### ***Managing risks***

Water-related hazards, such as floods, droughts, tropical storms, erosion and various kinds of pollution should be factored into any integrated approach to water resource management and policy. Although it is the world's poor who suffer the most when exposed to such dangers, everyone's security is at stake. One way to minimise risk is to develop more capacity in the monitoring and forecasting of extreme events. With this information, appropriate early-warning systems and infrastructure can be installed, and new planning strategies devised. It is also necessary to ensure that climate variability and change have their place in the total picture to obtain the transition from risk to resilience.

### ***Sharing water resources***

Competition over scarce or poorly-allocated resources can lead to tension and insecurity. Therefore decision-makers, communities, governments and regions must strive to develop policies that allow for sharing among all stakeholders. Many different interests are at stake and equitable solutions must be found: between cities and rural areas, rich and poor, arid lands and wetlands, public and private, infrastructure and natural environments, mainstream and marginal groups, local stakeholders and centralised authorities. At the regional and international level, many river basin and aquifer authorities are developing integrated approaches that stress cooperative management of the shared resource.

### ***Valuing water***

This question is among the most controversial of all the challenges identified in the Ministerial Declaration emerging from the *Second World Water Forum* in The Hague. In many societies the notion of putting a price tag on something as intrinsically valuable as water is unacceptable. Yet services must be paid for. There is also much disagreement about how to balance the costs of water provision and wastewater treatment with the goal of equity and finding ways to meet the needs of poor and vulnerable populations. Creative new partnerships between the public and private sectors should be developed, along with accounting and taxation systems that take full account of environmental and social factors.

### ***Ensuring the knowledge base***

This target takes account of the whole range of technical and non-technical information and knowledge, and seeks ways for all societies to benefit from their development, exchange and dissemination. National authorities and resource managers need sound scientific data on which to base their projections and decision-making. Stakeholders need access to other kinds of information and educational opportunities if they are

to understand and participate in the process as responsible citizens. With the development of modern telecommunications and the global marketplace, it is more necessary than ever to ensure that every community and country play a role in building a more sustainable future.

### ***Governing water wisely***

This challenge area is particularly complex and sensitive. It moves the debate about sustainability beyond water management issues and into processes of political, social and institutional change. Many countries agree that good governance means allowing every sector of society to participate in the decision-making process and that the interests of all stakeholders should be taken into account. However, mechanisms for doing so are not always in place, even if decentralisation and the increasing involvement of civil society are worldwide trends. International cooperation and assistance may play a crucial role, particularly in developing countries, by helping to strengthen institutional capacity.

### ***Research needs/issues***

- Impacts of climate change on people, the economy and the environment
- Support the national information systems on water resources improving the available water resource information, better management of information and enhanced information dissemination to stakeholders, especially CMAs
- Integration of surface water and groundwater assessments, explorations, planning and management
- National infrastructure development and management needs to meet the national growth target of 6% of GDP per year
- Adequate forecasting for flood management and disaster mitigation and preparedness
- Water quality control, mitigation measures in support of municipalities
- Evaluation and mitigation of the health impacts from human activities on surface water and groundwater
- Groundwater contamination impact on communities relying on sources for drinking water
- Challenges for sustainability of urban systems
- Institutional arrangements for regional water resource development to meet the Millennium Development Goals
- Decision support systems for CMAs
- Alignment of catchment management strategies, local economic development plans, IDPs, etc.
- Water use charges and the sustainability of water management institutions
- Benefit sharing in the management of transboundary waters

Another very important achievement in the South African sector, the *National Water Resource Strategy* (NWRS), developed and published in 2004 after a comprehensive public consultation

process, is due for review in the coming years. Required by the NWA, the NWRS provides information about ways in which water resources will be managed, including the institutions to be established. This KSA will support the implementation of the NWRS in the following broad ways:

- Through integrated water resource assessment (developing knowledge of the different components of the resource in terms of quantity and quality and its condition in relation to reference conditions)
- By developing and refining tools and methods to support implementation of resource directed measures and source directed controls
- By providing greater understanding of threats to water resources such as global climate change, water resource degradation, over-commitment of the resource, and impacts of land use and water storage and diversion on the water resource
- By providing tools for the assessment of policy and management options (such as re-allocation of water between users, modelling, decision-support systems, and predictive tools)
- By providing data and tools for assessment of the progress of resource management programmes, and their successful refinement

### Overview of technological trends

**Climate change:** In 2007 The National Climate Change Committee (NCCC) mandated DST to lead a Technology Needs Assessment (TNA) in relation to climate change. The TNA shows that, despite remaining uncertainties regarding the exact nature, magnitude and pattern of future rainfall changes in South Africa, it appears that water resources, already under pressure as a result of growing water demand in relation to a finite and limited supply, will be under even greater pressure in the future as a result of climate change. According to the IPCC technical paper on Climate Change and Water of June 2008, which agrees with the South African situation, the major gaps in observations of climate change related to freshwater and hydrological cycles are identified as follows:

- Difficulties in the measurement calculated from parameters such as solar radiation, relative humidity and wind speed. Records are often very short, and available for only a few regions, which impedes complete analysis of changes in droughts.
- There may be opportunities for river flow data rescue in some regions. Where no observations are available, the construction of new observing networks should be considered.
- Groundwater is not well monitored, and the processes of groundwater depletion and recharge are not well modelled in many regions
- Monitoring data are needed on water quality, water use and sediment transport
- There is a general lack of data from the Southern Hemisphere
- More information is needed on plant evapotranspiration

responses to the combined effects of rising atmospheric CO<sub>2</sub>, rising temperature and rising atmospheric water vapour concentration, in order to better understand the relationship between the direct effects of atmospheric CO<sub>2</sub> enrichment and changes in the hydrological cycle

- Quality assurance, homogenisation of data sets, and inter-calibration of methods and procedures could be important whenever different agencies, countries, etc., maintain monitoring within one region or catchment. Better observational data and data access are necessary to improve understanding of ongoing changes, to better constrain model projections, and are a prerequisite for adaptive management required under conditions of climate change. Progress in knowledge depends on improved data availability. Shrinkage of some observational networks is occurring. Relatively short records may not reveal the full extent of natural variability and confound detection studies, while long-term reconstruction can place recent trends and extremes in a broader context.

**Remote sensing:** Data monitoring using remote sensing is undergoing a revolution in terms of technical monitoring capabilities through the advances in spatial and spectral resolution of new sensors. The continuing improvements to the analysis are also expanding the level of detail that can be extracted from imagery. One of our research projects is now applying hyperspectral imagery to accurately estimate evapotranspiration, plant water content, water stress and plant- or soil-water availability. Unlike low-spectral resolution imagery which covers only selected regions of the electromagnetic spectrum, thus giving more generalised products, high-spectral resolution imagery covers a wide region of the electromagnetic spectrum (approximately 400 to 2 500 nm). This gives more spectral bands with finer bandwidths (generally less than 10 nm). The finer spectral resolution allows for detection of surface materials and their abundances, as well as inferences of biological and chemical processes.

**Satellite radar tools and applications:** Wider availability and use of satellite radar in water-use and evapo-transpiration monitoring. Our research has continued to investigate new techniques for improving measurements and estimates of evapotranspiration and other variables in the water balance. Most of our users are, however, still stuck in the use of outdated and less reliable sources of information such as open water evaporation data. Our research on evapotranspiration is now looking at how the knowledge gained can be incorporated in some of the commonly used water management tools. Water legislation and management guidelines are clearly showing that spatial processes such as those in water catchments and in land-use management practices will be driven by remotely sensed data in the future. In July 2006 the South African Cabinet approved the establishment of South Africa's first space agency, an initiative that heralds the wider development of many local and new research activities around satellite development and satellite data applications.

**Scenario building as a tool in water management:** Scenarios are a way of developing alternative futures based on different combinations of assumptions, facts and trends, and areas where more understanding is needed for any particular scenario project. They are called 'scenarios' because they are like 'scenes' in the theatre - a series of differing views or presentations of the same general topic. Once several scenarios are produced at the same time, one can better understand the available options or possibilities for informed decision making in the management of water resources.

### Key stakeholders

The major stakeholders remain to be the following five groups:

- The Minister of Water and Environmental Affairs as the shareholder
- Government departments representing a major group that has a large stake in the research conducted, especially DWA, which represents the water resource managers and planners, i.e. all those entrusted with developing and allocating water resources to meet the needs of the environment and various users
- Other departments such as the Department of Minerals and Energy, the Department of Science and Technology, the Department of Provincial and Local Government, the National Department of Agriculture, the Department of Health, the Department of Education, the Department of Environmental Affairs and the Portfolio Committee on Water represent the other stakeholder groups
- Major water users including farmers, mines, industries, water service providers and civil society
- South Africa shares many rivers with its neighbouring countries, therefore, the governments and major water-user groups from these countries constitute the fourth group of key stakeholders. South Africa is also a signatory to several international conventions that govern water resource management at all levels.

## STRATEGIC INITIATIVES

### National initiatives

Staff members continue to occupy various leadership positions and partake in initiatives. The following are contributions made by the KSA:

- The KSA is a member of the National Climate Change Committee which is a non-statutory stakeholder body that advises the Minister of Water and Environmental Affairs on water-related climate change issues at national and regional level
- Continues to coordinate the research collaboration between France and South Africa under the auspices of the Department of Science and Technology (DST) SAFe Water
- Is a member of the DWA climate change think tank under the chairmanship of the Director-General of DWA.

- Member of steering committee for the drafting of a National Groundwater Strategy (DWA).
- Supported the DWA in conceptualising and developing the National Climate Change Response Strategy
- Supporting the South African Academy of Science in conducting a study on the status of water resources in South Africa
- Supporting the Water Sector Leadership Group in defining water resource regulations through DWA
- Cyanonet initiative to collaborate with DWA on cyanobacteria blooms and to establish a web-based identification system
- The KSA initiated involvement in the cyanobacterial bloom problem and animal deaths in the Kruger National Park through its project with ARC Veterinary Institute.
- Member of DWA's project steering committee for the Vaal River System: Development of Integrated Water Quality Management Plan Study
- Member of DWA's project steering committee for the National Eutrophication Monitoring Programme
- Member of DWA's project study team for the Development of South African Risk Based Water Resource Quality Guidelines
- Member of DWA's project steering committee for the National Radioactivity Monitoring Programme
- Member on the DWA's flagship project on water allocation reform
- As part of the review of the Pricing Strategy, the KSA is heading the working group dealing with 'Water Management'
- Member of the DWA Institutional Alignment Working Group.
- Member of the regulation task team of the Water Sector Leadership Group
- Steering committee member of NIP (National Implementation Programme) of the Stockholm Convention on POPs (persistent organic pesticides)
- Member of South Africa Committee for the International Association of Hydrological Sciences
- Member of the National Water Resources Planning Systems User Forum
- Member of the technical steering committee of the Working for Water Hydrology Review Panel
- Member of the steering committee of the National Groundwater Strategy.
- Member of the Integrated Water Resources Planning National Steering Committee.

### Leadership positions

- Council member of the Water Institute of Southern Africa (WISA)
- Chairperson of the Groundwater Division of the Geological Society of South Africa
- Member of the Advisory Board of Monash University, Water Node
- Board member of EcoLink, an NGO responsible for water

- harvesting implementation in Mpumalanga
- Chairperson of the River Basins Group in the International Waters (IW) Global Environmental Facility (GEF) project for reviewing the science value in all GEF projects

### Public appreciation

The impact study 'Assessing the impact of research funded by the Water Research Commission on **capacity building in the groundwater sector**' is now available. Key recommendations emanating from the study are being incorporated within the National Groundwater Strategy of DWA which will in turn inform the National Water Resource Strategy.

The **eutrophication research** impact study was finalised in 2009/10 and is aimed at providing a concise assessment of the accumulated impact from the research investments made to date in this field. The assessment considered; socio-economic, technical, political and environmental aspects.

Other activities included:

- Completed 2 baseline reports on 'Basement aquifers of Southern Africa' and 'The Karst system of the Cradle of Humankind World Heritage Site'
- A popular or layman's book on 'Groundwater in South Africa' has also been completed
- *The Journey of MmaTshepo Khumbane* was published in recognition of the role this water activist has played in water management
- A joint Inkomati CMA, WRC and DWA publication was prepared entitled 'Learning Strategy Framework for the Inkomati Catchment Management Agency'
- Launched *Water Resources of South Africa 2005 (WR 2005)* during the 14th SANCIAHS Symposium in September, 2009
- A lecture was presented on 'South Africa's water quality and emerging issues' to students enrolled for an M.Sc. in Integrated Water Management at the University of Pretoria

### African leadership

- The WRC continues to represent the South African Academy of Science in discussions addressing the development of capacity for managing water resources by the Inter-Academy Programme (IAP) for Water
- Hosting and chairing the Southern Africa regional office of the TIGER Initiative from December 2009 at the WRC
- Through a WRC consultancy the project: 'Groundwater Knowledge Sharing and Cooperation in SADC' was established. The project has been accepted and will be funded by GTZ.
- During the *2nd Africa Water Week* held in Midrand, 9-13 November 2009, a Research Manager presented on the impact of climate change on water resources in Southern Africa and the Indian Ocean Island States.
- *Fresh water under threat, Africa Report* was launched by the WRC and UNEP at the *Africa Water Week*.

- Another joint study between UNEP and WRC was completed on the 'Assessment of African Transboundary Water Vulnerability' which is available electronically
- The WRC was invited to a seminar entitled 'Monitoring and Evaluating the Implementation of IWRM' which was held in Tunis from 25-29 May 2009. The Seminar was organized by the Joint Africa Institute in partnership with the African Development Bank.
- Negotiating a strategic partnership with the Global Water Partnership (GWP) Southern Africa.
- The KSA participated by invitation in the Strategic Planning session of the Global Environment Monitoring System (GEMS)/Water Programme of the United Nations Environment Programme (UNEP), Nairobi Kenya. The program was established in 1978, under the auspices of UNEP, WHO, WMO, and UNESCO, and was implemented through the WHO at the National Water Research Institute (NWRI) in Burlington, Canada.

### International player

The WRC continues to support SAFewater (the French-South African cooperation for research on water). It also continues to act as the Secretariat for the UNESCO IHP national committee.

- The KSA is implementing a World Bank project entitled 'South African Groundwater Governance'. The case studies will analyse the economics and the political economy of groundwater management in seven selected countries – India, Kenya, Peru, Morocco, Philippines, South Africa, and Tanzania – to identify and develop key policy and governance issues (including cross-sectoral linkages) and to propose activities to support management needs under different socioeconomic and hydrogeological settings.
- During the *United Nations Framework Convention on Climate Change* (UNFCCC) meetings, held from 7-18 November 2009 in Copenhagen, the WRC participated in the negotiation process, as a South African team member dealing with Research and Observation
- Attended and acted as a facilitator in a climate change workshop on water at Cambridge University, 21-24 September 2009. During the same event, the KSA held workshop sessions on water-related research showcasing South Africa's research.
- A Research Manager was invited by the Director-General of Environment for the European Union in Denmark to deliver a presentation on the artificial recharge of groundwater as an adaptation option for climate change impacts, 23 -24 November 2009.
- The WRC hosted the international conference *Stakeholder Involvement in Transboundary River Basin Management*. The conference was attended by presenters from Uruguay, Argentina, Zambia, Botswana, Mozambique, Pakistan, Swaziland, Zimbabwe, Namibia and South Africa.
- Initiated discussions with the Swedish Water Institute (SIWI) for future strategic partnerships
- The KSA is an active member of the World Water Council

## GROWING THE KNOWLEDGE BASE

### Capacity building initiatives

The table below illustrates the number of postgraduate students who benefited from WRC-funded research in this KSA. This is in line with the set targets.

**TABLE 1**  
**Capacity building through student involvement in KSA 1 projects in 2009/10**

Organisation/institution	No. of historically-disadvantaged (HD) students	Total no. of students
African Centre for Water Research	1	1
Agricultural Research Council (ARC)	1	2
Council for Geoscience	1	1
CSIR	5	9
GEOSS	0	2
Golder Associates Africa (Pty.) Ltd.	1	1
Groundwater Africa	0	1
Institute Of Natural Resources	0	1
Jeffares & Green (Pty.) Ltd.	1	3
Maluti Water and Community Engineering Services	1	1
Ninham Shand Consulting Engineers	1	1
North-West University (Potchefstroom campus)	0	3
Onderstepoort Veterinary Institute	1	1
Pegram and Associates (Pty.) Ltd.	2	3
Rhodes University	1	1
Sinelwati Scientific Research & Management	1	1
Umvoto Africa	0	1
University of Cape Town	2	3
University of KwaZulu-Natal	18	33
University of Pretoria	9	14
University of Stellenbosch	10	20
University of the Free State	4	9
University of the Western Cape	22	23
University of Venda	5	5
<b>TOTALS</b>	<b>87</b>	<b>140</b>

In total 18 project leaders were women (in 2008/09 the total was 25) and 13 project leaders were Black males (9 in 2008/09). This figure represents approximately 24% and 17%, respectively, of total projects (25% and 13%, respectively, in 2008/09). A total number of 140 students were capacitated within WRC projects, 87 of whom were HDIs (62%).

The KSA participated in a number of initiatives contributing to the water-centred knowledge base in South Africa. The following **workshops** were held in support of research outcomes:

- *Groundwater Resources Directed Measures: Updating and Revision of Current Groundwater Reserve Methodologies*
- *Reducing Uncertainties of Evapotranspiration and Preferential Flow in the Estimation of Groundwater Recharge*
- *Optimised Monitoring of Groundwater – Surface Water – Atmospheric Parameters for Enhanced Decision Making at a Local Scale*
- *Karst Hydro(geo)logy: State-of-the-Art and Future Research Needs*
- Workshop to develop the contents of the EDC Manual, Vol.1-4
- Workshop on a research strategy and collaboration between researchers and water suppliers on algal toxin research
- *Water Resources Institutional Reform Think Tank*
- Workshop on water law issues related to those contested in courts and the water tribunal
- *Water Allocation Reform*, held with high-level DWA officials and chaired by the Advisor to the Minister of Water and Environmental Affairs
- *Karst Hydrology*

### Knowledge dissemination

New knowledge dissemination mechanisms were implemented as follows:

- A new mechanism was established as a series of DVD productions dealing with different aspects of the water cycle and the water resources as a whole. The first draft work was completed in 2009/10 on the 'water cycle'.
- The approach which evolved and was adopted in the Knowledge Cafés has been packaged and patented as a 'water game' which can enhance communication between various groups and stakeholders in a non-threatening environment.
- The development of education booklets and a DVD has been investigated for children, starting from personal hygiene evolving to household hygiene and sanitation (KSA3), and expanding to the ecosystems (KSA2) and the water resources (KSA1). This initiative has expanded more rapidly than expected and discussions with funding agencies have underlined the need for a scientifically-based communication strategy on a wider spectrum than previously anticipated. The value of the WRC in ensuring sustainable water management would be emphasized during the campaign, as well as the importance of water scientists and role of water treatment related technicians and managers. This would encompass MoUs with the funding agencies, government departments and other stakeholders as well as licensing and copyright.

### Conference presentations and other activities by staff members

- A Research Manager gave a presentation on 'Groundwater' to the South African Qualifications Authority, as part of an awareness-building campaign, April 2009
- A Research Manager was co-author for the paper 'ORASECOMs institutional linkages and the role of groundwater' presented at the *Bi-annual Groundwater Division Conference*
- A Research Manager was author and co-author of 4 chapters published in WRC Report TT428/09:
  - Basement aquifers of southern Africa: Overview and Research Needs
  - A tectonic and geomorphic framework for the development of basement aquifers in Namaqualand – a review
  - A methodological approach to recharge estimation of semi-arid basement aquifers – the central Namaqualand case
  - Hydrogeochemical processes that influence the groundwater chemistry of basement aquifer systems, Namaqualand
- A Research Manager chaired the panel of Judges for the WRC-sponsored *Young Scientist Awards* at the *14th SANCIAHS Symposium*
- Reviewer for *Hydrogeology Journal*.
- A presentation of a discussion document on the regulation of water resources was made on behalf of the KSA to the Water Sector National Leadership Group
- A presentation on climate change and water was made to the Parliamentary Portfolio committee for Water and Environment, July 2009
- A presentation was made on 'Taking account of climate change in drought and low flow management' to DWA Mpumalanga, November 2009
- A presentation was made on 'Climate change research support to policy implementation and advice to parliamentarians on water related issues' at the UNFCCC, Copenhagen, November 2009

## IMPLEMENTATION PLAN

### Research portfolio for 2009/10

The primary objective of the research in this KSA remains largely the same as that developed in the previous year's business plan, which is to ensure that water resources of South Africa are protected, utilised, developed, conserved and managed to achieve environmental, social and economic sustainability. The research portfolio for 2009/10 addressed this primary objective, as reflected by the following secondary aims, to:

- Improve water resource information systems and access to data

- Achieve integration between surface and groundwater research. A programmatic approach will be designed addressing the need for joint studies.
- Build up appropriate quantitative understanding, tools and adaptive strategies for managing the impacts of extreme climatic events (floods and droughts) due to global warming and human-induced impacts on water resources (include understanding of health impacts on humans)
- Broaden the scope for policy and institutional studies to deal holistically with the legal, economic, compliance and implementation aspects

In the interests of fully articulating climate change research and grouping the water management research family under one thrust, Programmes 5 and 6 in Thrust 1 dealing with climate variability and water quality management have been moved to Thrust 2 as a consequence of human-induced impacts. Thrusts 3 and 4 remain unchanged.

The research portfolio for 2009/10 is presented in Table 2, which provides an overview and description of research thrusts and programmes.

**TABLE 2**  
**Overview and description of thrusts and programmes**

**THRUST 1: WATER RESOURCE ASSESSMENT AND PLANNING**

**Scope:** This thrust focuses on developing a scientific understanding of the hydrological cycle (and inter-linkages) in order to promote systematic water assessment and planning. The thrust will promote better understanding of the variability of the quantity and quality of water available for use and development in South Africa. Recent changes in national water resource infrastructure management, the awareness of the poor state of water resource infrastructure and increased knowledge of water resource planning needs are expected to receive attention, through the support of competent and sustainable solutions. Sound water resource assessment and planning can only be achieved with reasonably accurate and consistently recorded and processed data and information. The thrust will support the implementation and use of a national water resource information system.

<p><b>Programme 1:</b> <b>Catchment data and information systems</b></p>	<p><b>Scope:</b> This programme will support the provisions of Chapter 14 of the National Water Act, especially Part 2: National Information Systems on Water Resources. This programme is focused on supporting the national initiative for improving the available water resource information, better management of the information and improved information dissemination to stakeholders. It will establish direct linkages to the national information systems as well as identifying and resolving water resource information gaps. In this programme researched water resource information will be integrated into the national information system that is being established by DWA. The programme will also support the process of decentralising identified water resource data and information from broader national perspectives to detailed and highly resolved local and catchment scales.</p>
<p><b>Programme 2:</b> <b>Surface water / groundwater Hydrology</b></p>	<p><b>Scope:</b> This programme focuses on developing and utilising integrated hydrological approaches in surface and groundwater assessments, water resource explorations, planning and management. It will take advantage of gains made in improved understanding of groundwater and surface water hydrological processes as well as the availability of better hydrological data especially the various forms of more accurate remotely-sensed data with better coverage. Through this programme, strategic partnerships with international expertise in both groundwater and surface water hydrological research will be encouraged to flourish. Hydrological tools that have been developed in the past are expected to be upgraded, redeveloped or replaced by tools that are more suited to the current data availability, the improved knowledge and the recent technological advances in hydrological modelling. In this programme, the continued deterioration of hydrological gauging processes and other installed earth measurement devices will be addressed through the intensive use of new data sources from remote sensing coupled with the limited earth-based measurements.</p>

<p><b>Programme 3:</b> <b>Water resource planning</b></p>	<p><b>Scope:</b> This programme will address water resource planning for the purposes of improved water allocation, better management of water use activities and to ensure secure, sustainable and adequate national water resources. It is also focused on the development of tools that will address planning gaps such as the absence of reliable information in un-gauged areas and the persistent record gaps which exist in present data sets. The programme will promote a deliberate shift towards the development of water systems plans that will benefit from real-time, historic and stochastic data on a countrywide basis. Impacts of climate change on water resources and the planning processes will be accounted for so as to ensure a proactive approach and allowing for national preparedness. Integration will also be achieved through aligning this programme to wider national water resource planning needs as expressed in the objectives of <i>Water for Growth and Development</i> as well as account for other factors which include poverty alleviation, economic benefit, empowerment and the importance of meeting the Millennium Development Goals.</p> <p>Research on the planning of water resources will also address the information gaps in the understanding and subsequent utilisation of seawater in building water resource security. Saline water, brackish water, and other water bodies that can be purified and made available for regular water uses will be investigated and included as part of future water resource plans.</p>
<p><b>Programme 4:</b> <b>New Water</b></p>	<p><b>Scope:</b> This programme will improve the understanding of national needs for water resource development, existing water resource infrastructure maintenance and rehabilitation. The equitable allocation and access challenges and economic growth target of 6% of GDP per year will require thorough understanding and assessments of alternative sources of water. Such sources could be built into future projections for new water, virtual water, water transfers be they national or international, desalination, etc. The programme will also promote the integration of social, economic, and environmental considerations as key components of sustainable water resource development. Solutions for supporting and complementing the processes and strategies pursued by the Water Infrastructure Agency will be developed.</p> <p>The initial development of research under the new theme of Water and Energy will be initiated through this programme. In this water and energy research theme, the improvement of power supplies through the utilisation of water in various forms will be addressed. Also through this research theme, the investigation of the distribution, transport and transformation of water and energy within the national boundaries will receive attention to improve knowledge on the water and energy cycle. The research will aim to take advantage of the natural forces of the water and energy cycle to address water resource management objectives.</p>

**THRUST 2: MANAGEMENT OF NATURAL AND HUMAN-INDUCED IMPACTS ON WATER RESOURCES**

**Scope:** Research in this thrust focuses on the understanding of global climate-change impacts and hydro-climatic variability as well as vulnerability assessments and development of appropriate adaptation options and solutions. The focus is also on developing appropriate quantitative understanding, tools and strategies for managing the impacts of climate variability and change as well as human interventions on the hydrological cycle and related water resources, with the aim of supporting the development of policy responses, at regional, national or catchment scale, to existing and emerging problems. This includes development of systems (e.g. river flow and inundation forecast models, drought impact monitoring systems) for managing floods and droughts and the effects thereof on the resources and the people who rely on these resources, with special emphasis on water quality and quantity impacts. The focus is further on management of human-induced impacts on water quality and quantity.

<p><b>Programme 1:</b> <b><i>Developing predictive tools and adaptive measures to global climate change and hydro-climatic variability</i></b></p>	<p><b>Scope:</b> The need to prepare the country to cope with global climate change is of paramount and strategic importance. Taking the view that water is South Africa's key resource implies the need to adapt water resource management progressively as global climate change progresses, in order to maintain optimal levels of both resource protection and beneficial use of water for society. The development of coping strategies will require the development of informed, quantitative scenarios of potential impacts at regional and catchment level on rainfall regimes and rainfall variability, hydrological and geohydrological regimes, water availability and reliability, water quality, ecosystem structure and functions and ecological processes. The following key questions thus need to be considered and addressed in this programme: What confidence can be placed in current GCM-generated scenarios of global climate change? How reliable are current techniques for downscaling of scenarios from global to regional and catchment scales? At which point will anthropogenic climate change in the Southern Africa context become detectable and distinguishable from natural climate variability and which monitoring systems need to be in place in this regard? How will the frequency and magnitude of extreme rainfall and flow events be affected? Can existing conceptual and numerical models utilise global change-related, downscaled, hydro-climatic information effectively, to provide information regarding likely inter-related land-use, ecosystem, hydrological (including geohydrological), and water yield and water quality changes at regional/catchment level? How will existing management strategies and tools need to be adapted? What are the main socio-economic impacts likely to be, given the structure of society in Southern Africa, and what are appropriate technological, social and political coping strategies? This programme is also aimed at improving understanding of and forecasting of the variability of rainfall, flow and groundwater recharge as the ability to forecast at very short time scales would greatly benefit flood management and disaster mitigation and adaptation activities, and on improving the understanding of global climate change impacts and vulnerability for the purposes of better informing the nation on permanent changes of the climate which require long-term solutions and adaptation actions. Through this programme support will be provided for weather and climate disaster mitigation programmes at various levels which will include regional, national, provincial as well as other more localised scales.</p>
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<p><b>Programme 2:</b> <b>Managing human-induced impacts on water quality and quantity</b></p>	<p><b>Scope:</b> The quality of water is an important factor in determining the quantity of water that is potentially available for productive use. Determining the amount of water available for different uses is further complicated by the considerable variation that exists in quality requirements between and within different user groups. This programme is aimed at developing and refining fitness-for-use criteria, developing the means to monitor and assess water quality at regional and national levels, improving the manner in which water quality information is conveyed and the identification of emerging water quality issues. This programme also promotes water demand management and the use of poor quality water and further seeks to investigate and apply water quality control and mitigation measures. Various kinds of human activities can influence the quantity, quality, reliability and ecological health of water resources, including activities which take place in other environmental compartments within the hydrological cycle. Hence, the research focus is further aimed at improving our ability to assess, evaluate and predict the effects on surface and groundwater resources of human activities and human-induced impacts, with a view to developing strategies for management and mitigation of water quality and quantity impacts.</p>
<p><b>Programme 3:</b> <b>Integrated flood and drought management</b></p>	<p><b>Scope:</b> Flooding and drought are major natural hazards to human society and have important influences on social and economic development. This programme focuses on research that will result in the development and implementation of integrated institutional frameworks and technological tools to reduce and combat floods and their negative effects while enhancing positive flooding patterns that are important to the natural ecosystem. Research related to drought management will focus on integrated tools and strategies for early identification and mitigation of the social and economic impacts of drought, with the aim of supporting collaborative, multi-institutional processes and programmes.</p>

### THRUST 3: WATER RESOURCE PROTECTION

**Scope:** Research in this thrust focuses on the generation of information and understanding in order to improve water resource management, with reference to point sources and diffuse sources, and addressing chemical, microbial, and biological pollution impacts on surface water and groundwater. This thrust will also address water resource protection from flow-reduction processes as well as other physical processes such as sediment accumulation. Scientific and technological approaches that will help characterise and address these problems include: (1) Assessment, prediction and decision support; (2) Basic science (e.g. data and methods for evaluation of multi-scale interdependencies, uncertainty, etc.); (3) Technological innovation; and (4) Implementation approaches and technology transfer options.

<p><b>Programme 1:</b> <b>Protection and management of surface water and groundwater quality</b></p>	<p><b>Scope:</b> Urban and industrial activities expose groundwater and surface water resources to a range of chemical and microbiological pollutants. This programme investigates the natural and anthropogenic occurrences of hazardous constituents with the aim of developing strategies to minimise the negative impacts on groundwater and surface water resources. The development of improved pollution prevention, control, detection and remediation strategies is essential for the effective management of the water resources. The programme addresses both point and non-point sources of pollution, resulting from activities in the subsurface and/or on the surface.</p>
<p><b>Programme 2:</b> <b>Urban and rural water resource management</b></p>	<p><b>Scope:</b> An integrated approach to water resource planning and management is essential to the sustainability of urban and rural water resources. In many urban and rural areas, water shortages stem from improper use and degradation of the available water by pollution. The outcomes of this programme will enhance the capabilities of various authorities to protect water resources (groundwater, dams and rivers) in a sustainable manner through the development of, among others, groundwater protection zones, pollution control and monitoring as well as improved land-use planning.</p>
<p><b>Programme 3:</b> <b>Integrated river flow and catchment hydraulics</b></p>	<p><b>Scope:</b> Research in this programme is focused on establishing and maintaining high-quality river flows, reduction and mitigation of river degradation which is caused by river hydraulic processes such as damaging flow regimes, sediment transportation and deposition. The programme will also integrate improved catchment management as part of a holistic strategy for the protection of groundwater and surface water resources, and will seek to establish processes and practices that will ensure minimum disruptions to natural water flow regimes, especially low flows which usually result in periods of critical water constraints in river systems. The groundwater and surface water processes which are associated with the critical flow regimes are also investigated in this programme.</p>

#### THRUST 4: WATER RESOURCE INSTITUTIONAL ARRANGEMENTS

**Scope:** This thrust focuses on articulating the thinking for the new roles and responsibilities of the various stakeholders, based on catchment and water management area boundaries. The marked shift from central management of resources to a more localised scale is critical to the main founding concepts of IWRM. The defined management boundary based on watershed boundaries is another fundamental provision in IWRM as a concept. This thrust will support the suitable implementation of IWRM in South Africa. The further articulation of the NWA for the benefit of all South Africans and the fulfilment of the developmental role of the state within the water resource limitations will be investigated. Lessons learnt and evaluations of the IWRM applications in South Africa to date will be part of this portfolio focusing on home-grown approaches and experiences in water resource management.

<p><b>Programme 1:</b> <b><i>Institutional governance and reforms</i></b></p>	<p><b>Scope:</b> The principle of subsidiarity, or as is sometimes referred to as democratization, of water resource management has brought about challenging concepts, both conceptually and in terms of application. Although current reforms in South Africa are based on sound IWRM principles, to date the implementation thereof continues to break new ground, proving that institutional engineering cannot provide a one-size-fits-all solution to the new management paradigm. Further understanding and research are hence needed to learn and decide on best practice as defined in the South African or similar socio-economic settings.</p>
<p><b>Programme 2:</b> <b><i>Compliance and enforcement</i></b></p>	<p><b>Scope:</b> For the implementation of state-of-the-art legislation like the NWA, a matching enforcement and compliance regime needs to be in place to ensure effective implementation. The regulatory environment in the South African water sector is in its infancy and requires substantial support from research in creating the understanding and knowledge for informed decision making. Bench-marking and best practice is crucial here to learn from lessons.</p>
<p><b>Programme 3:</b> <b><i>Pricing and financing WRM</i></b></p>	<p><b>Scope:</b> The issues of financial sustainability, affordability of charges by users, transparency and corporate governance aspects are becoming central in the decentralization era. The new infrastructure agency responsible for new developments and maintaining national assets provides good ground- breaking research opportunities, especially to assess if water tariffs can indeed pay for managing and sustaining water resources. Does pricing water and introducing the water resource charges exclude the poor and will it further cripple local government from delivering services? The waste discharge charge is another serious introduction to the water sector fraught with considerable challenges. This programme can project and assess such issues.</p>
<p><b>Programme 4:</b> <b><i>Transboundary water resources</i></b></p>	<p><b>Scope:</b> This programme will provide tools and guidelines for resolving potential water-centred conflicts for the management of shared international rivers and transboundary aquifer systems, including development of appropriate institutional forms and functions, development and harmonisation of policy and regulation in shared river basins, strategies for knowledge-sharing and joint management of shared river basins. A need has been identified to define the roles and interrelationships between local WRM institutions and international basin organisations.</p>

<p><b>Programme 5: Future scenarios</b></p>	<p>Scope: This activity has been warranted a separate programme to ensure that local South African expertise is qualified to explore future scenarios and answer the 'what if' questions in support of reflection and evaluation of national policy applications. Projecting the water resource management and development institutional arrangements landscape 10 or 15 years from now would be of interest to decision makers to define policy reviews and enhance decision making. Further complexity can be added on through the introduction of the water services institutions. Mapping of the processes for tariff setting between both water resources and water services could allow further investigation into service delivery affordability and efficacy. This programme is likely to have a phased programmatic approach to adding more and more layers to the scenarios and for them to be customised for localised aspects that need not be of national interest.</p>
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**KSA alignment with DWA's objectives**

Due to the fact that the KSA interacts regularly with DWA, the research programmes are in alignment with the DWA Strategic Plan and their strategic framework *Water for Growth and Development*. Hence, the KSA project distribution did not change from the previous year and reflects good synergies and considerable alignment to the DWA strategic programmes, which remain to be:

- **Institutional realignment** is a new process within DWA aimed at identifying the integration between the existing and new institutions that are meant to be serving the water sector from a services and management perspective. A number of models have been proposed and many workshops have taken place to identify the right institutional arrangements in the sector.
- **Water for growth and development in South Africa:** Water for growth points to the relationship between water availability and the forms of economic activity that are dependent on available water supply of varying levels of quality depending on the technologies being used. To meet the 6% economic growth target without compromising the ecological integrity and sustainability of the resource or people's primary needs, research will have to be relevant to answer the pertinent questions as to how can this be achieved.
- **Equitable and sustainable supply** covers the policy, planning and regulatory functions required to ensure the reliable and equitable supply of water for sustainable economic and social development, including the

eradication of poverty. This includes assessing available water in a particular area and developing strategies to enable supply to meet demand. Sustainable supply supports the provision of a reliable and equitable supply of water as well as the bulk of the *Working for Water* and *Working for Fire* programmes for sustainable economic and social development, including the eradication of poverty.

- **Institutional regulation and development.** Institutional regulation provides policy and strategy support for developing and establishing effective water management institutions and includes revenue collection from water use charges. Institutional development ensures that effective water management institutions are developed in the regions.
- **Infrastructure development and rehabilitation** provides for the augmentation of the water-trading account to undertake the design, construction and commissioning of new water resource infrastructure, as well as the rehabilitation of existing infrastructure to ensure the safety and functionality of departmental dams and related structures. Operation of water resources provides for the augmentation of the water-trading account to ensure the effective management of water resources and the sustainable operation and management of bulk water infrastructure.

## RESEARCH PROJECTS FOR 2009/10

The findings of projects completed during the year under review are given, as well as a summary of current projects and the motivation and objectives of new projects which commenced between 01 April 2009 and 31 March 2010.

## COMPLETED PROJECTS

### THRUST 1: WATER RESOURCE ASSESSMENT AND PLANNING

#### *Programme 1: Catchment data and information systems*

#### **A synthesis of the hydrogeology of basement aquifers in Southern Africa: Research needs and priorities**

Council for Geoscience

**No. 1418**

Crystalline basement forms the largest part (40% of the land area) of the four hydrogeological zones of sub-Saharan Africa, where 220 million people live in rural areas that are underlain by crystalline basement rocks. In southern Africa, basement aquifers constitute approximately 55% of the land area. The only viable water supply to many communities is, more often than not, located in these systems. A number of important constraints are recognised in development of these resources. These are: the frequent high failure rate of boreholes, commonly in the range of 10 to 40%, with the higher rates in drier regions or where the weathered overburden is thin; the shallow occurrence and fissure permeability of the bedrock aquifer component which makes it susceptible to surface pollutants; the low storativity of basement aquifers, which may therefore deplete significantly during sustained drought periods. Recharge is also sensitive to certain land-use changes, notably those associated with desertification. It is estimated that 60% to 90% of the rural population in southern Africa relies on groundwater for its livelihood. However, it is generally acknowledged that groundwater management lags behind the current development of groundwater and the exploitation of the resource. Several management strategies or models are proposed for the effective management of groundwater in basement terrains.

Cost: R564 430

Term: 2003 - 2009

#### **A pilot project, applied to the Kat River, Eastern Cape Province, to develop methods for the cooperative evolution of a catchment management strategy, involving stakeholders, government agencies and specialists**

Rhodes University; Kat River Valley Water Users Association

**No. 1496**

This report details the process and outcomes of the development of a catchment management plan (CMP) for the Kat Valley by local stakeholders and Rhodes researchers. In 2004 the Kat River Water User Association (KRWUA) was given funding by the WRC to initiate a CMP for the Kat River Catchment, facilitated by researchers from Rhodes University. The involvement of Rhodes University researchers officially ended in 2007, though they were also involved in the implementation process for the ecological Reserve in 2008. This report documents the process from its inception up to August 2008. The principle objective of the CMP was to establish a water allocation plan (WAP) for present and future water use in the Kat Valley and to facilitate the water licensing process in the catchment. It is rare for local stakeholders to participate to such a level as to initiate the developments of such plans, and as such the Kat River situation presented itself as an invaluable case study in stakeholder participation, local water resource management institution development, and the implementation of the National Water Act in a small agricultural catchment.

Cost: R2 100 000

Term: 2004 - 2009

#### **Remote sensing as a tool for resource assessment and determination of the legal compliance of surface and groundwater use**

GEOSS; Council for Geoscience; University of Stellenbosch

**No. 1690**

The overall objective of this project is to determine the usefulness and applicability of using remote sensing technologies as a tool for resource assessment towards the determination of the legal compliance of surface and groundwater use. This project focused on the creation of new knowledge and being at the innovative edge of the topic. This study found that, in the context of illegal water use, using remote sensing as a tool to quantify water storage may be appropriate in identifying water bodies and generating a fair estimate of volumes stored. The application of the water balance equation to the G10K catchment did not determine the level of legal compliance of water users to legislation. However, new methodologies, untested in South Africa, were applied to the study area with many challenges encountered. There is much hope that, as remote sensing technology develops and remotely sensed data becomes available at a higher spatial and temporal resolution, the full potential of these models will be able to be fully tested, and, if proven accurate, could possibly be used operationally in the future. In addition, if the uncertainties and limitations encountered in the course of the research

project are considered and acted upon, it may be possible that at least parts of the methodology may be relevant at a later stage for water use determination. The uncertainties, limitations and challenges encountered during this research project can be categorised into four sections: the accuracy, availability and accessibility of input data; heterogeneity of the study area; skills shortage at supervisory level in South Africa; and computer resource intensive models and software. The anomalies in the WARMS database also made it difficult to compare water use and storage results to the registered values.

Cost: R1 259 600  
Term: 2006 - 2009

#### **A methodology for near-real time spatial estimation of evaporation**

CSIR

**No. 1751**

The overall aim of the research project was to review existing methodologies, at national and international levels, for estimating evaporation using remote sensing technology, and subsequently to recommend those methods that have potential for application in South Africa. Aspects reviewed included: different remote sensing data sources, models and methods of up-scaling instantaneous evaporation estimates to daily evaporation estimates, potential applications of spatial estimates of evaporation, operational examples of the application of remote sensing based evaporation estimation models and general shortcomings and research opportunities in this field. Four different models (SEBAL, SEBS, METRIC and VITT) were identified and parameterised for seven different land uses and the energy balances, and evaporation rates simulated were compared to field data collected with a range of methods, including the Eddy covariance method and Scintillometry as methods suitable for use in South Africa. Stakeholders were also accordingly informed on these tools.

Cost: R468 000  
Term: 2007 - 2009

#### **Programme 2: Surface water / groundwater hydrology**

##### **Flow conceptualisation and storage determination in TMG aquifer systems**

University of the Western Cape (Department of Earth Sciences)

**No. 1419**

The Table Mountain Group (TMG) constitutes a major regional aquifer system in South Africa. With the information derived from field measurements and interpreted from the remote sensing, the anisotropic hydraulic properties of the fractured aquifers are estimated using a hydraulic conductivity tensor technique. The estimated hydraulic conductivities at most sites fall in the range of  $10^{-2}$ ~ $10^{-3}$  m/d which is consistent with most of the pumping test results. However they decrease with

depth according to a negative power law, which implies that the majority of fractures display a tendency of closure at greater depths. Site hydraulic tests also showed a similar vertical variation of the hydraulic conductivities. The study revealed that fracture networks on a site scale occur as various fracture blocks nested in the system rather than as equally connected as originally postulated. The porosity of the TMG sandstones is strongly scale-dependent, of which the value of core sample laboratory tests yields an upper limit of 1.0%~3.6%. The porosity of *in situ* fracture measurements fall in the middle range of 0.05%~0.6%, whilst the application of lineament interpretation from remotely-sensed data produces its lower limit of  $1.2 \times 10^{-8}$  %. Evaluation of the bulk groundwater resource is made based on assumptions that the TMG aquifers are homogeneous at a regional scale, and an average storativity value is necessary across the entire aquifer. An available yield of  $<1 \times 10^9$  m<sup>3</sup>/year is proposed for the groundwater exploitation from the TMG aquifers based on the regional aquifer storage.

Cost: R3 500 000  
Term: 2003 - 2009

##### **Flow conceptualisation, recharge and storativity determination in Karoo aquifers with special emphasis on the Eastern Cape (Mzimvubu to Keiskamma WMA) and KwaZulu-Natal Province (Mvoti to Umzimkulu WMA)**

The Council for Geoscience

**No. 1565**

The study area covers the Mzimvubu-Keiskamma Water Management Area (WMA 12) in the Eastern Cape Province which spans an area of about 66 226 km<sup>2</sup>, as well as some portions of the Mvoti-Umzimkulu WMA (WMA 11). The area in WMA 11 covers  $\pm 18 166$  km<sup>2</sup> and is underlain by rocks of the Karoo Supergroup, as well as the Msikaba Formation of the Cape Supergroup. WMA 12 covers much of the former Transkei and Ciskei homelands. Detailed maps, using GIS approaches, field data and interpretations, have been produced for: groundwater exploration potential, groundwater development potential, aquifer cross sections, regional transmissivity as well as groundwater flow paths along the regional cross-sections. This report provides an assessment of the hydrogeology of the Eastern Karoo Basin and provides guidance on favourable drilling targets and aquifers for use in planning and groundwater development.

Cost: R1 771 000  
Term: 2005 - 2009

**The use of <sup>222</sup>Rn as a hydrological tracer in natural and polluted environments**

CSIR

**No. 1685**

Radon-222 (<sup>222</sup>Rn or simply radon) is an inert odourless and colourless noble gas that occurs naturally in air, water, rocks and soil. These properties have promoted its use as a natural tracer in numerous hydrological and hydrogeological applications. A known carcinogen, excessive exposure to <sup>222</sup>Rn through inhalation in a confined environment has long raised awareness of this radioisotope indoors, in the mining environment and, more recently, in caves frequented by tourists. The use of <sup>222</sup>Rn in groundwater studies has not enjoyed much attention in South Africa, being limited to the tracing of fault zones in groundwater exploration. The <sup>222</sup>Rn concentrations associated with mine water sources in the West Rand area do not distinguish this water from natural groundwater associated with the uraniferous strata. The latter typically exhibits the highest <sup>222</sup>Rn activity levels in groundwater in this area. Although the mine water sources show elevated activities of <sup>238</sup>U and <sup>234</sup>U compared to natural groundwater sources, this is not always the case in regard to <sup>226</sup>Ra concentrations. It is concluded that in an environment that also hosts gold mining activities, elevated <sup>222</sup>Rn concentrations alone are not necessarily indicative of mine water contamination, and that any assessment of radionuclides must also include the parent isotopes <sup>226</sup>Ra and <sup>238</sup>U. The measurable <sup>222</sup>Rn activities observed in the Kogelberg area indicate potential for the wider and greater application of <sup>222</sup>Rn measurements in this hydrogeological environment. Studies aimed at establishing the source of this radionuclide in the Table Mountain Group (TMG) strata are also indicated. It is concluded that the use of <sup>222</sup>Rn as a tracer in the local natural and polluted environments where it was studied has not been conclusively established. This is attributable to factors such as the low to very low <sup>222</sup>Rn concentrations found in rivers and streams in both the KOSH and West Rand areas, and the similar <sup>222</sup>Rn levels found in polluted (mine) water and natural groundwater sources in the West Rand area.

Cost: R1 376 745

Term: 2006 - 2009

**The role of antecedent conditions in determining rainfall characteristics during the early part of the rainfall season**

University of Cape Town

**No. 1681**

Little is currently known regarding global and regional controls of the early part of the rainfall season. An enhanced understanding of the controls of early-season rainfall characteristics are required to enable the design of new forecasting methodologies, which in turn may offer practical benefits to water managers and under-served members of the South African population e.g. subsistence farmers. New forecasting methodologies will require knowledge of which

antecedent conditions (vegetation, aerosols, soil moisture and SST) are important and to be able to use this information to predict early-season rainfall, given likely non-linear interactions. Such knowledge will also enable a clearer assessment of the impact of other human-induced changes (besides changing greenhouse gas levels), currently unknown factors in the development of scenarios of regional climate change. This project focused on the links between early season (September-January) rainfall and local antecedent conditions of vegetation, soil moisture and atmospheric aerosols. The primary reasons for choosing these foci were: early season rainfall is hard to forecast, yet it's inter-annual variability can have important impacts in many sectors; these antecedent conditions to date have received little attention and are currently assumed to have a small influence on forecasts at a range of timescales. The majority of the project has focused on using Regional Climate Models (RCMs) to simulate the impact of changes in these antecedent conditions on rainfall. Given that this is a computationally demanding task and that it was necessary to use several different RCMs (due to structural constraints some RCMs cannot be used for simulating particular changes), the modelling requirements of this project were high and took up the majority of the available time and work. The RCMs used in this work include the Weather Research and Forecasting (WRF) model, the Mesoscale Model 5 (MM5) and the Regional Climate Model 3 (RegCM3).

Cost: R1 642 600

Term: 2006 - 2010

**Multidisciplinary analysis of hydro-climatic variability at the catchment scale**

University of Cape Town

**No. 1747**

The study highlights the role of the equatorial and tropical remote region on Southern African rainfall, vegetation and streamflow in summer but also in winter. This includes mainly the role of ENSO and of the Madden Julian oscillation. It also documents the causes of the warming in the Agulhas Current system and the increase of the air-sea flux of moisture aloft. Two memory effects of the vegetation are described in detail, and it is demonstrated that the ocean atmosphere land system cannot be studied in isolation.

Cost: R1 706 895

Term: 2007 - 2010

**Development and testing of a health risk assessment framework to derive guidelines for endocrine disruptors (EDCs) in drinking water**

CSIR

**No. 1749**

A previous WRC report (KV 206/08) proposed a framework to deal with endocrine-disrupting chemicals for drinking water in South Africa. The framework suggests a tiered approach to screening and testing of chemicals in the water environment rather than testing for specific target chemicals, and recommended the use of a trigger value for oestrogen activity. The aim of the project was to determine the feasibility of such a framework to derive guidelines for treated drinking water. It was necessary to test whether the tools and organisational structures were available, if testing revealed results exceeding the trigger value which implies further tiered testing of water samples. It is evident from the study that the proposed South African framework to assess endocrine-disrupting activity in water and compare it with a trigger value is feasible. But, if the trigger value is exceeded, the possible cause or source would need to be identified and at this time the necessary capacity might not be available, even to do the first tier bio-assays. A multidisciplinary team would need to be assembled to look at the possible sources, such as industry, agriculture, waste streams etc., and follow-up samples would need to be taken to identify the specific chemicals responsible, before remedial action could be taken.

Cost: R650 500

Term: 2007 - 2009

**THRUST 3: WATER RESOURCE PROTECTION**

*Programme 1: Protection and management of surface water and groundwater quality*

**Land-use impacts on salinity in Western Cape waters**

University of Stellenbosch (Department of Soil Science)

**No. 1503**

This project further investigated the possibility that changes in land use, from extensive pastoral use to intensive cropping, over the last century or more may have triggered the same process of salt decantation as that which is so widespread in Australia. Investigations at different field sites and scales allowed the project team to arrive, with increasing confidence, at an understanding of the salinity problem in the Berg River (and Western Cape Rivers in general). Approximately 200 tons of salt per hectare is stored as a bulge in the unsaturated vadose zone above the water table and below the soil zone in the semi-arid coastal region. The salt is of marine origin and accumulated from rainwater over a very long period of time. The stored salt is being discharged mainly through lateral leaching by

groundwater at a rate of about half a ton per hectare per annum. The rate of salt discharge is sensitive to changes in both climate and agricultural practice

Cost: R2 347 068

Term: 2004 - 2009

**Investigation of the positive and negative consequences associated with the introduction of low-P detergents**

University of KwaZulu-Natal (Pietermaritzburg)

**No. 1768**

This project investigated the positive and negative consequences associated with the introduction of zero-phosphate powdered laundry detergents into the South African market, as already practiced in many other countries. Detergent phosphorous may contribute up to 32% of total phosphorous (TP) at WWTWs treating predominantly residential sewage. Removal of detergent phosphorous is projected to reduce in-dam TP of 24 priority dams by between 3% and 35% and modelled chlorophyll a concentrations within the dams by 2.5% to 30%. A qualitative cost-benefit analysis indicated that a switch to zero-phosphate detergents would offer potential benefits for the environment, the water purification industry and manufacturers, with negligible negative impacts to WWTWs and the consumer. This finding reverses the findings of previous cost-benefit studies. The shift to that of a net benefit is largely due to the rising cost of phosphate and the change in understanding that zero-phosphate detergents are not damaging to washing machines and fabric.

Cost: R689 200

Term: 2007 - 2009

**Development of a conceptual framework for the regulation of water quality within the context of an integrated, preventative management approach**

Golder Associates Africa (Pty.) Ltd.

**No. 1769**

The conceptual model is based on the premise that good water quality is in everyone's best interests. This 'change of mindset' integrated water quality management (IWQM) approach 'breaks down' the management of water quality into smaller management units. At the same time, both a horizontal and vertical reporting framework is established. This structure is aimed at addressing the problem of implementation of quality standards across the country, and also at improving enforcement, by reducing the volume of reports that should highlight problem areas and allow for prioritisation of regulatory or remedial action. A further benefit of the IWQM framework is that responsibility for water quality is based on significantly smaller geographical areas, and accountability to the adjoining areas (horizontal accountability) and to the next

level of management (vertical accountability) is established with the establishment of the management unit. This allows accountability for water quality to be focused on smaller management units, rather than diffused up ever higher levels of management. The IWQM management approach, therefore, addresses the magnitude of the water quality issue by breaking it down into focused geographical areas of management responsibility. In other words, by making all water users aware of their own responsibility for the protection of South Africa's water resources and accountable for the impacts that they have on the resource. Finally, the IWQM approach allows water quality information to be packaged for a broader audience, as reporting is simplified to provide information on whether or not a management unit is within the specifications of its CCPs or not; rather than submitting extensive technical reports to national level through the management chain. This addresses the issue of the raising of awareness in the broader community of the basic premise that good water quality is in everyone's best interests, while providing for 'everyone's' involvement in its management through the allocation of responsibility at more localised level.

Cost: R598 180  
Term: 2007 - 2009

### ***Programme 3: Integrated river flow and catchment hydraulics***

#### **Methods and guidelines for the licensing of SFRA's with particular reference to low flows**

University of KwaZulu-Natal (School of Bioresources Engineering and Environmental Hydrology)

#### **No. 1428**

The aim of this project was to improve the national estimates of water use by declared and candidate stream flow reduction activities (SFRAs), with a particular emphasis on low flows. Approaches to the licensing of SFRAs and other water uses and the allocation of water to the environment (the Reserve) have highlighted the importance of low flows in water resource assessments and the inconsistencies and inadequacies in approaches to consider them. The question as to how much of the low flow of a river can be allocated, without impacting on the economic viability of downstream users and the ability of the resource to meet the Reserve, is highly complex. In the absence of an adequate store of water, the low flow period is critical when considering competing water user needs, as it is in these periods that most conflict arises between different users, water supply schemes fail, river ecosystems are stressed and water pollution issues are highlighted. This complexity is increasingly highlighted in the implementation of South Africa's NWA of 1998, and is becoming increasingly problematic in the interpretation thereof. Difficulties range from different definitions and derivations of the term 'low flow' to a lack of understanding of the hydrological processes that generate low flows, together with the inadequacies of hydrological models

in representing them. The tools applied to estimate the water use of SFRAs must match the accuracy required by the decision maker to the spatial and temporal scales of the assessment. In many cases, the information contained in the BEEH SFRA Assessment Utility is sufficient to address SFRA licence applications. However, in many cases more detailed analysis will be necessary and more detailed catchment information will have to be collected. In such cases, the use of ACRU2000 is appropriate. The integration of the SFRA Assessment Utility and the BEEH Quinary Catchments Database provides a powerful tool for the future assessment of SFRAs. Through this integration, improved and more spatially representative information regarding rainfall, soils, potential evaporation and baseline vegetation are provided, leading to more spatially explicit estimates of water use with less uncertainty than those currently available. The ongoing improvement of this database is a strength that future SFRA licensing and planning should draw on.

Cost: R3 800 000  
Term: 2004 - 2009

#### **South African Handbook on Environmental Hydraulics** Ninham Shand **No. 1767**

This project was aimed at synthesising existing knowledge on ecohydraulics in South Africa and then packaging it in the form of a Review and Guide document. The Guide provides theories and techniques related to ecohydraulics as well as the ecological context and perspective for the application of ecohydraulics. Thus building capacity amongst engineers and ecologists and contributing towards the effective management of our aquatic environment. The Guide will also provide an overview of the current state of ecohydraulics research in South Africa, serving as a useful point of reference for identifying and prioritising future research needs for ecohydraulics in South Africa. It is of importance to note that the techniques and theory presented in this document deal exclusively with ecology and ecohydraulics within a river context, with the intention that environmental hydraulics in its broader sense, which typically includes biological and chemical aspects in lakes, estuaries and wetlands, will be addressed in subsequent research projects. Furthermore, it is necessary to point out that the hydraulic theory that is presented in this document assumes that the user of this Guide will have a graduate level of understanding of river hydraulics. However, the content is presented in such a way as to ensure that water resource practitioners and managers, as well as researchers across a wide spectrum of disciplines, should find the document informative and useful.

Cost: R920 000  
Term: 2007 - 2009

## THRUST 4: WATER RESOURCE INSTITUTIONAL ARRANGEMENTS

### *Programme 1: Institutional governance and reforms*

#### **A philosophy and strategy for Catchment Management Agencies (CMAs) to become learning organisations**

CSIR

**No. 1689**

It is the responsibility of catchment management agencies (CMAs) to manage water resources in their respective water management areas. The nature of the functions they have to perform and the complicating and complex internal and external realities within which they operate create very demanding circumstances. It is therefore imperative that CMAs are effective learning organisations. This means they should be adept at acquiring knowledge, creating knowledge, transferring knowledge and, importantly, adapting when necessary. The challenging CMA circumstances, an understanding of which is based particularly on insights into the Inkomati CMA, require that the right people are nurtured in the right environment within the organisation. The right environment entails building knowledge breadth and depth, learning and unlearning, being able to respond rapidly when necessary but also making the time to reflect patiently, facilitating both individual and group learning, balancing the use of both theory and practice, building on prior knowledge yet also experimenting, and applying a mix of single-, double- and triple-loop learning. Strategic adaptive management is assumed to be an appropriate framework within which to implement a learning strategy based on the above philosophy. The core purpose of the strategy is to encourage the CMA to explore and debate the above concepts and to develop a plan for their institutionalisation. This document is intended to be a somewhat generic. It is hoped that the ideas presented herein will lay a useful basis for detailed operational plans that will inevitably be specific to the CMAs for which they are developed.

Cost: R664 200

Term: 2006 - 2009

## CURRENT PROJECTS

## THRUST 1: WATER RESOURCE ASSESSMENT AND PLANNING

### *Programme 1: Catchment data and information systems*

#### **Land-water linkages: Agent-based modelling of land-use change and its impact on water resources in the Modder River basin**

Central University of Technology

**No. 1753**

Changes in land use have profound impacts on water resources. This study applies agent-based modelling to investigate land-use changes and how these have impacted on water resources in the Modder River basin. While previous studies of land-use changes have addressed simplistic representations of 2 or 3 driving forces, the agent-based modelling technique will involve several situation-specific interactions among a large number of factors at different spatial and temporal scales. The main objective of this research project is to analyse land-use changes and highlight the dynamic nature of coupled human-environment systems using agent-based modelling in relation to land-use change and its impact on water resources.

Estimated cost: R357 000

Expected term: 2007 - 2010

#### **Optimised monitoring of groundwater – surface water – atmospheric parameters for enhanced decision making at a local scale**

CSIR; University of the Western Cape; University of Stellenbosch; GEOSS; University of KwaZulu-Natal

**No. 1846**

The primary objective of this research will be to develop a framework for optimised monitoring of the most important variables required to manage groundwater resources and understand the fluxes between atmosphere – soil – groundwater – surface water systems at a local level. The secondary objectives of the project are to understanding the institutional and legal interactions of different agencies responsible for various monitoring programmes, develop guidelines for monitoring best practices applicable to South(ern) African conditions and further develop a framework for the monitoring of the different fluxes so that they are closely measured in time and space, where applicable.

Estimated cost: R1 300 000

Expected term: 2008 - 2011

**Development and application of global navigational satellite systems (GNSS) methodology for groundwater resource assessment**

Umvoto Africa (Pty.) Ltd.; Purdue University; Department of Land Affairs; Overstrand Municipality

**No. 1851**

The aim of this project is to demonstrate the use of high-precision global navigation satellite systems (GNSS) technology as a tool for groundwater resource monitoring and assessment; develop a methodology for relating GNSS measurements of natural or abstraction-induced surface deformation and conjunctive hydrogeological data in order to derive the *in situ*, bulk elastic properties of an underlying confined fractured-rock aquifer; and build South African capacity to establish the technical infrastructure and implement the data-processing methods required for pilot GNSS - for a groundwater scheme at the Gateway well field, Hermanus.

Estimated cost: R1 000 000

Expected term: 2008 - 2011

**Programme 2: Surface water / groundwater hydrology**

**Development of a user-friendly model for assessing the impact of waste discharge applications on downstream water quality**

Stewart Scott (CE) (Water Quality)

**No. 1212**

Successful catchment management from a water quality perspective requires, *inter alia*, an intelligent representation (modelling system) of the catchment which describes present water quality and which can be used to predict the effect that proposed new or modified impacts will have on water quality at specific points. Options that need to be incorporated in such a modelling system include applications for new discharge points, increased discharges or altered permit conditions. It is also necessary to assess the impact of current and projected water use and alternatives for managing water quality. This points to the need for a simple but robust technology that can be used to rapidly assess the impacts of applications to discharge waste and the effect of proposed management options. The purpose of this project is to develop such a tool that will not replace the more complex models, but could rather be used to sift options to determine if more complex models need to be applied. The proposed tool could also serve to standardise the approach taken by CMAs in evaluating the initial results obtained by a large variety of organisations. It will be developed in co-operation with DWA's Directorate of Water Quality Management and its Gauteng Region.

Estimated cost: R494 890

Expected term: 2001 - 2009

**Protocols assessing the sustainability of springs**

Maluti Water

**No. 1488**

This project intends to develop a protocol for defining a spring-flow sustainability index. The development of a sustainability index would assist with water resource planning and result in security of water supplies to communities. The successful outcome of this project can result in innovative approaches to protect and manage springs (both from a water supply and protection perspective). The objectives are:

- The development of a protocol for defining a spring-flow sustainability index (i.e. a tool for assessing the sustainability of springs)
- Review all the factors that affect spring-flow
- Assess the value of isotopes in characterising the sustainability of springs, including testing the correlation of perennial and seasonal springs with the isotopic signature
- Develop a weighting system to assess the sustainability of spring-flow

Estimated cost: R734 100

Expected term: 2004 - 2009

**Basement aquifers in support of rural communities in Limpopo, North-West and Mpumalanga Provinces (with special emphasis on transboundary aquifer systems)**

University of Pretoria

**No. 1693**

The primary intent of this project is to develop an understanding of groundwater resources in crystalline metamorphic and igneous terrains. The focus areas are the basement aquifers occurring in the Limpopo and Mpumalanga Provinces, specifically the Limpopo and Luvuvhu/Letaba Water Management Areas. The main objectives of this project are:

- Based on stakeholder involvement (e.g. DWA, etc.) and previous studies (including areas that are experiencing water stress), identify regionally-significant water-bearing structural features and geological domains for further detailed groundwater reconnaissance and exploration (to be based on utilising integrated groundwater exploration approaches viz. hydrocensus, tectonics and geodynamics analysis, strain analysis for field structural mapping, remote sensing, etc.)
- Conceptualize flow dynamics (interconnectivity, regional directional permeability and transmissivity) and flow paths (including dating and tracing of deep water) in the identified water-bearing structural features and geological domains
- Determine storage capacity and storage coefficients (and sustainability yield constraints) of the various geological domains and its reliability during droughts using appropriate investigative techniques.

Estimated cost: R3 400 000

Expected term: 2006 - 2010

**Hydro-pedological interpretation of the soils of selected catchments with the aim of improving efficiency of hydrological models**

University of the Free State

**No. 1748**

In catchment hydrology, water and soils have a very intricate relationship which is reflected in the soil water regime of specific soil horizons, the quality of released water and the catchment water balance. Hydrologists are usually restricted by a number of uncertainties in soil-related processes and other limitations where expert soils knowledge is required. This study is expected to improve data, knowledge and models in a way that provides better interaction of soils and water. In particular the study will investigate, recommend and test appropriate soil-survey procedures and the interpretation of the soil-survey data with the aim of making this information suitable for use by hydrologists at all key water management scales that are used in South Africa. The study will also provide a quantitative characterization of the annual and seasonal soil water regimes in a range of representative local soils. The study will also seek to optimise the intensity of soil-survey information that contributes effectively to hydrological modelling.

Estimated cost: R1 873 500

Expected term: 2007 - 2011

**Influence of catchment development on peak urban runoff**

University of Pretoria

**No. 1752**

Developments in urban and informal areas are regulated with regard to potential flooding by the National Water Act (No. 36 of 1998). The 1:100 year flood line is used to define the extent of the development. Furthermore it is required by the municipal authorities that all developers should create temporary storage if the development contributes to an increase in flood peaks. This study will provide a quantification of the influence of a catchment development on the flow rate and volume of runoff. The study will contribute to an effective stormwater drainage design and optimisation of costs for the upgrade of hydraulic infrastructures in targeted urban areas.

Estimated cost: R665 000

Expected term: 2007 - 2010

**Measurement of the bulk flow and transport characteristics of selected fractured-rock aquifer systems in South Africa**

University of the Free State

**No. 1760**

In South Africa, more than 90% of the aquifers are of a fractured nature. The physical properties of geological materials exert a significant influence on the storage and ability of fluids to move through them. The existing theory of flow cannot fully account for flow through fractured rocks. Field-scale studies and

direct observations/measurements are the most robust means of developing and calibrating models of flow and transport in fractured-rock aquifers. As a result these fractured-aquifer systems can be better exploited and managed through:

- Developing appropriate innovative methodologies/ approaches to measure bulk flow and transport characteristics of fractured-rock aquifers and of up-scaling those to appropriate scales and resolution; and
- Developing guidelines for future well-field developments in fractured aquifers

Estimated cost: R3 353 940

Expected term: 2007 - 2011

**The identification and delineation of high-yielding well-field areas in Karoo aquifers as future water supply options to local authorities**

Groundwater Africa

**No. 1763**

There have been a number of recent initiatives to quantify and delineate high-groundwater-potential areas, but they have either been based on inadequate data, or have fallen short in providing the necessary information that can be readily used by planners.

This project will address 2 main issues:

- Identify and quantify useable high-groundwater-potential areas in the Main Karoo Basin (through specific case studies)
- Develop the framework for incorporating the high-potential areas into the municipal, catchment and national planning models. This will allow for water resource planning at all levels to properly take into account groundwater as a bulk water source. The project will focus on the Main Karoo Basin, but the methodologies developed will be applicable to all Karoo aquifers.

Estimated cost: R3 499 200

Expected term: 2008 - 2011

**Field investigations to study the fate and transport of light non-aqueous phase liquids (LNAPLs) in groundwater**

University of the Free State

**No. 1766**

The programme outputs will establish an improved understanding of the origin of pollutants, the pathways of these pollutants into the environment and the ultimate fate of these pollutants (LNAPLs). This project will produce tested techniques and guidelines for application in the industry. Available approaches are usually based on international case studies dealing mostly with porous aquifers. South African-specific case studies will enable a better understanding of the behaviour of LNAPLs in the subsurface with a specific emphasis on the fractured-rock environments.

Estimated cost: R3 500 357

Expected term: 2007 - 2011

### **Programme 3: Water resource planning**

#### **Integrating water resource and water service management tools**

WRP Consulting Engineers; DMM Software Services

**No. 1840**

Integrated water resource management (IWRM) is a concept that has been used to refer to a system where all aspects of human interaction with water resources are considered as potentially inter-related and are therefore addressed together rather than separately. While this definition of IWRM readily accommodates water services provision, narrower definitions that exclude water services are usually preferred and pursued. Among other objectives, this research will develop a framework for the integration of water resource and service management tools. The framework to be developed will present the best solution which takes account of the present state of needs, available resources, existing commitments and institutional frameworks. As part of demonstrating how easily the research findings are packaged for application, this project will develop and present a case study solution that integrates water service and resource tools for a specific complex water use area such as a large municipal area.

Estimated cost: R2 000 000

Expected term: 2008 - 2011

### **Programme 4: Water resource development**

#### **Review and update of the SANCOLD guidelines for the design of freeboard of dams**

University of Stellenbosch

**No. 1759**

A DWA survey has estimated that as many as 37% of dams in South Africa have inadequately-sized spillways with a high likelihood of spillway failure. The lack of sufficient freeboard at dams also contributes to dam failures. The existing interim freeboard design guidelines *Freeboard for Dams* was published as a draft guideline in 1988 by SANCOLD. This document is still being used in the design of new dams, but a number of aspects of the document have become outdated. This project will review and update the existing guidelines for the design of dam freeboards. The project will improve the design provisions for wind, wave and surge effects on dam freeboards.

Estimated cost: R320 000

Expected term: 2008 - 2009

#### **The development and calibration of South Africa's National Standards for water-retaining structures**

University of Stellenbosch

**No. 1764**

The design of water-retaining structures in South Africa is often based on the British Standards for the reason that a local national code of standards does not exist. The British Standards which are currently in use in South Africa will soon be superseded by the Euro-codes, thus leaving the local practitioners with the dilemma of having to adopt yet another new foreign standard with no reference to South Africa or to develop new regionalised standards for the country. This research project will firstly exploit the extensive international and national research aimed at deriving rational design rules for civil engineering infrastructure and buildings. The research will ultimately lead to the development of the South African National Standards for water-retaining structures including the rainwater-harvesting storage facilities.

Estimated cost: R1 100 000

Expected term: 2007 - 2010

#### **Identification, estimation, quantification and incorporation of risk and uncertainty in water resource management tools in South Africa**

Rhodes University; University of KwaZulu-Natal; Water for Africa

**No.1838**

All estimation methods in natural resources are subject to uncertainty. Our failure to adequately account for uncertainty could lead to false 'security' in decision making. This research will investigate the links between risk and uncertainty in water resource management and develop an informed understanding of uncertainty and the associated risks in water resource management. Of importance is that the research will develop guidelines for incorporating uncertainty and the associated risk into water resource decision-making processes. Guidance on reducing uncertainty as well as mitigating the impact of uncertainty in water resource management is expected to be another key output of the research.

Estimated cost: R800 000

Expected term: 2008 - 2011

**An investigation of the potential use of ocean colour remote sensing to assess the influence of variations in freshwater inputs to coastal ecosystems: Phytoplankton and sediment dynamics of the Natal Bight**

CSIR; University of Cape Town

**No. 1852**

The freshwater flows into the estuarine systems and beyond, as well as the flow drivers, are of importance in cost-effective routine assessment of the productivity of riverine-influenced coastal ecosystems. Ocean colour remote sensing has been identified as a unique means of assessing the influence of variations in freshwater inputs to coastal ecosystems. The study will improve understanding of the relationship between freshwater-derived fluxes into the marine environment and ecosystem response; in particular this study will distinguish between inflow (drivers) and the associated response of marine systems.

Estimated cost: R315 000

Expected term: 2008 - 2010

**THRUST 2: MANAGEMENT OF NATURAL AND HUMAN-INDUCED IMPACTS ON WATER RESOURCES**

*Programme 1: Developing predictive tools and adaptive measures to global climate change*

**Secondary impacts on water resources due to primary changes in precipitation and temperature associated with climate change**

University of Cape Town

**No. 1562**

The WRC is currently funding a project to investigate the potential impact of global and regional changes in climate and climate variability on water resources, but this focuses only on hydrology at present. There are likely to be secondary effects on water resources arising through changes in flow regimes and ambient temperature – these include changes in nutrient cycling, changes in processes affecting sequestration of toxic substances such as metals, changes in chemical and biochemical oxidation and reduction processes, and changes in background concentrations of dissolved salts. The complex changes in water quality, water quality and temperature due to climate change will in turn have effects on aquatic ecosystem structure and function, with further implications for the quantity, quality, reliability and availability of water resources. This project will build on recent and current research within the WRC and other organisations, to generate potential scenarios for the secondary and tertiary impacts of climate change on water resources, with the aim of supporting the development of policy responses and coping mechanisms.

Estimated cost: R2 500 000

Expected term: 2005 - 2009

**An evaluation of the sensitivity of socio-economic activities to climate change in climatically divergent South African catchments**

University of KwaZulu-Natal (School of Agricultural Sciences and Agribusiness); University of Cape Town; Swedish Meteorological and Hydrological Institute (SMHI); DWA; Government of Queensland; German Development Institute (GDI)

**No. 1843**

Much effort has been expended to improve predictions of how global change will impact on primary biophysical changes such as rainfall and temperature, and the secondary effects on crop production, water resources and ecosystems. However, to date practically no effort has been made to integrate the causal relationships of global change to determine or assess its higher level socio-economic impacts. These impacts can be disastrous on a regional scale and its knock-on effect may have serious implications for the national economy. Vulnerable communities may be most seriously affected. On the other hand, socio-economic activities mostly display remarkable adaptive ability and thus resilience to change. This project will be undertaken to assess how sensitive socio-economic activities are to expected climate change in 4 divergent areas of South Africa.

Estimated cost: R2 500 000

Expected term: 2008 - 2011

**Tropical systems from the southwest Indian Ocean into Southern Africa: Impacts, dynamics and projected changes**

ARC; University of Pretoria

**No. 1847**

This project aims to determine from historical synoptic-scale weather data instances when tropical systems from the Indian Ocean have influenced rainfall over the Limpopo Province and Mozambique. The period that will be investigated is from 1948 to the present. During this time a sufficient network of rainfall stations allows for the investigation of the impact of these systems on rainfall over the province. The inclusion of rainfall data can enhance the analysis of these types of systems. Tropical depression track data from the Tropical Cyclone Centre, La Reunion, will also be used for this purpose.

Estimated cost: R680 200

Expected term: 2008 - 2011

## Programme 2: Human-induced impacts

### **A guideline for the selection of toxicity tests in support of the information requirements of the National Water Act** CSIR (Natural Resources and the Environment)

**No. 1211**

An important implication of the National Water Act (NWA) is that the introduction of both source-directed controls and resource-directed measures aimed at improving water quality will be based on the effect of these measures on the resource. Biological toxicity tests are ideally suited to assess these effects for stressors. Toxicity assessments can be used to set the standards used in source-directed controls, or to elicit a site or situation-specific response to a stressor. A large number and variety of biological tests are available internationally for aquatic toxicity assessment. A range of toxicity tests has also been established for South African use. Most of the local tests are presently applied in hazard assessments to establish toxicity at the source level. However, in order to implement the requirements of the NWA, methodologies appropriate for resource-directed measures and source-directed controls are required, as well as knowledge on how methodologies for one application relate to the other. The purpose of this project is, therefore, to establish a guideline for the selection of toxicity tests that would support the information requirements of the NWA. This will be compiled in a user-friendly document that will facilitate the application of toxicity assessment in water resource management.

Estimated cost: R450 000

Expected term: 2001 - 2009

### **An investigation into the impact of landfill leachate on the physical, chemical and microbiological quality of the Soutpan Stream and its immediate surroundings**

Tshwane University of Technology

**No. 1341**

The Soutpan Stream runs past a very poorly-managed landfill site which serves the local Soshanguve community. The landfill is used for dumping of domestic and industrial wastes. Visible leachate is observed on a regular basis running into the Soutpan Stream. The Soutpan Stream serves a huge informal settlement as sole water source and thus presents a health hazard. The community uses the water for household practices, gardening and for animals to drink. This project aims to improve the situation and make the water and the landfill practices acceptable according to set guidelines. This will serve as an upliftment project for the community as we will make use of their experience and knowledge. The research aims to:

- Conduct an environmental inventory and audit of the study area
- Obtain information on how the landfill site is managed, the hydrogeological conditions, attenuating factors, weather patterns, volume and type of waste dumped, the volume and characteristics of leachate produced

- Investigate the direct and indirect physical, chemical and microbiological impacts and consequences, over a defined range of temporal and spatial scales, of the leachate generated at the poorly-managed landfill site on the Soutpan Stream and its immediate surroundings
- Suggest measures which will help to minimise any adverse impacts on the environment and human health

Estimated cost: R386 000

Expected term: 2002 - 2009

### **Persistent organic pollutants (POPs) in the environment** North-West University

**No. 1561**

South Africa is a signatory to the Stockholm Convention, which is intended to minimise and prevent the release of harmful persistent toxic substances in the environment. Although the WRC has recently funded work on persistent organic pollutants (POPs) in the water environment, this research now needs to be taken further in order to:

- Assess with higher confidence the scale and significance of the occurrence of POPs in the water environment in South Africa, the potential short-term and long-term impacts on water resources and water-linked ecosystems and the associated threats to sustainability of water resources and water use
- Better identify and quantify the fate and effect of selected POPs in the water environment
- Guide and inform the development of appropriate policy and regulatory measures that will:
  - Support implementation of the requirements of the Stockholm Convention
  - Substantially contribute to the protection of water resources and water-linked ecosystems with regard to POPs.

Estimated cost: R1 500 000

Expected term: 2005 - 2009

### **Development of a model to assess the cost associated with eutrophication**

The Institute of Natural Resources

**No. 1568**

Eutrophication and its accompanying effects is one of the intractable symptoms of water pollution associated with modern society. It diminishes the quality of our water resources for many uses and costly treatment is often required to overcome its negative effects. In the prevention vs. cure debate, it is important to not only know the cost of prevention, but also the cost associated with eutrophication when it occurs at various levels, in order to justify often expensive preventative measures. Knowledge of the cost associated with eutrophication will also help in determining and justifying the introduction of waste discharge charges. Similarly to a study

that assessed the cost to users that can be associated with water salinity, a multidisciplinary team will conduct this project to determine the costs associated with eutrophication that are experienced by different water users, such as those associated with water purification, recreation, irrigation and the aquatic environment.

Estimated cost: R2 000 000

Expected term: 2005 - 2009

**Endocrine disruptive chemical (EDC) activity and health effects of identified veterinary compounds in surface- and groundwater**

University of Pretoria

**No. 1686**

The adverse effects of endocrine disrupting chemicals (EDCs) in the water environment have been widely recognised. The impact of livestock wastes as a source of endocrine disruption in aquatic environments is not well known. Most of the excretions of natural hormones from both human and animal origin are degraded in the environment, but the synthetic ones are relatively stable in liquid manure and solid dung. The excretions from animals are recycled into other production systems such as fertilisers for soil or agricultural land. In South Africa no data is available on the contamination of the environmental water as a direct result of the usage and excretion of synthetic hormones during the production cycle of the animal. In this study the presence/absence of veterinary drugs in the environment will be obtained. The veterinary compounds, growth promoters and animal dips used in South Africa will be identified and tested and water sources screened for oestrogenic and anti-androgenic activity, using a battery of bio-assays

Estimated cost: R1 900 000

Expected term: 2006 - 2009

**GIS-based assessment of non-point source pollution in Kuils-Eerste River catchments, Cape Town**

University of the Western Cape

**No. 1692**

The water quality and hydrological character of the Kuils River and Eerste River in the Western Cape, which discharge into False Bay, have been changed drastically by land use in the catchment area. Major sources of pollution are the continuous effluent dischargers from the Macassar Sewage Works as well as non-point source (NPS) pollution due to the present land-use practices in the Kuils-Eerste River Catchment. The assessment and quantification of NPS pollutants in this area and others has always been a major challenge. This study will aim to provide techniques for assessing and quantifying NPS pollutants and developing intervention measures for the Kuils-Eerste River catchment. In addition, this project will also assess runoff-water quality over different land-use types, extend the existing data on stream flow measurements and water chemistry of stream

flow and other surface runoff water in the area, generate a GIS-based water quality hydrologic model (catchment-loading model) and provide guidance for the mitigation of water resource pollution in the Kuils-Eerste River system.

Estimated cost: R713 000

Expected term: 2006 - 2009

**An investigation into the effects of atmospheric pollutants on surface water quality in the eastern regions of South Africa**

University of KwaZulu-Natal

**No. 1697**

South Africa possesses abundant sources of coal, found chiefly in Mpumalanga Province. This region therefore houses power-generation facilities which supply the majority of the country's electricity needs. The process of combustion of coal leads to the production of wastes which are discharged to the atmosphere, whence they are transported across the region by atmospheric circulation before being re-deposited on the land surface. Amongst the pollutants emitted by the burning of fossil fuels are oxides of nitrogen and sulphur (NOx and SOx). These compounds have for decades been associated with large-scale environmental degradation (chiefly acidification of soils and water) in the First World. More recently their deleterious effects have been recognised as potential threats to ecosystems in other parts of the world, including the eastern regions of South Africa. The project therefore aims to:

- Investigate the deterioration of surface water quality in selected catchments of the eastern regions of South Africa over the past few decades, due to the effects of atmospheric pollution
- Investigate deterioration of soil quality in selected catchments of the eastern regions of South Africa over the past decade and a half, due to the effects of atmospheric pollution
- Project, by means of modelling, future deterioration of soil and water quality in selected catchments of the eastern regions of South Africa under various management scenarios
- Illustrate the cost-benefit dynamics of managing pollution from atmospheric sources
- Ascertain the reliability of available estimates of atmospheric deposition

Estimated cost: R1 435 300

Expected term: 2006 - 2009

**A national survey of mercury levels in South African resources**

CSIR

**No. 1754**

Recent estimates indicate that Hg emissions from sources in South Africa, mostly coal combustion and gold mining, contribute more than 10% to the global Hg emissions, thereby ranking the country second after China on the list of major Hg polluters globally. Mercury (Hg) pollution is a world-wide problem that should be addressed at global, regional and national levels. Mercury is released into the atmosphere from anthropogenic sources both as elemental Hg (Hg<sup>0</sup>) and in the ionic oxidized form (Hg<sup>II</sup>). The major concern with Hg<sup>0</sup> is that once released into the atmosphere it is oxidized, contributing to the oxidized Hg pool. This Hg<sup>II</sup> is very water-soluble, and is removed from the atmosphere by both wet and dry deposition and enters freshwater and marine resources, where it is rapidly converted into the more toxic methyl-mercury (CH<sub>3</sub>Hg) form. This more toxic form bio-accumulates in the aquatic food chain and poses a serious health risk to humans who consume fish or other aquatic organisms that are contaminated with CH<sub>3</sub>Hg. Anthropogenic activities, such as artisan gold-mining activities, industrial and small-scale coal combustion, as sources of Hg in the atmosphere, the deposit thereof into water resources, and its effects on water quality, are not well characterized in South Africa. Accordingly, as one important step towards such characterization, this project aims to carry out a national survey of Hg levels in South African water resources. This should provide a sound basis for establishing the extent to which Hg is currently a problem in South Africa. The aims of the study are to survey the levels and speciation of mercury in water, sediments and biota in priority South African water resources; to assess the degree of compliance of the measured mercury levels with national and international guidelines; to assess the degree to which mercury may be a problematic pollutant in South Africa; and to create local capacity relating to mercury sampling and analysis.

Estimated cost: R918 850

Expected term: 2007 - 2009

**Water quality monitoring data and target users:****Maximising value**

CSIR

**No. 1755**

DWA operates a vast water quality monitoring network. The information transfer which should form an integral part of the design of such networks is not functioning optimally at present. Much of the value of water quality information is lost if it is not effectively conveyed to users. This project will aim to maximise the value of water quality monitoring programmes by optimising the way in which information is transferred to users. This could have a knock-on effect regarding the appreciation of water quality management by politicians and the man in the street.

Estimated cost: R488 960

Expected term: 2007 - 2009

**Investigation into the effects of water quality (organic vs. inorganic) on the immune systems of humans**

University of the Western Cape

**No. 1756**

This will be a comprehensive study of the effects of water quality on the immune system of humans. The quality of potable and raw water could vary considerably from place to place and this depends on the microbiological and chemical constituents of the water. Several of the physiological systems (e.g. immune, thyroid-hypothalamus, reproductive and the neuro-physiological system) can be impacted on by the quality of the water. The complexity of mixtures is that different constituents (depending on the concentration of each) could have synergistic or antagonistic or no effects in the particular mixture on the human body. Some man-made chemicals affect the function of one or more immune pathways and this can have adverse effects on the health of man and animals. The objective of the study will be to develop and validate analytical tools to evaluate the impact of aquatic pollutants on the immune system. Water extracts obtained from various areas will be evaluated for its immunotoxicity and analytical procedures will be verified to measure the different effects on the human immune system.

Estimated cost: R1 500 000

Expected term: 2007 - 2010

**A comparison of the costs associated with pollution-prevention measures to that required to treat polluted water resources**

CSIR; University of Cape Town

**No. 1845**

It is widely assumed that prevention is better than cure. This project will determine whether or not this assumption holds when applied to cleaner production technology costs (prevention) compared to the cost of treatment of pollution and the external costs borne by downstream users (cure). Four of the most important water quality contaminants will be covered: namely, salinity, eutrophication, microbial pollution and sediments. Because of the differences in the sources of the contaminants to be investigated and in the levels of information available for each, a differential approach will be followed in conducting this project. Specific catchments where the specified pollutants are of concern will be identified and the study will be undertaken in the identified catchment, e.g. salinisation in the Vaal catchment and eutrophication in the Crocodile catchment.

Estimated cost: R2 000 000

Expected term: 2008 - 2011

### **Programme 3: Integrated flood and drought management**

#### **Soil moisture from satellites: Daily rainfall maps over RSA, for flash flood forecasting, drought monitoring, catchment management and agriculture**

Pegram & Associates

**No. 1683**

The amount of water in the soil acts as a vital switch between the atmosphere and the ground, governing many earth-bound water processes: infiltration, evapotranspiration, interflow and groundwater recharge. If accurate spatial estimates of soil moisture (SM) over large areas were available, they would be useful in many applications in hydrology, meteorology and agriculture. A number of satellites launched in the recent past have capabilities to measure variables for calculating countrywide SM at fairly high resolution. This project is expected to develop, and put in place, the scientific capacity to exploit the hardware, software and skills that exist in different international satellite agents. Other key project aims include:

- Developing a daily soil moisture map over Southern Africa at a resolution of 1 minute of arc and loading it onto the internet
- Ground validation for remote sensing using soil moisture estimates at probes deployed by SAWS
- Interpolation over Southern Africa of meteorological variables near ground level: temperature, pressure, humidity, wind speed and energy

Estimated cost: R2 483 200

Expected term: 2006 - 2010

### **THRUST 3: WATER RESOURCE PROTECTION**

#### **Programme 1: Protection and management of surface water and groundwater quality**

##### **Importance of groundwater in the hydrological cycle and the relationship to surface water bodies**

University of Zululand (Department of Hydrology)

**No. 1168**

Understanding the processes involved in groundwater-surface water interactions is becoming increasingly important for protecting the integrity of ecosystems. This project aims to develop models of typical groundwater-surface water processes in South Africa and also to establish compatible methods for estimating time series of surface and groundwater rates for comparative analyses.

Estimated cost: R770 000

Expected term: 2000 - 2009

#### **Novel silicone rubber integrative passive field sampler**

University of Venda (School of Environmental Sciences/  
Department of Ecology and Resource Management)

**No. 1504**

Time-weighted average (TWA) passive field samplers provide vital information in ecological risk assessment of chemical pollutants. The passive field samplers quantify the freely-dissolved pollutant in water that approximates the bio-available fraction in longer exposure times. They therefore also give vital information on changes in pollutant level over time. However, not many passive field samplers are available and those that are available are mostly not very selective. They furthermore require additional clean-up steps before analysing the extracted samples. This project aims to develop, construct and test a simple and cheap TWA passive field sampler that will require no mechanical device and can be used in remote sites. The sampler will utilise silicone rubber in the form of a hollow fibre as absorbing medium. The inside of the hollow fibre will serve as the receiving phase and the outside as the donor phase. The pH of the solution in the receiving phase will be set such that target analytes are ionised and trapped. It is anticipated that this will result in very high enrichment factors over longer exposure periods. The developed sampler will be evaluated under laboratory conditions for its trapping efficiency for a range of pollutant groups as well as potential synergism and antagonism associated with trapping combinations of pollutant groups. The objectives are to:

- Develop a time-integrated sampling device based on silicone rubber for measurements of pesticide concentrations at environmental levels under field conditions
- Evaluate the efficiency of the sampling device for trapping representative examples of pesticides and other pollutant groups
- Determine the synergism and antagonism associated with trapping combinations of pollutant groups
- Evaluate the release of high concentrations during subsequent exposure to lower environmental concentrations.

Estimated cost: R250 000

Expected term: 2004 - 2009

#### **Sampling and monitoring protocol for radioactive elements**

University of the Western Cape

**No. 1694**

The presence of radioactive constituents (uranium, thorium and associated daughter elements) in groundwater poses a health risk. Weathering and leaching of trace element-rich geological formations and also mining wastes result in high concentrations of these constituents in groundwater. The National Radioactive Monitoring Programme (NRMP) of DWA aims to monitor radioactive elements on a national scale. The focus of this study is to support the NRMP by implementing investigations around

impacted sites for local monitoring programmes. Specific objectives are:

- Re-evaluate the results of earlier research findings on uranium speciation and the associated anomalies (i.e. anomalies in the aqueous environment) at the selected study area
- Applying recent advances to characterize flow regimes in fractured-rock aquifer systems, with reference to 'tracing' the distribution of radioactive elements in fractured media
- Development of local-scale sampling and monitoring protocol for radioactive elements in fractured rock formations
- Delineating a groundwater protection zone around a selected study area with respect to an unstressed system taking into account the hydraulics, behaviour of selected radioactive elements, relevant policy documents, etc.

Estimated cost: R1 500 000

Expected term: 2006 - 2009

**Management of human-induced salinisation in the Berg River catchment and development of criteria for regulating land use in terms of salt-generating capacity**

University of Pretoria; University of the Western Cape; Western Cape Department of Agriculture

**No. 1849**

Salinisation is a major problem affecting Western Cape waters. The situation is exacerbated by an increasing demand for water. The recognition that dry-land agricultural practices (rather than only irrigation return flow) make a major contribution in this regard is of relatively recent origin (the current WRC Project No. 1503 made a significant contribution in this regard). This follow-on project intends to continue with its small-scale process studies, expand their breadth by incorporating long-term studies of the Department of Agriculture and integrating the cumulative knowledge into predictive models to simulate the salt load and the contributions made by different land-use practices. The insights gained in this way will be used to develop guidelines for regulating land use in terms of salt-generating capacity.

Estimated cost: R2 964 000

Expected term: 2008 - 2012

**Assessment of the toxicity of cyanobacteria in the Kruger National Park**

ARC; SANParks Veterinary Wildlife Services; University of Pretoria; State Veterinary Services

**No. 1850**

Cyanobacteria (blue-green algae) are found throughout the world in freshwater and marine habitats. Cyanobacteria produce a variety of toxins known as cyanotoxins which have an adverse effect on livestock, domestic animals and wildlife. There have been reports of deaths of wildlife suspected to have been caused by cyanobacteria in the Kruger National Park after exposure to water containing cyanobacteria. It is suspected that a large percentage of wildlife succumb to cyanobacterial poisoning every year as no normal data on mortality are recorded. The only time there is assessment of the surface water is when there are deaths of wildlife, and sometimes the cyanobacterial toxin content of the nearby rivers/dams, which the animals were exposed to, would have changed completely by the time of assessment of the water, thus not reflecting the toxin levels that caused mortality. The study aims to generate information (database) on the extent to which cyanobacteria and their toxins affect wildlife.

Estimated cost: R395 000

Expected term: 2008 - 2010

**Quality control and assurance guideline for South African toxicity testing laboratories**

CSIR; Golder & Associates Africa; Renaissance Environmental Hub; Umgeni Water; Rand Water; DWA; SASOL; South African National Accreditation System (SANAS)

**No. 1853**

The South African National Water Act (Act 36 of 1998) (NWA) mandates the establishment of policies and approaches to reduce and prevent degradation; and to assess the quality of water resources. To comply with the above requirements the National Toxicity Monitoring Programme for Surface Waters (NTMP) (DWA, 2005) and the Direct Estimation of Ecological Effect Potential (DEEEP) approach for waste discharge (DWA, 2003) were introduced. Standard methods were documented for both of these approaches. The toxicity methods are presented in terms of the test environment; materials; equipment and reagents; test organism (breeding and maintenance); test procedure; data analysis and expression of results; test precision of results; test report format; as well as related issues such as sample collection; transport; and storage and waste disposal. Quality requirements pertaining to the above-mentioned sub-sections and training of new staff to comply with minimum requirements for accreditation purposes, will also be addressed.

Estimated cost: R600 000

Expected term: 2008 - 2010

**Development of a risk indicator methodology to estimate the relative risk of pesticide contamination in South African water resources**

CSIR; DWA; University of Johannesburg; Università Cattolica del Sacro Cuore

**No. 1854**

Pesticides are among the most crucial non-point-source pollutants, because of their extremely high toxicity to many non-target aquatic organisms (fish and macroinvertebrates). The Department of Water Affairs (DWA) has recently designed and implemented the National Toxicity Monitoring Programme (NTMP), which monitors toxicity and a number of priority toxic chemicals, the majority of which are pesticides. The National Water Act (Act 36 of 1998) requires rivers to be classified according to a specific class and the establishment of resource quality objectives (RQOs) to protect the desired class of a specific river. Risk indicators can be regarded as lower-tier risk assessment tools that provide a relative assessment of the environmental impact of pesticides through integration of ecotoxicological, environmental fate and pesticide use data. This study proposes to examine the application of pesticide risk indicators as a meaningful tool to predict the relative impacts of pesticides on the aquatic environment.

Estimated cost: R900 000

Expected term: 2008 - 2011

**Programme 2: Protection and management of surface water and quality**

**Nitrate removal for groundwater supply to rural communities**

CSIR; University of Stellenbosch; Biostream

**No. 1848**

This is a follow-up project whose main contribution will be the design criteria for a range of *in situ* and *ex situ* treatment of nitrates in groundwater. This provides alternatives for the specific needs of rural communities. The project investigates applicable identification systems in specific circumstances (i.e. rural communities, town water supply and stock watering, etc.).

Estimated cost: R600 000

Expected term: 2008 - 2010

**Programme 3: Integrated river flow and catchment hydraulics**

**The impact of deep-rooted trees on the hydrological balance of a small catchment in the KwaZulu-Natal midlands**

CSIR

**No. 1682**

Recent WRC studies and modelling of forestry water use have shown that our best estimates of tree water use, and in particular dry season water use, are not within acceptable error margins. One of the main reasons for this is the inability of hydrological models to accurately simulate the deeper soil water processes. This project, which will rely on field-based experimental work and computer modelling, is expected to:

- Quantify the long-term effects of commercial forestry species on deep soil water profiles, streamflow and evaporation
- To investigate and describe environmental and soil water processes which allow for total evaporation to exceed the annual rainfall
- To provide a modelling framework for the catchment water balance to improve streamflow predictions and specifically low flows
- To extend and test the database of catchment hydrological variables, including data on tree root behaviour and its effect on soil water in deeper soil layers, in modelling studies

Estimated cost: R639 200

Expected term: 2006 - 2009

**Sedimentation and sediment yield maps for South Africa**

University of Stellenbosch

**No. 1765**

Loss of storage capacity in dams due to sedimentation is a major strategic threat to our country's available water resources. Soil erosion, and therefore sediment yield and reservoir sedimentation, is accelerated by human activities such as clearing of vegetation and poor farming practices. In order to regulate and manage these negative actions, it is important to have accurate national maps of eroded areas and sediment yield. The sediment yield maps to be developed in this project are expected to assist DWA in mitigating sedimentation impacts and making adequate provisions for sedimentation in dam developments. The better understanding of localised sedimentation processes from this research will feed into the land and soils conservation and management practices which are major concerns in farming communities and the National Department of Agriculture.

Estimated cost: R1 400 000

Expected term: 2007 - 2010

## **THRUST 4: WATER RESOURCE INSTITUTIONAL ARRANGEMENTS**

### *Programme 1: Institutional governance and reforms*

#### **Water resource management in rainwater harvesting (RwH):**

##### **An integrated system**

Source Strategic Focus (Pty.) Ltd.

**No. 1563**

Rainwater harvesting (RwH), an old technology that dates back thousands of years, is gaining popularity in a new way. The global trend towards cheap and less ecologically-disruptive water supply systems has tended to favour the development and application of cheap, environmentally-friendly and readily-available techniques that are decentralized as opposed to huge centralized water infrastructure. RwH, one of the cheaper and decentralized water provision techniques, is set to expand nationally to cater for South Africa's unserved population in rural and agricultural communities, which currently exceeds half the population. Larger-scale implementation of RwH will require improved management to enhance benefits and mitigate negative impacts. Increased understanding and a better synthesis of RwH techniques to be achieved in this project will lead to the development of a model-based decision support tool as well as a policy document on the RwH practice. The RwH decision support tool and the policy document are set to guide and direct the RwH practice within the boundaries of integrated water resource management in accordance with the provisions of the National Water Act and other related legislation such as the Environmental Conservation Act. As part of the RwH decision support tools, methodologies for quantifying socio-economic, hydrological, ecological and environmental impacts of RwH are expected to be developed and refined for packaging as standalone applications or for incorporation into existing water resource management and water systems analysis models.

Estimated cost: R2 800 000

Expected term: 2005 - 2008

#### **Institutional dimensions of water resource management in South Africa: Socio-cultural perspectives**

University of Cape Town

**No. 1698**

This project seeks to analyse, monitor and evaluate the new water management institutional arrangements by focusing on the role of socio-cultural issues, particularly the role of traditional leadership, customary water tenure and cultural and religious practices in determining water management outcomes. Some of the long-term benefits of the research include enhancing public participation in water management and the voices of local people, and alleviating tensions and

conflict in water management institutions so that they can ultimately function more efficiently and sustainably.

Estimated cost: R390 400

Expected term: 2006 - 2009

#### **The criteria necessary for the success of women in the water sector**

Palmer Development Group

**No. 1762**

A number of successful women can be found in the political, corporate and business worlds in South Africa. Whether their success can be attributed to positive family endowments such as well-defined gender roles at the home and/or community level, the enabling legislation in support of gender parity, etc., or a combination of all the above, might explain why still only few women manage to make it to the top echelons. The project will seek to personalise the success by investigating real-life examples to draw out the criteria necessary for the success of women in the water sector. The intention is to uplift those feeling disempowered and to identify gaps if any hindering the progress of women in the water arena.

Cost: R712 320

Term: 2007 - 2010

#### **Exploring the lowest appropriate level of water governance in South Africa**

University of the Western Cape; University of Botswana

**No. 1837**

This project aims to develop an unambiguous conception of the management-governance relationship. Clarify the resource management responsibilities and concomitant governance responsibilities of each type of water organisation as intended by government and other stakeholders. Investigate the execution of the governance responsibility of each organisation type within a water management area and advise on possible reforms. The project aims to derive the most appropriate structure of water governance, particularly at local level, based on local experience in comparison with international practice.

Estimated cost: R1 000 000

Expected term: 2008 - 2010

### **The impact of IWRM on the lives of women and the poor in**

#### **South Africa**

Ninham Shand; University of the Western Cape; Groundwater Africa; North-West University; Rand Water; The Rural Action Committee; Mbumba Development Services; Umhlaba Consulting Group; FAO; Gavin Quibell (independent consultant); Roger Short (independent consultant); DANIDA/DWA; PLAAS (Institute for Poverty, Land and Agrarian Studies, UWC)

#### **No. 1839**

This project aims to: conduct a comprehensive literature review of how IWRM has been conceived and applied both in international literature and in selected national legislation and policy; to develop indicators for assessing how IWRM will impact on the lives of women and the poor and to apply these indicators to South African case studies; and to build research capacity locally and internationally on approaches to implement and monitor IWRM.

Estimated cost: R1 000 000

Expected term: 2008 - 2010

### **Water allocation reform, instruments and processes for achieving equity and gender balance**

Sinelwati Scientific cc; Scientific and Technical Services Institution

#### **No. 1855**

This project aims to interrogate and derive lessons from international (regional) experiences with respect to sustainable use of water to meet the needs of historically-disadvantaged individuals and the poor; to evaluate immediate past interventions designed to achieve redress, establish reasons for success or failures and derive lessons; to evaluate each of the current processes and instruments for water allocation reform and investigate the conditions under which they can meaningfully redress race and gender inequities; to develop discussion documents and guidelines to inform and improve future implementation of the water allocation reform processes and instruments; to participate and share lessons with the department as the water allocation reform is implemented; and to develop a learning journey manual for the water allocation reform experience in South Africa

Estimated cost: R1 050 000

Expected term: 2008 - 2010

### **Development of the AWARE model for the Inkomati CMA**

University of KwaZulu-Natal

#### **No. 1935**

RISKOMAN, a joint project with UNESCO-IHE, aims to develop a policy tool that: (a) can optimise water allocation in multi-purpose multi-reservoir systems in water scarce environments, based on economic values and socio-political preferences; that (b) can continuously adjust these allocation policies based on seasonal flow forecasts and knowledge of their uncertainties; and that (c) can hedge against inflow risks using adaptive, risk

dynamic, management and operation strategies. This project adds 2 extra components to the RISKOMAN research: i.e. (a) The development of an interactive multi-level information system in which information will be provided to different levels of basin water resources stakeholders, with an emphasis on providing the integrated information from RISKOMAN to the level of CMA Board members; (b) improved understanding of the hydrological functioning of the Inkomati Basin through focused research on the spatial and temporal variability of hydrological drivers in the catchment with the use of remote-sensing methodologies and the application of these within the RISKOMAN project as a whole.

Estimated cost: R1 800 000

Expected term: 2009 - 2013

### **Programme 3: Pricing and financing WRM**

#### **Econometric model to predict the effect that various water resource management scenarios would have on South Africa's economic development**

Conningarth Economist

#### **No. 1570**

Water being a limited resource, it is accepted that its availability will constrain the economic development of South Africa. At present it is very difficult to predict which unforeseen negative effects well-intended management decisions may have on development. Australia developed a model of the Australian economy that relates the present and future water demands to potential growth in production in 55 industry groups across 18 regions. This model is used to predict how the Australian economy would be affected under different scenarios of water resource management. The model that will be developed under this project will do the same for the South African situation.

Estimated cost: R2 000 000

Expected term: 2005 - 2009

#### **An investigation into the water infrastructure development financial allocation pathways in municipalities**

African Centre for Water Research; Pegasys Strategy and Development; Oscar Somers (independent consultant)

#### **No. 1844**

This project aims to describe and quantify the water and sanitation sector value chain; assess the impact of widely differing financial and institutional capacity of the sector actors on the financing of service delivery; describe and analyse financial decision-making in the value chain; identify constraints to financial effectiveness or to the use of any particular financial instruments in the pursuit of sector goals; and to develop scenarios and recommendations for improvements in the value chain.

Estimated cost: R2 000 000

Expected term: 2008 - 2010

#### *Programme 4: Transboundary water resources*

##### **Review of the involvements of national water institutions and civil society in international agreements in South Africa**

Pegasys Strategic Management

**No. 1758**

Water management institutional reform is taking place within most of the SADC countries, and new local catchment councils and/or agencies are already in existence in the respective countries. At higher interstate levels, Shared River Commissions are established in accordance with the SADC protocol on shared rivers. To date, little or no attention has been paid to the interaction and integration of local actors vs. international bodies and the quest to separate the governance and implementation/management dimensions in internationally shared rivers for effective management and long-term sustainable use of such resources. This project could look at some examples such as the Inko-Maputo Agreement and the roles and responsibilities of the different local and international role players to ensure effective implementation. Other examples can also be considered.

Estimated cost: R3 000 000

Expected term: 2007 - 2010

#### *Programme 5: Future scenarios*

##### **The water sector institutional landscape by 2025**

CSIR; Barbara Heinzen (independent consultant); HSRC

**No. 1841**

The implementation of institutional reforms in South Africa is moving ahead despite a number of challenges and an environment that is changing constantly. The purpose of this investment is to project to the future and paint a futuristic picture of the organisational landscape for both the management of water resources and for the provision of services. A good set of scenarios should leave the reader wondering which one is more likely or more probable. That forces the reader to think more, and that is the whole point of a scenario - to learn more about alternative futures, so that one can make better choices today. In this exercise, the scenario building must be conducted in a participatory and inclusive manner, and very systematically so that it could make a major contribution to refining the future outcomes in institutional rationing and to build new capacities in the country.

Estimated cost: R2 000 000

Expected term: 2008 - 2011

## NEW PROJECTS

### **THRUST 1: WATER RESOURCE ASSESSMENT AND PLANNING**

#### *Programme 1: Catchment data and information systems*

##### **The preparation of a hydrologically improved digital elevation model for South Africa based on the SRTM data set**

ARC

**No. 1908**

The Shuttle Radar Topography Mission (SRTM) obtained elevation data on a near-global scale to generate the most complete high-resolution digital topographic database of the earth. This data set is currently in use in most hydrological studies. The data come with several errors that require processing. The worst of these errors are sinks, which are cells whose flow direction cannot be assigned. This study will develop methods for producing hydrologically correct SRTM datasets with gaps and sinks filled. The research will also re-interpolate hydrologically corrected SA DEM to 30 m and do a comparative analysis for a small study over the USA area where both 30 m and 90 m SRTM datasets are available.

Estimated cost: R350 000

Expected term: 2009 - 2011

##### **Reducing uncertainties of evapotranspiration and preferential flow in the estimation of groundwater recharge**

CSIR

**No.1909**

This project proposes to develop improved process-based estimates of groundwater recharge. Attention will be focused on the determination of two important components of the water balance, in particular, evapotranspiration and water movement through preferential flow. Improved recharge determination will allow more accurate estimates of associated processes, such as, for example, transport and transformation of possible contaminants, leaching, etc., as well as predictions of possible climate change impacts on the groundwater resource. The main outcome will be to develop improved methodologies for the estimation of recharge, by reducing uncertainties in evapotranspiration estimates and preferential flow.

Estimated cost: R2 000 000

Expected term: 2009 - 2011

### **The hydrogeology of groundwater Region 10: Karst Belt**

R Meyer (private consultant)

**No.1916**

The following reports in this series have thus far been published by the WRC: Region 1 (Makoppa Dome) and Region 3 (Limpopo Granulite-Gneiss belt) in 2000, Region 7 (Polokwane/Pietersburg Plateau) and Region 19 (Lowveld) in 2003, and Region 26 (Bushmanland) in 2007. The Karst Belt, also referred to as Region 10, has been identified as the next region for which the current state of hydrogeological knowledge should be documented. This region was selected for the following reasons: (a) the importance of the dolomitic/karst aquifers as potential sources of good quality groundwater in large quantities, (b) the vulnerability of these groundwater resources to contamination from a wide range of human and land use activities, and (c) the need to collate in a single reference a synthesis of the current knowledge and understanding of these hydrogeological systems.

Estimated cost: R550 000

Expected term: 2009 - 2011

### ***Programme 2: Surface water / groundwater hydrology***

#### **The use of isotope hydrology to characterise and assess water resources in South(ern) Africa**

University of the Witwatersrand

**No.1907**

This project will be used to assess the water resources of selected areas, building on new, existing and earlier, uncompleted studies, information and data. The other main aim is to re-establish and develop the required capacity to analyse and interpret isotopic data and information. This will be achieved through the re-interpretation of available isotope data in South(ern) Africa as well as developing new studies whereby the usefulness of isotope hydrology is demonstrated.

Estimated cost: R2 009 200

Expected term: 2009 - 2012

#### **Modelled sea-surface temperature scenario considerations and Southern Africa's seasonal rainfall and temperature predictability**

South African Weather Service

**No.1913**

The objective of this project is to investigate an optimal model configuration that includes the best available description of the surface boundary conditions, as reflected in the projected global sea surface temperature, in order to force global circulation models (GCMs) to produce seasonal rainfall and temperature over South Africa at lead times of several months. A comprehensive analysis between one-tiered and two-tiered forecasting systems will be conducted to inform decisions

on development of a fully coupled forecasting system for the region. The model will then be implemented and run to generate required data. Seasonal predictability will also enhance adaptive water management capacity.

Estimated cost: R 488 625

Expected term: 2009 - 2012

### **THRUST 2: MANAGEMENT OF NATURAL AND HUMAN-INDUCED IMPACTS ON WATER RESOURCES**

#### ***Programme 1: Developing predictive tools and adaptive measures to global climate change and hydroclimatic variability***

#### **Water resources in rural communities in the Limpopo Province: Social, chemical and microbiological quality evaluations and interactions**

University of Venda

**No.1910**

In most rural areas, river water is consumed without any treatment. Previous studies in the Limpopo Province have indicated high levels of bacterial indicators in river waters; however, the occurrence of parasitic organisms has not been investigated, as well as the interactions between human activity, groundwater, river water and wastewater. Such information is important and will advise on the involvement of the community in water governance crucial to the protection of water sources. This study will investigate the possible interactions between rivers, borehole water and wastewater, through the analysis of the chemical and molecular profiles of parasitic organisms isolated from the different sources.

Estimated cost: R600 000

Expected term: 2009 - 2011

#### **Investigation of unsteady flow conditions at dam-bottom outlet works due to air entrainment during gate closure**

University of Stellenbosch

**No.1914**

The behaviour of dam outlets that are located in the conduit passing underneath the dams, for large volumes of water releases, is not adequately understood in practice and dam design. Potentially dangerous unsteady flow patterns were experienced during the commissioning tests of the Berg River Dam in June 2008. Air that was sucked into the outlet conduit and released at high flow rates with water resulted in unsteady outflow conditions which could have led to damage and failure of the outlet works, with devastating consequences. This study will investigate in more detail the behaviour and role of air-vent pipes at gates at bottom outlets of dams, to ensure the safe design and operation of outlet works in future.

Estimated cost: R872 800

Expected term: 2009 - 2011

**Programme 3: Integrated flood and drought management**

**A comprehensive short-term heavy rainfall forecasting system for South Africa with first implementation over the Gauteng Province (SHORTRAIN)**

University of Pretoria

**No.1906**

The project is aimed at developing an ingredients-based heavy-rainfall forecasting system for RSA, with emphasis on the forecast period from 0 to 24 hours, for use in flood-forecasting systems. The specific objectives include: providing multi-model ensemble forecasts based on numerical weather prediction models; verification of the accuracy and skill of the short-range multi-model ensemble forecasting system; investigation and analysis of characteristics of heavy rainfall over Gauteng at very short time-scales ranging from 5 minutes to 1 hour, as well as at daily, monthly and seasonal time scales. Convective Initiation (CI) climatology for Gauteng and South Africa will also be developed and weather prediction models will be used for forecasting of CI over South Africa. Lightning features associated with heavy rainfall will be examined as well as attempting to understand changes in its characteristics.

Estimated cost: R965 900

Expected term: 2009 - 2011

**Development of a system dynamics model for the implementation of IWRM in South Africa: Phase 1 - deriving performance indicators for IWRM implementation on a catchment scale**

Jeffares & Green (Pty.) Ltd.

**No.1911**

The aims of this project are: to optimise the approach to integrated water resource management; fostering of successful cooperative governance in the water sector; integration of existing information management systems within the water sector; synergising existing research and other related activities within the water sector; development of a comprehensive water sector database; development of a performance management system for catchment scale IWRM; capacity creation and development in IWRM within the SA water sector; and information dissemination and knowledge creation in the water sector.

Estimated cost: R488 255

Expected term: 2009 - 2010

**Programme 4: Water resource Development**

**Nutrient and organic carbon fluxes from small-scale agriculture**

University of KwaZulu-Natal

**No.1904**

The understanding of the sources and pathways of water in a catchment is essential for successful prediction of water quality impacts on receiving streams as well as for the evaluation of remedial measures proposed to abate unacceptable water quality loads. This is especially true for sediment and nutrient fluxes in agricultural catchments. The research will quantify impacts on larger scale catchment sediment, nutrient and organic carbon loading from extended small-scale agricultural land use changes. Nutrient management advice for small-scale farmers, as well as to downstream water resource managers, will be available through this project. Carbon flux evaluation will contribute to quantification of the global carbon budget and implications for climate change.

Estimated cost: R1 639 600

Expected term: 2009 - 2012

**The Manual of Guidelines for Projects on EDCs in Water Resources: Volume 1: Monitoring and Assessment Guide**

University of Pretoria

**No.1915**

The EDC research programme has been developed with the aim to provide aid to stakeholders and the Government in the monitoring and management of EDCs. During the first phases the analytical methodologies have been developed and the programme is now in the phase of developing guidelines on how to monitor and manage pollution to improve water quality or prevent further degradation of water quality. This volume will give guidance on when to monitor, how to do monitoring and, after receiving the data, how to assess and interpret the data for follow-up actions. This will be in line with the National Toxicant Monitoring Programme of DWA. This project will be the first volume of the series of guidelines, and will provide a general background and definitions as well as key issues related to planning and executing an EDC study in a catchment, to be able to make informed decisions to prevent pollution.

Estimated cost: R 1 500 000

Expected term: 2009 - 2012

**Guidelines for EDC Management in Water Resources:  
Volume 4: Management Options for EDCs in Catchments**  
Golder Associates Africa (Pty.) Ltd  
**No.1933**

The EDC research programme has been developed with the aim to provide aid to stakeholders and the Government in the monitoring and management of EDCs. During the first phases the analytical methodologies were developed and the programme is now in the phase of developing guidelines on how to monitor and manage pollution to improve water quality or prevent further degradation of water quality. This project will give guidance on how to identify, investigate and develop possible management options. This will be in line with the National Toxicant Monitoring Programme of DWA. This project will run parallel to WRC Project No. 1915 (Volume 1 of the management options for EDCs) and will use the first volume to build on and deal with issues arising after analytical results have been submitted to the relevant institution / project leader / organisation.

Estimated cost: R 1 500 000

Expected term: 2009 - 2012

**THRUST 3: WATER RESOURCE PROTECTION**

***Programme 1: Protection and management of surface water and groundwater quality***

**Investigation of the fate and transport of selected microorganisms in two simulated aquifer conditions in the laboratory and in the field**

CSIR

**No.1905**

The detailed behaviour of microorganisms in groundwater is not well understood. There are many kinds of microorganisms and many processes that affect their fate and transport, and these vary from one aquifer type to another. The National Microbial Monitoring Programme for groundwater has been developed for DWA. Besides the movement of groundwater, there are processes such as natural die-off, formation of biofilms, adsorption, etc., which are taking place, and there is inadequate local understanding of the nature and extent of the chemical, physical, biological and microbiological processes that control the fate and transport of micro-organisms in South African aquifers. This project aims to develop a sound database and monitoring protocol upon which future comprehensive fate-and-transport modelling of micro-organisms in dolomitic aquifers can be based, and which would enable more detailed modelling (inevitably scenario-based) and could contribute significantly to the development of appropriate strategies that mitigate associated human health risks.

Estimated cost: R 1 500 000

Expected term: 2009 - 2012

**Implementation of a conceptual framework model for the regulation of water quality in an integrated, preventative management approach**

Golder Associates Africa (Pty.) Ltd.

**No.1912**

This project follows on from WRC Project No. 1769, entitled 'Implementation of a conceptual framework model for the regulation of water quality in an integrated, preventative management approach'. The earlier project indicated that the management framework under current legislation is inadequate when evaluated against the integrated catchment-to-consumer cycle. The regulatory process is indistinct in the sense that water resources and water services are managed under different Acts and different institutional structures. The current management framework is, furthermore, reactive rather than proactive since it is primarily focused on the monitoring of raw and drinking water quality. The project produced a structured conceptual model for integrating water quality management, taking into account the current legislative gaps, as well as indicating required changes to the legislative framework that will strengthen the regulatory framework for integrated management. This project will implement the conceptual framework model for the regulation of water quality in an integrated, preventative management approach, and test it at the various management boundaries that have been identified (e.g. catchment, WSA, industrial zone).

Estimated cost: R857 120

Expected term: 2009 - 2011

**Groundwater management functions**

Umvoto Africa (Pty.) Ltd.

**No.1917**

Strengthening the capacity of catchment-based authorities to manage groundwater effectively is an important challenge. This can be achieved by identifying local needs and trends, facilitating communication and cooperation, and promoting best management practices. The success of any groundwater management plan depends on the effectiveness of the authorities that are responsible and is also a prerequisite for integrated water resource management. The main aims of this project are: (a) Define the functions of planning, organising, directing and control, in terms of groundwater management; (b) Develop and incorporate the appropriate management functions into a groundwater management framework for improved resource management, targeting local municipalities; and (c) To establish the value of groundwater for different users and to determine a tariff strategy for groundwater which will consider both the actual supply costs (fixed and variable) and the value of water.

Estimated cost: R 398 600

Expected term: 2009 - 2011

**Scoping study on the management of microbial contamination (taking also chemical quality in consideration) in water resources in CMAs**

University of Pretoria

**No.1934**

Developing countries experiencing a growing demand for housing and sanitation provision are placing a burden on local authorities to provide for the need. The growing informal settlements around towns and cities are often also near water resources in South Africa. Due to the lack of sanitation the water sources are receiving great loads of microbial pollution making the source water unfit for direct consumption and recreation activities, as well as for irrigation. These sources are often also

used for laundry purposes and children play in this water. The sewage treatment plants can often not handle the extra burden of sanitation projects, resulting in these plants not performing to standards and overflows occurring during heavy rainstorms. The study will investigate available management options and models to determine and manage the microbial pollution on a catchment scale. This will include the possible effect of the chemical quality of the receiving waters in the catchments. The project will make recommendations on research needs and follow-up projects.

Estimated cost: R250 000

Expected term: 2009 - 2010

## CONTACT PERSONS

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## KSA 2: WATER-LINKED ECOSYSTEMS



Dr Stanley Liphadzi:  
Director

### SCOPE

Water-linked ecosystems are defined as in-stream (fully aquatic), riparian (dependent on water stored in the river banks and linked to the river) and water table-dependent (dependent on a water table, but not on surface water). This KSA focuses on the protection and sustainable utilisation of the aquatic environment and biota (in-stream, riparian and groundwater). This includes the research needs around the international conventions on environmental management (e.g. biodiversity) as well as human needs from the aquatic environment (e.g. sustainable management for equitable ecosystem resource utilisation, recreation and ecotourism).

The above will be achieved by developing technologies and methodologies, adaptive management processes and capacity to protect the resource and to sustain the flow of goods and services in a time of both demographic and climatic change in the Southern African context. Technologies and methodologies will be developed within this KSA to support the implementation of the national water policy to ensure protection and sustainable resource use.

### OBJECTIVES

In the light of international trends in research, the portfolio of research falling within the scope of and addressing this KSA has been adjusted. However, the main (primary) and secondary objectives of this KSA have been reviewed and found to address future research need scenarios appropriately. The main objective is the provision of knowledge to enable good environmental governance so as to ensure the utilisation

and sustainable management of water; and to develop an understanding of the ecological processes underlying the delivery of goods and services from the water-linked ecosystems in a water-scarce country during a time of demographic and climate change.

This will be achieved through the following (secondary) objectives aiming to:

- Develop an understanding of the ecological processes underlying the delivery of goods and services
- Develop the knowledge to sustainably manage, protect and utilise aquatic ecosystems
- Transfer the knowledge to appropriate end-users. A part of this will be the development of innovative tools and methods for effective knowledge dissemination. These will be developed in conjunction with other KSAs within the WRC.
- Strategically align research with WRC impact areas and government (DWA) priority projects and the *Water for Growth and Development* strategy, where relevant
- Promote good science and build capacity in both research and management to sustainably manage aquatic ecosystems

### THRUSTS AND PROGRAMMES

As indicated above, the research portfolio for 2009/10 did not deviate materially from that of the previous year. The thrust addressing Ecosystem Processes is progressing well. A general description of thrust and programme structure is presented below. New initiatives and current projects have been grouped into strategic thrusts and programmes which directly address the above-mentioned objectives and are summarised as follows:

### THRUST 1: ECOSYSTEM PROCESSES

**Scope:** This thrust includes research addressing the biophysical processes, form and function of ecosystems. This understanding will assist those managing the resource (water services, crop and aquaculture, biodiversity, etc.) to maximise socio-economic benefits in a sustainable manner. The aim is to generate knowledge to inform policy and management. Current programmes are:

- Estuarine processes
- Riverine processes
- Wetland processes
- Groundwater-dependent ecosystems
- Impoundments

### THRUST 2: ECOSYSTEM MANAGEMENT AND UTILISATION

**Scope:** This thrust includes research which specifically addresses the management of ecosystems for sustainable utilisation for the provision of the ecosystem benefits that people depend on. Central to this is the need to manage the social and economic requirements of society from ecosystems and the implementation of policy and legislation. Capacity will be built to implement the research findings. The following programmes are addressed:

- Ecological Reserve
- Estuary management
- Ecosystem health
- Environmental water quality
- Endocrine disrupting compounds in water sources
- Socio-economic considerations
- Ecosystem governance

### THRUST 3: ECOSYSTEM REHABILITATION

**Scope:** This thrust addresses the rehabilitation of the aquatic environment (including both the abiotic and the biotic components) which has been degraded through anthropogenic activities with the view to restoring, as far as possible, process, form and function in order to provide the stream of goods and services that a healthy aquatic ecosystem should provide. This will be done in terms of both relevant international conventions and national legislation, and seeks to restore biodiversity where possible. Capacity will be built to implement the research findings. Programmes include:

- Wetland rehabilitation
- River and impoundment rehabilitation
- Influence of instream-constructed barriers.

## RESEARCH PORTFOLIO FOR 2009/10

This KSA focuses on the protection and sustainable utilisation of the aquatic environment (abiotic and biotic) and the economic (livelihoods) and social benefits related to their use. It addresses national research needs (strategic and shorter term) as well as those of international conventions on environmental

management (e.g. wetland conservation [RAMSAR] and biodiversity). Work done within this KSA has contributed to the development of the National Water Act (NWA) and associated policies, an example being the ecological Reserve. This has meant that work within this field has not only addressed the strategic needs of the country, which have increased in line with the increased global recognition of the importance of the role of sustainable environmental management, but has also addressed some of the immediate research needs related to the NWA and its implementation. What people require of the environment is an area of increasing importance, and the building of capacity amongst the country's citizens (managers and the various user groups) to manage the environment sustainably is of cardinal importance.

National research drivers in ecosystem research continue to be aligned with international trends, although the emphasis is on the local situation, and includes the following:

- **Ecosystem processes and functions.** Research into these aspects is important for the sustainable management of ecosystems and their support of livelihoods, and it is anticipated that this will remain a priority research driver for the foreseeable future. Research in this area provides the basic understanding on which management decisions may be based.
- **The ecological Reserve** provides a tool which enables managers to balance resource use sustainably. Action research on catchment governance structures has been initiated to facilitate the implementation of the Reserve in areas where it has already been determined. The wider field encompassed by ecohydrology will assist in the understanding and implementation of integrated water resource management that is needed for this.
- **Co-operative environmental management** and governance is being developed within the context of research programmes addressing estuaries, wetlands, the ecological Reserve and other initiatives. This develops the capability to integrate ecosystem management with the social and economic requirements of the stakeholders.
- Knowledge of **ecosystem health and environmental water quality** provide the basis for balancing the use of the resource and the discharge of effluents with the ecological health and sustainability of the resource as well as human health related issues. Endocrine disrupting compounds form a specific focus within the general topic of ecosystem health and environmental water quality. It is anticipated that research into this topic will continue into the foreseeable future.
- **Rehabilitation research** in its present form has a finite duration. It is becoming linked to wetland rehabilitation within the Working for Water programme as well as within DWA, and will probably cease to exist as a research initiative within 10 years. However, international trends in impoundment management involve their rehabilitation through the manipulation of ecosystem processes, and research along these lines is currently being initiated

through the WRC. This is a new research field globally, and is likely to continue for some time.

- **Technology transfer** continues to be important. Some of the activities routinely taken within the KSA have proved successful, but it is necessary to hone these activities in order to ensure that this important link is managed as efficiently as possible. More efficient methods of transferring knowledge generated through research into the arena of implementation need to be embedded in the routine of research implementation, and this will require a change of focus as well as a reallocation of funds to address this aspect.

A number of research initiatives have been identified, some of which are being piloted. It is anticipated that some of these will become large programmes which will run for longer than a decade. Resource constraints prevent all of these from being initiated simultaneously. These are discussed briefly below:

- Knowledge of the **socio-economic aspects of sustainable ecosystem management** lags behind knowledge of the ecosystem functions and processes, a WRC-wide shortcoming identified during the Institutional Review. Knowledge of this aspect needs to be improved if we are to ensure long-term sustainability of the resource. It is anticipated that research in this area will continue for the foreseeable future.
- Research initiated on the **Reserve determination for non-perennial rivers** is developing new understanding in the dynamics of rivers in the environment. Perennial rivers are largely limited to the well-watered east and the main stems in the arid west of South Africa. However, many of the tributaries, even in the well-watered east, are non-perennial. The initial programme is planned to be completed by 2011, but it is certain that a number of research questions will be raised during the research, and will require a decision as to which should be addressed in future research initiatives.
- South Africa has a very rich history of **diatomology**. Recently developed indices using diatoms as indicators of water quality appear to be promising, as indicators of water quality which are both robust and easy to use, but will also be able to give insight into historical water quality for areas where early collections exist. It appears that these indices may be successfully applied to both historical collections and to recently collected diatoms. WRC and DWA are investigating the potential of using diatoms as an indicator for wetland health as the conventional indicators have not measured up to expectations in this complex environment.
- Research into the **management of biodiversity** (in terms of the recent legislation) has started with a small project on fish biodiversity. It is likely that this field will expand substantially once the outcome of the conservation planning programme (above) becomes known. This initiative is being expanded to, *inter alia*, develop conservation.

- **Ecosystem governance** has been identified as an essential component of sustainable management as shown by the failure of some research programmes to achieve the results that the technology developed during these programmes promised. To this end, greater emphasis will be placed on ensuring that this aspect is addressed during research providing technologies for implementation. Research is being initiated specifically to develop the necessary understanding to achieve this.
- Action research that has been conducted within this KSA has been largely focused on the **communal management of wetlands** for agriculture and natural resource harvesting. This research continues to be supported, and, in addition, an initiative within the Eastern Cape Estuaries Research Programme will develop ways for the economic empowerment of rural communities based on naturally available resources.

## BUDGET FOR 2009/10

The approved funding of the research portfolio for 2009/10 led to a committed funding budget of R16 294 229 (excluding roll-over), with R7585 289 committed to new projects.

## CORE STRATEGY

Healthy people depend on a healthy environment. This is particularly true in the case of the rural poor who rely directly on the environment for their livelihood. For instance, while poor quality water can be improved in treatment works (at increased cost), those directly dependent on the resource will suffer the consequences of drinking water containing pollutants or disease-causing organisms. At the same time, the flow of goods and services such as fish, fibres as well as cultivated and medicinal plants from a poor quality ecosystem will be less than it should be. For these and other reasons, sustainable management of the ecosystems making up the environment is central to an improved quality of life. The scale of ecosystem benefits varies from individual, for example, fibre for mat- and basket-weaving or medicinal benefits for individual livelihoods, to universal, such as good quality water for abstraction and urban use and intact wetlands to aid in improvement of water quality and flood attenuation. In short, society cannot survive without the underpinning support from the environment.

The core strategy was fundamentally unchanged from 2008/09 but focus was given to DWA's *Water for Growth and Development* strategy. The KSA will furthermore internalise national strategies such as ASGISA, JIPSA, and DST's 10-year Innovation Plan. Research funded from within this KSA will continue to address, within the mission and vision of the WRC, the three legs of sustainability (society, economy, and environment) as defined

by the 2002 Johannesburg Summit and the needs of South African legislation and the international conventions to which South Africa is signatory.

### Strategic context

The KSA for **Water-Linked Ecosystems** may be defined both by the physical boundaries of the area addressed by the KSA, as well as by the strategic role occupied by the WRC in the field, with relevance to organisations active in ecosystem research and management. Physically, the field includes aquatic and riparian ecosystems as well as those dependent on groundwater.

Research funded through this KSA not only provides knowledge for the protection of the resource and the biodiversity of aquatic ecosystems, but also supports sustainable utilisation of aquatic resources while ensuring equity between generations. The KSA 2 research further addresses the commitment to international conventions, the needs and implementation of policy as well as sustaining the capability of the environment to support the flow of benefits on which society depends.

Aquatic ecosystems comprise the resource in terms of the National Water Act of 1998. Even without this they are important for a number of reasons. They provide a barometer of ecosystem health, and hence environmental quality, which is responsive to change and easy to interpret. They also provide a number of goods and services which are used by all sectors of the population. Examples of these are water for domestic, agricultural and industrial use, polishing of effluents, basic food and fibre (fish, plants), traditional medicines, and opportunities for recreation, to name a few. A stable ecosystem provides the necessary resilience to cope with extreme events such as floods and droughts (natural) and pollution events (anthropogenic). In the past a proportion of the national cost for the treatment of wastes was externalised to the environment and, although the environment was degraded by this, by and large the load did not exceed the capacity of the environment to cope with it. However, it is beneficial for all to maintain the resource in a good condition rather than to carry the costs associated with a poor-quality resource.

To this end, the WRC has funded research on ecosystems since the latter part of the 1980s. The work funded has been a balance between the generation of knowledge needed to understand ecosystem processes and ensuring that the knowledge generated supports sustainable management and utilisation of aquatic resources. Knowledge gained through the KSA research is utilised to guide the direction of future resource management and planning, which supports DWA's strategy on *Water for Growth and Development*. Some examples of this research which was funded during 2009/10 are: Establishing ranges of water quality variables in wetlands and their relationship to land-use and ecosystem response, which is aimed towards refining the ecological Reserve methodologies to suit the needs of users;

food-web interactions in South African reservoirs traced using stable isotopes that will support DWA's effort in rehabilitation and management of impoundments.

The WRC, with its mandate to improve the national capability to sustainably manage water in the country, has a specific role which differs from that of other research funders. The WRC supports DWA and other Government departments in their objectives to effectively manage the national water resource. The KSA aims to continue to build partnerships, to reduce overlap where possible and to establish strong synergy with other institutions. This will expand the limited sources of funds available to this area of research. The research funded by this KSA ranges from more fundamental to highly applied work within the area defined by the mandate of the WRC. The number of collaborative initiatives and projects between this KSA and DWA, as well as the number of partnerships and initiatives at local, regional and international levels continues to increase.

### Needs analysis

This KSA closely supports DWA in its strategy for *Water for Growth and Development*, DEA and also the initiatives of other Government departments. However, the need also exists, possibly more than ever, for strategic research for innovation, the lead for which may come from global trends not necessarily reflected yet as needs in South Africa. The need to implement legislation tends to distract attention from this long-term need, although this is handled proactively as far as possible within this KSA so that anticipated research products are available when needed. The KSA will continue to support research that addresses the longer-term needs of the country. Funding research to contribute to the capability to sustainably manage ecosystems is an overarching need which this KSA continues to address. In addition, involving both the decision makers and the community in the above is key to the successful implementation of the research findings.

At the higher level, it is necessary to improve the interface between scientists on the one hand, and managers and the public, including rural communities, on the other. Without this, the concept of sustainable management will remain in the realm of theory. The implementation of research findings requires specific attention and this was addressed within the KSA through a WRC-wide initiative.

Research is needed to address the processes and functions of various components of aquatic ecosystems. It is becoming increasingly apparent that, with the switch to largely addressing the needs of management over the past decade and a half, we are reaching the limits of current knowledge. More research needs to be initiated in selected areas in order to ensure that our knowledge remains ahead of the need to apply it and this KSA will continue to provide guidance and leadership to the research community.

Water quality deterioration has reached crisis levels in the country's heavily used catchments, with fish kills in the Vaal River and Olifants River (Mpumalanga) and crocodile deaths in the Lower Olifants River. A multidisciplinary approach is necessary to address this problem adequately, and to this end KSA 2 has initiated a scoping study which will lead to a larger research programme in conjunction with SANParks and other organisations.

At the operational level, in addition to the issues around the implementation of legislation, there is a need to provide knowledge on the mitigation of the effect of development on ecosystems. The KSA, in collaboration with DWA, will pay special attention to the effectiveness and efficiency of RDM methods and tools, particularly those used in the Reserve determination, with the intention to meet the needs of users and beneficiaries.

### Overview of technological trends

Several important recent trends in inland water research have been emerging internationally, and these are briefly discussed below. These trends are being implemented in the medium- to long-term planning within the KSA where they are relevant to the country:

**Climate change** (DST Grand Challenge area): New knowledge further emphasises the importance of the phenomenon of climate change. There is an increasing body of knowledge on the effects of climate change from the temperate latitudes, but this deals largely with increasing temperature. More relevant to Southern Africa is the predicted change in rainfall, with the dry west becoming drier. The ramifications of this for management of the resource could be substantial. Research in this field has developed methods for continual monitoring of river water temperature, and this will be piloted in a new project.

**Ecohydrology:** The science of ecohydrology is gaining momentum in many countries. Research conducted in this KSA and in KSA 1 addresses aspects of ecohydrology, and these linkages will be explored.

**Impoundment management:** Toxic blue-green algal blooms resulting from the eutrophication of impoundments pose increasing problems worldwide. Research work internationally is addressing the possibility of managing the natural ecological processes within these impoundments in order to reduce the impact of these blooms. The ability to do this would not only protect the natural environment, but would also assist in keeping the cost of water treatment down. KSA 2, as part of a wider national and international consortium, will continue to facilitate research on this recalcitrant problem.

**Natural resources as a source for livelihoods:** Linking ecosystem utilisation to poverty alleviation, job creation and food security means the effective and sustainable management of ecosystems

- Capacity for sustainable utilisation in the context of sustainable development is a key intervention in this regard and is being built through initiatives in this KSA
- Research on wise use of wetlands should accommodate the DST 10-year Innovation Plan's focus area on 'Farmer to Pharma' (DST Grand Challenge area), which is aimed at developing pharmaceutical products from indigenous medicinal plants and aquatic biodiversity.

**Shared rivers:** It has become clear that research work is required on the management of our shared rivers to enable South Africa to be able to meet international commitments and conventions. This is possible by having collaborative initiatives with affected neighbouring countries. The KSA has initiated a long-term initiative that will focus on management aspects of rivers that South Africa shares with her neighbours. A focus of this initiative is the implementation of the NWA as well as seeking to achieve congruence between the implementation of the NWA and related policies and legislation.

The successful implementation of all of the above hinges on thorough knowledge of **ecosystem functions and processes** as well as the will to implement.

### Key stakeholders

The key stakeholders remain largely unchanged. In addition to the Minister of Water and Environmental Affairs and DWA, other Government departments such as DEA are of importance. This KSA closely supports DWA specifically at this time when they are implementing new legislation. Provincial and local government form another group of stakeholders, and the needs of catchment management agencies (CMAs), which are currently being established, influence research direction. Other end-users of the research are rural communities and others living on the land.

Donor funding is available in this field, usually for specific tasks which satisfy the donor's mandate. The largest funder is the Global Environment Facility (GEF), funded by the World Bank, which has been instrumental in establishing large biosphere reserves as well as the Cape Action Plan for the Environment (CAPE) in South Africa. Both the IUCN and Wetlands International (international NGOs) fund specific projects within their mandates in this field, and the latter is becoming increasingly active in Africa. Funding may also be available from industry for specific projects.

# STRATEGIC INITIATIVES

## National initiatives

- The KSA, in collaboration with DWA, resuscitated the Adopt-a-River initiative of the River Health Programme (RHP). 'Mini-SASS' brochures were distributed during the re-launch, which took place during Water Week 2010, at Eerste River, Stellenbosch. The Adopt-a-River initiative is a voluntary monitoring initiative aimed at public awareness and participation in water resource management across the country. The WRC is one of three national custodians (with DWA and DEA) of this initiative and is also a member of the national Steering Committee.
- The WRC was requested to chair a session on Water Quality and Wetland Biology at the Wetlands Indaba. The WRC also played a significant role (in collaboration with SANBI, DAFF) as a member of the organising committee and sponsor of the World Wetlands Day in South Africa, 2 February 2010
- KSA 2 contributed as an invited panel member to advise the Limpopo ANC Agricultural Sector
- The KSA participated in the induction of the Parliamentary Portfolio Committee on Water Affairs
- The KSA was responsible for leading FETWater Phase 2

## Leadership positions

- Member of the ARC Board
- Board of the Institute of Water Research, Rhodes University
- National Science and Technology Foundation – Executive Committee representing the Science Council Sector
- Chairman of NSTF Science Councils and Statutory Bodies Sector
- Member of NSTF Awards Adjudication panel for 2009/10.
- Member of the Board of Sci-Bono Discovery Centre
- Member of the South African Mercury Association (SAMA)
- Wetland Inventory Advisory Committee – Working for Wetlands.
- Member of the steering committee of the Working for Wetlands programme. Other members are DWA, SANBI, and DEA.
- Executive committee member of DWA's 'Adopt-a-River' programme
- Chairman of the University of Venda's Agricultural Alumni Association

## Public appreciation

The following three impact studies were initiated and will be completed in March 2010:

- **Estuarine research:** The purpose of the study was to determine the extent to which all relevant historical research in estuarine science, funded by the WRC, has contributed to the organisational aims of the WRC. A preliminary analysis suggests that WRC funding for research

on estuaries has had very significant positive impacts. For example, the relevance of WRC-funded research is rated highly and WRC funding has facilitated knowledge sharing among and between research providers and research users.

- **Wetlands research:** An impact assessment study has shown that the WRC has invested nearly R50 million in 66 research studies with a wetland-related objective, confirming stakeholder perceptions that the WRC plays a critical role in funding and guiding wetland research. Preliminary results indicate that the wetland research funded by the WRC is directly relevant to matters of policy and integrated water resource management, and to national and international environmental, economic and social (including public health and capacity) matters of global importance. Research products include useful tools for end-users, are accessible through WRC publications and websites, and are disseminated in various user-friendly forms. Initial indications are that research products are being used to guide policy and management models, make decisions regarding water-use license and development applications, inform management of public health issues such as wastewater treatment, inform Reserve determination, and the planning and monitoring of wetland rehabilitation. Incidental reports indicate that wetland rehabilitation is in some instances resulting in improved flows and return of biodiversity.
- **FETWater Programme (Phase 1 and 2):** This study assessed the impact of the FETWater programme (particularly its networks and products) on the water sector in South Africa and beyond. Both Phases 1 and 2 were considered in this assessment. However, more emphasis was placed on Phase II, which was implemented by the WRC. The study showed that FETWater programme was managed fairly well by the WRC and that the programme has had more outstanding achievements (output and outcome) under the guidance of the WRC.

## African leadership

- Organised of a side-session during the *African Water Week*, November 2010, on 'Valuation of freshwater ecosystems' goods and services"
- Partnered with IUCN in running a workshop on *Energy Livelihoods and Ecosystems in Africa*
- Member of IWMI wetlands steering committee for the Limpopo basin (where the focus is on the Gamampa Wetlands and community) and for the Southern Africa region. The focus at this level covers countries within SADC.

## International player

- A KSA 2 member is a member of RAMSAR's Science and Technical Review Panel (STRP) representing the African Region. This has given the WRC a platform to influence wetlands research and technology transfer throughout the African continent through collaboration with RAMSAR

- focal points appointed in each member country.
- The WRC, through this KSA, has initiated R&D collaboration talks with Oregon State University, USA. The collaboration will also include DWA (RQS).
  - The WRC, through this KSA, was chosen as one of the organisation in South Africa to contribute to the overall evaluation of UNEP-IWMI wetland-related projects
  - The KSA staff acted as reviewers of scientific papers for five Elsevier Journals (*Journal of Hazardous Waste, Chemosphere, Environmental Pollution, Archives of Environmental Contamination and Toxicology, Science of the Total Environment*).
  - Presented a keynote address entitled 'Grasslands and

biodiversity as natural water infrastructure' at the *Grassland Partnership Symposium* at SANBI, November 2009

## GROWING THE KNOWLEDGE BASE

### Capacity building initiatives

Table 1 illustrates the numbers of postgraduate students who benefited from WRC-funded research in this KSA in 2009/10.

**TABLE 1**  
**Capacity building through student involvement in KSA 2 projects in 2009/10**

Organisation/institution	No. of historically-disadvantaged (HD) students	Total No. of students
Agricultural Research Council (ARC)	0	2
Association for Water and Rural Development (AWARD)	0	3
CSIR	3	7
DH Environmental Consulting	3	9
Nelson Mandela Metropolitan University	1	2
North-West University	2	6
Prime Africa Consultants (previously CIC International)	1	2
Rhodes University	1	3
South African National Biodiversity Institute (SANBI)	2	2
University of Cape Town	2	9
University of Limpopo	5	6
University of Stellenbosch	2	5
University of the Free State	0	5
University of the Witwatersrand	4	11
University of Venda	1	2
Water for Africa	3	6
<b>TOTAL</b>	<b>30</b>	<b>80</b>

In addition, the KSA sponsored 6 M.Sc. and Ph.D. students to attend and present research papers in at the *2009 Southern African Society of Aquatic Scientists* conference in May 2009; the majority of the students sponsored students were PDIs. The KSA has worked closely with the FETwater networks in facilitating students' mobility, especially for attending training workshops and professional conferences.

The KSA led, participated in and/or supported the following 9 technical **workshops**:

- Shared Rivers Initiative strategic meeting to address issues emerging from Phase I (K5/1711), Skukuza, May 2009
- Workshop on the industrial implementation of toxicity testing to devise a strategic plan for the implementation of toxicity testing for complex discharge management, April 2009, Pretoria
- *Environmental Water Requirements Network: Estuary Training Course (KwaZulu-Natal)*, May 2009
- *Workshop for Practitioners of Ecological Water Assessments*, held to bring together practitioners for rivers, wetlands, estuaries, water quality and groundwater with DWA senior water managers, to streamline methods nationally, 26-27 November 2009, Pretoria
- *Setting Conservation Targets for Wetlands when Setting Conservation Targets for Rivers*, April 2009, Pretoria
- Workshop on linking land use to water quality attempting to enhance IWRM and providing an integrated approach to managers and developers, February 2010, Pretoria
- *National Stakeholder Workshop on Methodology and Development of Buffer Zones for all Water Resource Types with Implementation as the End Point*, March 2010, Pretoria
- *A Framework for the Classification of Drainage Networks in Savanna Landscapes*, Skukuza, March 2010

### Knowledge dissemination

New knowledge dissemination mechanisms were implemented as follows:

- In collaboration with SABC TV and the University of Johannesburg, a video entitled *SABC NUUS Yellowfish Genetics Study* funded by the WRC (K8/677 & K8/818) was broadcast
- A book on the Reserve will be published in 2010, addressing strength and gaps of the NWA of 1998 in the context of implementation in South Africa. This initiative has brought all stakeholders together to effect NWA implementation.
- The KSA has collaborated with SABC TV to collate interviews on Environmental Water (Flows) that were conducted during the IEWA conference in Port Elizabeth in February 2010. The DVD is now available.
- A 'MiniSASS' brochure has been published and was used in the launch of the second phase of the Adopt-a-River' programme during *National Water Week 2010*.

### Conference presentations and other activities by staff members

- Presented a keynote address entitled 'Grasslands and biodiversity as natural water infrastructure' at the *Grassland Partnership Symposium*, SANBI, Pretoria, November 2009
- *Southern African Society of Aquatic Scientists (SASAQS)*, Magalies Lodge, North West Province, May 2009
- *International Biodiversity (Diversitas) Conference*, Cape Town, October 2009
- *Wetlands Indaba*, Langebaan, October 2009
- *2nd African Water Week*, Gallagher Estate, November 2009

## IMPLEMENTATION PLAN

### Research portfolio for 2009/10

In essence, the implementation plan follows that of previous years in that the primary objective of this research portfolio is the provision of knowledge to enable good environmental governance so as to ensure the utilisation and sustainable management of water-linked ecosystems in a water-scarce country during a time of demographic and climate change.

This will continue to be achieved through the following:

- Development of an understanding of the ecological processes underlying the delivery of goods and services
- Development of the knowledge to sustainably manage, protect, utilise and rehabilitate the aquatic ecosystem
- Transfer of the knowledge to appropriate end-users. A part of this will be the development of innovative tools and methods for effective knowledge dissemination.
- Strategically align research with WRC impact areas and government (DWA) priority projects where relevant
- Building of capacity in both research and management to sustainably manage aquatic ecosystems

The research portfolio for 2009/10 is presented in Table 2.

**TABLE 2**

**Overview and description of thrusts and programmes**

**THRUST 1: ECOSYSTEM PROCESSES**

**Scope:** This thrust includes research addressing the biophysical processes, form and function of ecosystems. This understanding will assist those managing the resource (water services, crop and aquaculture, biodiversity, etc.) to maximise socio-economic benefits in a sustainable manner. The aim is to generate knowledge to inform policy and management.

<b>Programme 1: Estuarine processes</b>	Estuaries are fragile and highly productive ecosystems and are highly sought after as places to live. Projects in this programme address the ecological processes occurring in estuaries.
<b>Programme 2: Riverine processes</b>	Programmes to investigate the ecosystem functioning and processes of riparian zones, rivers and impoundments will be developed. This is an area in which South Africa needs improved capability to manage, and in the case of riparian zones is a topic attracting international interest.
<b>Programme 3: Wetland processes</b>	Within this programme research will be conducted to develop understanding of the ecological processes and functioning of wetlands, and to assess their value to both the catchment and the people living adjacent to them.
<b>Programme 4: Groundwater-dependent ecosystems</b>	Within this programme the dynamics of groundwater-dependent ecosystems will be investigated in relation to the aquifers on which they depend. This will be related to exploitation of the groundwater. Special attention will be given to the vulnerability of these systems.
<b>Programme 5: Impoundments</b>	Research within this programme will cover ecological functions and processes within impoundments with a view to improving our ability to manage these.

**THRUST 2: ECOSYSTEM MANAGEMENT AND UTILISATION**

**Scope:** This thrust includes research which specifically addresses the management of ecosystems for sustainable utilisation for the provision of the ecosystem benefits that people depend on. Central to this is the need to manage the social and economic requirements of society from ecosystems and the implementation of policy and legislation. Capacity will be built to implement the research findings.

<b>Programme 1: Ecological Reserve</b>	Within this programme research will be conducted to develop and refine methods for determining and operationalising the ecological Reserve as required by the NWA. The programme will address the more strategic issues such as the development of new and improved methods as well as the shorter-term issues such as implementation of the Reserve. This programme is managed in close association with DWA.
<b>Programme 2: Estuary management</b>	Within this programme research will be conducted to develop an understanding of the ecological processes within estuaries, and the effect of anthropogenic disturbance on these. This understanding is then conveyed to stakeholders (tiers of Government, communities) as management guidelines to inform them on how to manage estuaries sustainability. This programme is managed in close association with Marine and Coastal Management, DEA.

<p><b>Programme 3:</b> <b>Ecosystem health</b></p>	<p>The River Health Programme (RHP: custodians are DWA, WRC and DEA) aims to implement nationally (at the level of provincial Government and industry) a coherent bio-monitoring programme with well-defined indices. Much of the R&amp;D is done within this programme. Additional issues on the management of river health, although they may not directly be part of the RHP, link closely with it and so are kept in the same programme. Research on the environmental health of wetlands, estuaries and impoundments is also included in this programme. This programme links to the WRC impact area <b>Water and Health</b> and includes resource management actions which may affect human health.</p>
<p><b>Programme 4:</b> <b>Environmental water quality</b></p>	<p>Within this programme research will be conducted to develop bio-assays (both in the laboratory and the field) which will be employed to protect people and the environment from the effects of poor water quality. It will develop methods and competence to enable the use of toxicology in effluent discharge licences as well as its use in environmental water quality as required in the ecological Reserve. This programme addresses the longer-term development and refinement of methods and the competence to use them, as well as the shorter-term competence required to implement policy in terms of the NWA. This programme links to the endocrine disrupter programme within the WRC impact area <b>Water and Health</b>.</p>
<p><b>Programme 5:</b> <b>Endocrine disrupting compounds</b></p>	<p>The overall objective is to characterise, and acquire information for assessing, the EDC effects of various chemicals and compounds in water (singly or in combination), both those occurring naturally and those resulting from pollution, which have the potential to cause detrimental health effects in humans, animals and the aquatic environment, as a guide to develop and implement cost-effective treatment and control strategies. Further emphasis is on the development of simple, rapid and cost-effective detection techniques. This programme will be implemented in three phases, of which the first phase is already completed.</p>
<p><b>Programme 6:</b> <b>Socio-economic considerations</b></p>	<p>The overall objective of this programme is to develop and integrate knowledge on the sociological and economic aspects of water-linked ecosystems with the ecological knowledge, in order to develop the understanding and competence necessary to sustainably manage the aquatic environment.</p>
<p><b>Programme 7:</b> <b>Ecosystem governance</b></p>	<p>The overall objective of this programme is to develop understanding of what is required for the successful governance of aquatic ecosystems and how to build the necessary capacity to implement this.</p>

### THRUST 3: ECOSYSTEM REHABILITATION

**Scope:** This thrust addresses the rehabilitation of the aquatic environment (including both the abiotic and the biotic components) which has been degraded through anthropogenic activities, with the view to restoring, as far as possible, process, form and function in order to provide the stream of goods and services that a healthy aquatic ecosystem should provide. This will be done in terms of both relevant international conventions and national legislation, and seeks to restore biodiversity where possible. Capacity will be built to implement the research findings.

<p><b>Programme 1:</b> <b>Wetland rehabilitation</b></p>	<p>Within this programme research will be conducted to develop methods to rehabilitate wetlands which will address both abiotic and biotic components and seek to rehabilitate ecological processes and restore biodiversity, as far as possible, in degraded wetlands. This will be done in terms of both the international conventions to which South Africa is signatory as well as recent legislation from both DEA and DWA. The programme will also develop the competence to implement rehabilitation. Projects in this programme link closely with each other, and are managed as a unit.</p>
<p><b>Programme 2:</b> <b>River and impoundment rehabilitation</b></p>	<p>The research conducted within this programme aims to provide protocols for the rehabilitation of rivers and impoundments, with the emphasis on urban rivers and the impoundments that they feed, that have been degraded as a result of anthropogenic activities or invasive biota.</p>
<p><b>Programme 3:</b> <b>Influence of instream- constructed barriers</b></p>	<p>This programme investigates ways to ameliorate the effects of barriers such as weirs and impoundments on natural river systems.</p>

### KSA alignment with DWA's objectives

The DWA strategy *Water for Growth and Development* articulates the fact that social and economic growth can be supported by water without compromising ecological sustainability. The KSA research will contribute knowledge in the following high-level recommendations as identified in the strategy:

- **Strengthening institutional capacity** – KSA 2 carries out research that supports this recommendation to ensure, among others, that there is equity between generations, and to make sure that there is no attenuation of the flow of goods and services from the aquatic ecosystems. The KSA has research projects such as 'Knowing, caring, and acting: Making use of socio-cultural perspectives to understand and improve conservation'; 'Shared Rivers Initiative' and 'Estuaries and economic empowerment'.
- **Striking a balance between supply and demand-side measures** – This is supported through research that focuses on conservation of the water resource. Examples of this type of research are the projects on integrated weed management and food-web interactions in South African reservoirs.
- **Water for Growth: challenging water use behaviour for the future** – The KSA supports institutions concerned with ecosystem governance such as CMAs and water user associations (WUAs) as well as a suite of projects dealing with social-ecological systems (SES). A new programme focusing on the linkages between land use with water

resource protection will start in 2010.

- **Nurturing attitudinal and behavioural changes towards the value of water** – Lesson plans for teachers were designed specifically for the schools (grades R to 12), giving lessons centred on water in several different subjects for each grade. These have been distributed all over the country. KSA 2 research and activities promote understanding and discussion on key issues that support ecological sustainability. The 2nd edition of *Watermark* (a book promoting public understanding of science around the ecological Reserve) will be published in 2009. Postgraduate students are included in research teams of WRC projects to advance both human capacity development and technology transfer to ensure high levels of competency in water research for South Africa. Moreover, our project meetings, workshops, open days, and field days are attended by representatives of different institutions such as NGOs and local government, and this assists in disseminating relevant knowledge which changes people's attitudes and behaviour regarding water ecosystems.

## RESEARCH PROJECTS FOR 2009/10

The findings of projects completed during the year under review are given, as well as a summary of current projects and the motivation and objectives of new projects which commenced between 01 April 2009 and 31 March 2010.

## COMPLETED PROJECTS

### THRUST 1: ECOSYSTEM PROCESSES

#### *Programme 3: Wetland processes*

##### **National Wetland Research Programme: Phase II - Wetland Health and Integrity**

University of Cape Town (Freshwater Research Unit)

**No. 1584**

This solicited programme was Phase 2 of the WRC Wetland Research Programme conceptualised in 2002. Phase 1, Wetland Rehabilitation, has been completed and Phase 3, Wise Use of Wetlands, needs to be re-conceptualised. Wetlands are important in the delivery of ecosystem services. They are also highly productive and so are used for agriculture and over 50% of South Africa's wetlands have been lost through conversion. A number of projects, each led by a specialist, addressed the specific aspects of the research, including biotic indices using macrophytes and aquatic invertebrates, as well as a method for the assessment of temporary wetlands during dry conditions. A method was developed for the assessment of the cumulative impacts of human activities at the landscape and catchment level on wetlands. The socio-economic aspects of wetland ecosystem services were investigated and case studies are presented. The product of this programme is a series of 11 reports covering the topics researched.

Cost: R3 450 000

Term: 2005 - 2009

### THRUST 2: ECOSYSTEM MANAGEMENT AND UTILISATION

#### *Programme 4: Environmental water quality*

##### **Development of a research programme on the application of aquatic ecotoxicology to water resource management**

Rhodes University

**No. 1313**

This project was initiated in response to the recognition that neither government nor industry were proactively adopting ecotoxicology as a valuable technology in water resource

management, particularly with regard to water resource protection. The research work has crystallised into the area of environmental water quality (EWQ), an integrated approach that advocates the use of water chemistry, biomonitoring and ecotoxicological data to achieve and understand the interactions between biota and their physico-chemical habitat. A workshop was held to develop an objectives hierarchy that would enhance the likelihood of ecotoxicology being an integral part of approaches to and methods used in integrated water resource management. The long-term goal of the project was to ensure that aquatic ecotoxicology is developed, established and implemented, to contribute to effective and sustainable water resource use. The results and products of the project feed into the DWA initiative for a National Toxicity Monitoring Programme and the development of guidelines for toxic organic substances, and the WRC initiative to link aquatic ecotoxicology with human health and endocrine-disrupting compounds.

Cost: R600 000

Term: 2002 - 2009

##### **Application of chronic (sub-lethal) toxicity endpoints to the development of resource quality objectives**

Rhodes University (Institute for Water Research)

**No. 1484**

Deriving sublethal endpoints from acute toxicity data using selected extrapolation methods:

The research has shown that it is possible to extrapolate acute (specifically, mortality) data to derive chronic (sublethal) endpoints which can then be used to derive protective WQGs. This study determined that the LRA LC50/5 extrapolation method was the most environmentally realistic (and most protective) of those methods assessed and proposed that the more scientifically defensible LRA method replace the ACR method in future guideline development.

The use of selected biochemical markers as sublethal endpoints in water resource management:

In order to determine the advantages and limitations of using biochemical data in WQG development, this study investigated: techniques of generating biochemical endpoints in invertebrates; assessing the usefulness and quality of biochemical endpoints generated from these invertebrates; assessing usefulness of selected biochemical data in the US EPA Aquire database and scientific literature; and the possibility (philosophically and statistically) of including biochemical endpoints in WQG development. The sublethality benchmark derived using the Jooste and Rossouw (2002) method (which included the biochemical data) is slightly lower than the range of NOECs of 0.25-0.50mg/l generated from mesocosm studies (Van de Plassche et al. 1999; Belanger et al. 2002), and the Australian and New Zealand WQG for LAS of 0.28mg/l.

Cost: R1 340 000

Term: w2004 - 2009

**Investigating the applicability of ecological informatics modelling techniques for predicting harmful algal blooms in hypertrophic reservoirs of South Africa**

North-West University (Potchefstroom, School for Environmental Sciences)

**No. 1675**

The study showed that eutrophication and the associated problems are a real threat to South African freshwater resources, but that modelling methods can assist in managing the problem. The list of recommendations needs to be taken further by a number of stakeholders, e.g. the Department of Water Affairs, future CMAs, universities and other researchers, in order to:

- Determine the necessary variables and monitor these for future modelling exercises
- Include total microcystin monitoring in impacted freshwater resources at least during the summer periods to enable resource managers to issue warnings to all potential impacted stakeholders
- Initiate and test available management options to minimise serious eutrophication levels in South Africa
- Manage the risk imposed by the cyanobacterial blooms and the associated toxins produced in the water resources, on drinking water facilities and the health of recreational users
- Develop short-term forecasting tools, for the algal blooms of *Microcystis* and *Ceratium*, with online water quality monitoring for early-warning and real-time forecasting for reservoir managers
- Investigate the cause and effects for changing composition of the phytoplankton of these five reservoirs
- Monitor at different depths to determine the best depth for abstraction for treatment purposes

The successful use of the Hybrid Evolutionary Algorithm method to develop predictive tools for algal blooms indicated the necessity to develop capacity (both human and equipment) in South Africa to use the Hybrid Evolutionary Algorithm (HEA) RULE set development in all research spheres, as the method is applicable to any type of numerical data and can be applied to any research field.

Cost: R225 000

Term: 2006 - 2009

**Programme 7: Ecosystem governance**

**Sustainability indicators in communal wetlands and their catchments**

AWARD

**No. 1709**

The study provides an in-depth review of sustainability indicators, their categorisation and uses, as well specific indicators of different components of the model (Chapter 2). This includes governance, wetland health, soil health, water and sediment balance and plant production. Indicators may be diagnostic, process, performance or outcome indicators depending on the objective at hand. Indicators of soil health and the relationship of this with crop types reveal important baseline parameters, notably that croplands on granitic sandy soils in the communal areas that have not had applications of manure or inorganic fertilisers now show nutrient deficiencies. Craigieburn village and wetlands of the Sand River Catchment were used as case study (Chapter 3). Craigieburn is located in the north-eastern region of the country, where wetlands comprise 10 to 15% of the catchment area. Land use pressures around and within the wetlands have led to increased erosion, desiccation of the landscape, decreasing fertility and decreased production. The baseline research (Phase I) established the relationship between these factors. The objective of 'wise and effective governance of natural resources' is central to the development of indicators (Chapter 4). *Wise* governance understands and balances the immediate needs and rights of people, sustainable use of natural resources, and the rights of future generations to a healthy environment. *Effective* governance responds to issues through action and feedback. Chapter 5 addresses support for sustainable practices – and hence indicators – that can be used by farmers at the scale of their agricultural plots, as well as for the wetland and micro-catchment. The framework – known as the 'hand of change' – was used as a heuristic to organise key concepts, principles and indicators, thereby supporting learning-for-change. Beyond the plot, a wetland-scale assessment is important for two reasons: (a) it creates a sense for farmers that they and their plot-level practices exist within and are linked to a wider system, and (b) a number of threats to wetland integrity come from beyond the scale of plot. To this, a sixth principle was added, i.e., the protection of *sensitive* areas within or around the wetland. Chapter 6 places indicator development within the broader context of strategic adaptive management.

Cost: R236 100

Term: 2007 - 2009

**Management effectiveness in implementing cross-sector policy objectives for conserving freshwater biodiversity**  
CSIR (Natural Resources and the Environment)

**No. 1710**

South Africa's National Spatial Biodiversity Assessment concluded that freshwater ecosystems are in a much poorer state than terrestrial ecosystems. Coherent policies and coordinated actions between responsible departments are required if freshwater ecosystems are to be conserved effectively. Cooperation is necessary for effective conservation management and this study developed a scorecard, not for policing performance but for facilitating cooperative and sustained conservation action amongst these agencies. This has been achieved through the development of performance indicators for freshwater biodiversity conservation amongst mandated stakeholders that will promote collaborative learning. The scorecard, tested in the Crocodile West - Marico Water Management Area, revealed that the regulatory framework is sound and a high level of trust and good communication exists among those active in biodiversity conservation. Through the identification of the strengths and constraints provided by this scorecard, within the context of Strategic Adaptive Management, the participants were able to improve their performance. It is recommended that a reflective assessment tool like the one developed in this work be used because the preferred emphasis is on trusting people rather than systems.

Cost: R697 820

Term: 2007 - 2009

**THRUST 3: ECOSYSTEM REHABILITATION**

*Programme 2: River rehabilitation*

**Development of an integrated management plan for water hyacinth control, combining biological control, herbicidal control and nutrient control, tailored to the climatic regions of South Africa**

University of the Witwatersrand (School of Animal, Plant & Environmental Sciences)

**No. 1487**

Water hyacinth, *Eichhornia crassipes* (Martius) Solms-Laubach (Pontederiaceae), is South Africa's most damaging floating aquatic weed. Despite notable successes with the biological control of other floating aquatic weeds, and a concerted biological control effort against water hyacinth, its populations continue to reach newsworthy proportions on major rivers and dams. Hill and Olckers (2001) ascribed the variable success of the biological control programme on water hyacinth in South Africa to variable climatic conditions, eutrophication of aquatic ecosystems, interference from integrated control operations, the hydrology of infested systems and techniques for establishing biological control agents. The research presented in this report addresses the effect of temperature and nutrients on the growth

of water hyacinth and some of its biological control agents and investigates the interaction of herbicide application with biological control. This has been done in light of discovering a sublethal dose of herbicide which will retain water hyacinth plants in a system to maintain populations of the agents. In addition, a management plan has been developed to guide water managers as to what action should be taken in terms of combining biological control with herbicidal control under different climatic and nutrient conditions.

Cost: R1 655 600

Term: 2004 - 2009

**CURRENT PROJECTS**

**THRUST 1: ECOSYSTEM PROCESSES**

*Programme 1: Estuarine processes*

**Biochemical processes in a groundwater-fed inter-tidal ecosystem: Biogeochemical controls on the plant biodiversity within a salt-marsh ecosystem in the West Coast National Park: Impact of saltwater-groundwater interaction on pore water chemistry and vegetation**

University of Cape Town (Department of Geological Sciences)

**No. 1591**

The relationship between groundwater and surface water is poorly understood and the relationship between groundwater and the marine environment is even less well understood. However, the impact of poorly managed groundwater exploitation on the latter would have a severe impact on the ecology of the system. The groundwater – seawater mixing process impacts the salinity, anoxia and water movement, bioturbation and nutrient availability in the sub-surface coastal environment thereby controlling the distribution of halophytes and freshwater loving plants and any change in this balance will reverberate through the ecosystem. Over-exploitation of the groundwater resource will have this effect. This project aims to investigate this relationship in the West Coast National Park, an area of low rainfall and permeable geology where the Langebaan Lagoon which is primarily a groundwater-fed estuary. The area is undergoing development and so the demand for exploitation of the groundwater is increasing. This research will refine the understanding of the groundwater discharge around Langebaan, generate water quality maps, and identify any relationship between plant species and geohydrological characteristics. It will also identify specific characteristics which may be used in a monitoring programme and make recommendations on environmental water requirements of the area.

Estimated cost: R397 400

Expected term: 2006 - 2009

## **Programme 2: Riverine processes**

### **Periphyton flow dynamics**

University of Cape Town (Zoology Department)

**No. 1676**

Periphyton (benthic algae) in rivers is highly sensitive to changes in both water quality and flow. Periphyton forms the base of the riverine food chain and any change at this level will be reflected throughout the ecosystem. In addition, the growth of undesirable periphyton can have negative economic consequences in several ways. Filamentous algae can clog irrigation and water purification equipment as well as render the habitat unfit for sensitive organisms, blue-green algae can cause toxin, taste or odour problems and any excessive algal growth will reduce the recreational value of the water body. Knowledge of the dynamics of the relationship between water quality and flow on the one hand, and the response of the periphyton on the other, will enable more accurate prediction of this response; this capability is required in the determination of the ecological Reserve. During this project understanding of the interrelationship between periphyton growth and water quality/flow will be developed to a point where preliminary predictions can be made, and this knowledge will be transferred to managers involved in determination and implementation of the Reserve

Estimated cost: R1 000 000

Expected term: 2006 - 2009

### **A framework for the classification of drainage networks in savanna landscapes**

University of the Witwatersrand (Centre for Water in the Environment), SANParks (Kruger National Park); CSIR (Satellite Applications Centre)

**No.1790**

The character of rivers depends on the nature of their catchment. However, catchments are also shaped by their rivers. The gravity-induced movement of water and sediment down and through hill-slopes is a major control on the distribution of soils and vegetation. However, hill-slopes and channels are still generally studied separately, within different disciplines that use different paradigms and methods of investigation. Even within river science, individual river reaches are generally studied in isolation, neglecting linkages, either upstream-downstream or within the river network. A holistic approach is needed, recognising the 4-dimensional character of river networks. This 4-dimensional character is often described using a hierarchical classification system. In this case, this will include patches of terrestrial landscape between channels, allowing the holistic study and management of river systems. In order to achieve this, the research seeks to describe the spatial organisation of savannah landscapes in the Kruger National Park in terms of the patterns constrained by both the drainage

networks and the hierarchy of interdependent soil, vegetation and hydrological systems.

Estimated cost: R570 000

Expected term: 2008 - 2011

### **Deriving conservation targets for freshwater systems**

Ezemvelo KZN Wildlife; Albany Museum; ARC (Range and Forage Institute)

**No.1796**

Systematic conservation planning provides a structured approach for identifying biologically significant areas which require conservation action. Conservation planners aim to protect biodiversity by planning for persistence and representivity. Rivers are complex, longitudinal systems showing continuous gradients, and conceptually, the application of the process to rivers (freshwaters) is at least a decade behind the application to terrestrial systems. Systematic conservation planning for terrestrial systems makes use of island biogeography theory and species-area curves to set defensible conservation targets. Rivers are characterised by length not area, and species persistence at one site is a function of upstream and downstream ecological processes. Therefore, the species-area method is not suitable in these situations. An approach with a theoretical grounding similar to the species-area curve is necessary for setting meaningful targets in freshwater conservation planning. The research seeks to develop such an approach.

Estimated cost: R404 015

Expected term: 2008 - 2011

## **Programme 3: Wetland processes**

### **To investigate the capability of the Mfabeni Mire (St Lucia) to respond to climatic and land-use stresses and its role in sustaining discharge to downstream and adjacent ecosystems**

University of KwaZulu-Natal (School of Environmental Sciences)

**No. 1704**

The relationship between ground- and surface water is important and not well understood. The Mfabeni Peatland (at 1 250 ha one of South Africa's largest, and at ~45 000 years before present one of South Africa's oldest peatlands) is situated on the east shore of Lake St Lucia within the Greater St Lucia Wetland National Park. The water from this wetland flows into Lake St Lucia where it provides freshwater refugia for biota in times of drought. During times of climate change wetlands such as this will potentially become more important for maintaining the biodiversity of Lake St Lucia and other similar systems. The research undertaken during this project will quantify the water balance of the peatland, the contribution of fresh water to Lake St Lucia, and evaluate the effects of climate change and

land use on the water flux. Principles drawn from this work will increase understanding of the relationship between ground- and surface water elsewhere and give guidance in managing this interface.

Estimated cost: R1 123 391

Expected term: 2007 - 2010

#### **Programme 4: Groundwater-dependent ecosystems**

##### **Framework development for the sampling, classification and geographical occurrences of stygobiont amphipods in South Africa**

North-West University (Zoology Department)

**No. 1586**

Groundwater ecosystems are virtually unknown in South Africa. However, in Australia recent research has shown them to be highly diverse. Fundamentally, they are of interest because there are certainly organisms which will be new to science, and the physiology and food chain dynamics of the organisms inhabiting these areas is of interest. In terms of the new legislation on biodiversity it is necessary to protect the ecosystems. However, the introduction of the concept of a groundwater Reserve in the national water policy means that if we are to implement the policy effectively we need knowledge of the ecosystem that is to be protected. The objective of this study is to broadly characterise the ecosystem in which stygobiont amphipods occur, develop a sampling method and conceptualise a biomonitoring protocol for groundwater using stygobionts.

Estimated cost: R1 350 000

Expected term: 2006 - 2009

## **THRUST 2: ECOSYSTEM MANAGEMENT AND UTILISATION**

### **Programme 1: Ecological Reserve**

#### **Environmental water requirements in non-perennial systems**

University of the Free State (Centre for Environmental Management)

**No. 1587**

Methods for the determination of environmental flows for the Reserve have been developed and used for rivers with permanent flow. However, many rivers in the semi-arid west of the country are ephemeral. The NWA requires that the Reserve be determined before licences may be issued, and currently used methods have not been verified for ephemeral rivers. Verification needs to be done and, where necessary, new methods.

Estimated cost: R2 737 000

Expected term: 2005 - 2009

#### **Development of methods for Reserve determination of wetlands. Phase 1: Rapid Reserve**

Fluvius Environmental Consultants; Water for Africa; Golder Associates Africa; University of Cape Town; Wetland Consulting Services; Dr Patsy Sherman; North-West University (Potchefstroom); CSIR; University of KwaZulu-Natal

**No. 1788**

While satisfactory methods for determining environmental water requirements in permanent waters exist, wetlands have proved to be more complex. During the dry phase they provide a rich and productive flow of ecosystem services to the terrestrial system (e.g. grazing, agriculture) and during the flooded phase provide an equally important flow of ecosystem services to the aquatic system (e.g. water quality, flood attenuation, fish). The method developed needs to be able to cope with the alternate states of wetlands and their importance to the economies that they serve.

Estimated cost: R1 402 911

Expected term: 2008 - 2009

#### **Application and testing of a strategic adaptive management system for freshwater protection, associated with implementation of South Africa's national water policy**

SANParks Scientific Services; University of the Witwatersrand; Fluvius Environmental Consultants; Alexander & Llewellyn (Environmental Division); SAEON (Ndlovu Node)

**No. 1797**

River-based goods and services, with the explicit benefits to society, rely on healthy sustainable ecosystems. South Africa's water policy requires CMAs to manage the resource to achieve equity and social justice within ecological limits. These management practices are usually in conflict, but there is a growing body of research, geographically centred on South Africa's north-east Lowveld, on gaining coherence between these goals to achieve sustainable development. Strategic Adaptive Management (SAM) provides a proven vehicle for learning-by-doing by providing effective knowledge management. This project seeks to consolidate the SAM process developed within the Kruger National Park for wider and long-term implementation in water management areas (WMA) and to ensure that it is appropriately underpinned by the necessary knowledge, integration with the WMAs in the area and to support a wider enabling environment to ensure successful resource management

Estimated cost: R1 335 725

Expected term: 2008 - 2012

**Testing a prototype methodology for environmental water assessments in non-perennial rivers**

University of the Free State (Centre for Environmental Management); University of Cape Town; Rhodes University; Limpopo Province (Department of Economic Development, Environment and Tourism)

**No. 1798**

This proposal will extend an existing 3-year contract (K5/1587) on environmental water requirements for non-perennial rivers scheduled to end March 2008. The environmental Reserve must be determined for each significant water body before water-use licenses may be issued, but methods are needed to determine environmental water requirements for non-perennial systems as non-perennial systems predominate in the arid west of the country. Standard hydrological models cannot predict along the whole hydrological spectrum from perennial to episodic systems, so water licensing will have to be based on a new understanding of the non-perennial hydrology. This study will test the prototype methodologies which have been developed on one system on a different system.

Estimated cost: R3 000 000

Expected term: 2008 - 2012

**Water temperatures and the ecological Reserve**

Rhodes University (Institute for Water Research); Freshwater Consulting Group; Albany Museum

**No. 1799**

In preliminary investigations, scientific literature has been seen to highlight the importance of water temperature as a primary abiotic driver for ecosystems. Northern hemisphere practices cannot be blindly applied to management issues in Southern African rivers. The persistence of these ecosystems is more likely to be achieved through a better understanding of water temperature patterns and processes. This project defines principles based on long-term trends and data of water temperature variation relevant to South Africa, in order to inform policy. Fundamental research, linking water temperatures and biotic response will inform about the baseline water temperature requirements for the ecological Reserve. The usefulness of these data will be further enhanced through a more complete spatial understanding of water temperatures, and a series of scenario analyses based on temperature simulations using a suitable water temperature model. This project will investigate aquatic invertebrates as indicators of thermal change and identify indicators of thermal change. In addition the team will adapt a generic water temperature model for application to Southern African conditions.

Estimated cost: R2 000 000

Expected term: 2008 - 2011

**Development of a revised desktop Reserve estimation model: application of abiotic components of the Reserve within SPATSIM and other tools**

Water for Africa; Rhodes University (Institute for Water Research)  
**No. 1856**

The existing desktop Reserve model is dependent upon the characteristics of the reference hydrology used and largely ignores the advances in understanding of habitat-flow-ecology relationships that have emerged in the last 5 years or so. It also ignores regional differences in these relationships. While a comprehensive ecological Reserve study is expensive and typically addresses the main stem of major rivers and key tributaries and also takes a long time to complete, it is frequently inappropriate for many smaller water resource development assessments where the Reserve is required. The Desktop Reserve model has been demonstrated to be an appropriate analysis tool, whether used with default parameters or after adjustment through a Rapid Reserve assessment. However, the uncertainty associated with the outputs from the Desktop Reserve model remains a major concern, especially if these outputs are ever likely to be challenged in a court of law. Recent research has made a great deal of progress towards improving our understanding of the relationships between physical drivers and biotic response and how these relationships vary in different parts of the country. The existing project is expected to develop initial databases related to the habitat requirements of fish and invertebrates that could contribute to quantifying the parameters of an improved Desktop Reserve model. The research will further enhance our understanding of the relationships between flow and ecological functioning, as well as enhancing our ability to use that understanding to make improved Reserve estimates. Research carried out within this project seeks to review the current understanding of the links between habitat availability and ecological functioning for different ecoregions, develop a hydraulic habitat generator model, and to incorporate the hydraulic habitat generator model and the ecological functioning rule base into an updated version of the Desktop model.

Estimated cost: R850 100

Expected term: 2008 - 2010

**Development of methods for Reserve determination of wetlands. Phase 2: Intermediate and full Reserve determination**

To be solicited

While satisfactory methods for determining environmental water requirements in permanent waters exist, wetlands have proved to be more complex. During the dry phase they provide a rich and productive flow of ecosystem services to the terrestrial system (e.g. grazing, agriculture) and during the flooded phase provide an equally important flow of ecosystem services to the aquatic system (e.g. water quality, flood

attenuation, fish). The method developed needs to be able to cope with the alternate states of wetlands, and this phase will concentrate on the methods for the determination of the intermediate and comprehensive ecological Reserve.

Estimated cost: R2 000 000

Expected term: 2009 - 2012

### **Programme 2: Estuary management**

#### **Valuation of estuary services in South Africa**

Nelson Mandela Metropolitan University (Department of Economics)

**No. 1413**

Estuaries are delicate systems that are not only in high demand for development, but also deliver important goods and services with a value out of proportion to the geographical area occupied. The continued delivery of these goods and services is dependent on adequate freshwater inflow, and with the high rates of abstraction this is decreasing. The Reserve determination process takes into account ecological processes and functions, but does not adequately account for the values placed on estuaries by people. This follow-up project will build a database of the value of freshwater inflow into estuaries using the contingent valuation method to value the goods and services provided by the freshwater inflow and based on the value attributed to the freshwater inflow by estuary users.

Estimated cost: R2 170 000

Expected term: 2004 - 2009

#### **Estuaries and economic empowerment**

University of KwaZulu-Natal (Centre for Environment, Agriculture & Development)

**No. 1705**

Earlier phases of the Eastern Cape Estuaries Management Programme researched the estuarine systems with the long-term aim of enabling communities living alongside the estuaries to generate income from the resource in a sustainable manner. Courseware was prepared and presented to local authorities (ranging from poorly- to well-resourced) on estuarine planning and management with a view to including the estuary in the Integrated Development Plan (IDP) of the local authority. This follow-up project will focus on subsistence livelihoods and will examine such issues as economic empowerment, institutional arrangements, participatory governance in the light of available opportunities, and will establish a framework where identified opportunities can be picked up in the IDP process. Principles developed during this suite of projects will be applicable to wetlands and other areas where natural resource-based enterprises may be developed.

Estimated cost: R1 500 000

Expected term: 2007 - 2010

### **Programme 3: Ecosystem health**

#### **Osmoregulation in freshwater invertebrates in response to salt pollution**

Rhodes University (Institute for Water Research)

**No. 1585**

Salinisation is a major cause of water quality deterioration. Current methods for water quality assessment include boundary values for specific salts. Biological data is scarce for most of these salts, and what exists is based on acute toxicity data. This research aims to provide chronic toxicity test data, for selected indigenous stream organisms, which are biologically relevant for the country. This will be done through physiological experimental research (oxygen consumption and osmolarity), using samples generated during acute and chronic toxicity testing, and evaluating the salt boundary values in the setting of resource quality objectives.

Estimated cost: R201 160

Expected term: 2005 - 2009

#### **The effects of streamflow manipulation on the intermediate hosts and vector populations of disease and the transmission of associated parasites**

Institute of Natural Resources

**No. 1589**

Altering the flow of a water body will alter the environment. One of the effects of an altered environment is a change of the organisms that inhabit the environment. When making decisions on environmental flows, the status of disease vectors or intermediate hosts is not considered, and yet diseases such as malaria, bilharzia (in people) and fascioliasis (in livestock) have a substantial impact on the economy of areas where they prevail. The overall objective of this study is to assess the impact on the economy and to investigate ways in which it can be ameliorated, either through management actions or through altering the behaviour of the population groups at risk.

Estimated cost: R400 000

Expected term: 2006 - 2009

#### **Conservation model for threatened fish species**

University of Limpopo, (School of Agricultural and Environmental Sciences, Aquaculture Unit)

**No. 1677**

Freshwater ecosystems are recognised as the most threatened ecosystems world-wide, and in an inherently water-short situation this threat is increased. Fish, being fairly large and requiring larger units of habitat, are generally more sensitive to disturbance than invertebrates. The 3 main threats are from habitat loss, impact of aliens and exploitation. The objective of this project is to develop a conservation model for threatened fish species using *Opsaridium peringueyi* as a reference species, and the study will examine the population status, threats to the population and rehabilitation.

Estimated cost: R1 078 170

Expected term: 2006 - 2009

#### **Programme 4: Environmental water quality**

##### **Development of a diatom-based bio-monitoring protocol for South African rivers and streams. Phase III: Regional testing, method refinement & calibration; index formulation and river health programme**

DH Environmental Consulting

**No. 1707**

The study is an extension of 2 earlier phases (Phases 1 & 2) of the development of a diatom-based biomonitoring tool. The National Water Act ensures the protection of water resources, and therefore methods are needed to identify the health of aquatic systems. It is envisaged that the results from this study will be used in State of River reporting and will form part of the River Health Programme. The Diatom Assessment Protocol (DAP) as a biomonitoring tool can be used to test the water quality of various waterways, including the urban waterways. This study (Phase 3) will deal with the formulation and calibration of a Diatom Index for South Africa. Through testing of diatom species over a time period, the species that are most ecologically important will be determined for use in calculations. This study will determine those important diatom species in order to develop a South African Diatom Index. A diatom-based index will be accepted by DWA and key stakeholders as a biomonitoring tool related to the 6 RDM water quality/condition classes (A-F). The objectives of the study are to:

- Formulate and validate a unique SA Diatom Index for rivers and streams related to the 6 RDM water quality/conditions classes
- Validate DAP methodology in close association with the ongoing development of the suite of aquatic ecosystem assessment models (VEGRAI, FRAI, GAI & MIRAI)
- Establish an inter-laboratory calibration and testing component for diatom identification
- Report on the modification of DAP for the rehabilitation of

urban streams and canals with the inclusion of the DAP in the testing protocol

- Build capacity of scientists and DWA personnel in the use of this tool in determining water quality and as a supplementary tool to determine the eco-status of rivers and wetlands
- Develop courseware for DAP for tertiary level education
- Report on river reference conditions based on historical diatom data

Estimated cost: R1 824 450

Expected term: 2007 - 2010

#### **Programme 5: Endocrine-disrupting compounds (EDC) in water sources**

##### **The environmental exposure and health risk assessment in an area where ongoing DDT spraying occurs**

University of Pretoria

**No. 1674**

The presence of DDT and metabolites in single pilot water, sediment and fish samples from the Vhembe district, Thohoyandou, Limpopo Province, is of concern. The concordant high prevalence of urogenital birth defects and the DDE concentrations in cord blood in babies born in a DDT-sprayed area should be regarded as a matter of extreme concern. The research question is whether environmental levels of DDT and DDE may contribute to adverse health effects in catfish and may pose a health risk for humans. The project will review the effects of EDCs on aquatic invertebrates and develop a comprehensive research programme to investigate the use of aquatic invertebrates as monitors of ecological health effects of endocrine disruptors. A further objective is to link possible health effects in biota from a DDT-sprayed area to adverse health effects in humans living in the Vhembe area. A scenario-based health risk analysis will be performed, EDC assessment techniques evaluated, and a toolkit of tests for wider application in other spraying areas will be developed.

Estimated cost: R1 985 000

Expected term: 2006 - 2009

##### **Thyroid-disrupting activity in South African waters: Amphibian metamorphosis as biological model to study effects of endocrine contaminants on thyroid function**

University of Stellenbosch (Department of Zoology)

**No. 1680**

Endocrine disruption of the control and functioning of the reproductive system is of global concern but there is also evidence that EDCs may interfere with the normal functioning of the thyroid system. Changes in thyroid function could adversely affect several physiological systems in humans and wildlife but the specific effects and toxicants involved are not well-known. This project aims to set up, validate and

review protocols of the *Xenopus* metamorphosis assay (XEMA) for testing effects of water-borne chemicals on the thyroid endocrine system. A chemical and water serial diluter system and a flow-through water exposure system for EDC screening will be designed and tested.

Estimated cost: R400 000  
Expected term: 2006 - 2009

#### **Environmental assessment in an area where ongoing DDT spraying occurs**

Rhodes University (Institute for Water Research)  
**No. 1706**

Previous research at Rietvlei Dam, (WRC Project No K5/1505) identified a number of possible endocrine disrupting compounds (EDCs). DDT was a major contributor in many of the samples analysed. In Limpopo Province and KwaZulu-Natal, DDT is used for malaria control, and higher environmental levels were expected in studies there. This research will add value to the variables being investigated by WRC Project No K5/1674 in the Limpopo Province. The data will also contribute to the risk assessment to be undertaken in the same area. Several invertebrates and vertebrates will be examined for the effect of DDT:

- Snails have been identified as a promising endocrine-disruption biomarker
- *Xenopus laevis* and other frog species will be collected at small ponds, and investigated for indication of endocrine disturbance, possibly related to DDT
- Pied Kingfishers (*Ceryle rudis*), have been shown to be good indicators of aquatic pollution, and eggs will also be collected from other water birds as well from sparrows and this will provide an indication of the transfer of DDT from food and soil particles
- Small mammals (mice and rats as appropriate) will be collected and examined for EDC-induced abnormalities

This battery of vertebrate and invertebrate indicators, (snails, frogs, birds, rats and mice), collected *in situ*, could provide further evidence for endocrine-disrupting activity, and contribute towards risk assessment under locally-relevant conditions

Estimated cost: R398 330  
Expected term: 2007 - 2009

#### **Programme 6: Socio-economic considerations**

##### **Framework and manual for the valuation of goods and services of aquatic ecosystems for resource-directed measures**

CIC International  
**No. 1644**

The determination of the ecological Reserve for a particular catchment area requires the integration of the catchment area's management class, the related Reserve and the resource quality objectives. In addition, benefit trade-offs with other water users also have to be considered. The National Water Resource System (NWRS) recognises this by seeking to find a 'balance between protection and utilisation'. Therefore, in order to develop resource-directed measures (RDMs) that are technically sound, scientifically credible, practical and affordable, a framework and manual for the valuation of goods and services from aquatic ecosystems for the RDM are now required. The set of problems to be addressed here is therefore clear: in order to enable interpretation (and negotiation) of the likely consequences of changes in management class as embodied in the RDM procedures, the 'invaluable' aquatic ecosystem threshold must be determined, while trade-offs in ecological, social and economic benefits of the other management classes must be made transparent to users and other interested and affected parties. This project aims to develop a framework that will enable decisions to be made based on appropriate definitions of value, aligned with appropriate valuation techniques, based on sound data, within a context where benefit trade-offs are clarified.

Estimated cost: R 750 000  
Expected term: 2006 - 2009

##### **Knowing, caring, and acting: making use of socio-cultural perspectives to understand and improve conservation**

CSIR (Natural Resources and the Environment)  
**No. 1800**

This project is an extension of Enriching Freshwater Conservation (K5/1678). This project will focus on issues that make society more aware of the value of a healthy environment for the wellbeing of both current and future generations, i.e. will focus on increasing the success rate of the implementation of conservation. A WRC study entitled Enriching Freshwater Conservation (K5/1678) identified 4 potential 'actor clusters' which feel and act differently towards the environment. In order to understand some of the nuances of the implementation crisis facing freshwater conservation initiatives, one needs to interrogate the 'knowing, caring and acting' sequence. But, the expectation that society should be influenced by, and should adjust their knowledge systems, their values and behaviours in greater support of conservation, is an enormous challenge. This is especially true in the context of freshwater ecosystems where, apart from water, the ecosystem benefits to society

are sometimes hidden and typically not felt in a commercial or market-oriented fashion. The overall aim of the project is to develop a conceptual understanding of how the conservation process is influenced by the 'knowing, caring and acting' dynamic.

Estimated cost: R500 000  
Expected term: 2008 - 2011

### ***Programme 7: Ecosystem governance***

#### **The Shared Rivers Initiative Phase 1: Part A - Contextual profiles of the shared rivers of the Kruger National Park**

AWARD; SANParks (Kruger National Park); University of the Witwatersrand; CSIR; Tlou & Mallory (Pty.) Ltd.

**No. 1711**

Research undertaken during this project will address a recently-identified gap in the governance process of water resources, in that a formal route of response to the red flag raised when a Threshold of Probable Concern is exceeded during the Strategic Adaptive Management process needs to be defined. There is growing concern among scientists, managers and the general public in South Africa about the continuing decline in the integrity of the river systems of South Africa's north-east Lowveld in spite of an excellent knowledge base on the biophysical aspects of the rivers and an enabling legislative and institutional framework to support river management. The Lowveld river basins are all shared between neighbouring sovereign states (Zimbabwe, Mozambique, South Africa, Botswana and Swaziland). Each has to achieve their own important resource management and water supply priorities within their portions of these basins. Each neighbour faces a similar set of needs and challenges in its attempts to balance social development imperatives with management for resource sustainability. There is a clear need to harmonize management and decision-making within relevant institutions and between neighbours to ensure fair and effective policy implementation and water service delivery. This project aims to explore water policy implementation as a complex social-ecological process and initiate an action research programme that combines research, learning and implementation to secure institutional and operational competency in river management. During this process, an understanding will be developed towards managing the Lowveld rivers following a cooperative, international and basin-wide approach.

Estimated cost: R1 500 000  
Expected term: 2007 - 2009

#### **The Shared Rivers Initiative Phase I: Communication and fundraising**

CSIR (Natural Resources and the Environment); AWARD; SANParks (Kruger National Park); University of the Witwatersrand

**No. 1783**

There is growing concern about the continuing decline in the integrity of the Lowveld river systems despite an excellent knowledge base on the biophysical aspects of the rivers and an enabling legislative and institutional framework to support river management. These river basins are all shared between neighbouring sovereign states (Zimbabwe, Mozambique, South Africa, Botswana and Swaziland) and each has to achieve their own resource and supply priorities within their portions of these basins. There is a clear need to harmonize management and decision-making within relevant institutions and between neighbours to ensure fair and effective policy implementation and water service delivery. This must be done within the constraints of seasonal and longer term variability of the water resources. River systems are complex, comprising interrelated social and ecological sub-systems, which make addressing issues of implementation and compliance difficult within an international river context. Recognising the Lowveld rivers as complex social-ecological systems has many implications in the way they are/should be managed. This project (Phase 1 of a larger initiative) aims to understand and effect change in the implementation of policies and legislations relevant to the wise use of the Lowveld river systems by exploring water policy implementation as a complex social-ecological problem from a theoretical perspective, initiating an action research programme that combines research, learning and implementation to secure institutional and operational competency in river management and to improve broad stakeholder awareness and compliance that leads to the implementation of real solutions to real problems, the outcome of which delivers the river ecosystem goods and services upon which people depend. Research in the other countries with which South Africa shares these basins will depend on funding from sources other than the WRC. Thus, it is important that, during this phase, other funders are recruited to broaden the geographical scope of the research.

Estimated cost: R548 000  
Expected term: 2008 - 2010

#### **Identifying and enabling protection of national freshwater heritage ecosystems for South Africa**

SANBI; CSIR (Natural Resources and the Environment)

**No. 1801**

Freshwater ecosystems and biodiversity comprise a valuable natural resource, but it is becoming increasingly apparent that these may be the most threatened ecosystems in the world. The National Spatial Biodiversity Assessment (2004) found that 44% of South Africa's freshwater ecosystems associated

with main rivers are critically endangered, compared with only 5% of terrestrial systems. Rivers and wetlands reflect the state of the catchment and as such the conservation of freshwater ecosystems depends on whole-catchment management in a manner integrated to maintain ecological integrity as well as achieving sustainable development in the social and economic spheres. To this end, this project seeks to identify a national network of freshwater conservation areas, national freshwater heritage ecosystems and national freshwater rehabilitation priorities. It seeks also to develop an institutional basis to enable effective implementation of this national network of freshwater conservation areas.

Estimated cost: R930 000  
Expected term: 2008 - 2010

### **THRUST 3: ECOSYSTEM REHABILITATION**

#### ***Programme 1: Wetland Rehabilitation***

##### **Wetlands and livelihoods: Restoration of the wetlands ecological process, form and function to provide the ecosystem goods and services necessary to support livelihoods**

University of KwaZulu-Natal  
**No. 1986**

We understand the biophysical nature of wetlands fairly well. We understand how they have evolved, but not their roles as integral parts of social-ecological systems. We continually strive to establish 'stable' wetland states rather than resilient social-ecological states. As long as we continue to take a simplistic view of such complex systems and adopt reductionist approaches we are not likely to progress with our understanding of the roles of the interactions between wetlands and livelihoods in the context of promoting resilience. Sustainable use cannot be understood or promoted unless we strive to achieve social-ecological resilience. This research proposal is premised on the assumption that 'wetlands and livelihoods' should be contextualised as dimensions of social-ecological systems. This encourages a more inclusive, holistic and dynamic appreciation for the 'institutional configurations the interactions among resources, resource users, public infrastructure providers and public infrastructure' (Anderies et al., 2004). Inherent in this assumption is the notion that we need to manage the social-ecological system for resilience and not manage the wetland alone for either the supply of services or resilience. Inherent in this interpretation is the critical role of evidenced-based analysis for co-learning, assessing risk and making tradeoffs that are supported because they are perceived to be legitimate. The aims of the research are: to adapt the Anderies et al social-ecological system framework (currently being applied in an estuaries context) and other supporting frameworks for application in a livelihoods context on freshwater wetlands; to test the framework(s) through field and/or desktop application at four wetlands and refine

accordingly; and to develop a decision support system that supports management action aimed at improving resilience in social-ecological wetland systems.

Estimated cost: R800 000  
Expected term: 2010 - 2013

##### **Guidelines for the determination and management of wetlands buffer zones**

University of KwaZulu-Natal  
**No. 1789**

Watercourses are able to adapt to changing circumstances, but the current state of watercourses in the country is a clear indication that a threshold is easily reached and impacts of surrounding land uses and human activities can be detrimental. The Reserve, resource class and resource quality objectives are, however, legislative tools developed to reverse or prevent such detrimental impacts/consequences for the resource. The main importance of a buffer zone is to act as a safeguard or a defence against surrounding impacts when resources are stressed or negatively impacted on. The research conducted within this project seeks to identify ways of delineating the riparian buffer zone in order to protect the resource and the riparian fringe in order to provide ongoing protection for the resource. It is envisaged that the results of this buffer zone study, in addition to the appropriate delineation, would be used by all relevant Departments for activities associated with watercourses.

Estimated cost: R2 500 000  
Expected term: 2008 - 2011

#### ***Programme 2: River rehabilitation***

##### **The potential of food-web manipulation for the restoration of eutrophic South African impoundments**

DH Environmental Consultants  
**No. 1643**

The project will address the challenge of eutrophication through the application of food-web manipulation as a cost-effective management option for South Africa's indubitably most limiting natural resource – freshwater. Many South African waters subsist in an advanced state of eutrophication, viz. a plagio-climatic condition dominated by a few taxa of coarse phytoplankton and fish. Such systems are resilient to remediation and require shock treatments such as the rapid bulk removal of problematic fish to allow the system to reset. In South Africa, eradication of Common Carp was seen as the first step in rehabilitation of most dams with eutrophication problems because it is this alien fish that preys on zooplankton, feeds in open waters among macrophytes, and contributes to sediment disturbance and water column turbidity. The project will develop a scientific understanding regarding the storage vessels (dams) that largely supply all water user sectors (industry, agriculture, and domestic supply). The aims of this study are to:

- Determine fish assemblages at a suite of impacted and control dams in the same eco-region, coupled with identification of trophic state and eutrophication impact assessment
- Determine harvesting requirements to reset the fishery to a desirable assemblage
- Determine harvesting requirements to sustain the desired assemblage
- Collect data on specific abiotic and biotic components (stable isotopes, phytoplankton and zooplankton assemblage)
- Compare and contrast commonalities of ecosystem response and degree of system (site) specificity
- Assess in broad terms, economic and financial implications of the recommended approach
- Identify constraints to the proposed rehabilitation methodology
- Evaluate the findings in terms of the potential of this approach as a method for impoundment rehabilitation, as well as for commercial opportunities

Estimated cost: R1 727 760

Expected term: 2007 - 2009

## NEW PROJECTS

### THRUST 1: ECOSYSTEM PROCESSES

#### *Programme 2: Riverine processes*

##### **An assessment of the current biodiversity of amphibians associated with the major river systems of the Kruger National Park (KNP) and the physical and chemical factors affecting their distribution**

Bioassets cc

**No. 1928**

Amphibian population declines and species extinctions are being recorded around the world (amphibians are proportionally the most threatened group of vertebrates). The declines cannot be attributed to any single causative factor because complex mechanisms involving abiotic and biotic interactions are responsible for this phenomenon. These declines have been attributed to a combination of factors, including climate change, chemical pollution, habitat loss and disease. This research project is aimed at determining the current status of the amphibian biodiversity in the Kruger National Park main rivers and associated wetlands.

Estimated cost: R1 036 500

Expected term: 2009 - 2012

##### **Biomonitoring the fish health of two impoundments in Olifants River, Limpopo Province**

University of Limpopo

**No. 1929**

In South Africa pollution of aquatic ecosystems can be linked to diffuse surface runoff and point-source discharges. As a result of these anthropogenic activities, organisms, including people, may be exposed to harmful contaminants which may affect their health and livelihood. The research will focus mainly on generation of information about the water quality of Flag Boshielo Dam and the Phalaborwa Barrage by testing selected abiotic and biotic parameters to determine the ecosystems' health.

Estimated cost: R674 500

Expected term: 2009 - 2012

#### *Programme 3: Wetland processes*

##### **Establishing ranges of water quality variables in wetlands and their relationship to land use and ecosystem response: towards refining the ecological Reserve**

University of Cape Town (Freshwater Research Unit)

**No. 1921**

Wetland water quality data, especially long-term datasets, are limited and, in addition, wetlands are naturally more variable in terms of water chemistry than rivers, both spatially and temporally. We have a poor understanding of the range of values of water quality parameters that occur in wetlands, both under natural conditions and in the impacted state and how this varies with different types of wetland. The research will further our understanding of the relationships between catchment environmental condition (and land use), water quality in wetlands and biotic response.

Estimated cost: R1 070 064

Expected term: 2009 - 2011

##### **Regional wetland processes of the Maputaland coastal aquifer on the Zululand coastal plain**

ARC (Institute for Soil, Climate and Water)

**No. 1923**

Previous studies about the wetlands on the Zululand coastal plain could not use environmental attributes to explain the wetland type and distribution on a regional scale. There is no clear classification and characterisation of wetlands which addresses the interaction of environmental factors and processes on a broad scale. An understanding of environmental factors and processes is required before human-induced changes can be evaluated. The research will provide a workable

framework that will link environmental factors and processes for different wetland types and distributions on the Zululand coastal plain and enable the prediction of the response to land-use and water-linked ecosystem change on a regional scale.

Estimated cost: R893 364  
Expected term: 2009 - 2011

**Evapotranspiration from the Nkazana Swamp Forest and the Mfabeni Mire**

CSIR (Natural Resources and the Environment, Pietermaritzburg)  
**No. 1926**

There is general consensus amongst wetland scientists in South Africa that wetland evapotranspiration (ET) has not been adequately quantified. This research project will complement the WRC-funded project (K5/1704) at the Isimangaliso/ Greater St Lucia Wetland Park by quantifying seasonal wetland evaporation using state-of-the-art ET measurement techniques.

Estimated cost: R908 000  
Expected term: 2009 - 2011

**Identifying relationships between soil processes and biodiversity to improve restoration of riparian ecotones invaded by invasive acacias**

University of Stellenbosch  
**No. 1927**

Invasive alien plants have now become weeds in conservation areas and agricultural land, threatening the country's biodiversity and agriculture. In addition, they can reduce runoff from water catchment areas, thus diminishing flow in streams and adversely affecting the water table. The research is aimed at finding ways to improve restoration of riparian areas invaded mostly by alien plants and the output of this work will provide knowledge needed in catchment management for holistic water resource management.

Estimated cost: R1 978 000  
Expected term: 2009 - 2012

**THRUST 2: ECOSYSTEM MANAGEMENT AND UTILISATION**

*Programme 1: Ecological Reserve*

**Environmental water requirements for non-perennial systems: Phase III**

University of the Free State  
**No. 1798**

Non-perennial rivers are distinguishable from perennial rivers, in that their hydrology is spatially and temporally much more variable, creating high levels of disturbance for stream communities. Previous WRC research has shown differences in

Reserve determination between perennial and non-perennial systems using existing methodology, e.g. the relevance of groundwater in relation to surface water. Furthermore, standard hydrological models cannot predict along the whole hydrological spectrum, from perennial to episodic systems; therefore, water licensing will have to be based on a new understanding or model of the non-perennial hydrology. This study is aimed at testing the prototype methodologies on different river systems.

Estimated cost: R3 000 000  
Expected term: 2009 - 2012

**Shared Rivers Initiative: Phase II: Analysis of the ecological Reserve implementation scenarios with the intention to design an effective implementation approach/plan**

AWARD  
**No. 1920**

There are conflicting views among communities with regard to the use and management of water resources, which has complicated the implementation of trans-boundary water resource management, particularly the ecological Reserve, in RSA. In spite of all the challenges, there are situations where implementation of the ecological Reserve has been successfully executed. There are also situations where implementation has not been successful. Effective planning needs to critique these case studies, to identify the strengths and weaknesses (gaps) of the implementation approaches and methods and the policy itself. The results or output will be used to design 'a new way of doing things' as far as implementation of the Reserve is concerned. The output may also suggest refinement of the policy if need be.

Estimated cost: R800 000  
Expected term: 2010 - 2013

**Review and update of resource directed measures (RDM) for estuaries**

Anchor Environmental Consultants  
**No. 1930**

The increase in understanding of the RDM methodologies for estuaries, together with the increased variety of systems studied in the RDM process, has led to the realisation that some areas of the RDM methodology are problematic and need further refinement. The conducted modelling study, run in conjunction with the research and RDM study of the East Kleinemonde estuary, highlighted several issues of concern regarding assumptions made in scoring present condition and future scenarios. This research study will investigate and improve the alignment of the RDM process with the classification process.

Estimated cost: R604 400  
Expected term: 2009 - 2010

**Decision support system for determination of environmental water requirements**

Southern Waters

**No. 1873**

Current methods for the assessment of environmental water requirements need the input of subject specialists, and this is a process that is both expensive and difficult for water managers who are not specialists to interact with. The feasibility of the decision support system (DSS) to be developed has been researched and shown to be possible. This DSS will enable water managers to set scenarios and to run the system themselves. In this way they will be able to predictively test different scenarios themselves, and thus select the scenario which best suits their needs, without ongoing specialist input. This will empower managers to make decisions themselves.

Estimated cost: R1 800 000

Expected term: 2009 - 2011

***Programme 2: Estuary Management***

**The application of choice modelling techniques to guide the management of estuaries in South Africa – case studies at the Kromme, Bushmans, Sundays and Keurbooms estuaries**

Nelson Mandela Metropolitan University

**No. 1924**

The research to be undertaken during this follow-on project will support managers in their decisions on the inflow of freshwater into estuaries, through the provision of information on the economic value of the flow of ecosystem goods and services provided by estuaries and linked to the quantity of freshwater flowing into the estuary. Research conducted during the previous projects has developed the contingency valuation method for the valuation of freshwater inflows into estuaries, and the research proposed in this project will, working together with estuary managers, apply the methods developed to four specific estuaries, in a way that will provide the interface between the method developed during the previous research and the information requirements of the estuary managers.

Estimated cost: R770 000

Expected term: 2009 - 2011

***Programme 5: Endocrine disrupting compounds (EDCs) in water sources***

**A study of the interactive effects of pesticide mixtures in water on selected species**

University of Stellenbosch

**No. 1932**

Scientific research revealed that all major aquatic wildlife groups are experiencing endocrine disruption (ED) in contaminated sites, and that at many sites this is caused by a

complex mixture of substances. Our ability to predict higher-order effects is still weak, and the imperfect state of our knowledge about the effects of EDCs on ecosystem structure has implications for environmental risk assessment of EDCs; therefore ecosystem-based research is much needed. Only in a few cases could a causal link between EDCs in freshwater systems and altered endocrine activity/function in exposed fish or amphibians be established. This study will be a laboratory study to investigate the explicit ED effects of mixtures of at least two pesticides, used in agricultural areas of intensive and concentrated crop-cultivation practices, which could contribute to the ED effects seen in the environment (thus not taking the effects of industrial or other pollution into account).

Estimated cost: R1 600 000

Expected term: 2009 - 2012

***Programme 6: Socio-economic considerations***

**Establishing the fishery potential of the Nandoni Dam in the Luvuvhu River, Limpopo Province**

University of Venda

**No. 1925**

Nandoni Dam was completed in 2004, and is ideally suited for both an extensive commercial fishery and an aquaculture industry. However, in order to manage the resource sustainably it is necessary to know what the productivity of the impoundment is. Impoundments typically go through a period of high productivity just after filling, as a result of the release of nutrients from the recently flooded land. This then settles down to the long-term level once the initial nutrient release is over. Nandoni Dam is reaching this stage and the level of fishery that the impoundment can sustain needs to be determined in order that the management target can be effectively set. The research conducted during this project is aimed at providing this information.

Estimated cost: R823 200

Expected term: 2009 - 2012

**THRUST 3: ECOSYSTEM REHABILITATION**

***Programme 2: River and impoundment rehabilitation***

**Conservation of tigerfish, *Hydrocynus vittatus*, in the Kruger National Park with the emphasis on the establishment of management plans for the protection of its riverine habitat**

University of Johannesburg

**No. 1922**

The tigerfish is a flagship species in tropical and subtropical environments. It is also a species which requires healthy environmental conditions and as a result it is vulnerable to declined environmental quality. South African National Parks are charged with the maintenance of biodiversity, both aquatic

and terrestrial, and so need to manage their parks to maintain conditions suitable for the biota. The rivers flowing through the Kruger National Park (KNP) are all heavily utilised upstream and these activities impact on both the quality and quantity of water in the rivers. Under the National Water Act the ecological Reserve has been determined for these rivers, and research conducted during this project will ascertain the state of the tigerfish population in the KNP and will investigate whether the ecological Reserve, as determined, is sufficient to maintain a viable population of tigerfish in the rivers flowing through the KNP.

Estimated cost: R1 844 120

Expected term: 2009 - 2012

**Food-web manipulation Phase II: Food-web interactions in South African reservoirs traced using stable isotopes**

DH Environmental Consulting

**No. 1918**

A number of the impoundments in and around Gauteng are highly polluted, and the pollution loads are increasing with the increasing load that urbanisation is placing on the treatment of effluents. Management of this pollution demands a multipronged approach, both in the catchment and in the impoundment itself. Elsewhere in the world it has been shown that the control of the numbers of zooplanktivorous fish species in the reservoir allows for an increase in the phytoplanktivorous zooplankton biomass. This in turn acts as a control of the phytoplankton, so reducing the retention time of nutrients, particularly phosphorus, in the water column. In this way the effects of eutrophication can be controlled to an extent. The research conducted in this follow-on project will investigate whether the removal of selected fish species may be effectively used as part of the suite of methods needed to bring eutrophication, and its deleterious effects on these water bodies, under control.

Estimated cost: R1 500 000

Expected term: 2009 - 2011

## CONTACT PERSONS

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# KSA 3: WATER USE AND WASTE MANAGEMENT



*Mr Jay Bhagwan:  
Director*

## SCOPE

The **Water Use and Waste Management KSA** focuses mainly on the domestic, industrial and mining water sectors. It aims to proactively and effectively lead and support the advancement of technology, science, management and policies relevant to water supply, waste and effluent management, for these sectors. This KSA also supports studies on institutional and management issues, with special emphasis on the efficient functioning of water service institutions and their viability. Research on infrastructure for both water supply and sanitation is included. A further focus is on water supply and treatment technology serving the domestic (urban, rural, large and small systems) as well as the industrial/commercial and mining sectors of our economy. This KSA also focuses on waste and effluent as well as reuse technologies that can support the municipal, mining and industrial sectors and improve management in these sectors with the aim of improving productivity and supporting economic growth while minimising the negative effect on human and environmental health.

The provision and supply of water of adequate quality and quantity for economic and public health purposes remain continuous challenges. Water is a finite resource and, specifically in the context of South Africa, becoming incrementally scarce. Managing water use and the waste released to the water environment is thus of paramount importance to ensure the sustainability of the resource and the activities relying on it. Water use and waste management in South Africa is consequently a key factor for social and economic growth, as well as for our environment. The entire way we think about and use water is thus an important factor in determining our future. In recent years the focus of the KSA has been on

supporting the implementation of various pieces of legislation that impact on the provision of sustainable water services. The support was in the form of unpacking and understanding key elements within legislation and the impact on the water services sector. The result has been a bias towards developing guidelines and tools to assist new and emerging municipalities and politicians to understand their responsibilities, which also included repackaging information of technical nature. In the process we have maintained a balance with dealing with cutting edge technological advances and have been concentrating on their application and commercialisation. Developing innovative processes and technologies for water purification and treatment of wastewater from domestic to industrial and mining activities has been and is even of greater importance to our country, especially in the light of problems related to the increase in pollution of our water resources and problems related to the provision of clean drinking water. The KSA has initiated scoping studies and strategy development to respond to the above challenges, as well as to examine the achievements of the sector within the policy framework which existed over the past 12 years. Considering the emerging challenges, as well as the policy shifts in the sector, research in the KSA will move towards greater innovation and development of cutting edge technologies to respond to the issues of poor O&M, competency and capacity constraints, energy constraints and the aspect of water quality.

## OBJECTIVES

The primary objective of this KSA is to provide knowledge that ensures reliable, affordable and efficient water use and waste management services to enhance the quality of life, and contribute to economic growth and improved public health.

The secondary objectives are to:

- Improve the management of water services in both rural and urban areas
- Develop appropriate technologies for improving the quality and quantity of our water supplies for both domestic use and industrial applications
- Develop new approaches to manage and enhance hygiene and sanitation practices
- Provide appropriate, innovative and integrated solutions to water and waste management in the industrial and mining sectors
- Develop applications for improved treatment of wastewater and effluent and improve processes for enabling increased reuse thereof
- Improve health, economic and environmental conditions, while supporting the development of appropriate technologies and socially-focused management practices related to water and effluent management

## THRUSTS AND PROGRAMMES

The objectives of the KSA are orientated towards making a difference and impact in the areas of health, economy, environment and society. These are achieved through a portfolio of focused thrusts:

Thrust 1:	Water Services – Institutional and Management Issues
Thrust 2:	Water Supply and Treatment Technology
Thrust 3:	Sustainable Municipal Wastewater and Sanitation
Thrust 4:	Industrial and Mine-Water Management
Thrust 5:	Sanitation, Health and Hygiene Education

### THRUST 1: WATER SERVICES – INSTITUTIONAL AND MANAGEMENT ISSUES

**Scope:** The efficient functioning of water service institutions and their viability is key to sustaining water services in rural and urban areas. The focus of this thrust is to address strategic research aspects related to policy issues, institutional reform, regulation, infrastructure management, operations and maintenance, sanitation (storm water, sewerage and on-site sanitation), water-related competencies and capacity required for the strengthening of water institutions (water service providers, water service authorities, water boards, national departments) in providing sustainable water services.

Current programmes are:

- Cost-recovery in water services
- Institutional and management issues – Water services
- Innovative management arrangements – Rural water supply
- Regulation of water services
- Impact of water and sanitation interventions

### THRUST 2: WATER SUPPLY AND TREATMENT TECHNOLOGY

**Scope:** The provision and supply of affordable and reliable water of sufficient quality and quantity for domestic and economic (industrial/commercial and mining) activities, remain continuous challenges. Research support for these activities is the focus of this thrust. Linked to water supply is the all-important aspect of the protection of human health. The objective of this thrust is to develop innovative technologies, processes and procedures that address aspects related to bulk water supply, water treatment technology, distribution and water quality.

Current programmes are:

- Drinking water treatment technology
- Water treatment for rural communities
- Drinking water quality
- Water distribution and distribution systems

### THRUST 3: SUSTAINABLE MUNICIPAL WASTEWATER AND SANITATION

**Scope:** This thrust focuses on the development of technologies and systems that optimise the full wastewater and sanitation services chain in the municipal (domestic) sector. This includes the reticulation, treatment and management of the residues. The challenge is to implement fitting solutions for a particular application that will remain functional throughout the intended life span of the installed infrastructure. This includes the responsible management of the wastewater sludge and faecal sludge that is generated. The need for innovative technologies and solutions is recognised as we prepare for the future – achieving more stringent effluent discharge standards, developing acceptable non-waterborne sewerage solutions, reliable treatment of ever-increasing high-strength domestic wastewater, and informing future policy.

Current programmes are:

- Emerging treatment technologies
- Application of appropriate technologies and tools
- Stormwater and sewerage systems
- Wastewater sludge and faecal sludge management

### THRUST 4: INDUSTRIAL AND MINE-WATER MANAGEMENT

**Scope:** The usage of water in the mining and industrial sectors produces high concentrations of wastes and effluents. Some mining activities produce wastes that act as non-point sources of water quality degradation and acid mine drainage. This thrust aims to provide appropriate, innovative and integrated solutions to water use and waste management in the industrial and mining sectors.

Current programmes are:

- Quantification of water use and waste production
- Regulatory mechanisms to improve industrial and mine-water management
- Minimising the impact of waste on the water environment
- Minimising waste production

- Improved ability to predict and quantify effects
- Beneficiation and treatment of industrial and mining effluents

#### **THRUST 5: SANITATION AND HYGIENE EDUCATION**

**Scope:** This thrust addresses the research required to assist the national Government to achieve its goal of clearing the sanitation service backlog by 2010. It also identifies research that is essential to support planning for basic sanitation service delivery beyond 2010. The focus is on low-cost and affordable sanitation technologies.

Current programmes are:

- Advocacy, health and hygiene education
- Peri-urban sanitation research
- Institutional and management aspects of sanitation service delivery
- Technical sustainability of sanitation services

## RESEARCH PORTFOLIO FOR 2009/10

The KSA's continuous activities, the results of the strategic needs analysis and its review, needs expressed by the Minister of Water and Environmental Affairs through the variety of workshops and seminars, engagement with DWA and other stakeholders, with regard to its objectives and thrusts, have been well supported. The 'External Review' of 2006 highlighted that the relative weight of this KSA's thrusts seems to be well-balanced regarding the needs of urban-industrial-mining and rural research needs, but, given the urgency to redress past inequities, there is a need to increase the number/weight and relevance of research projects related to sustainable rural water supply and sanitation projects. Feedback from these exercises has ratified the KSA direction and the many valuable inputs assisted in strengthening the portfolio. Thus, the primary and secondary objectives of the KSA remain unchanged.

During 2009/10 the portfolio continued to build on the strategic changes from previous years, as well as to strengthen the portfolio towards making greater impacts on the social, health, environment and economy of the country. In summary, we do not foresee any major changes to the KSA strategy and portfolio of thrusts over the next few years.

The primary objective of this KSA is to continue to provide knowledge that ensures reliable, affordable and efficient services to enhance the quality of life, and contribute to economic growth. These objectives are in line with the Department of Water Affairs' strategic goals in meeting the objectives set in the Water Services Act and the National Water Resource Strategy, as well as the new framework strategy *Water for Growth and Development* (Version 6). To achieve these objectives, the programmes and projects need to be

more strongly orientated to the challenges. This will therefore continue to receive greater attention.

## BUDGET FOR 2009/10

The approved funding of the research portfolio for 2009/10 led to a committed funding budget of R 34 107 586, including R9 599 509 for new projects.

## CORE STRATEGY

### **Strategic context**

Water is an essential ingredient for economic development, the maintenance of natural life support systems and basic human existence. Urbanisation and industrialisation rates in developing countries have escalated significantly and continue to grow. Economic growth and development, resulting in a greater demand for water, causes annual consumption to continue to rise in most countries. Ensuring a reliable source of clean water and adequate treatment of wastes and wastewater for large urban populations and rural communities poses great challenges for many developing countries. South Africa is no exception to this situation and this has led the Government to embark on major water-related infrastructure development projects and to introduce water conservation measures, the focus being on optimal utilisation of existing water resources, the upgrading of existing sources and the conservation and protection of catchment areas.

Although the water requirements for the domestic (rural 4% and urban 23%), industrial (3.5%), power generation (2%) and mining (2.5%) sectors are a fraction compared to total water availability and water consumed, it is the assurance (98%) and continuation of the supply that dictates the high capital and infrastructure costs. Industrial and mining processes, though a small user of water, together contribute to the bulk of the pollution affecting our water environment. The commercial use of water in the domestic urban areas accounts for 20% of the total urban water use. With the increase in population and the economy, it is projected that by 2025 water demand in the domestic sector will increase to between 30 and 35%. Any future peaks in water demand will affect the assurance levels, resulting in demand being exceeded and vulnerability increasing.

Whereas the provision of water for human needs plays a cardinal socio-economic role in the upliftment of people and in promoting a healthy population, it is the industrial and mining sectors which play a primary role in the development of the South African economy and, hence, in the development of the country in terms of wealth creation, employment creation and export earnings. Sanitation and wastewater treatment

are essential elements of service delivery that contribute to maintaining a healthy environment for our population. Environmentally, the mining and industrial sectors have common features, such as an intensive demand on material and energy resources, a major impact on the landscape, a relatively low demand on the national water use and a proportionately much higher pollutant profile. This includes effluents of high concentration, contaminants that are difficult or expensive to remove and have the potential to degrade large volumes of water, thereby rendering them less fit for other beneficial uses. Effluents from all of these sources arise either as point sources (e.g. piped effluents from factories or sewers) or as non-point sources (e.g. runoff from un-served high-density settlements and seepage from mine slimes dumps or mine workings).

With a situation of a growing dichotomy created by past practices, the current challenges for the water services sector are split into bridging the gap between the poor and un-served in terms of access to water and sanitation services, while supporting the growth of the economy through improving infrastructure and services to industry. The rate of urbanisation is fundamentally affecting the provision of water services and is beginning to result in regular failure of existing infrastructure. The increased migration from rural areas and influx to urban areas is continually putting demands on existing systems. In the rural areas, traditional settlements present significant challenges to service delivery. While many achievements have been made over the years by the water sector in addressing these issues, the greatest challenge is the aspect of sustainability of these achievements. The lack of investment in infrastructure operation and maintenance over the years, coupled with a skills shortage and lack of investment in replacement of infrastructure is resulting in many systems failing to meet the requirements of good service delivery. This situation is escalating and is evidenced by the increase in reports highlighting these problems.

The situation is further compounded by climate change, and shortages of high-quality water sources, the development of mega-cities, capacity and financial constraints, energy shortages and higher expectations for water are challenging the sustainability of the water industry in the long term. Efficient use of water for domestic, industrial and mining purposes, as well as improved sanitation, are critical for improving public health, eradicating poverty and contributing to global competitiveness.

Taking into account all of the achievements and developments to date, it is clear that South Africa has amassed a substantial knowledge base and the competencies required to face the future challenges. However, there is a need to develop more environmentally-sound technologies and processes that command greater integration in the solutions they provide. A more holistic and integrated approach is required towards providing sustainable solutions, focusing on aspects related to the participation of society, the impact on the environment

and resource base, institutional and management issues, minimisation of wastes and other emerging issues.

As water consumption continues to rise, Government will face the huge challenge of meeting increasing water supply and wastewater treatment demands. Only by developing long-term strategies to address these issues, including the introduction of water conservation measures and continued investment in water-related infrastructure, will access to clean water and treatment facilities be available to a greater proportion of the population in the future. It is clear that the cost of providing clean water to an expanding and growing population and growing economy will continue to increase.

To achieve the above, more innovative policies and improved implementation strategies for water use and waste management will be required, supported by a strong basis for appropriate technologies, changes in infrastructure approaches and broader water management policies. It is essential that institutional processes and capacity be in place, supported by sound technologies and methodologies.

### **Needs analysis**

The KSA, in its endeavour towards identifying research needs, as well as developing and improving research strategies at the thrust level, has continuously engaged at a strategic level both nationally and internationally, to identify any gaps and to strengthen the portfolio of priority research topics and areas requiring attention. We believe that the continuous process of analysing and reviewing our strategy ensures that the KSA remains on a strategic path, as well as responding to challenges of the sector. The DWA framework, *Water for Growth and Development*, has set priority imperatives for the water sector and the KSA portfolio is aligned to respond to the challenges posed. Specifically, with regard to the scope of this KSA, the framework gives greater impetus to the following related areas:

### ***Mainstreaming water in decision-making***

Water is at the nucleus of planning and decision-making, which includes but is not limited to sectoral planning. In an effort to elevate the status of water as a scarce and vulnerable resource, the importance of strengthening regulatory processes, and providing support and guidance to the plethora of stakeholders affecting and influencing the sector, should be acknowledged.

Examples of our related programmes are:

- Regulation of water services
- Quantification of water use and waste production
- Regulatory mechanisms to improve industrial and mine-water management
- Improved ability to predict and quantify effects

### ***Diversifying the water mix***

Water availability is currently based on surface water (77%),

return flows (14%) and groundwater (9%). Reconciliation studies undertaken in major urban centres have revealed that, in addition to these sources, desalination and effluent reuse ought to be considered given the high risk of water shortages. The KSA response is covered by the following programmes:

- Beneficiation and treatment of industrial and mining effluents
- Emerging treatment technologies
- Drinking water treatment technology
- Water distribution and distribution systems

### ***Striking a balance between supply- and demand-side measures***

As a country we can no longer afford water losses and therefore it is imperative that the focus on water conservation and water demand measures must be strengthened, especially as there is a greater return on investment through water loss control and water use efficiency. A key challenge to sustained and safe water supplies is the poor maintenance of wastewater treatment works (WWTW).

- Minimising the impact of waste on the water environment
- Minimising waste production

### ***Water for growth: changing water use behaviour for the future and nurturing attitudinal and behavioural changes towards the value of water***

Current water use behaviour impacts negatively on the resource both quantitatively and qualitatively. It is imperative that mechanisms are developed to change this behaviour, which include regulatory instruments, market-based instruments, self-regulation, and awareness and education, and which will match appropriate mechanisms to mitigate offending behaviour. Our programmes which address these aspects are:

- Cost-recovery in water services
- Impact of water and sanitation interventions
- Application of appropriate technologies and tools
- Advocacy, health and hygiene education

### ***Water for development: Changing water use behaviour***

The achievement of the Millennium Development Goals (MDGs) in respect to the halving of water and sanitation backlogs in 2005 and 2008, respectively, has been satisfactory. However, too many South Africans still do not have access to basic water and sanitation services and this programme therefore wishes to achieve the target of full access to basic water and sanitation services for all by 2014. These are covered by the following KSA programmes:

- Institutional and management issues – Water services
- Innovative management arrangements – Rural water supply
- Peri-urban sanitation research
- Institutional and management aspects of sanitation service delivery
- Drinking water quality

In reviewing the wealth of information generated through the various processes of needs analysis, consultation with DWA and other stakeholders, it is clear that the key challenges facing the water sector in South Africa, as identified in previous years, remain unchanged and warrant greater emphasis and support. We believe that our strategy and focus are in line with supporting Government's long- and short-term objectives, and especially those of ASGISA (Accelerated Shared Growth Initiative for South Africa) and the recent DWA framework strategy *Water for Growth and Development*. These objectives are:

- In a changing and dynamic legislative and strategic environment many solutions are required for sustainable and affordable water services provision. A key focus over the next few years will be on strengthening the capacity of local government to function in this challenging environment, introduction of successful models of service delivery which enjoy the support of all stakeholders, addressing the issue of poverty and service provision (including affordability and cost-recovery), development of appropriate strategies, tools and policies to regulate water services and give effect to the water services and related legislation. The aspects of community participation and local economic development are central to these objectives.
- The realisation of the challenges of meeting the MDG targets, and, in the case of South Africa, eliminating the water and sanitation backlogs
- The water services environment is in a continuous process of dynamic change. The newly published related legislation, besides setting a new set of challenges and goals for the sector, has reached a point of review. It will be imperative that the success of these frameworks and legislation will realise the ultimate goal of national water policy and local government legislation
- The provision of sanitation is more complex and provides greater challenges, as the responsibility is spread across many Government departments. The short-, medium- and long-term goals are to find effective and efficient mechanisms to accelerate sanitation delivery and hygiene education coverage. These two components are essential ingredients for sustainability and for achieving public health objectives. Focus areas over the short term are to develop appropriate technical solutions, finding cost-effective ways to provide high-impact hygiene education, finding acceptable and affordable service arrangements, models for sanitation delivery and O&M, and improving the legislation and policies that contribute to an enabling environment. Challenges to the sustainability of low-cost and on-site sanitation systems are already beginning to surface. Short design life, pit emptying, relocation and access to pits are some of the key technical challenges which may jeopardise achievements made to date and the provision of sustainable sanitation.
- It is evident that new issues in water supply (water treatment, distribution, etc.) will continue to emerge as

new contaminants are introduced into the water sources. Great challenges also exist in providing sustainable and affordable technical solutions for the poor and indigent sections of the population.

- The energy crisis of recent years has raised the need for more efficient use of electricity and the need for alternative energy sources. As part of the KSA's objective of efficient and affordable water services, three key variables have been the focus for many years, these being energy, chemicals and materials, which together make up an estimated 70% of the operational cost of providing water services. More emphasis is now being placed on energy issues and proactively we have initiated and promoted many approaches to support this important cause. For example, BioSure™ and Petro™ processes of treating wastewaters require lower energy inputs. We have moved into the area of finding solutions for alternative energy sources from wastewater and sludges. The research on efficient water use has also been stepped up, and this has a direct bearing on the energy requirements of supplying water services. These areas will continue to grow in an endeavour to meet the needs.
- Gearing the sector towards the impetus created towards water for growth and development
- In water supply and treatment technology, the needs over the next few years revolve around the supply of more affordable water of improved quality, especially to those people who do not yet have reliable drinking water supply. Specific issues and research needs include the reduction in cost of water treatment and supply; the removal of organic contaminants; the removal of *Cryptosporidium*, *Giardia* and other pathogens; safe and efficient water fluoridation; improvement in the cost efficiency and sustainability of small- to medium- sized water treatment plants; dependable and efficient distribution systems; cost-effective distribution systems for rural water supply and sustainable and low-cost small water treatment systems. Medium- and long-term goals are to focus on infrastructure and asset management.
- Most of the country's industrial and mining activities are concentrated in areas where there is a lack of water resources. These sectors generate large amounts of wastes (toxic and non-toxic), which have a profound impact on the ecology of the receiving water environments. As urbanisation and industrialisation increase, increasingly complex wastewater streams are introduced. It is imperative that solutions are generated to manage these negative impacts. Furthermore, there is growing recognition of more innovative approaches such as cleaner production and waste minimisation. These areas require greater research support for knowledge generation and application.
- The mining industry presents additional needs that emanate from its legacy of water quality-degrading waste that has been accumulating for more than a century, and which could potentially affect water quality for future

generations. In the case of gold mines these needs have to be addressed with urgency, as many mines are about to close down, which may represent lost opportunities to introduce pollution-prevention measures. Key areas to be addressed include the process of acceleration of cleaner production and waste minimisation technology and the development of innovative solutions, to deal with the legacy of waste and acid mine drainage potential that has accumulated as a result of mining activities.

- There is a need for improving institutional capacity in the management of water and wastewater problems, as it has become increasingly clear that these problems cannot (in the South African context) be solved by technical solutions alone. Institutional reform and strategic management issues (such as regulation, capacity, competencies, partnerships, tariffs, community participation, etc.) all play an equivalent role in achieving an integrated solution. Great strides in information gathering and knowledge generation and application are required in this area over a short period.
- Over the past few years great strides have been made in covering water and sanitation backlogs resulting in significant achievements. This has also resulted in the expansion and growth in infrastructure in urban and rural areas. More small schemes have come into existence and, based on international and local experience, they pose greater challenges in their sustainable management.
- Furthermore, the infrastructure and associated resources are the assets of our country and contribute to improving the quality of life, and these assets need to be managed effectively. Lack of attention over the past few years to O&M, together with the lack of training and capacity, is beginning to show its weaknesses in the state of our water infrastructure. This valuable investment, if not given due attention, could prove costly for the country.

### Overview of technological trends

At an international level there is a continuous move towards new approaches for the provision of water services and adaptation of new approaches for improved domestic water quality and improved availability of water through alternative advanced technologies. Within these objectives climate change and energy efficiency are now becoming key drivers and influences. In the quest to achieve efficient and sustainable water service delivery, it is becoming more and more important to include these two variables or factors which have a significant impact on the continuous provision of services. Against the background of South Africa's current electricity challenges, energy efficiency and wise water use are priorities.

An emerging trend in developing countries is to **decentralise the management of services to a local level** or to a local government level, with the national authorities moving into a stronger regulatory environment. This shift provides a number of challenges of capacity and competency in the delivery of

water services, especially in developing countries when there is the need to address the plight of the poor and indigent who make up a large portion of the customer base. Thus, innovative institutional arrangements and partnership models between public/private/community are being investigated to provide optimum solutions. Specifically in Africa, the issue of capacity and competency requirements, technology choices, institutional arrangements and costs and affordability are key areas of activity.

Internationally, there is a new drive to **accelerate sanitation and hygiene education delivery** and radical new policies and strategies are being investigated to achieve the millennium goals. It is essential that these concepts and ideas be translated at a local level, thus requiring the need for developing improved strategies, policies and mechanisms that create a sustainable and enabling environment.

In water supply, the emphasis is on **efficient use of water and managing demand**, as well as looking at the contributory elements such as energy, pipe components and materials, water supply components and behavioural aspects. In terms of treatment technology, the current international trends are toward the **increased removal of more specific contaminants** in the water. In addition, it is aimed at adding fewer chemicals to the treated water product (improved source quality). The removal of pesticides, heavy metals, endocrine disruptors, disinfection byproducts and other harmful organics is receiving attention. The removal of *Cryptosporidium* and *Giardia* and the use of membrane filtration in this regard are receiving much attention – especially in the USA. There is a strong trend towards improving determination techniques of these new emerging contaminants. An area receiving considerable attention is in the use of molecular biology and genetic engineering techniques. In developing countries the emphasis continues to be on breaking the transmission cycle of water and faecal-oral related diseases through understanding the practices and behaviours which contribute to the spread of disease. Improved education and knowledge are central strategies to tackle these problems.

In the developed world, there is greater attention and focus being placed on **managing source quality for improved potable water quality**. Secondly, as desalination technologies become cheaper, we see more use of these technologies (Singapore/Middle East are examples). This source of water is also seriously being considered by some South African coastal cities. Further to the concerns about diminishing levels of fossil fuels, water and waste are being looked at amongst the renewable resources for energy creation. Greater attention is also being given to new promising technologies such as nanotechnologies, membranes, etc., as they may greatly benefit water treatment technology.

In both the municipal and industrial sectors, the most significant trend internationally, nationally and at local authority level has been the growing realisation of **recognising effluent wastewater and wastes as a resource**. The treatment of wastewaters and wastes that have been generated without the application of cleaner production and waste minimisation principles is a losing game, ultimately costing all of the parties material and energy resources, i.e. money. The consequences are profound: co-regulation becomes a meaningful negotiation; value as co-product is extracted from 'wastes' before discharge, thereby further reducing the waste load requiring treatment; technologies for treatment aim at being 'cleaner', are more focused towards specific waste fractions or even constituents and include recovery and reuse where technically and economically justifiable; resource-efficient technologies are not only favoured, but even their optimum deployment ('where' in the process stream) is critically examined, etc. These trends are predicted to not only continue, but, in fact, to accelerate in the future.

The mining industry has yet to embrace these new realities, and wastewater and waste treatment in this sector presently continues to be material- (e.g. chemicals) and energy-intensive, although more environmentally-friendly solutions are increasingly favoured, for example, biotechnological treatment of acid mine drainage associated with potential recovery and reuse of the renovated water for a variety of purposes. The cost-effectiveness of **cleaner production technology** is increasingly recognised and will in itself be a strong driving force for the accelerated introduction of the technology. Another driving force is the international trade sanctions that are increasingly being applied against manufacturers that do not apply responsible environmental practices. In South Africa, it is foreseen that the introduction of waste discharge charges will be a further powerful driver towards internalising pollution costs and implementation of cleaner technology.

The contribution of **mining-related non-point sources** to water quality degradation is increasingly appreciated and has given rise to a need for improved techniques with which to quantify their contribution and improved technologies to minimise their effect.

### Key stakeholders

The Minister of Water and Environmental Affairs is the shareholder of the WRC, and DWA and DST are its key stakeholders. In addition, the following stakeholders also continue to be of key importance to the WRC in general and to this KSA in particular. They are divided into internal and external stakeholders. Over the years, our international partners and business partners have also proven valuable to us.

The internal stakeholders are the WRC personnel, Executive Management and the Board, and DWA. The external stakeholders include:

- Government ministries and departments (DEA, CoGTA, DoH, DME, DST, etc.)
- Advisory groups
- Beneficiaries (i.e. the users or potential users of research, development and knowledge products produced through WRC funding)
- SALGA, local government, provincial government units
- Development Bank of Southern Africa
- Water boards, water services providers, catchment management agencies, water user associations
- Industrial sectors and industry-representative bodies (mining, forestry, water services, etc.)
- NGOs, CBOs and international aid agencies
- Private consultants
- Tertiary institutions, primary and secondary education institutions, science councils, professional bodies (WISA, SAICE, IMESA, etc.) media agencies
- The public
- International coalitions such as GWRC, WSSCC, WUP, ET, UNEP, IRC, WARFSA
- The business sector

## STRATEGIC INITIATIVES

### National initiatives

- The WRC continues to play a key role in supporting DST's nanotechnology platform, whereby the Water Nanotechnology Strategy and Centre was established through a collaborative effort of MINTEK, WRC and DST. WRC serves on the advisory board.
- The KSA serves on the National Multi-sectoral Committee on Cholera and Influenza A (H1N1) of DoH
- The KSA has initiated the development of hygiene education booklets for children, along with a DVD, starting with personal hygiene and later evolving to household hygiene and sanitation, and finally expanding to include ecosystems (KSA2) and water resources (KSA1)
- The WRC signed a MoU with the CSIR, Irish Aid, Amanz'abantu and DoE, Eastern Cape for the pilot programme for the franchising of water and sanitation facilities at schools in the Butterworth Educational District. The first phase was initiated and covers around 80 schools.
- The KSA renewed research with Anglo Platinum into treatment of mine water currently held in indefinite storage. This strengthens WRC's links with the platinum industry, through a project on biological treatment solutions for recalcitrant wastewaters that contain various platinum group metals.
- The WRC was invited to chair and contribute to a 'Sasol and Water/Energy Conservation' meeting in July 2009, which included key role-players like DWA, Eskom, Sasol, and Lephalale Municipality, and discussed strategy and planning towards the new Mafuta town and Eskom power station in the Limpopo Province.
- The WRC, together with WIN-SA, DWA, and DBSA, has formalised the creation of an Infrastructure Asset Management (IAM) Reference Group whose first aim is to build capacity for IAM in the Northern Cape, as a pilot, which will be rolled out to other smaller district municipalities and local authorities.
- Three 'lessons learnt' publications have been produced by WIN in collaboration with the KSA, on health and hygiene and safe water provision.
- WRC continues to participate and assist the DST/DWA initiative on 'Accelerating Services Delivery through Use of Appropriate Technology'
- The WRC, in association with Mvula Trust, is promoting and championing the case of better use of appropriate solutions for wastewater in the country
- The KSA supported Rand Water in successfully hosting the *IWA International Conference on Water Loss Management*, April 2009, Cape Town
- The KSA continues to facilitate the National Water Services Benchmarking Initiative in partnership with DWA and SALGA
- The Water Dialogues, a multi-partner research project of which WRC is a member, reached conclusion. The Dialogues is linked to an international process looking at successes and failures of water services delivery. The findings and the final report was launched at a function hosted in Pretoria on 15 September 2009.
- The WRC is playing an advisory role on the DBSA Siyenza Manje initiative to roll out a R300 m. project to deal with water losses in municipalities
- WRC and SEI signed an agreement in July 2009 to collaborate on issues of common interest. The first area identified was that of sustainable sanitation.
- The KSA was invited to be part of the Eskom task group on Demand Side Management which forms part of an initiative to use funds available to drive energy-saving initiatives in all sectors, including water and wastewater management by local government

### Leadership positions

KSA members continue to occupy key positions on a variety of strategic bodies and forums:

- A KSA member was elected as the first President of the Southern African Young Water Professionals. The aim of the Young Water Professionals programme is to fulfil the present and future needs of the water and wastewater industries, which requires the continuous development of a workforce which is both adequate in size, capable in skills and strong in leadership.
- A KSA member was elected chairperson of WISA's Small Waste-water Treatment Division. The SWWTW Division

aims to build relationships between the various role-players which will ultimately lead to better consensus building approaches to designing, managing, operating, maintaining, supplying and regulating small WWTW whilst meeting the need of protecting the environment and society through responsible application of appropriate technologies.

- Member of SALGA Sanitation Technical Advisory Committee
- Advisor on Water Services Infrastructure Asset Management Strategy team of DWA
- Member of the advisory committee on the DWA projects on Water Tariffs.
- Advisor on the WASH campaign of Unicef and DoH
- Member of the National Water Conservation and Water Demand Management Reference Group
- Member of the reference group of the The Water Demand Management (WDM) Programme, hosted by the Development Bank of Southern Africa (DBSA), and supported by the Swedish International Development Cooperation Agency (SIDA), a Southern Africa Development Community (SADC) Programme

In addition, the WRC and the KSA are represented on the following forums, among others:

- Member of the Free Basic Water Services Task Team
- Member of the Water Demand Management and Conservation Task Team
- Member of DWA Water Services Regulation Team
- Advisory position on the DWA – Sanitation Technical Advisory Group
- DWA's project steering committee concerning the development of a Comprehensive Framework for Integrated Water Resource Management in the Mining Industry
- A member of the Government task team convened by DME to develop an overarching strategy for mine closure
- Chamber of Mine's Steering Committee to develop Guidelines for the Vegetation of Residue Deposits against Water and Wind Erosion
- A member of the Coaltech 2020 Surface Environment Committee
- DEA's steering committee to develop a National Strategy on Cleaner Production and Sustainable Consumption
- Management committee of WISA's Mine Water Technical Committee
- Member of the South African Power Utility Research Advisory Board (Eskom)
- Member of the Advisory Board of the DST's new Nanotechnology Innovation Centre
- Management and steering committee of the National Benchmarking Initiative

### Public appreciation

The KSA is on track to complete one impact study, dealing with WRC's investment in the field of biological nutrient removal:

- **Biological Nutrient Removal (BNR) Research impact Assessment:** This study will assess the process of simultaneous biological nitrogen and phosphate removal, which was first discovered by Dr James Barnard in 1974. Ever since Barnard's first discovery, major breakthroughs in the BNR process have taken place which have resulted in the development of various BNR configurations, such as the University of Cape Town and the Johannesburg processes. The WRC has been undertaking research into the BNR process and most of these studies have focused on investigating ways of optimising the BNR process and gaining an idea of the complex population dynamics in the systems. The BNR process is currently utilised extensively throughout the world.

### African leadership

- A Research Manager met with the Director of the new IWA Africa Office, to discuss the development of a WRC Water Safety Plan in South Africa and the potential for implementation in other African countries
- As part of the agreement for collaboration between SEI and the WRC, the WRC engaged in a contract to implement a regional Southern Africa Knowledge Node on Sustainable Sanitation on behalf of the SEI
- The WRC, in partnership with SEI and GTZ, hosted a workshop ahead of the *Afriwater Conference*. The objectives were to get the voices and positions of the regional players on issues of sustainable sanitation and feed these inputs into the Afriwater process
- Two Research Managers held a workshop with the theme 'Developing, growing and leveraging intellectual capacity in Africa'. Participants from five African countries outside South Africa attended the workshop at the WRC. The programme included information sharing by the WRC, CAP-NET, WIN-SA (SAKNSS), World Association of Young Scientists and IWA Africa.
- Member of the World Health Organization Small Community Supply Network

### International player

- **TECHNEAU:** The WRC continued to provide support to Chris Swartz Water Utilisation Engineers in completing the following work areas: Work Area 2: Treatment Technologies for High Quality Water Supply; Work Area 4: Risk Assessment and Risk Management; Work Area 8: Dissemination and Training

- Global Water Research Coalition (GWRC):
  - The KSA contributed several case studies to the GWRC project *Energy Efficiency in the Water Industry: A Compendium of Best Practices and Case Studies*. The objective of this research study is to develop a Compendium of best practice in the energy efficient design and operation of water industry assets.
  - The WRC contributed to the development of a new study by the GWRC on thyroid function, which is one of a suite of projects on EDCs
  - The GWRC *Global Cyanobacteria Manual* has been completed with the WRC serving on the review committee and two SA researchers involved in three of the chapters
  - The KSA completed the compilation of a best practice manual on asset management on behalf of GWRC. The *Compendium of Best Practice in Asset Management* was launched in Miami in November 2009.
  - International Network for Acid Prevention (INAP): The WRC continues to be a member of the Global Alliance of Research Organisations of INAP, an international grouping of mining companies that was created to help meet the challenge of effectively dealing with the acid rock drainage (ARD) problem. This network was founded in 1998 and has since become a leader in mobilising international information and experience in research, technology transfer and networking. INAP engages with a number of key regional organisations active in the field of ARD through a Global Alliance. A recently completed major initiative of INAP was to develop a *Global Guide for the Management of ARD*, and as the WRC is currently one of five members of this Global Alliance consisting

of organisations in Australia, Canada, Europe and the USA, the WRC's representative on the Global Alliance, a KSA member attended its meetings with INAP's Operational Committee to report on WRC research and discuss current and future initiatives by INAP and other members of the Global Alliance. This helped to secure Golder Associates Africa Pty Ltd as the lead organisation to develop the GARD Guide, which was published and further disseminated through workshops during 2009.

- A Research Manager was elected to the management committee of the International Water Association Special Group on Nano Materials and Water and now serves on the organising committee for the first Nano and Water Conference in Switzerland in 2011
- The WRC, CSIR and its partners hosted a special workshop at the *Stockholm Water Week*, August 2009. The objective was to promote the concept of franchising of water services O&M.
- The WRC co-hosted a risk assessment workshop in Durban in February 2010 with UKZN and the Swedish Institute for Disease Control, on microbial risk assessment as a tool for sanitation projects

## GROWING THE KNOWLEDGE BASE

### Capacity building initiatives

Table 1 below illustrates the numbers of postgraduate students who benefited from WRC-funded research in this KSA in 2009/10.

**TABLE 1**  
**Capacity building through student involvement in KSA 3 projects in 2009/10**

Organisation/institution	No. of historically-disadvantaged (HD) students	Total No. of students
Arcus Gibb (Pty) Ltd	0	0
African Centre for Water Research	1	1
Althydro CC	3	3
ARTechnologies	4	4
Cape Peninsula University of Technology	15	18
Chris Swartz Water Utilisation Engineers	0	0
Counterpoint Development	1	2
CSIR	8	10
Durban University of Technology	4	4
eManti Management	5	5

Golder Associates Africa	1	1
Hlathi Development Services	2	2
Nelson Mandela Metropolitan University (NMMU)	3	5
Nemai Consulting	4	4
Partners in Development	3	5
Phathamanzi Water Treatment	0	0
Process Optimization and Resource Management	2	2
Pulles, Howard and De Lange	2	2
Resolve Consulting	0	0
Rhodes University	11	17
Sarah Slabbert Associates	0	1
Sustento Development Services	0	2
The Impact Free Water Group	4	5
The Mvula Trust	1	1
Tshwane University of Technology	4	4
Umgeni Water	3	3
Umvoto Africa	0	0
University of Cape Town	19	28
University of Johannesburg	9	9
University of KwaZulu-Natal	6	6
University of Pretoria	10	21
University of Stellenbosch	2	13
University of the Western Cape	18	18
University of the Witwatersrand	4	11
University of Venda	5	5
WRP Consulting Engineers	2	2
<b>TOTAL</b>	<b>156</b>	<b>214</b>

In terms of demographics 44 Black males, 42 Black females, 13 White males and 11 White females were involved.

The following technology transfer actions were undertaken:

- The WRC organised a workshop on the project 'Emergency Disinfection of Drinking Water', which was held at the *WISA Drinking Water Quality Conference* in Port Elizabeth, May 2009.
- In September 2009, the WRC hosted the Free Basic Water Think Tank, in partnership with the Department of Water Affairs (DWA) Directorate Water Services Policy and Strategy Coordination.
- As part of an ongoing project on Lightweight VIPs, demonstrations of the product were conducted

countrywide in November 2009.

- The WRC co-hosted a workshop on the impact of WATSAN over the past ten years, in partnership with TUT, in November 2009.
- In March 2010 the WRC hosted a seminar presented by two eminent scientists, Prof. Sandy Cairncross and Prof. Paul Hunter, on the subject of the impact of water and sanitation
- A Research Manager was an 'expert guest' on 20 January 2010 on the television programme *African Views*, which is aired between 20:00 and 21:00 weekdays on SABC International throughout Africa and parts of the USA. The Research Manager participated in discussing water issues in Africa and the role of the Young Water Professionals and the World Association of Young Scientists.

## Knowledge dissemination

New knowledge dissemination mechanisms were implemented as follows:

- The establishment and piloting of the first national Technical Assistance Centre for small wastewater treatment works arose as a need to provide technical expertise and management assistance to small- to medium-sized water treatment plants which experience serious challenges with compliance and sustainability. The pilot project is currently being undertaken in the Eastern Cape Province (where major challenges exist) and the Western Cape Province (as parallel best practice support) to help build an understanding of the frameworks and mechanisms required for a sustainable national rollout of such a centre.
- WIN-SA, WRC, DWA and DBSA are actively promoting the use of the WIN-SA Water Portal as a knowledge dissemination and discussion forum for the Integrated Asset Management Reference Group for the Northern Cape, in order to build capacity on infrastructure asset management
- On 10 June 2009 the WRC had a special meeting with the Tshwane Metro Division of Revenue, to discuss assisting municipalities, on a pilot basis, to evaluate their current water bills, as well as their proposed new bills, against a WRC framework which was developed through a research project. A similar intervention was also made with eThekweni Metro.

## Conference presentations and other activities by staff members

The following papers, among others, have been published or presented at international and local conferences by WRC staff:

- A paper was presented at ICARD, Sweden, June 2009, entitled 'Progress on South African mining-related water research and other activities'
- A popular paper was published in *Succeed Journal* in September 2009, entitled 'Water efficiency – measures needed now'
- A paper was presented at IMESA on domestic water accounts in October 2009, Cape Town
- A presentation and keynote address on the WRC's involvement in and impact on membrane research was given at the Ikusasa Launch, Somerset West, October 2009
- Two papers were presented at the *IWA Development Congress*, November 2009' on 'Franchising O&M in School Sanitation – the Eastern Cape Experience' and 'Energy from Wastewater; opportunities and challenges'
- A keynote address on 'Drinking water challenges into the future' was delivered at the launch of the District Water Services Managers' Forum (DWSMF), Birchwood Conference Centre, September 2009
- A presentation on 'The Challenge of Water Quality Research' was made at the Rand Water Forum for Water Service Providers, May 2009
- The following papers were published in scholarly journals:

- Harding WR, Downing TG, van Ginkel CE and Moolman APM (2009)'An overview of cyanobacterial research and management in South Africa post-2000. *Water SA* 35 (4) 479-484
- Moore BA and Burgess JE (2009). Metal-biomass interactions: a comparison of visualisation techniques available in South Africa. *South African Journal of Science* 105 (3-4) 115-119
- Zuma BM, Tandlich R, Whittington-Jones KJ and Burgess JE (2009). Mulch tower treatment system. Part I: Overall performance in greywater treatment. *Desalination*, 242 (1-3) 38-56
- Tandlich R, Zuma BM, Whittington-Jones KJ and Burgess JE (2009). Mulch tower treatment system. Part II: destructive testing and effluent treatment. *Desalination* 242 (1-3) 57-69

## IMPLEMENTATION PLAN

### Research portfolio for 2009/10

The KSA's continuous activities, the results of the strategic needs analysis and its review, needs expressed by the Minister of Water and Environmental Affairs through the variety of workshops and seminars, and engagement with DWA and other stakeholders with regard to its objectives and thrusts, have been well supported. The External Review 2006 highlighted that the relative weight of this KSA's thrusts seems to be well-balanced regarding the needs of urban-industrial-mining and rural research needs, but, given the urgency to redress past inequities, there is a need to increase the number/weight and relevance of research projects related to sustainable rural water supply and sanitation projects. Feedback from these exercises has ratified the KSA direction and the many valuable inputs assisted in strengthening the portfolio. Thus, the primary and secondary objectives of the KSA remain unchanged.

During 2009/10 the portfolio will continue to build on the strategic changes from previous years, as well as strengthen the portfolio towards making greater impacts on the social and health aspects, environment and economy of the country. In summary, we do not foresee any major changes to the KSA strategy and portfolio of thrusts over the next few years.

The primary objective of this is to continue to provide knowledge that ensures reliable, affordable and efficient services to enhance the quality of life, and contribute to economic growth. These objectives are in line with the Department of Water Affairs' strategic goals in meeting the objectives set in the Water Services Act and the National Water Resource Strategy, as well as the new DWA framework strategy *Water for Growth and Development* (Version 6). To achieve these objectives, the programmes and projects need to be more strongly orientated to the challenges.

The new portfolio of projects continues to provide solutions that support these directions in the following ways:

- Developing tools, guidelines and appropriate institutional models for accelerating sustainable delivery of water and sanitation services
- Providing information that supports the development and application of water services legislation
- Improving understanding and knowledge on sanitation and hygiene education
- Extending the implementation of waste minimisation, cleaner production, cleaner consumption and clean technologies
- Investigating the potential and technologies required for recovery and reuse of water from industrial, mining and domestic wastewaters (including grey-water and stormwater)

- Furthering the knowledge and technologies for recovery and reuse of material and energy resources in water and wastewater management
- Enhancing ways to predict pollutants and their impacts
- Addressing infrastructure security and sustainability
- Optimisation of water and wastewater treatment processes
- Opportunities of energy from water and sanitation
- Supporting water for growth and development
- Developing innovative and cutting-edge technologies and solutions
- Producing cutting-edge science and technology

Twenty-six (26) new projects have been approved for funding, made up of 17 non-solicited and 9 solicited projects. The scope and expected outcomes of the thrusts and programmes are provided in Table 2.

**TABLE 2**  
**Overview and description of thrusts and programmes**

**THRUST 1: WATER SERVICES – INSTITUTIONAL AND MANAGEMENT ISSUES**

**Scope:** The efficient functioning of water service institutions and their viability is key to sustaining water services in rural and urban areas. The focus of this thrust is to address strategic research aspects related to policy issues, institutional reform, regulation, infrastructure management, water-related competencies and capacity required for the strengthening of water institutions (water services providers, water services authorities, water boards, national departments) in providing sustainable water services.

<p><b>Programme 1:</b> <b>Cost-recovery in water services</b></p>	<p><b>Scope:</b> The issue of cost-recovery has been identified as a critical aspect affecting sustainable services. In an environment where genuine poverty affects cost-recovery, this programme intends to develop innovative strategies and processes to tackle the problem. The focus will be on generating in-depth knowledge of the problem and testing new approaches.</p>
<p><b>Programme 2:</b> <b>Institutional and management issues - Water services</b></p>	<p><b>Scope:</b> Relationships and partnerships between service providers, both external and internal, are important prerequisites for sustainable water service delivery. This programme's objective is to generate knowledge and processes that would support this new form of service delivery. Innovative management techniques are a necessity for viable and sustainable water service provision. This programme intends to find innovative solutions to critical problems with the financing and management of essential services such as water supply and sanitation.</p>
<p><b>Programme 3:</b> <b>Innovative management arrangements - Rural water supply</b></p>	<p><b>Scope:</b> The focus of research within this programme is to provide support to water service institutions with special reference to sustainable cost-recovery and implementation of the free basic water policy; key performance indicators for monitoring and evaluation of service delivery; guidelines for sound management of water service institutions and development of effective strategies for promoting an integrated approach to rural development.</p>

<p><b>Programme 4:</b> <b>Regulation of water services</b></p>	<p><b>Scope:</b> Regulation of water services is important for the sector to achieve improved functioning and performance of the delivery of water and sanitation services, to the benefit of the population. Furthermore, it ensures greater efficiency and improved management of the infrastructure and customers. This programme will support, through knowledge creation, the development of an effective water regulatory environment.</p>
<p><b>Programme 5:</b> <b>Impact of water and sanitation interventions</b></p>	<p><b>Scope:</b> The programme will address aspects related to determining and quantifying the sociological, economic, technical, health, etc., impacts and benefits of 11 years of water supply and sanitation interventions in South Africa. Over the years the Government has spent considerable sums of money to meet the backlogs and substantial progress has been made. However, very little work has been undertaken to quantify the benefits which improved water and sanitation has brought to the communities and the countries. Thus, the time is most appropriate to undertake a study of this nature.</p>

## **THRUST 2: WATER SUPPLY AND TREATMENT TECHNOLOGY**

Scope: The provision and supply of affordable and reliable water of sufficient quality and quantity for drinking (domestic) and economic (industrial/commercial and mining) activities, remain continuous challenges. Research support for these activities is the focus of this thrust. The objective of this thrust is to develop innovative technologies and processes that address aspects related to bulk water supply, water treatment technology, distribution and water quality.

<p><b>Programme 1:</b> <b>Drinking water treatment technology</b></p>	<p><b>Scope:</b> The programme aims to acquire adequate understanding of potable water treatment processes and related activities and to be able to assist in treating our scarce water resources in the most efficient and cost-effective way, to an acceptable quality for potable and industrial use. Expected outcomes include improved and more cost-efficient process technologies, increased operational efficiency of treatment plants and an improved manpower training level and knowledge base.</p>
<p><b>Programme 2:</b> <b>Water treatment for rural communities</b></p>	<p><b>Scope:</b> This programme aims to produce innovative and appropriate water treatment and supply technologies and processes that will ensure an adequate supply of safe and clean drinking water for rural communities.</p>
<p><b>Programme 3:</b> <b>Drinking water quality</b></p>	<p><b>Scope:</b> The programme aims to protect human health by ensuring that water supplies are of acceptable quality and standards. Outcomes include improved analytical methodologies, treatment technologies and hygiene practices.</p>
<p><b>Programme 4:</b> <b>Water distribution and distribution systems</b></p>	<p><b>Scope:</b> The programme aims to optimise the quality, quantity and reliability of the distribution and supply of treated potable water to the end-users. The programme has the following expected outcomes: to develop reliable processes in predicting and improving the operational efficiencies in distribution systems, with the purpose of reducing both capital and operational costs; to ensure that the quality and quantity of water is maintained in the distribution system - from the water treatment plant to the furthest end user; and to develop innovative methods, tools and processes that will improve system integrity and reliability.</p>

### THRUST 3: SUSTAINABLE MUNICIPAL WASTEWATER AND SANITATION

Scope: This thrust focuses on the development of technologies and systems that optimise the full wastewater and sanitation services chain in the municipal (domestic) sector. This includes the reticulation, treatment and management of the residues. The challenge is to implement fitting solutions for a particular application that will remain functional throughout the intended life span of the installed infrastructure. This includes the responsible management of the wastewater sludge and faecal sludge that is generated. The need for innovative technologies and solutions is recognised as we prepare for the future – achieving more stringent effluent discharge standards, developing acceptable non-waterborne sewerage solutions, reliable treatment of ever-increasing high-strength domestic wastewater, informing future policy, etc.

<p><b>Programme 1:</b> <b>Emerging treatment technologies – Preparing for the future</b></p>	<p><b>Scope:</b> It is imperative to develop technologies which can achieve future policy objectives and stricter standards. It is also recognised that research generates information which could inform future policy. This programme encourages the development of technologies to address the future anticipated municipal waterborne sewage and sanitation needs as well as to support government by informing future policy. It supports development of technological solutions addressing amongst others: reuse, recovery, non-waterborne sewerage solutions, grey-water management, peri-urban sanitation solutions, high strength effluent treatment, industrial and domestic effluent co-treatment, etc. It also supports research aimed at informing future policy through data interpretation, projections, risk assessments, addressing emerging pollutants, predictive models, etc.</p>
<p><b>Programme 2:</b> <b>Application of appropriate technologies and tools</b></p>	<p><b>Scope:</b> This programme addresses the improvement and innovative application of existing ‘fit for purpose’ technology for waterborne sewage treatment and on-site sanitation. The objective is to optimise appropriate application to consistently achieve strict standards with added benefits such as cost saving, ensuring ease of operation and maintenance, and improving reliability and energy efficiency. The integration of social and local economic development objectives is encouraged. The programme further focuses on the technical sustainability of wastewater treatment and sanitation services by critically appraising existing policy (including effluent discharge standards) and impacts.</p>
<p><b>Programme 3:</b> <b>Stormwater and sewerage systems</b></p>	<p><b>Scope:</b> The programme supports the strategic and technical aspects of managing stormwater and sewerage and impacts in urban, peri-urban and rural contexts. The development of generic stormwater and sewerage planning and technology selection, design and maintenance tools is encouraged to address current needs. In order to address anticipated needs, the programme supports research focusing on improved technology including water-sensitive urban design (WSUD) and stormwater reuse. It will cover aspects of technical design, operational, maintenance, refurbishment and management aspects of stormwater and sewerage reticulation systems, to provide sustainable infrastructure in the extended delivery of sanitation services as a national priority.</p>

<p><b>Programme 4:</b> <b>Wastewater sludge and faecal sludge management</b></p>	<p><b>Scope:</b> All wastewater treatment and on-site sanitation facilities generate a solid/sludge that needs to be managed responsibly. This programme focuses on research dedicated to improving wastewater sludge and faecal sludge management practices. Research on characterisation, emerging technologies and solutions, anaerobic processes for stabilisation, minimisation, stabilisation, dewatering, disinfection and beneficiation is encouraged.</p>
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#### **THRUST 4: INDUSTRIAL AND MINE-WATER MANAGEMENT**

Scope: The usage of water in the mining and industrial sectors produces high concentrations of wastes and effluents. Some mining activities produce wastes that act as non-point sources of water quality degradation and acid mine drainage. This thrust aims to provide appropriate, innovative and integrated solutions for water use and waste management in the industrial and mining sectors.

<p><b>Programme 1:</b> <b>Quantification of water use and waste production</b></p>	<p><b>Scope:</b> In order to prioritise those facets of industrial and mine-water management that need most urgent attention, it is important to quantify the water used and waste produced by different sectors. The NATSURV investigation conducted by the WRC provides the benchmark for water use and waste that are produced by the major South African industries. While the WRC has reported on water use by coal mines and COMRO on water use by gold mines, no overall assessment of the effect of mining or industrial waste on water quality is available. The available information thus needs to be updated and refined. Furthermore, new information needs to be gathered for those sectors that may present important emerging issues.</p>
<p><b>Programme 2:</b> <b>Regulatory mechanisms to improve industrial and mine-water management</b></p>	<p><b>Scope:</b> The regulatory authorities are responsible for managing the impact of industrial and mining waste on the quality and quantity of our water resources. Traditionally the resource-intensive command-and-control approach was used almost exclusively to manage water quality. Internationally, use is increasingly made of indirect economic or other instruments to supplement or even replace the command-and-control approach to water quality management. These new approaches are believed to be more cost effective and to improve equity. Both the established and new approaches are being investigated and refined in order to support improvements to the regulatory mechanisms that are used to control and reduce the negative environmental effects associated with industrial and mining waste.</p>
<p><b>Programme 3:</b> <b>Minimising the impact of waste on the water environment</b></p>	<p><b>Scope:</b> South Africa has a large legacy of mining and industrial waste products that impact negatively on the water environment. In spite of efforts to the contrary, the quantity and range of waste products are expected to increase for the foreseeable future. It is thus necessary to develop cost-effective techniques and approaches to minimise or reduce the impact that historical and new waste products have on the water environment. Approaches such as pollution prevention, rehabilitation, waste beneficiation and reuse, are investigated to assess their application potential and suitability to reduce and minimise the negative impact of industrial and mining waste on water quality.</p>

<p><b>Programme 4:</b> <b>Minimising waste production</b></p>	<p><b>Scope:</b> A direct link exists between the quantity of waste produced and its impact on the water environment. The type of waste that is produced may, however, often be of even greater importance than quantity. In order to reduce the negative impact of waste production, it is important to reduce both the quantity and toxicity of waste. The international trend towards waste management is therefore to minimise the production of waste by adopting cleaner production processes. Approaches such as life-cycle analysis are employed to ensure that the net effect is positive and does not merely represent the transfer of negative effects from one sector or environmental medium to another. This programme investigates and promotes the implementation of approaches that minimise waste production.</p>
<p><b>Programme 5:</b> <b>Improved ability to predict and quantify effects</b></p>	<p><b>Scope:</b> The environmental consequences of waste products are almost always long-term in nature, with impacts that may potentially last for hundreds of years. These long-lasting effects were often not fully appreciated in the past, and consequently were not properly considered when waste was disposed of. In the present regulatory environment it is increasingly expected of waste producers to quantify the present and future environmental impact of their operations and to indicate how these will be remedied. This programme is primarily aimed at establishing and improving pollution prediction capabilities appropriate to the South African situation.</p>
<p><b>Programme 6:</b> <b>Beneficiation and treatment of industrial and mining effluents</b></p>	<p><b>Scope:</b> In spite of efforts to minimise waste production it is acknowledged that effluent production will for the foreseeable future remain an expected consequence of industrial and mining activities. This programme aims to support the development of a range of processes for effective treatment, beneficiation and disposal of industrial and mining effluents, with as aim to minimise negative consequences associated with the effluents and derive potential benefits associated with them. Expected outcomes include the potential recovery of materials, water and energy for beneficial reuse and fundamental scientific/engineering support for process development.</p>

#### **THRUST 5: SANITATION, HEALTH AND HYGIENE EDUCATION**

Scope: This thrust addresses the research required to assist the national Government to achieve its goal of clearing the sanitation service backlog by 2010. It also identifies research that is essential to support planning for basic sanitation service delivery (O&M, sustainability, etc.) beyond 2010. The focus is on low-cost and affordable sanitation technologies.

<p><b>Programme 1:</b> <b>Advocacy, health and hygiene education</b></p>	<p><b>Scope:</b> The main objective of this programme is to support the integration of health and hygiene into the delivery of water and sanitation in order to ensure that these services lead to maximum health benefits for the beneficiary communities.</p>
<p><b>Programme 2:</b> <b>Peri-urban sanitation research</b></p>	<p><b>Scope:</b> The aim of this programme is to provide research support to sanitation in informal and developing urban areas. Until recently the focus of sanitation has been on rural areas, but the situation in urban areas is much more critical and volatile in terms of public health. Urban sanitation differs from rural sanitation issues related to institutional arrangements, community dynamics and management of interventions. Due to the high densities, technical choices are more complex where an affordable and sustainable service is to be provided. Outcomes from this programme will support local authorities in implementing sustainable solutions, which cater for both the user and the institutions' needs.</p>

<p><b>Programme 3:</b> <b><i>Institutional and management aspects of sanitation service delivery</i></b></p>	<p><b>Scope:</b> The main objective of this research programme is to develop institutional models, tools and guidelines that will support the improvement of delivery (O&amp;M, sustainability, etc.) of sanitation services.</p>
<p><b>Programme 4:</b> <b><i>Technical sustainability of sanitation services</i></b></p>	<p><b>Scope:</b> To develop tools, procedures and guidelines that will guide those responsible for implementing projects in their selection of appropriate sanitation technologies that are socially, environmentally and financially sustainable.</p>

### KSA alignment with DWA's objectives

The research thrusts and programmes in KSA 3 have been strategically aligned and structured to respond to its scope, viz., to provide knowledge that ensures reliable, affordable and efficient water use and waste management services to enhance the quality of life, and to contribute to economic growth and improved public health. Consequently, the KSA's scope is aligned to DWA's Strategic Plan for 2009/10 to 2010/11 and the KSA portfolio of thrusts, programmes and projects directly contributes to DWA's strategic objectives. The new DWA framework *Water for Growth and Development* (Version 6) has set priority imperatives for the water sector and the KSA portfolio is aligned to respond to the challenges posed. Specifically, with regard to the scope of the framework, the relationship and contribution of the KSA thrusts, programmes and projects are as follows:

- Mainstreaming water:** Water is at the nucleus of planning and decision-making, which includes but is not limited to sectoral planning. In an effort to elevate the status of water as a scarce and vulnerable resource, the importance of strengthening regulatory processes, and providing support and guidance to the plethora of stakeholders affecting and influencing the sector, should be acknowledged. The WRC initiatives support DWA's regulatory function in its strategic area of ensuring protection of the water resources. The WRC projects focus on developing simple techniques for identifying pollutants, technologies and processes to recover and reduce contaminants in waste streams, and on supporting the strengthening of existing policies, such as closure and decanting of mines. DWAs strategic role as a sector leader in ensuring effective service delivery is supported by research through the development of training aids, guidelines and tools. These instruments are used in support of both capacity building and regulation.
- Diversifying the water mix:** Water availability is currently based on surface water (77%), return flows (14%) and groundwater (9%). Reconciliation studies undertaken in major urban centres have revealed that, in addition to these sources, desalination and effluent reuse ought to be considered given the high risk of water shortages. In this area the programmes and projects are orientated towards developing cutting-edge technologies and processes which support the aspects of beneficiation, reuse and recovery of contaminants. Wastewater and other forms of effluents are all considered as strategic resources which will complement the ever-increasing demand for water.
- Striking a balance between supply and demand-side measures:** As a country we can no longer afford water losses and therefore it is imperative that the focus on water conservation and water demand measures must be strengthened, especially as there is a greater return on investment through water loss control and water use efficiency. A key challenge to sustained and potable water supplies is the poor maintenance of wastewater treatment works (WWTW). The KSA tackles issues of inefficient use and water losses through the development of knowledge of the processes which will influence efficient use. Some of the initiatives include the development of user-friendly models and tools to determine the amount of water losses in the supply of water, technologies for promoting efficient use, improving the management of water infrastructure assets and improvements in current practices and policy.
- Water for growth: Changing water use behaviour for the future and nurturing attitudinal and behavioural changes towards the value of water:** Current water use behaviour impacts negatively on the resource both quantitatively and qualitatively. It is imperative that mechanisms are developed to change this behaviour, which include regulatory instruments, market-based instruments, self-regulation, and awareness and education, and which will match appropriate mechanisms to mitigate offending behaviour. The KSA addresses this area by providing knowledge on people's attitude to water services. Initiatives include innovative ways to stimulate local regulation of water services, bringing in innovative tools such as informative billing which improve people's awareness, assessing how people value water and sanitation services, their readiness to use different qualities of water, and assessing social vulnerability and scarcity.
- Water for development: Addressing service backlogs:** The achievement of the Millennium Development Goals (MDGs) in respect to the halving of water and sanitation backlogs in 2005 and 2008, respectively, has been satisfactory. However, too many South Africans still do not have access to basic water and sanitation services and the intention is therefore to achieve the target of full access to basic water and sanitation services for all by 2014. The KSA focus and support are threefold. Firstly, the research supports the implementation of policy; secondly, it evaluates or reviews the effectiveness of the policy; and thirdly, in response to this, the WRC provides appropriate solutions in the event of policy and knowledge gaps. An example of this is reviewing

current sanitation policy and the scope to introduce a free basic sanitation component, and developing techniques to implement a basic sanitation component successfully.

## RESEARCH PROJECTS FOR 2009/10

The findings of projects completed during the year under review are given, as well as a summary of current projects and the motivation and objectives of new projects which commenced between 01 April 2009 and 31 March 2010.

## COMPLETED PROJECTS

### THRUST 1: WATER SERVICES – INSTITUTIONAL AND MANAGEMENT ISSUES

#### *Programme 1: Cost-recovery in water services*

##### **Guidelines on domestic water accounts – Towards a consistent approach in RSA**

Sarah Slabbert Associates; Neilsen Company; Zitholele Consulting

**No. 1810**

The domestic water accounts (or consolidated accounts) that municipalities send out to consumers on a monthly basis are a key interface between local government and citizens. A municipal account is a unique one-on-one communication event between the municipality and the individual consumer (or customer) to whom the account is addressed. As such, municipal accounts offer a unique opportunity for municipalities to inform, educate and influence their customers and to establish their communication as clear, accurate and customer-friendly. The research assessed current South African and international regulation, guidelines and research relating to accounts/invoices/bills, with special reference to domestic water accounts. This was supported by a survey of current municipal account practices, as well as a critical analysis of a representative sample of domestic water (or consolidated) accounts. The assessment tool that was developed, as well as the results of the analysis, were discussed at a workshop with municipal representatives. A survey was also conducted with a national urban sample of 2 500 respondents to test three municipal accounts (two from the sample accounts, and a prototype that was developed on the basis of the assessment). In conclusion, the study developed standards or guidelines for optimising domestic accounts for accessibility, individual needs and transforming consumer behaviour regarding payment and efficient water/resource use.

Cost: R500 000

Term: 2008 - 2010

#### *Programme 2: Institutional and management issues - Water services*

##### **Water services franchising: An innovative approach to water services delivery in rural and peri-urban areas**

CSIR

**No. 1610**

The rapid rate of construction and commissioning of new water services infrastructure is severely challenging the public sector institutions in South Africa responsible for operating and managing this infrastructure. Innovative approaches are required. Even if all the existing water services institutions were coping with the responsibility, there would be good reason to investigate alternative institutional models, on the grounds that it needs to be found out if alternatives could be more cost-effective, and/or could offer a range of other advantages (including greater local economic development). There is an alternative institutional model that is more suited for the ongoing operation and maintenance of water services systems than for investment in new infrastructure – and, importantly, that is friendly to small business and local economic development. This alternative is the franchising partnership. Franchising is a way of accelerating the development of a business, based on tried and tested methodology. The franchise system firstly correlates and systematises the business, and then facilitates the setting up of the business, and supports and disciplines it thereafter. The key is the incentive, to franchisor and franchisee alike, to improve efficiency, and to provide improved service reliability and quality control.

Cost: R600 000

Term: 2005 - 2009

##### **Review of technology used in strategic asset management: existing and future needs**

Africon

**No. 1785**

In order to ensure that assets are effectively managed and controlled, it is important that water utilities are aware of the current condition of their assets. This will enable water utilities to conduct effective planning activities around projects and finances required to ensure that the assets remain in working order. This study was commissioned by the WRC primarily to determine what technologies are currently available to water utilities that can be used to determine the condition of assets deployed for water extraction, storage and distribution. The study also reviewed national and international trends in management processes with regard to condition assessment, and prediction of asset performance and asset

risk determination techniques as applicable to water assets. Discussions with sector experts revealed that there are a vast number of technologies available to water utilities in South Africa. There are, however, very few water utilities actually making use of these tools. In most cases these technologies are implemented in the larger water utilities and metropolitan municipalities. It is also unfortunate to note that these technologies were usually only employed in a reactive instead of a preventative mode. Condition assessment is currently not being widely practiced as a structured activity across the country. Most condition assessment is in the form of ad hoc visual maintenance inspections or initial high-level screening, visual inspections for the compilation of asset registers. From the results of the survey, there does not appear to be much consistency in the visual inspection method. Predictive modelling of risk, condition and reliability for water assets is currently not widely practiced in South Africa. There appears to be a widespread awareness of the need to determine asset risks as a management practice, but there is much inconsistency in the quantification and the management of the risks.

Cost: R500 000  
Term: 2007 - 2009

**Development of a toolkit for strategic asset management**  
WRP Consulting Engineers (Pty.) Ltd.  
**No. 1786**

A key element for ensuring greater understanding of Strategic Asset Management (SAM) and its needs is a toolbox of advocacy and awareness materials targeting customers, officials and policy makers. This element has been identified as a priority action which received little attention in many international initiatives, and which has as a result led to poor uptake. It is therefore key that the linkages of SAM are made to the daily operations of water services maintenance, planning and strategic decision making. Thus it became imperative to develop a user-friendly multi-media tool for asset management, which can be used as a guide and reference point for water suppliers, water managers, and various government organisations who are involved with water delivery in South Africa. The objective was to produce different modules which enable various users to adopt the concepts of SAM. The tool will also serve as a training aid. The tool provides guidance to the user, through a multi-media platform, on how to get started, and should provide sufficient information on the processes involved with asset management and how it should be implemented.

Cost: R700 000  
Term: 2007 - 2009

**Programme 3: Innovative management arrangements - Rural water supply**

**Best practice institutional and project guidelines based on national and international experience to manage the impact of gender in the South African rural water services sector**

Council for Geoscience  
**No. 1612**

This study was aimed at enhancing the impact of gender mainstreaming in the water services sector, and at evaluating current South African guidelines according to specific principles. The project also aimed to increase the understanding of how cultural dynamics impact on gender mainstreaming and to propose a conceptual approach to measuring the impact of gender mainstreaming. The study was qualitative in nature, and both theoretical and empirical information was used to derive principles for successful gender mainstreaming. The study resulted in a proposed framework of fourteen focus areas for gender mainstreaming in the water services sector. The proposed framework was validated by a panel of gender experts who were also asked to rate the proposed focus areas as critical or not. In order to yield personal information on how individuals are affected by traditional culture, narratology was used. The conceptual method proposed to measure the impact of gender mainstreaming has been structured to address the constraints of classical cost-benefit analysis or social cost-benefit analysis. The method yields an efficiency index for gender mainstreaming based on the inputs, outputs, outcomes and impacts of interventions. The lowest recommended level of analysis is the suite of gender mainstreaming projects conducted by a local authority.

Cost: R600 000  
Term: 2005 - 2009

**Productive use of domestic water for sustainable livelihoods**  
Nemai Consulting  
**No. 1666**

The major question raised by the research is whether water for productive use should be subsidised. This research report has demonstrated that water is being used for productive use and identified the various uses to which this water is being put. The research report also highlights that poor households using water for productive use consume 122% more water than poor households that do not. The levels of water debts are high, and that 40% of the households surveyed indicate that they pay for water, when possible, demonstrates both that water affordability can be low amongst the poor and that the provision of more water to households for beneficial use may experience financial sustainability challenges. This research indicated that the majority of water users surveyed have stated that they would use water if it were available. It is suggested

that wanting to use water in such a manner and actually using the water are not the same thing. This research also indicates that households with higher levels of service use more water for productive use than those with lower service level standards.

Cost: R700 000  
Term: 2006 - 2009

**Guidelines for the integration of community-based procurement for providing operational services for basic water and sanitation**

Cape Peninsula University of Technology  
**No. 1714**

As municipalities are coming to terms with the scale of the operation and maintenance requirements of basic services, more municipalities are considering integrating community-based procurement opportunities for the provision of operation and maintenance functions of basic water and sanitation services. While there is a willingness to integrate pro-poor strategies and improve operation and maintenance of basic services, the challenge in implementation is a guideline at local level to create an enabling environment for the integration, monitoring and support of community-based opportunities in operation and maintenance systems. This study was initiated in response to this challenge and is in line with the ASGISA call for 'procurement and capacity-building strategies for poverty alleviation in the context of basic infrastructure programmes'. Drawing on international experience, the study investigated local approaches in the context of specific case study sites (Cape Town, Stellenbosch, eThekweni and Alfred Nzo District Municipalities) in order to develop a guideline. The key findings in the study relate to the following:

- The rationale for community-based procurement in O&M of basic services
- Identifying O&M tasks and specifying community-based opportunities
- Setting up local monitoring and support structures
- Facilitating institutional support for integrating community-based O&M approaches

Cost: R667 324  
Term: 2007 - 2009

**Programme 4: Regulation of water services**

**Review of regulatory aspects of the water services sector**

African Centre for Water Research  
**No. 1667**

The purpose of regulation is to ensure that the service providers or operators of water services deliver in accordance with the law and the policy of the government. This research examined the international literature and case studies where the concept of a 'regulator' is understood more as referring to an entity that is separated from the line departments of government.

Whether the institutional form is government as regulator or an independent entity as regulator conceptually makes no difference to its objectives or its basic task. The international focus on independent regulators relates largely to effectiveness. The limited survey conducted as part of this research suggests that, within South Africa, stakeholders outside of national government appear to favour an independent regulator because, it is said, DWA will be unable to simultaneously fulfil the three roles it defines for itself as regulator, supporter and enabler. The unfavourable side to an independent regulator is the cost and the requirement for skills that are in short supply. The research found that the legislation, regulations and policy that a regulator would have to apply are already well defined. Further, it was found that there are a number of core skills, such as finance, economics and engineering, that are required irrespective of the range of aspects that will be regulated. Depending on the functions and mandate, regulation will require between 48 and 80 direct staff and cost between R40 and R67m. per annum. A similar estimate for an independent regulator suggests staff of between 65 and 112 and annual costs of between R63 and R99 m. per annum.

Cost: R800 000  
Term: 2006 - 2009

**Towards the regulation of the competences of South Africa's water services managers**

University of the Witwatersrand  
**No. 1715**

The efficient, effective and sustainable provision of water supply and sanitation services, essential to public health and social well-being, economic activity and environmental sustainability, requires managers and staff with appropriate competences. South Africa faces a challenge in producing and deploying such competences. This study reviews the challenges and considers measures that could be taken to address them. A key finding is that South Africa has a qualifications system, an existing family of professional institutions and a system of municipal regulation that provides a supportive framework for a combination of professionalisation and regulation. The development of qualifications, skills and competences requires a combination of an appropriate pre-service educational foundation, in-service training, hands-on work experience, and lifelong learning. Competence implies: an adequate academic qualification, specific sector-related knowledge and, critically, the ability to apply the knowledge gained. Professional bodies play an important role in certifying these abilities. Based on the findings, it is concluded that an appropriate model for South Africa would be municipal regulation that requires water service institutions to use qualified personnel to take management responsibility for the provision of water supply and sanitation services. Regulations should be promulgated in terms of the Water Services Act to ensure that they are applicable to all water services institutions, reflecting the approach already adopted by National Treasury and DPLG.

This would establish a category of 'certified water services manager' (CWSM). The content of minimum qualifications for CWSMs would be set in terms of the processes established under the National Qualifications Framework. A Water Services Professional Council, led by existing professional institutions with participation of key government and training stakeholders, would undertake the standard-setting process as well as the certification of CWSMs and the implementation of other requirements such as structured training programmes and continued professional development.

Cost: R350 000  
Term: 2007 - 2009

## **THRUST 2: WATER SUPPLY AND TREATMENT TECHNOLOGY**

### *Programme 1: Drinking water treatment technology*

#### **Evaluating the potential for upgrading existing SA filtration plants to high-rate filters**

Umgeni Water

**No. 1395**

The capital cost of water treatment plants has doubled in recent years and these costs could increase even further over the next few years due to the escalation in the price of steel and civil construction costs. It is thus imperative that researchers and practitioners explore the options of minimising the capital costs of treatment plants without compromising public health. Filtration is one of the most critical unit processes in the treatment process for the removal of suspended matter and microorganisms as it is the last physical barrier. Failure of filtration can result in major failure of the treatment process leading to the production of poor water quality. The design or upgrade of the filtration unit process should be kept simple to minimise capital costs. At the same time, the efficiency of the filtration process should be optimised to reduce operating and maintenance costs. There is a drive to increase the filtration rate of the filters to achieve higher filter loading rates in order to delay capital expenditure. The possibility of upgrading filters to higher filtration rates should be explored before adding filters to a process. Pilot plant studies, to establish the design limits of filters, should be undertaken before implementing the upgrade to a high-rate filtration plant. This report provides the practising engineer with an excellent guide for the design and operation of pilot plants to establish the design parameters for the full-scale upgrade of a water works. It also provides a comprehensive literature review of the application of high-rate filtration in the international arena. A survey of the South Africa filtration industry indicates that there is limited application of the technology which is contributing to the high unit capital

costs of water treatment plants. Recommendations for the full-scale design and operation are also included in the research report.

Cost: R208 000  
Term: 2002 - 2009

#### **Two-stage reclamation of filter backwash water at treatment plants using source water with high algal content**

University of Pretoria

**No. 1717**

The quality of drinking water has dramatically declined over the years due to agricultural, municipal and industrial pollution. Poor quality water sources include eutrophic surface water (from dams), previously wasted filter backwash water and industrial wastewater. Supplementing freshwater supply by recycling treated wastewater is a trend that is rapidly gaining acceptability, but its practise is limited by the problems of accumulation of toxic organic pollutants in industrial and municipal wastewaters; and the presence of taste and odours caused by microbial metabolites, geosmin and 2-methylisoborneol (MIB). Humic substances, also known as natural organic materials (NOMs), are produced in large amounts in highly eutrophic water bodies. These contribute to volatile organic compound (VOC) content and they serve as precursors of disinfection byproducts (DBPs) during chlorination. Both components (odour-causing compounds and humic substances) contribute refractory organic pollutants that are persistent in the potable water treatment process. It is feared that, if recycled directly, organic pollutants may accumulate in the backwash water. This research was thus aimed at investigating methods for destroying the organics in the backwash water stream using a semiconductor photocatalytic process. Organic pollutants of concern were detected in the raw water and backwash water of two Pretoria water treatment plants (Rietvlei and Roodeplaat Water Treatment Works). The organics of concern detected in the water were the taste- and odour-causing compounds trans-1,10-dimethyl-trans-9-decalol (geosmin) and 2-methyl-isoborneol (MIB), the phenolics – naphthalene, 2-ethylnaphthalene, 2-(1-methylethyl)naphthalene, 2-(1,1-dimethylethyl)-5-methylphenol and 2,6-bis[1,1-dimethylethyl]-4-methylphenol (butylated hydroxytoluene), and trace amounts of the herbicide atrazine. The investigation on the biodegradability of these families of compounds was conducted using geosmin to represent the semivolatile groups and phenol to represent the non-volatiles. The taste and odour compound, geosmin, completely degraded in the solution after exposure for 40 minutes under an optimum titanium dioxide (TiO<sub>2</sub>) concentration of 50-60 mg/ℓ. The degradation of the taste and odour compound geosmin at a concentration as high

as 230 ng/ℓ is of practical importance since the tested value was an order of magnitude higher than the levels that result in complaints from consumers (1.3 to 6.3 ng/ℓ). The tested range of concentration of phenolics was too high for the purpose of measuring impacts on drinking water treatment. One of the challenges of the current system is that high temperatures are generated due to the high wattage of the UV lamps used in the study. To circumvent this problem, the lamp sleeve was surrounded by a cooling water jacket. However, this increased the effective circumference of the photoreactor, thereby decreasing light intensity. This could drastically increase the power input to the system to achieve the same efficiency.

Cost: R830 000  
Term: 2007 - 2009

### **Programme 2: Water treatment for rural communities**

#### **Development of appropriate brine electrolyzers for disinfection of rural water supplies**

University of the Western Cape (Department of Chemistry)  
**No. 1442**

Hypochlorite generators are amongst the most suitable technologies for providing safe drinking water in rural areas, because the dosing of hypochlorite provides a chlorine residual in the water, and the generators can be run at low cost requiring just common salt and solar panels. This study developed a small-scale membrane-based hypochlorite generator, or 'membrane electrolyser' to operate on a disinfection scale of 2.5-20 kℓ of water per day, i.e. appropriate for management by very small communities. The approach was to determine the optimal running conditions and anodic materials for the electrolyser. A disinfection system was then designed to operate on a low pressure, gravity-flow model. Gravitational energy was targeted to control both the supply of brine to the electrolyser and dosing of chlorine to water. The disinfection system was tested in the laboratory and a suitable rural site was found for a pilot plant, which was installed and tested for a year. Plant operation over a year was achieved and monitored, but problems arose from erratic increases in turbidity of the source water. However, the system gave a reliable chlorine output between 2 and 4 mg/ℓ, sufficient to maintain a 48 h chlorine residual between 0.1 and 0.6 mg/ℓ in the storage tank. These results are promising, and demonstrate that successful operation, within the recommended NTU range for chlorination, was achieved.

Cost: R480 000  
Term: 2003 - 2009

#### **The development of immersed membrane microfiltration systems for the treatment of rural waters and industrial waters**

Durban Institute of Technology  
**No. 1598**

The lack of potable water of adequate quality is a major barrier to good public health and economic development in most developing economies, hence the production and provision of potable water is regarded as a major developmental priority. Rural areas pose particular challenges. Membrane technology is ideal for potable water production in rural regions, since the product quality is not dependent on the skills of the operator or the raw water quality, and membrane systems are modular, facilitating various scales of operation. This project developed a robust, inexpensive and sustainable water treatment unit for rural areas, based on a woven fibre microfiltration fabric. The water treatment unit was designed to generate safe drinking water for people who have to fetch water from a local river or dam, to be gravity driven and to be robust enough for use by the general population. The membrane used is a flat-sheet woven fibre microfiltration fabric produced locally. The module consists of a PVC frame incorporating a permeate outlet, two sheets of fabric glued to either side of the frame, and a spacer between the sheets of fabric to facilitate fluid flow to the permeate outlet. The operation of the unit is simple: the user pours raw water onto the tank, the tap is then opened and product is withdrawn. The user adds an appropriate disinfectant to the product. Options for disinfection include liquid disinfectant (e.g. sodium hypochlorite). When the membrane is dirty, it can be cleaned with a bottle brush. The product water meets national potable water quality guidelines. It has been proven on high turbidity waters, which conventional water treatment systems find problematic. It is potentially very inexpensive, and is fabricated from easily available off-the-shelf items. This device has a huge potential in rural water provision in developing economies, as well as for flood and emergency relief.

Cost: R765 000  
Term: 2005 - 2009

#### **Compliance of non-metropolitan South African potable water providers with accepted drinking water quality and management guidelines and norms**

University of Venda; Chris Schwartz Water Utilisation Engineers; University of Fort Hare  
**No. 1668**

The project report contains the guidelines and procedures that were developed for water services providers (WSPs) and water services authorities (WSAs) to assist them with assessment of the compliance of their drinking water supply systems with accepted drinking water quality standards and management norms. These guidelines aim at providing South African potable water providers with the required water quality targets and a

set of other operational and management norms, and a tool that could be used to identify the reasons for non-compliance and suggest solutions to any problems experienced which are preventing compliance to these guidelines and norms. A Diagnostic Tool was developed to establish the reasons for non-compliance, and to provide remedial measures that can be used to achieve compliance. Compliance here not only relates to technical compliance, but also, and even more importantly in many instances, to compliance with non-technical (mostly human resources related) norms. A further important objective of the development of this Diagnostic Tool was that it can be used to establish not only the symptomatic problems, but also the underlying causes. Addressing the underlying causes leads to more efficient and sustained solutions to the problems. The Diagnostic Tool contains a set of criteria and norms to be used for the judgement of compliance of potable water providers. Differences existing in the country, such as different water types, geography and management structures, were all taken into account. The Diagnostic Tool for Technical Compliance is used to perform an assessment of technical treatment plant measurements, which includes design aspects, quality control, process control, plant monitoring, maintenance aspects and risk management. A main focus point is to measure the chemical and microbiological quality of the final water against the SANS 241 specifications for drinking water. The Diagnostic Tool for Non-Technical Compliance uses as departure point an audit of all management and human resources issues involving the drinking water supply function within the WSP or WSA. It therefore also includes the human resources, financial and planning departments of the WSP. At water treatment plant level, it assesses the human resources issues involved in the plant management for process control and also support-personnel functions. This includes the very important aspects of process controller classification, job condition, motivational levels and inter-relationships (communication). Specific aspects that are investigated are the financial and budgeting systems used, the communication systems used, the safety, health and the environment, and the community involvement and awareness. For every area of non-compliance, the causes and/or underlying problems are identified, and flagged for further attention and action. Corrective and preventative measures are then proposed for each of these causes and problems, and re-measurement of the total programme undertaken to eliminate or manage these issues. The diagnostic tool is intended for use by water care managers, engineers and supervisors to ensure compliance of their water treatment plants. The full assessments can be performed as often as is required, but would normally be done on a yearly basis. Re-measurements to obtain compliance should be performed on an ongoing basis until compliance is achieved.

Cost: R1 200 000  
Term: 2006 - 2009

### THRUST 3: SUSTAINABLE MUNICIPAL WASTEWATER AND SANITATION

#### *Programme 1: Emerging treatment technologies – Preparing for the future*

##### **To investigate the performance and kinetics of biological nitrogen and phosphorus removal with ultrafiltration membranes for solid-liquid separation**

University of Cape Town

**No. 1537**

Previous investigations have illustrated that including membranes influences the activated sludge (AS) system (bacterial communities, structure of the flocs and metabolic activities), but these have been restricted to aerobic AS (COD removal and nitrification) systems. Recently, the project team concluded that incorporating membranes in BNR AS systems makes a profound difference, not only to the design of the BNR system, but also to the approach to the design of the whole wastewater treatment plant. These observations would suggest that the introduction of membranes into BNR systems may cause associated changes in the kinetics of BNR. This will impact on the system performance and hence on the procedures and methods for design and simulation of BNR systems. In this study the nutrient removal process kinetics rates for denitrification, anaerobic P release, anoxic P release/uptake and aerobic P uptake were investigated and quantified from batch tests on sludge harvested from the MBR-BNR system. Additionally, the influence of the high total suspended solids (TSS) concentrations present in the MBR BNR system on the substrate utilisation rate was investigated. Similarly, the influence of the limitation of substrate (nitrate, phosphorus, acetic) concentrations on the kinetics was studied. The results obtained with different initial concentrations of added nitrate show the denitrification rate to be zero order with respect to nitrate concentration, in agreement with studies in the literature on conventional activated sludge (CAS) BNR systems. Moreover, the denitrification rates obtained for different mixed liquor (ML) concentrations indicate no effect of ML concentration on the specific denitrification rate. The denitrification took place at a single specific rate ( $K_2$ ) of  $0.234 (\pm 0.031)$  mgN/mgAVSS d with respect to the non phosphorus-accumulating organism (PAO) active mass. This is very close to the range of values in the literature for conventional BNR systems. Similarly, results have been obtained for the P removal process kinetics: no differences in specific rates have been observed for different ML or substrate concentrations. The maximum specific P release rate ( $P_{\text{release}}$ ), the maximum acetic acid (HAc) consumption rate ( $q_{\text{max}}$ ) and the  $P_{\text{release}}/HAc_{\text{consumed}}$  ratio were found to be  $19.1 (\pm 2.45)$  mgP/gVSS h,  $33.4 (\pm 2.9)$  mgCOD/gVSS h and  $0.527 (\pm 0.05)$  mgP/mgCOD respectively, while the maximum P uptake rate ( $P_{\text{uptake}}$ ) under aerobic and anoxic conditions were  $9.8 (\pm 2.13)$  and  $2.7 (\pm 0.55)$  mgP/gVSS h respectively. These values all fall within the wide range of values found in the literature for CAS BNR systems. This would suggest that, in contrast to

the nitrification process, for the denitrification and P removal processes, the kinetics and stoichiometry incorporated in the design procedures and simulation models for CAS BNR systems can be applied directly to MBR BNR systems.

Cost: R1 132 400

Term: 2004 - 2009

#### **Energy from wastewater – a feasibility study**

University of Cape Town

**No. 1732**

Currently, wastewaters are viewed as a burden which incurs energy costs in processing before it can safely be released into the environment. This study explored the various waste streams and the appropriate technologies that could be used to generate energy. A survey of the quality and quantity of wastewaters in South Africa identified the top three sectors having the greatest potential energy recovery as: the formal and informal animal husbandry sector (cows, pigs and chickens), fruit and beverage industries (distillery, brewery, winery, fruit juicing and canning) and domestic black-water (sewage). The study showed that an estimated 10 000 MWh can be recovered from the wastewaters in the whole of South Africa, representing 7% of the current Eskom electrical power supply. However, since most of the waste streams are widely distributed, the energy from wastewater is best viewed as on-site power. There are several factors which will govern the success or failure of the 'appropriate technologies' for energy generation. This study highlighted the following as having potential for success either in the immediate or long term:

- Anaerobic digestion (AD) is the most commonly recognised technology and has been applied to wastewaters of different characteristics at both small and large scales
- Bioethanol production by fermentation is suited to concentrated, high carbohydrate wastewaters and has potential in the fruit industry where sugar-rich wastewaters are generated in large volumes
- Similarly, combustion and gasification are restricted to applications with concentrated waste streams (containing <40% water) due to the energy expended in de-watering and are most appropriate in the treatment of de-watered and solar-dried (or previously stockpiled) wastes
- In contrast to these technologies, the growth of plant biomass for combustion/gasification and algal biomass for biodiesel production is suited to dilute waste streams. The sequestration of carbon dioxide and facilitated wastewater-treatment by photosynthetic oxygenation are added benefits.
- Microbial fuel cells (MFC) are an emerging technology that can also operate with dilute waste streams while producing electricity directly. MFCs are suited to applications in remote/rural sites with no infrastructure, but the technology is still in early development.

The greatest potentials are realised when an industrial ecology approach is used to integrate process or waste heat from several industries, with pre-planning and the formation of industrial parks. Several risks, barriers and drivers to developing an 'energy from wastewater' project were identified. Therefore, this project also produced a set of guides; (a) Technology Developers And Researchers ; (b) Industry And Wastewater Generators, and (c) Policy Makers.

Cost: R420 000

Term: 2007 - 2009

#### ***Programme 4: Wastewater sludge and faecal sludge management***

##### **Development of the South African wastewater sludge disposal guidelines dealing with land and ocean disposal, beneficial use, use in commercial products and thermal treatment**

Zitholele Consulting (Pty.) Ltd.

**No. 1622**

Seeking innovative solutions for the handling of wastewater sludge requires a paradigm shift in our perception and understanding of wastewater sludge as a resource and not a waste product. Such a shift creates an opportunity for local authorities to generate a range of economic and social spin-offs to the benefit of their local communities. The WRC and DWA developed this guideline series to support sustainable wastewater sludge management in South Africa. The aim of the project was to develop a series of guidelines to encourage the beneficial use of wastewater sludge but also to provide solutions in cases where beneficial use is not feasible. Rather than develop a single guideline to address the range of sludge management options (beneficial and non-beneficial uses), five separate Guideline Volumes were developed. Volume 1 and 2 were published in 2006 as part of Project No. K5/1453 while Volumes 3, 4 and 5 were completed through a follow-up project (K5/1622).

Cost: R1 428 800

Term: 2005 - 2009

## **THRUST 4: INDUSTRIAL AND MINE-WATER MANAGEMENT**

### *Programme 1: Quantification of water use and waste production*

#### **A first-order inventory of water use and waste production by the South African industrial, mining and power generation sectors**

Arcus Gibb; University of Pretoria

**No. 1547**

This project compiled a first order quantification of the water use and effluent production by the mining, industrial and power generation sectors of the economy and assessed the impact these might have on water quality. Existing data sets were of limited value and outdated. Water use information from metropolitan councils helped to identify the major water users. This was supplemented by additional data from major users and captured into a database. Of the total quantity of water used by these sectors, the industry sector consumed 55%, mining 23%, power generation 20% and the food industry 2%. The industry sector produced 74% of the effluent, mining 10%, food and beverage 9% and power generation 7%. A risk assessment based on the chemical composition of effluent indicated that mining sector poses the greatest potential risk followed by the food and beverage sector and power generation.

Cost: R600 000

Term: 2004 - 2009

#### **A first-order assessment of the quantity and quality of non-point sources of pollution associated with the industrial, mining and power generation sectors**

Golder Associates Africa (Pty.) Ltd.

**No. 1627**

This project compiled the limited available information on non-point source pollution into a consolidated overview of the current status of literature and available data for the industrial, mining and power generation sectors. The majority of the information was obtained from unpublished reports or a format that required manipulation to extract relevant information. Gold and coal mining were identified as the mining commodities with the highest potential to contribute to non-point source pollution. This can be attributed mainly to the magnitude at which gold and coal is currently and was historically mined. The main 'hot spots' in terms of non-point industrial sources are the sites from an earlier period where wastes had been disposed of into inadequately designed facilities with inadequate control. The majority of the non-point sources of impacts of the power generation sector are as a result of atmospheric deposition.

Cost: R1 000 000

Term: 2005 - 2009

### *Programme 2: Regulatory mechanisms to improve industrial and mine-water management*

#### **Development of guidelines to facilitate legal compliance with respect to industrial waste management**

Nancy Oosthuizen Consulting cc

**No. 1733**

Understanding legal responsibilities with respect to waste management can be a daunting task. This series of guideline documents sets out to provide waste generators, waste contractors and authorities with the necessary tools to assess waste practices by breaking down the complex requirements into simple and easy to understand language. Three separate Guideline Volumes deal with Waste Generators (Volume 1: Managing your wastes to achieve legal compliance: An Industry Guide), Intermediate Waste Contractors (Volume 2: Achieving legal compliance for intermediate waste contractors: A Waste Contractor's Guide) and Authorities (Volume 3: Auditing waste generators and intermediate waste contractors to assess and monitor legal compliance: An Authorities' Guide). The focus of the guide is on solid and liquid wastes discarded for recycling, treatment or landfill disposal, although some references are made to trade effluent and air emissions. Finally this project also produced a review document of a selection of local waste by-laws against the framework of the National Environmental Management Waste Bill, 2007. An analysis of the existing and pending national (and in some instances, provincial) legislation and policy provides direction and guidelines as to what municipalities should be responsible for, what should be in their by-laws, and how integrated waste management should be implemented in their jurisdictions.

Cost: R350 000

Term: 2007 - 2009

### *Programme 4: Minimising waste production*

#### **An investigation of innovative approaches to brine handling**

Proxa

**No. 1669**

Managing the sludges and brines produced during desalination is expensive and can exceed the cost of desalination itself. This project found that 530 000 kℓ/d of effluent, containing 1060 t/d of salt, is currently being discharged within inland systems. Volumes are expected to grow significantly over the next 20 years with salt loads projected to reach 15 000 t/d. Lined evaporation ponds are the most frequently used brine disposal option, with a trend to develop technologies that achieve fractional precipitation of constituents. However, the byproducts produced in this way offer only limited potential for import replacement. Reducing the volume of brine as much as possible, through brine softening and treatment, is the most cost-effective strategy to manage brine disposal. The

proof of concept of three promising technologies was evaluated at laboratory scale. Two utilised enhanced evaporation, viz. Wind Aided Intensified eVaporation (WAIV) and Dewvaporation; the third being freeze desalination. On a cost basis all three technologies compare favourably with traditional brine disposal options (evaporation ponds and mechanical evaporation and crystallisation).

Cost: R1 290 000

Term: 2006 - 2009

#### ***Programme 5: Improved ability to predict and quantify effects***

##### **Study of the kinetic development of oxidation zones of tailings dams with specific reference to the Witwatersrand gold mine tailings dams**

Pulles, Howard & de Lange

**No. 1554**

This project investigated the development and characteristics of oxidation zones in gold tailings dams. The active reclamation of gold tailings dams provided a perfect opportunity to study tailings dam profiles and characterise their oxidation profiles. Three zones of oxidation were recognised based on differences in oxidation intensities, which varies with depth. These zones are: (a) mature oxidation zone, (b) transitional oxidation zone and (c) primary or un-oxidized zone. Zones (a) and (b) constitute the total oxidizing zone with a depth of between 450 cm and 900 cm. The depth of Zone (a) ranges from 150 cm to 350 cm. The metal concentrations in Zone (b) are higher than in Zone (a), suggestive of pore water migration with soluble secondary minerals into Zone (b). Useful data was collected from a number of tailings dams in the Wits basin that will have a positive impact on the accuracy of ARD predictions.

Cost: R360 000

Term: 2004 - 2009

#### ***Programme 6: Beneficiation and treatment of industrial and mining effluents***

##### **Continued evaluation of the integrated managed passive water treatment system (IMPI), long-term monitoring of VCC passive treatment plant and three-dimensional characterisation of decommissioned sulphate-reducing units**

Pulles, Howard & de Lange

**No. 1623**

A pilot plant for the passive treatment of AMD that has been operating at Vryheid Coronation Colliery since 1996 is believed to be the longest running of its kind in the world. This project verified its long-term performance and performed a post-mortem on some reactors. The original sulphate reducing units (SRUs) displayed typical trends of high initial sulphate reduction rates which declined after 6 to 9 months. Replacing some SRUs with

performance-enhancing degrading packed bed reactor (DPBR) technology and readily degradable 'kick-start' carbon sources proved successful, and resulted in stable high sulphate reduction activity. A post-mortem on a reactor provided evidence of extremely poor utilisation of the substrate and poor lignocellulose degradation. Phylogenetic results indicated that the failure of the SRU system was not due to the lack of appropriate biocatalytic genetic potential, but rather a lack of readily biodegradable carbon to drive the process over the depth of the reactor and enhance lignocellulose degradation.

Cost: R400 000

Term: 2005 - 2009

#### **THRUST 5: SANITATION, HEALTH AND HYGIENE EDUCATION**

##### ***Programme 1: Advocacy, health and hygiene education***

##### **The environmental exposure and health risk assessment in an area where ongoing DDT spraying occurs**

University of Pretoria

**No 1674**

Dichloro-diphenyl-trichloroethane (DDT) is a pesticide used in control of the malaria-carrying mosquito in areas where malaria occurs. One such area is the Vhembe District Municipality of Limpopo Province where this study was undertaken. The overall aim of this study was to determine whether environmental levels of DDT and DDE may contribute to adverse health effects in humans and aquatic animals. Possible effects of DDT and metabolites on vertebrate and macro-invertebrate populations were studied at sites representing the Luvuvhu River system. The data for water and biological samples were used to conduct both a quantitative and qualitative scenario-based human health risk assessment. Human data for the epidemiological studies performed in this area were obtained for the health risk assessment. *p,p'*-DDT and -DDE levels were found in all matrices analysed, namely water, sediment, soil, chicken and fish tissue and vegetables. Water showed estrogenic activity, albeit low. Fish health effects, including histo-morphological changes in the gills, liver, heart and gonads were demonstrated and sperm motility was impaired in higher DDT exposed waters. The predicted human health risks for both carcinogenic and toxic effects are high, with chicken and fish ingestion causing the highest risks, followed by vegetable ingestion (resulting from DDT in water used to irrigate the vegetables). Endocrine-disrupting effects were also observed and can be anticipated in the exposed population with effects observed in both the human and animal population and at the cellular level. The last aim of the study was to compare EDC assessment techniques and develop an integrated, standardised, SA-relevant toolkit manual of tests for wider application.

Cost: R1 985 000

Term: 2006-2008

### **Programme 3: Institutional and management aspects of sanitation service delivery**

#### **Financial sustainability of sanitation services**

Partners in Development

##### **No. 1632**

The purpose of this study has been to investigate whether the improvements made are working, and whether they are financially sustainable. In its coverage the study is biased towards rural sanitation, as the overwhelming majority of South Africans without proper sanitation live in rural areas. The study finds that, with few exceptions, the practice since 1994 has been to provide funds for the initial capital costs of sanitation projects and not for operation and maintenance. The reason for this is that funding for new infrastructure is typically provided to municipalities by central government as grant funding, while the funding for operation and maintenance is required to come from the municipal coffers. Strictly speaking the funding for operation and maintenance is covered by the Equitable Share grant, in terms of which most poor municipalities receive an operations subsidy of between R20 and R60 per month for sanitation for every poor family in their area. However the Equitable Share is an unconditional grant and in practice this is not seen by local government as funding that has to be spent on operation and maintenance of services. Research indicates that the funding is typically used to finance the municipal overhead costs, as well as to finance other infrastructure projects not covered by the Municipal Infrastructure Grant. This practice, of building sanitation infrastructure while not allowing for adequate maintenance in the future, whether it is basic VIP sanitation or full waterborne sanitation, is short-sighted and will result in South Africa facing a sanitation crisis in the medium term.

Cost: R600 000

Term: 2005 - 2009

#### **Examine the understanding and interpretation of sanitation policy and programmes**

Hlathi Development Services

##### **No. 1741**

The WRC initiated this study to examine the understanding and interpretation of the national sanitation policy and programme by municipalities, to identify aspects of the policy that were poorly understood and/or misinterpreted, and to make recommendations for bridging the gap between policy and practice. Questions have been raised on the appropriateness of a single national sanitation policy for all settlement types (urban formal, dense urban informal and rural settlements). Our working hypothesis was that the sanitation policy principles of the 2001 White Paper on Basic Household Sanitation were relevant to urban, rural and informal settlements; the only variable was how these principles were interpreted under different local contexts. The main objectives of the study

were to investigate the understanding of current sanitation policy and programmes relating to the subsidy, ownership of infrastructure, responsibility for O&M, responsibility for monitoring issues of new pits, etc. A key finding is that the national sanitation policy framework provides an enabling environment for municipalities to deliver sustainable sanitation services, but the problem lies in the interpretation of the policy, such as too much focus on toilet construction without paying enough attention to the other important aspects of sanitation, such as hygiene awareness, behavioural change, operation and maintenance, community involvement, solid waste disposal and grey-water management. Although the sanitation policy is underpinned by the principle of access to basic sanitation as a human right, there were no clear policy guidelines for prioritising the provision of basic sanitation services to the severely marginalised groups, such as households living in dense urban informal settlements, people with physical disabilities, HIV/AIDS-infected people and other vulnerable groups.

Cost: R400 000

Term: 2007 - 2009

#### **What do we do to accelerate sanitation?**

Development Systems Engineering

##### **No. 1742**

Since 2003, municipalities acting as water services authorities (WSAs) have been fully responsible for sanitation delivery across all villages within their areas of jurisdiction. In terms of the Municipal Systems Act, delegated authority provides for nominated WSAs to plan and carry out water and sanitation service provision making use of a capital conditional grant known as the Municipal Infrastructure Grant (MIG) in order to promptly tackle service backlogs. The above-mentioned change in the context of the national delivery of sanitation does have major significance for the way strategies to tackle sanitation backlogs should be formulated and carried out. The main objective of this research project was therefore to identify bottlenecks which obstruct delivery and then capture innovative sustainable sanitation approaches and experiences which have been developed. The study highlighted gaps related to gathering accurate baseline information to populate IDPs and WSDPs and revealed that a lack of proper backlog data impacts negatively on the development of sanitation delivery strategies, levels of service planning and the longer-term sustainability of sanitation services. A review of municipal financial planning and management showed that MIG funding allocations are often prioritised towards water supply projects as opposed to sanitation delivery projects, and that levels of capital expenditure on sanitation projects far outweigh the required operational budgets allocated to operate and maintain sanitation infrastructure and services. An assessment of WSA institutional capacity and arrangements for effectively implementing sanitation delivery highlighted municipal skills and capacity gaps and gaps in integrated planning

approaches, as well as the high turnover of staff, as impeding sanitation delivery. In many municipalities there is also a lack of alignment between MIG Project Management Units and municipal Technical Service Units in effectively liaising and ensuring adequate project and programme management. It can be concluded that there are broad and common challenges and bottlenecks which are faced by all local government municipalities in terms of the delivery of sanitation services, as well as examples of successful sanitation delivery approaches and methodologies.

Cost: R700 000  
Term: 2007 - 2009

## CURRENT PROJECTS

### **THRUST 1: WATER SERVICES – INSTITUTIONAL AND MANAGEMENT ISSUES**

#### *Programme 1: Cost-recovery in water services*

##### **Guidelines on pricing and debt management for municipalities**

Arcus Gibb (Pty.) Ltd.  
**No. 1811**

Poor debt management and pricing continue to be some of the elements which are resulting in municipalities not performing in a financially viable manner and the customers not receiving an affordable service. DWAF produced a document entitled Model Credit Control and Debt Collection By-Laws (DWAF, 2005), which sets a framework and rules around this subject. It was aimed at water services authorities who did not have any legal framework to introduce effective debt collections and credit control. Thus the by-laws were seen as model by-laws. Though the bylaws (DWAF, 2005) provided the necessary legal framework, not much has however been done with regards to the provision of guidelines, tools and strategies to assist water services institutions to give effect to the bylaws and its contents. In the complex environment of water services delivery and the growing gap of poor revenue collection, it is becoming apparent that very radical and innovative approaches are required with regard to debt control and credit control.

Estimated cost: R600 000  
Expected term: 2008 - 2010

#### **Programme 2: Institutional and management issues - Water services**

##### **Situational analysis of water services provision in South Africa – establishing future strategies for consideration by municipalities**

PD Naidoo & Associates (Pty.) Ltd.  
**No. 1812**

To date centralised service provision has been the norm in the development of many cities and towns. The attraction towards centralised systems is based on established experience and practice of the benefits obtained from the economies of scale offered. Questions of efficiency, vulnerability, long-term technology decisions which prevent application of new technology, etc., are all new constraints which are questioning current approaches. This is further compounded by the fact that as cities and areas within cities get established it becomes more challenging to replace and rehabilitate existing infrastructure. These approaches come with pros and cons; however, the new and future challenges are different from those which influenced centralised approaches, from both new developments, operation and maintenance, energy constraints/costs and the availability of new technology. Similarly, decentralised systems also have their pros and cons. There is good evidence of the challenges faced in managing stand-alone and dispersed schemes, with the contributing factors being capacity and competency constraints. Thus this study will contribute to the growing understanding of the operational realities of decentralised and centralised water and sanitation systems. An analysis and review of the approaches required will assist the sector to plan smarter for the future and shape our growing cities/towns/villages to support sustainable water services.

Estimated cost: R600 000  
Expected term: 2008 - 2010

##### **Development of strategies and guidelines for integrated water meter management**

University of Johannesburg; Rand Water  
**No. 1814**

Water metering plays an indispensable role in proper management of water distribution systems. Measured consumption forms the basis for most Water Services Authority and Water Services Provider accounts, and thus affects revenue directly. Bulk water meters are used to measure water entering the system, whether from raw water sources, water treatment plants or bulk water suppliers and is used to manage the system, including water balances, water loss calculations, consumption patterns and trends, pumping requirements and future planning. It is thus very important for all parties involved in the supply or consumption of potable water that water meters are used appropriately, managed optimally and maintained at regular intervals to ensure that water accounts, loss estimates and management decisions are based on

accurate information. There is currently a lack of proper water meter management in South Africa, with many bulk water suppliers and municipalities without optimal and integrated meter calibration, replacement, reading, and information management systems. In addition, water meters of 80 mm and smaller are regulated by the Trade and Metrology Act, while larger meters are not.

Estimated cost: R660 000  
Expected term: 2008 - 2010

### ***Programme 3: Innovative management arrangements - Rural water supply***

#### **Development of people-centred programmes**

Mvula Trust

##### **No. 1815**

The challenges in developing good operations and maintenance (O&M) practice are perhaps greatest in remote rural areas with stand-alone schemes. There are no economies of scale for this kind of infrastructure provision as there are vast distances between the location of WSA/WSP and where human settlements are scattered. Given this geographical reality, innovative solutions are required to ensure the sustainability of infrastructure in these areas. International and South African experience has shown that community-based approaches yield sustainable results in the field of service delivery. Several factors, however, have contributed to the decline of community-based (or people-centred) approaches in South Africa. The main reason seems to be that water services authorities (WSAs), have neither the experience nor the tools to apply people-centred approaches. From the viewpoint of service delivery sustainability and the rights of communities, this research will try to close this gap.

Estimated cost: R800 000  
Expected term: 2008 - 2009

### ***Programme 5: Impact of water and sanitation intervention***

#### **Toolkit to measure sociological, economic, technical and health impacts and benefits of 10 years of water supply and sanitation interventions in South Africa**

Tshwane University of Technology

##### **No. 1700**

Over the years, the government has spent billions of rand to meet the backlogs in water supply and sanitation services in South Africa, and substantial progress has been made. However, very little work has been undertaken to quantify the benefits that improved water and sanitation has brought to the communities and the countries. Over the years the WHO has undertaken a number of case studies at an international level to quantify the benefits of improved water services and

has recently completed a new initiative. The methodologies used are based on a wide range of assumptions, which have not been tested. There is a need at a national level to build on these processes towards development of a standard methodology to quantify the benefits (social, technical, health, economic and environmental).

Estimated cost: R1 200 000  
Expected term: 2006 - 2009

### **THRUST 2: WATER SUPPLY AND TREATMENT TECHNOLOGY**

#### ***Programme 1: Drinking water treatment technology***

##### **Biological filtration of iron and manganese from groundwater**

Umgeni Water

##### **No. 1526**

The project aims to develop criteria for the design of biological filtration systems that will remove iron and manganese from groundwater in rural areas in an economical and sustainable fashion. The effectiveness of such systems will further be demonstrated by the operation of a small water treatment system in a rural area in KwaZulu-Natal.

Estimated cost: R750 000  
Expected term: 2004 - 2009

##### **Development of enhanced floating media separation for drinking water production and pre-treatment in rural water supply**

University of Stellenbosch

##### **No. 1527**

The project proposes to further develop a filter with floating plastic media for the supply of water for rural communities. Performance of the filter both on its own, and as a pre-treatment system for ultrafiltration membranes, will be evaluated and the operability of the system will be compared to that of a conventional coagulation, sedimentation and sand filtration plant. This system should be a more efficient and cost-effective alternative to sand filters if the research is successfully executed. It is also simple to operate and requires less head for back-washing than conventional sand filters. A successful project can ensure that more small communities will have the benefit of membrane-treated potable water supply.

Estimated cost: R914 000  
Expected term: 2004 - 2009

**The defouling of membranes by moving magnetic dipole polymer beads, containing nano-magnetic particles, in a scouring motion across the membrane using external magnetic fields**

University of Stellenbosch

**No. 1592**

Fouling of membranes remains the main problem preventing the large-scale and economic use of membranes in more applications internationally. Various chemical, hydraulic and ultrasonic membrane-defouling methods have been investigated, with varying success. This project aims to investigate nanotechnology for the *in situ* defouling of membranes. Nano-magnets will be incorporated into small polymer beads and the magnetic fields in all of the nano-magnets inside the beads will be aligned. Movement of the polymer beads on the surface of the membrane will then be induced in order to scour the surface, which will hopefully clean and prevent fouling on the membrane surface. The resulting system will be evaluated on a typical coloured surface water purification application.

Estimated cost: R794 000

Expected term: 2005 - 2009

**Development of a durable and reliable wave-energy reverse osmosis system**

The Impact Free Water Group

**No. 1716**

Small, rural communities living at or close to the sea along the coastline of the country rarely have a good and reliable supply of potable water – nor do they generally have electricity. The project aims to further develop an innovative reverse osmosis system which utilises ocean wave power in order to produce the elevated pressures required in the desalination of seawater to potable standards. A few prototypes will be constructed to evaluate the effect of various wave parameters on the system performance and improve the system into a practical, working technology.

Estimated cost: R650 000

Expected term: 2007 - 2010

**Programme 2: Water treatment for rural communities**

**A management information tool for the efficient operation and maintenance of small water treatment plants**

Chris Swartz Water Utilisation Engineers

**No. 1718**

The performance of small (and also some medium-sized) water treatment plants in terms of the provision of a potable standard of drinking water to the end consumer is suspect. Studies have shown that the overall management of water provision is not as effective as it should be – with particular reference to plant operation and maintenance. One of these reasons is the lack of

an adequate and efficient management information system.

The project, therefore, aims to develop and compile a practical and user-friendly management information tool to facilitate the efficient operation and maintenance of small water treatment plants under the jurisdiction of a water services authority.

Estimated cost: R800 000

Expected term: 2007 - 2009

**Application and performance of slow sand filtration**

Cape Peninsula University of Technology

**No. 1836**

Slow sand filtration is generally highly recommended in small and rural community water treatment because of its simplicity in design, operation and maintenance. However, little awareness of the application of slow sand filters exists in South Africa. Very little is further known about the slow sand filters in operation in South Africa and how they are performing. The project, therefore, aims to investigate the extent of slow sand filtration applications in the country and practical performance of these filters, covering both successful and failed examples. It will also investigate and document the types, application and performance of the various pre-treatment processes prior to slow sand filtration. A database of all sand filtration plants in the country will further be compiled.

Estimated cost: R760 000

Expected term: 2008 - 2011

**Programme 3: Drinking water quality**

**New detection methods for EDCs**

University of Stellenbosch

**No. 1534**

The project will aim to produce and test an endocrine-disrupting compound (EDC) indicator system. This will be achieved by execution of the following objectives:

- Clone cDNA for the human oestrogen receptor ligand-binding domain (LBDER) into a suitable yeast (*Pichia pastoris*) expression vector for large-scale expression
- Production of antibodies against LBDER-EDC complexes
- Prepare LBDER by large-scale fermentation expression and protein purification
- Biotinylation of LBDER and preparation of biotinylated pluronic acid needed for non-covalent attachment of LBDER to polysulphone membranes or hydrophobic contactors
- Development of specialised polysulphone contactors for the non-covalent immobilisation of the LBDER via pluronic biotin/avidin technology
- Development of the ELISA indicator system for EDC detection

Estimated cost: R647 500

Expected term: 2004 - 2009

**Investigation of the distribution and diversity of South African toxic freshwater cyanobacteria with special reference to analysis of the neurotoxin BMAA and molecular genetic methods for microcystin screening**

Nelson Mandela Metropolitan University

**No. 1719**

There is a lack of standardised methods and facilities for analysis of toxic cyanobacteria and quantification of cyanobacterial toxins in South Africa. Commercial primer sets for such screening will soon be available, but their suitability or applicability to South African isolates is totally unknown. No comprehensive analysis of wild strains has been attempted using any molecular technique. The application of appropriate techniques will yield information on the relationship between South African and other strains and information on the distribution and spread of strains within South Africa. Screening studies by various laboratories have indicated that all known species of cyanobacteria can produce BMAA. This has obvious implications for the human/health-related chronic exposure to BMAA in water, where cyanobacterial aggressions occur. The aim of the study will therefore be to investigate the distribution and diversity of South African freshwater toxic cyanobacteria from a phylogenetic/phylogeographic perspective with specific reference to toxicity for known toxins and including the establishment of analytical procedures for the novel toxin BMAA.

Estimated cost: R1 000 000

Expected term: 2007 - 2009

**Situation and gap analysis of water quality testing in South Africa**

Jeffares & Green

**No. 1720**

The irregularities and occasional health risks currently experienced in water quality throughout South Africa highlights the urgent need for the introduction of an accepted and practical water quality testing standard to be employed by all laboratories in South Africa and enforced at national regulatory level. In order to produce such a standard, it is imperative that a thorough investigation be carried out into existing conditions, problems and capacities of all water-testing laboratories in South Africa. The assessment of the current status of testing laboratories will therefore play an important role in establishing what action needs to be taken to ensure acceptable water quality throughout South Africa. The overall aim of the project will be to develop a strategy for a national programme that will address the needs of the water quality assessment in South Africa.

Expected cost: R800 000

Estimated term: 2007 - 2009

**EDC bio-assay toolbox**

University of Pretoria; A Burger (independent consultant); North-West University, CSIR (Natural Resources and the Environment)

**No. 1816**

The WRC has been funding a structured and well planned endocrine-disruptor chemical (EDC) and toxicant research programme from 2001. Education (training) and awareness building and management of EDCs form an integral part of the programme and several manuals will be developed. The sampling, biological and analytical procedures used in this programme and in collaboration with the Global Water Research Coalition (GWRC), now need to be taken a step further to the development of training and user-friendly manuals. It is also of utmost importance to the success of the programme and benefits to the country that the training manuals will be ready during the 3rd phase of the EDC programme, and the implementation of the National Toxicant Monitoring Programme (NTMP) of DWA. This volume (III) will focus on the identification, selection and standardisation of biological assays for EDCs, with special reference to oestrogenic compounds.

Estimated cost: R870 000

Expected term: 2008 - 2010

***Programme 4: Water distribution and distribution systems***

**Grouted lining systems for the renovation of old steel pipelines and the design of new pipelines**

Rand Water

**No. 1448**

Steel pipes are used extensively in South Africa and need to be protected against corrosion, hence the need for internal linings and external coatings. In pressure pipes there are many problems associated with the use of grouted-viscous-elastic linings at joints, bends and fittings, etc. This study aims, through laboratory trials and investigations, to provide solutions to this unresolved problem experienced by water suppliers, which costs them large sums of money due to failures.

Estimated cost: R736 300

Expected term: 2003 - 2009

### **Inverse transients to determine deficiencies in pipelines**

University of Pretoria

**No. 1721**

A major shortcoming in the optimal utilisation of water distribution systems is the uncertainty about the physical status and the identification of operational deficiencies. In a WRC study (Report No. 1177/1/04) the influence of localised air pockets on the hydraulic capacity of pipelines was shown. Another major problem that negates the optimal distribution of water is the presence of unidentified leakages in the systems. Inverse transients can be used to determine the location and magnitude of leaks and air pockets. The technique was already tested in laboratory conditions, indicating the advantage of this technique. The procedure could be applied without isolating the section to be investigated (no interruption of the service). The objective now is to test and develop this further and provide assistance in the implementation of this procedure. The value of the development of this technique is that a non-destructive, non-intrusive and non-intermittent procedure will be available to investigate the status of water distribution systems.

Expected cost: R530 000

Estimated term: 2007 - 2010

### **Guidelines on how to determine and reduce apparent losses**

Conward Consulting

**No. 1722**

Non-revenue demand is one of the key performance criteria of water services providers (WSP) in South Africa. The current level of non-revenue demand is estimated at more than 30% of the total water supplied. Non-revenue demand can be divided into 2 main categories: real losses and apparent losses. Before WSP can begin to address non-revenue demand, they need to understand the extent of real losses versus apparent losses. Currently, there is no common approach or guidelines on how to estimate apparent losses and this is widely considered as one of the main constraints in dealing with the overall issue of non-revenue demand. The development of guidelines on how to accurately determine apparent losses will provide a key breakthrough for WSP to deal with non-revenue demand and for the regulator in setting benchmarks and targets.

Estimated cost: R400 000

Expected term: 2007 - 2009

### **Durability of FC tanks**

Partners in Development

**No. 1818**

Ferro-cement is a cement-rich reinforced modified mortar which is easily adaptable to rural construction projects and well suited to smaller sizes of reservoir. Ferro-cement reservoirs are constructed using very simple sets of shuttering and consequently can be built predominantly by utilising local labour with the assistance of a foreman and team leader. They are also considerably cheaper than reinforced concrete reservoirs. However, although the construction cost of ferro-cement reservoirs is significantly cheaper than for reinforced concrete reservoirs, they are not particularly well known and thus are often regarded with a fair amount of scepticism. As they are also a relatively recent technology, very little is known about their long-term durability. This study hopes to address this problem by investigating the status of numerous reservoirs built over the previous 15 years in KwaZulu-Natal and the Eastern Cape in order to ascertain a better estimate of their design life.

Estimated cost: R220 000

Expected term: 2008 - 2009

### **Investigating private on-site water use and its impacts**

University of Stellenbosch

**No. 1819**

Water resource managers, water demand managers and water infrastructure planners alike, are faced with an acute lack of knowledge regarding private on-site water resources (conveniently termed 'POSWAR' in this application). The most common water resources of this nature include:

- On-site groundwater abstraction by means of private boreholes
- Rainwater harvesting from rooftops
- Grey-water reuse

The nature and extent of POSWAR application by individual water users, particularly in residential areas, impact on all infrastructure elements of the water supply and waste cycle. POSWAR-application creates an apparent load reduction on all piped reticulation systems, treatment works and on the water supply resources. Unfortunately these 'insignificant' resources are entirely neglected during urban and resource-planning exercises. This study will determine and confirm the extent to which and in which way water demand and wastewater flow are influenced by the application of POSWAR.

Estimated cost: R300 000

Expected term: 2008 - 2009

### **Determining the change in hydraulic capacity of pipelines**

University of Pretoria; Rand Water

**No. 1820**

It is generally accepted that the operational life of pipelines could well be longer than the 30 years which are used in the economic analyses of pipeline systems. Networks of Rand Water and other water utilities prove this, although there are a number of reported cases where pipelines fell short of the expected operational lifespan. Funding of new water projects in the near future will have to compete with the capital that is required for the renovation, replacement and upgrade of existing infrastructure. An informed status assessment of a pipeline can only be made if the operational performance history of the pipeline is known. Optimal capital expenditure and operational cost is based on the performance and the expected hydraulic performance decay rate of pipeline systems. Long-term performance data are essential for this assessment and an effort should now be made to gather information on a regular basis for a number of different pipelines in South Africa.

Estimated cost: R785 000

Expected term: 2008 - 2011

### **Dual grey-water and drinking water reticulation for high density urban residential dwellings**

University of the Witwatersrand; University of Johannesburg; University of Cape Town

**No. 1821**

South Africa views water as one of its most fundamental and indispensable natural resources. Although renewable, water is also a finite resource, distributed unevenly in time and space. Increased development of South African communities has led to an overall increase in water demand. This water demand has traditionally been met with water from the best available sources. However, over the years, it has become evident that high quality water sources in many provinces are inadequate to meet demands and, that not all uses require the same water quality. Some water uses can be supplied with water of an inferior quality, which frees the high quality sources for higher quality uses, e.g. drinking water production. Dual grey and drinking water reticulation systems (henceforth called dual systems) are particularly promising for application in high-density (especially multi-storey, access-controlled and centrally managed) urban residential dwellings (HDURDs) (e.g. university halls of residence) located in arid South African environments. This project is aimed at investigating the potential for implementing dual systems in HDURDs, primarily for toilet flushing and if possible, limited private irrigation using a pilot study in a university.

Estimated cost: R1 055 500

Expected term: 2008 - 2011

## **THRUST 3: SUSTAINABLE MUNICIPAL WASTEWATER AND SANITATION**

### *Programme 1: Emerging treatment technologies – Preparing for the future*

#### **Evaluation of a South African clinoptilolite for ammonia-nitrogen removal from secondary sewage effluent for pollution control**

University of Pretoria (Department of Chemical Engineering)

**No. 1658**

Ammonia discharged into the water environment accelerates eutrophication of dams and depletes dissolved oxygen in receiving waters, and, in its undissociated form, is also toxic to fish even at low concentrations (0.5 mg N/l). The current discharge limit for ammonia-nitrogen (NH<sub>3</sub>-N) in treated sewage effluent is 10 mg/l (likely to be reduced to 6 mg/l in the near future). At many wastewater works in South Africa, particularly in winter when biological activity slows down because of lower temperatures, it is difficult to produce treated effluent containing less than 10 mg/l NH<sub>3</sub>-N by the usual biological nitrification process, with consequent negative environmental and ecological impacts. As an alternative or stand-by process, absorption of NH<sub>3</sub>-N by clinoptilolites (naturally occurring zeolites) has potential as an effective low-cost means for final polishing of treated sewage to reduce NH<sub>3</sub>-N to acceptable levels. Previous work in this regard has been carried out using imported clinoptilolites, with cost and foreign exchange implications, and knowledge is needed in South Africa on the performance of the locally-mined clinoptilolite for removing NH<sub>3</sub>-N from treated sewage. The aims of this project are to determine the performance of local clinoptilolite for removing NH<sub>3</sub>-N from treated sewage effluent on laboratory- and pilot-scale, to determine the efficiency of ammonia recovery from the spent regenerant, to develop appropriate process design criteria and costs, and to develop an operational and maintenance manual for the process.

Estimated cost: R317 000

Expected term: 2006 - 2009

#### **Mass balance modelling over wastewater treatment plants III**

University of Cape Town; University of KwaZulu-Natal

**No. 1822**

The series of projects aims to develop a plant-wide wastewater treatment plant (WWTP) model used to accurately predict the outcome of the various biological, physical and chemical processes taking place in a WWTP. These tools can result in more economical wastewater plant design and operation and improved effluent quality. Significant advances have been made towards developing steady state mass balance-based integrated WWTP models which link primary sedimentation, nitrification-denitrification activated sludge and aerobic or

anaerobic digestion of primary and waste activated sludges (K5/1338 and K5/1620). This project aims to determine the kinetics of P release from biological P-removal systems and determine the extent to which mineral precipitation takes place. The P release in anaerobic digestion will be compared to that observed in aerobic digestion. Certain aspects such as the mineral precipitation in aerobic digestion, the un-biodegradable fraction of primary sludge and the un-biodegradable fraction of the waste activated sludge from nitrification-denitrification systems will be confirmed. The research will determine whether the presence of primary sludge will assist in the hydrolysis of waste activated in anaerobic digestion.

Estimated cost: R998 950  
Expected term: 2008 - 2010

#### **FISHing for indigenous anammox bacteria**

Stellenbosch University; CSIR (Natural Resources and the Environment)

**No. 1823**

Nitrogen is conventionally removed from wastewater via nitrification followed by denitrification. Nitrogen removal via anaerobic ammonium oxidation (anammox) requires only 24% of the total primary energy as compared to conventional nitrification. Anammox bacteria were first discovered in the Netherlands during the 1990s and have since then revolutionized the wastewater industry. Different configurations of anammox reactors are now appearing all over the world. In this project the researchers aim to locate and identify indigenous anammox bacteria from anaerobic habitats. Once these have been found and enriched, they aim to compare the kinetics and stoichiometry between known organisms (from literature) and the organisms located in local habitats. Parameters defining the key physiology of the local bacteria, including their optimum growth conditions under varying temperature, pH, ammonium-nitrite concentration, and dissolved oxygen concentration would be the first pointers towards implementation of this process on a larger scale in South Africa.

Estimated cost: R612 750  
Expected term: 2008 - 2010

#### **Effects of urine separation and treatment on wastewater effluent quality**

CSIR (Stellenbosch); AFRICON; University of Stellenbosch

**No. 1824**

The project deals with alternative sewage collection and treatment for both low and high income communities in urban settings. The concept includes the separate treatment of urine and the rest of the black/grey sewage to achieve better effluent quality. This project aims to demonstrate at pilot scale that the DWA Special Standards can be achieved through (partial)

separate collection of urine. In addition, this increases the capacity of the receiving wastewater treatment plant which could delay extensions. The research will be reconfiguring toilets and urinals to allow (partial) urine separation on pilot scale. It will determine the composition of urine and demonstrate the effectiveness of treating wastewater with less urine than normal in varying quantities to achieve very low nutrient effluent concentrations (DWA special authorisation), as well as relatively low salt effluent concentrations. The study will assess the operational issues, such as struvite and other forms of scaling in urine drains, odours, etc. This project will assist in creating awareness for the potential positive impacts of urine separation and the feasibility thereof.

Estimated cost: R1 200 000  
Expected term: 2008 - 2011

#### ***Programme 2: Application of appropriate technologies and tools***

#### **Practical implementation of external nitrification in biological nutrient removal activated sludge systems**

University of Cape Town (Division of Water Quality Engineering)

**No. 1262**

In this project, full-scale trials are being run on external nitrification in biological nutrient removal activated sludge (BNRAS) systems to test the fundamental, laboratory-scale and economic studies done to date by this research group, which have shown that external nitrification in BNRAS systems can be a more efficient and cheaper (20 to 25% lower) alternative compared to other BNRAS systems covering both green-fields and retro-fitting situations. In this collaborative exercise between UCT, the Cape Metropolitan Council, and Water & Sanitation Services SA (Pty.) Ltd. (the local agent for CIRSEE/Suez Lyonnaise-des-Eaux), the cash contributions by others (excluding contributions in kind) amount to about 40% of the total budget.

Estimated cost: R1 280 000  
Expected term: 2001 - 2009

#### **A status quo assessment of the effectiveness of wastewater pond systems for containment and treatment of wastewaters, and the development of practical operating guidelines**

Emanti Management (Pty.) Ltd.

**No. 1657**

In various parts of South Africa, algal ponding systems constitute a significant proportion of the installed capacity for sewage treatment and have generally been effective in limiting environmental pollution and associated health impacts. In a preliminary study of waste-stabilisation ponds recently commissioned by the Free State DWA office, the current status of waste-stabilisation ponds in the Free State

was documented. Some of the key findings from the study were that the pond systems were generally well-designed and showed good operational performance, but scored very poorly in terms of maintenance, safety and supervision/management. A simple strategic decision-support tool was accordingly developed to guide future interventions. Considering that the above situation is not only limited to the Free State but is commonplace throughout the country, there is a need to document the occurrence of pond systems throughout South Africa, investigate their current operational status and practices followed, identify in what instances the technology is applicable or whether alternative technologies should be considered, identify how operation and maintenance (O&M) of these systems can be improved (through capacity building, technical guidelines, monitoring, etc.), and assess the potential for reusing treated effluent from pond systems. These aims are addressed in this project, using the Free State and the Eastern Cape as case-study areas. Guidelines will be prepared highlighting O&M procedures, common issues of concern, best practice techniques, criteria for selection of treated effluent for reuse purposes and criteria for selection of alternative technologies (if applicable). The existing MS Excel-based strategic support tool will be updated and further developed to a web-based format, allowing easy access to pond system information for all relevant stakeholders.

Estimated cost: R700 000  
Expected term: 2006 - 2009

**Support to EU - EUROMBRA project: Development of an anaerobic membrane bioreactor**

University of KwaZulu-Natal (Pollution Research Group)  
**No. 1661**

The highest development priority in the South African water sector at present is the provision of affordable but safe community wastewater treatment (MDGs, etc.) and particularly also to provide a barrier against the transmission of water-borne diseases in the context of a population which is immunologically-challenged and under-nourished. Aerobic treatment systems, other than algal ponding systems (which however have a land footprint not suitable for urban or peri-urban situations) require a significant and probably unsustainable energy and/or chemical input to be effective in terms of the treated water quality achieved. Anaerobic systems have a significantly lower resource requirement, but to date have not been able to produce the microbiological water quality required for community health safety and concomitant quality-of-life. This project targets this problem, using an innovative approach based on established anaerobic treatment technology enhanced by the use of membranes (which over the past few years have become sustainably affordable and increasingly robust in their performance, with the major and strategic benefit of providing a physical barrier to microbial passage). The research issues addressed are the basic system performance and the requirement to limit membrane fouling

and/or to develop a membrane-cleaning regime that does not require external energy inputs. If successful, the system would have an immediate and major impact on the provision of low-cost and safe sanitation to a range of communities in South Africa. This project supports an EU programme, and the potential for roll-out to a wider base, e.g. SADC/Africa/the developing world, is thus strong.

Estimated cost: R693 280  
Expected term: 2006 - 2009

**Denitrification in trickling filters**

CSIR (Stellenbosch); Virtual Buro; Tshwane University of Technology  
**No. 1825**

Many wastewater treatment plants in South Africa are equipped with trickling filters which could be obsolete if they cannot achieve denitrification. The researchers aim to demonstrate (at full scale) that trickling filters can denitrify by changing the effluent recycle over trickling filters and/or limiting the rotation speed of distribution arms. They will then model the processes of aerobic COD removal, nitrification and denitrification in a biofilm system and calibrate the model with results from 2 trickling filters in order to gain a better mechanistic understanding of the combined processes. This will result in a set of practical operating guidelines to achieve denitrification in trickling filters.

Estimated cost: R930 500  
Expected term: 2008 - 2010

**Programme 3: Stormwater and sewerage systems**

**Stormwater ingress in South African sewer systems: Understanding the problem and dealing with it**

Duzi-uMngeni Conservation Trust (DUCT)  
**No. 1731**

A cost-effective way to reduce the burden on the sewer system would be to reduce domestic stormwater ingress into the sewers. This study will investigate the extent to which stormwater ingress is overloading the sewage treatment plants in South Africa; investigate the causes of the stormwater ingress; identify legislation and local by-laws that can be used by municipal departments to prevent stormwater ingress; and develop and test a cost-effective education and inspection programme to reduce stormwater ingress to sewer systems using a case study. Using this case study, other municipalities could note the benefit and adopt similar approaches, if applicable.

Estimated cost: R334 250  
Expected term: 2007 - 2009

**Development of a South African guide for the design and operation of waterborne sewerage systems**

University of Pretoria

**No. 1744**

Among the various sanitation options available, waterborne sanitation and its associated conventional sewerage system, or derivatives of such a system, still offers numerous advantages, especially in high-density settlements. A study of the methods used to treat the effluent arising from waterborne sewage has been completed and it is opportune to look at the reticulation systems themselves. With the growth in the economy, there will be growth in the residential and commercial developments in metros, cities and small towns. This will place greater demand on water services authorities to provide sanitation services. With new emerging authorities, lack of capacity and competency at a local level, the situation can escalate and be costly to the country. Presently, there is no dedicated guide in South Africa which addresses the design and operation of waterborne sanitation systems. Much of the information is scattered in publications such as the Red Book (CSIR) and the good practical experience gained over the years within municipalities. Thus, the objectives of the study are to consolidate technical knowledge, information and advancements (local and international) on all waterborne sanitation systems.

Estimated cost: R615 000

Expected term: 2007 - 2009

**Alternative technology for stormwater management**

University of Cape Town; SRK; City of Cape Town; eThekweni Municipality; Johannesburg Municipality; City of Tshwane; IDS

**No. 1826**

Currently, stormwater planning and design in the urban areas of South Africa focuses on collecting runoff and channelling it to the closest watercourse, frequently having a significant impact on the environment through the resulting erosion and siltation. Whilst some local authorities reduce runoff peaks through the use of retention and detention ponds, few examples exist of quality improvement apart from pumping the base flow of the most polluted streams to sewerage, and the installation of litter traps. Internationally, numerous alternatives to the traditional stormwater management approach have been developed to manage the quantity and quality impacts associated with urban runoff, generally by dealing with stormwater as close to its source as possible. This solicited project aims to identify and develop new and appropriate, practical and affordable alternative stormwater management technology/ technologies for South Africa in line with water-sensitive urban design (WSUD) principles. The researchers will also evaluate the technology options in terms of the ability to improve stormwater management in urban areas, i.e. reduce impacts on receiving watercourses resulting from increased velocities

and volumes of runoff and deterioration of runoff quality. Four large local authorities (CCT, eThekweni, JHB and Tshwane) have expressed interest in participating in pilot studies.

Estimated cost: R1 800 000

Expected term: 2008 - 2012

**Improving sewerage for South Africa**

University of Cape Town; City of Cape Town; eThekweni Municipality

**No. 1827**

With ever-increasing development and expansion of municipal sewerage networks it is important to ensure that the current rationale applied to the selection of new sewerage is sustainable over the longer term. The integrity of the existing systems also needs to be maintained through systematic replacement of sewers that have exceeded their design. It is therefore necessary to evaluate whether there is a better way of sewerage areas which would offer long-term benefits over current conventional practices. The primary objective of this solicited project is to establish whether there is a viable alternative to conventional reticulated sewer systems, which offers tangible improvements over current conventional reticulated systems. The focus will be on application in new development and unserved areas as well as the potential as a solution for the replacement of conventional sewers which have exceeded their design life. The research will critically evaluate impending technologies and provide practical guidance to implementers on where suitable circumstances exist where these technologies will prosper. The project is supported by some major local authorities committed to assist with a pilot project to assess the operation of the new or proposed technologies.

Estimated cost: R1 500 000

Expected term: 2008 - 2012

**Sewer master planning tools and guidelines**

Stellenbosch University; GLS Consulting Engineers

**No. 1828**

The objective of this solicited project is to establish design tools and guidelines for the compilation of sewer master plans for local authorities which will ultimately assist in the improvement of planning functions, service delivery and inputs to the water services development planning process through enhanced methods, practices and interventions. The tools should assist managers at all levels of local and regional authorities to complete basic assessment of their sewer systems through compilation of basic inputs and generation of results or reports. The guidelines should give structure to the master planning process and include a methodology for compilation of such a plan. The intention is to develop a simple product that gives

immediate benefits to the user by providing fundamental principles in developing a sewer master plan and providing usable tools to the sewer manager/engineer.

Estimated cost: R600 000

Expected term: 2008 - 2010

#### **Programme 4: Wastewater sludge and faecal sludge management**

##### **Scale-up development of the Rhodes BioSURE™ process for sewage sludge solubilisation and disposal**

Rhodes University (Department of Biochemistry, Microbiology and Biotechnology)

###### **No. 1336**

The overall aim is to derive process design criteria for full-scale implementation of the Rhodes BioSURE™ process for sewage sludge solubilisation. To achieve this, the demonstration-scale BioSURE™ plant established at Ancor Sewage Works (Springs) will be operated, monitored and optimised, and the facility will be extended to include sulphide bio-oxidation and sulphur recovery. A smaller pilot plant at Makana Sewage Works (Grahamstown) will be operated and monitored to study process variables in finer detail, to identify and investigate areas of sulphidogenic sewage sludge solubilisation that require further development for scale-up.

Cost: R1 510 900

Term: 2002 – 2009

##### **Influence of sludge conditioners on the soil-conditioning properties of sewage sludge**

University of Pretoria

###### **No. 1540**

This project aims to determine the influence of sludge conditioners used during sewage treatment processes on the soil conditioning properties of sewage sludge.

Estimated cost: R101 000

Expected term: 2004 - 2009

##### **Materials mass balances modelling of wastewater treatment systems**

University of Cape Town (Department of Civil Engineering)

###### **No. 1620**

This project follows on WRC Project No. K5/1338 in which the novel and far-reaching integrated chemical/physical/biological process modelling approach for biological waste treatment processes was developed and confirmed. In the new project, the overall aims are:

- To develop a mass-balance-based steady state model for wastewater treatment plants (WWTP) for preliminary design and operations overview

- To develop a kinetic simulation model that integrates the mixed weak-acid/base chemical, physical and biological processes for detailed design, dynamic simulation, process operation and optimization

These two aims represent high-end long-term objectives that require closing of several important knowledge gaps with experimental research at laboratory and full-scale supported by theoretical modelling. The project has far-reaching implications with significant spin-off benefits for other WRC research projects, as already demonstrated in the previous Project No. 1338 which is delivering modelling of activated sludge, algal ponding, and methanogenic and sulphidogenic anaerobic digestion processes.

Estimated cost: R720 000

Expected term: 2005 - 2009

##### **Guidelines for the utilisation and disposal of water treatment residues**

Golder Associates Africa

###### **No. 1723**

WRC Project No. 1148 found that the disposal of water treatment residues (WTR) to land could have positive effects. No local guidelines for land disposal exist at present. In order to determine what information is still required to develop such guidelines, a follow-on project (No. 1601) produced a scoping report on the development of guidelines for the land disposal of WTR. Although a number of knowledge gaps remain, this new study will develop guidelines based on the best current local and international information. The objective is to revisit these guidelines after 5 to 10 years of application and include actual field data and experience gained during this period. A national survey will determine the variation in the characteristics of different WTRs. The previous research and survey data will be used to develop guidelines that describe the requirements for the land disposal and agricultural use of WTR. A stakeholder consultation and scientific peer review process is planned to gain broad acceptance for the guidelines.

Estimated cost: R746 820

Expected term: 2007 - 2009

##### **Sustainable and beneficial use of biosolids land application strategies: Quantifying nitrogen and phosphorus plant-soil mass balances**

University of Pretoria

###### **No. 1724**

The recently-published *Guidelines for the Utilisation and Disposal of Wastewater Sludge* promotes the sustainable use of sewage sludge as a soil ameliorant and source of nutrients for crop production. However, limited research on the topic has been conducted under local conditions. This study will investigate aspects of the use of wastewater sludge on land, including high application rates. This will focus on N and P

release from sludges and on soil-plant-water interactions with the released nutrients, in order to promote responsible sludge use and minimise groundwater pollution. Use will be made of laboratory, lysimeter and field experiments. Findings will be incorporated into a mechanistic daily time-step nutrient and water balance model to improve the management of sludges and effluents.

Estimated cost: R1 150 000

Expected term: 2007 - 2010

**Investigating the potential of deep row entrenchment of pit latrine and wastewater treatment works sludge for forestry and land rehabilitation purposes**

Partners in Development (Pty.) Ltd.; University of KwaZulu-Natal

**No. 1829**

A substantial amount of existing basic sanitation infrastructure (conventional pit latrines and VIPs) has reached or is reaching the end of its design life. Urgent interventions are required to deal with the escalating accumulation of sludge in these basic units. The options for disposal of this sludge are limited. This project aims to investigate how the sludge entrenchment technique may be applied under South African conditions and what safe working procedures (handling and transport, maximum application rates, etc.) should be developed to protect the health of workers, local communities and the environment. Research will be conducted at different sites that vary in such features as soil characteristics, slope, aspect, microclimate and end-use potential. The study will specifically focus on:

- Monitoring changes in the sludge contents of the covered trench and movement of solutes and any changes taking place in the surrounding soil and groundwater
- Investigating the management, logistics, health and politico-legal aspects of transporting sludge, excavating trenches and planting trees/ vegetation

Assessing the commercial and any other opportunities created (agroforestry, biofuel-producing tree species and environmental rehabilitation).

Estimated cost: R1 600 000

Expected term: 2008 - 2011

**THRUST 4: INDUSTRIAL AND MINE-WATER MANAGEMENT**

***Programme 1: Quantification of water use and waste production***

**An assessment of how water quality and quantity will be affected by mining method and mining of the Waterberg coal reserves**

University of the Free State

**No. 1830**

The Waterberg coal reserves are the only remaining large area with proven coal reserves in South Africa and they are being targeted for large-scale mining in the foreseeable future. It is appropriate that the lessons which have been learnt in other mining areas should be applied here. This project will therefore undertake a scoping level study to consolidate the existing information (with limited field work where existing information is lacking) about the geohydrology and pre-mining water quantity and quality of water resources associated with the Waterberg coal reserves, predict how the water resources would be affected by alternative mining methods, make provisional recommendations on the management of the water resources and identify which further research concerning the impact of mining of the Waterberg coal reserves on water resources should be undertaken.

Estimated cost: R700 000

Expected term: 2008 - 2009

***Programme 2: Regulatory mechanisms to improve industrial and mine-water management***

**Valuing water for South African industries: A production function approach**

CSIR (Natural Resources and the Environment)

**No. 1366**

The industrial sector in South Africa is one of the fastest-growing sectors and relies to varying degrees (ranging from wet to essentially dry industries) on water resources as an input to many production processes. Industrial water use currently comprises about 10% of the total water use in South Africa (WSAM, 2000) and is therefore a significant water-using (and effluent-generating) sector. Very little is, however, currently known about the responsiveness to water pricing within the industrial sector in South Africa, probably because of historically low pricing structures and the perception that industrial water use is better suited to engineering rather than economic analysis. International literature offers mixed results, with industrial price elasticities ranging from very inelastic to more elastic. In the context of the National Water Act and its emphasis on economic pricing, and the significance of industrial water use in South Africa, it is necessary to provide econometric tools to decision-makers. The project aims to quantify and

characterise the role that water plays in various local industries and their responsiveness to price changes; and to develop a set of indicators and judgement criteria for policy-makers, decision-takers and other stakeholders to use economic analysis for appropriate water resource management. The project's overall aim is to determine the marginal value of industrial water in South Africa, in keeping with the National Water Act's objectives to price water correctly. The specific sub-goals are listed below:

- To assess the role that industries play in the overall water demand for South Africa, and to determine which industries are the most water-intensive industries and which industries are relatively 'dry'
- To determine price elasticities of demand for water for the respective industrial sectors within South Africa, and develop a set of indicators that can be used in existing models or to assist existing techniques to ensure sustainable and equitable conservation of water resources
- To demonstrate through practical application how economics can be used to value water resources, and to document this application so that it may be applied across sectors
- To provide a value judgement for water resource management and policy based on the results and an extended analysis of the data
- To build capacity in all stakeholders and parties participating in the research project, through the transfer of knowledge

Estimated cost: R549 600  
Expected term: 2002 - 2009

#### **Geochemical sampling and analyses for environmental risk assessments using the Wits Basin as a case study**

Pulles, Howard & de Lange

**No. 1624**

Each environmental risk assessment (ERA) study is faced with questions regarding the location, number, size and type of samples that need to be collected for a proper assessment. Answers to these questions are partially dependent on the predictions that need to be made, the available material and costs. This project will establish a methodology to guide users of an ERA process to quantify the uncertainty associated with predicted mine drainage quality as a function of sample representivity. Existing mineralogical and geochemical data for the Wits Basin, that are available from previous studies, will be used to demonstrate the application of the methodology that will be developed.

Estimated cost: R 562 000  
Expected term: 2005 - 2009

#### **Protocol for quantitative assessment of industrial effluents for discharge permitting**

University of KwaZulu-Natal

**No. 1734**

Local authorities manage industrial wastewater by:

- Using its wastewater treatment plants for remediation
- Issuing discharge permits with limits on discharge
- Charging a discharge tariff for financing the treatment and for providing incentives and penalties to influence users of the system

An optimal management strategy will use all these elements in the proper relation to one another. However, the relationships are complex and poorly understood because of the complex and variable nature of both the multitude of effluents discharged from industries, and the response of the biological processes to them. The study aims to provide a means of determining the link between what a particular industry is permitted to discharge and the capacity of the WWTP that received the wastewater to serve all its clients while meeting the quality standard for its treated effluent. This information will inform the process of setting the conditions for the industry's discharge permit.

Estimated cost: R1 500 000  
Expected term: 2007 - 2011

#### **Programme 3: Minimising the impact of waste on the water environment**

#### **Arsenate resistance in microbial communities developing in maturing FA-AMD solids**

University of the Western Cape (Department of Microbiology)

**No. 1655**

The WRC and the mining industry are investigating the use of fly ash to neutralize AMD and produce useful by-products, such as zeolites. The use of fly ash AMD substrate as backfill in underground mines is under consideration. However, the potential mobilisation of undesirable metals and other contaminants by microbial activity gives rise to concern. A recently-completed project (**No. 1549**) found that while microbial populations are slow to develop in the substrates, they are readily sustained once they are introduced. This project will continue with the current research and study specifically arsenate reactions, as proxy for other contaminants that are subject to redox reactions.

Estimated cost: R220 000  
Expected term: 2006 - 2009

**Reclamation of water from flooded Witwatersrand gold mines by selective dewatering of key underground compartments**

Pulles, Howard & de Lange  
**No. 1659**

Defunct gold mines on the East and West Rand are rapidly filling up with contaminated water that will decant into the Vaal River system. Previous studies focused on either reducing inflow to the underground or on diverting decant water to preferred locations for treatment. This project will identify locations within the flooded basin where water quality is relatively good and which are also major recharge points (and therefore decant drivers). It is proposed to dewater the basins from these points. If found feasible, the extraction of water from such points, would serve as a source of water for Gauteng and at the same time reduce the magnitude of decant.

Estimated cost: R501 300  
Expected term: 2006 - 2009

**Refinement of the decision support system for metalliferous tailing disposal facilities**

Golder Associates Africa  
**No. 1735**

WRC Project No. 1551 developed a first-order decision support system (DSS) for the sustainable design, operation and closure of metalliferous tailings disposal facilities as part of a long-term programme to deal with these facilities on a sustainable basis. This follow-on project will refine the first-order DSS by developing guidance and support to demonstrate that the environmental impacts on the surface stability and water aspects are acceptable and to identify new and promising technologies and approaches.

Estimated cost: R2 200 000  
Expected term: 2007 - 2009

**Consideration of the impact of classification and landfilling of hazardous waste**

CSIR  
**No. 1736**

The minimum requirements for general and hazardous waste have been in place for over a decade. A systematic assessment is needed to determine whether the desired groundwater protection has been achieved, particularly at sites that have received delisted wastes. The assumptions made in the delisting process (i.e. whether they are conservative or not) are tested against field data from operational landfills. Further, the impact of the disposal of hazardous waste on leachate quality and landfill processes is required. This study aims to begin the process by considering the impact of selected delisted hazardous or industrial waste on a selection of landfill sites. The study includes an assessment of leachate quality from a

selection of general waste landfill sites that receive hazardous wastes compared to those that do not, to validate the assumptions made in the delisting process and to determine to what extent a selected hazardous waste type impacts on leachate quality.

Estimated cost: R800 000  
Expected term: 2007 - 2009

**A systematic approach to sulphidic waste rock and tailings management to minimise AMD formation**

University of Cape Town  
**No. 1831**

Acid mine drainage (AMD) is almost certainly the biggest environmental issue facing the South African mining industry. Changes in legislation have put the burden of responsibility for perpetuity on mining companies. This has led to a change in process thinking in order to reduce potentially harmful emissions from deposits and thus reduce long-term costs of tailings management and AMD remediation. This project will address aspects of disposal of dump rock and tailings from mining operations processing mineral sulphides, specifically with the focus of reducing capacity to form AMD through removal of the sulphidic component of the waste. It will use the understanding of the factors governing AMD generation from dump rock and tailings (similar to those governing mineral bioleaching) with the view to the improved categorisation, separation and planned disposal of its components to mitigate AMD generation.

Estimated cost: R598 320  
Expected term: 2008 - 2010

**Programme 4: Minimising waste production**

**The introduction of cleaner production technologies in the mining industry**

Digby Wells & Associates  
**No. 1553**

While the mining industry has played a major role in the development of South Africa (and is still continuing to do so) it has also been identified as the largest producer of waste and as a major contributor to water quality degradation in many of our important catchments. It is recognised that the long-term solution to waste management is to minimise waste production and introduce cleaner production technologies. An analysis of the WRC's past and present project portfolio indicated that most of the research effort to address water and waste management in the mining industry was devoted to minimising the impact of waste on the environment, to improve our ability to predict and quantify effects, and to develop technologies to treat polluted waters. No projects devoted specifically to waste minimisation and cleaner production technologies were undertaken. Although cleaner production is an essential

backdrop against which to do environmental management, and the mining industry has launched initiatives such as the mining, minerals and sustainable development project, it does not appear as if the industry has embraced cleaner production as yet. This project is aimed at introducing cleaner production to the mining industry and at entrenching its concepts where it is already being practised. For this purpose, multi-faceted initiatives will be undertaken to raise the awareness of the mining industry concerning the benefits and need for adopting cleaner production approaches. The project will start by assessing the level of awareness in the industry and identifying threats that could be alleviated by cleaner production technologies. Opportunities will be created to implement these and establish cleaner production forums (waste minimisation clubs) so that success stories can be generated which in turn can be used in an awareness campaign.

Estimated cost: R3 295 000  
Expected term: 2004 - 2009

#### **Development of a complete process integration framework for wastewater minimisation in multipurpose batch plants**

University of Pretoria  
**No. 1625**

The approach followed was to employ mathematical programming principles, where the overall chemical plant is mathematically modelled. The objective is to maximise profit while minimising effluent. The development of the model was conducted while taking into account the current gaps in research and limitations of current methodologies so as to ensure that the overall methodology addressed the problems at hand. The mathematical model is based on mathematical programming principles using optimisation as an underlying framework. The main contribution of the project was to treat both scheduling and wastewater minimisation as optimisation problems within a unified framework, which indeed proved more appropriate and optimal than published methods. The final stage was the application of the developed mathematical technique to a pharmaceutical production facility. This was done in 3 steps. The 1st step involved the application of a single contaminant methodology to the operation. The 1st step gave insight into the operation and the data that was required. From the 1st step it was observed that product and wastewater compatibilities needed to be taken into account. Based on this the multiple contaminant wastewater minimisation methodology with a single storage vessel was applied to the industrial site. This formed the 2nd step of the application. During the application of the multiple contaminant model an important change came about in the sanitising method used. The chemical sanitising step was changed to a heat sanitising step. Based on this a final model was derived in the final step of the application of the methodologies. The final model schedules the production in such a manner as to maximise the amount of water that is reused, thus producing less effluent. The amount of water saved for each washout is dependent on

the amount of water used for the sanitising step. The amount of water saved varies between 22% and 55%. The derived model finds practical application as it takes the current water usage into consideration. The output from the model was a production schedule, which shows the allocation of mixers to various products under the actual production requirements. Since water from the sanitising step goes to a central storage vessel, independent of the mixer, no extra pipe connections are needed to achieve water savings.

Estimated cost: R198 000  
Expected term: 2005 - 2009

#### **Cleaner production evaluation system and optimisation for metal finishing**

Durban Institute of Technology  
**No. 1626**

The metal-finishing industry is notorious for its polluting activities. Cleaner production audits to benchmark a company's operations and identify room for improvement, require a level of detailed information that is normally not recorded by smaller companies. This project aims to develop a tool that can be used to readily conduct a systematic environmental evaluation of electroplating plants and which will provide a comprehensive audit, with limited data, in a consistent way.

Estimated cost: R492 000  
Expected term: 2005 - 2009

#### **Technical guidelines for the implementation of cleaner production initiatives (for point sources of pollution) in support of determining an incentive charge for municipal effluent charges**

Process Optimisation and Resource Management (PRO&RM)  
**No. 1832**

This project surmises that the only realistic way to calculate an incentive charge to promote the implementation of cleaner production technologies by industries disposing of their effluent into municipal sewers is to determine the equivalent implementation cost of cleaner production initiatives. The imminent implementation of the Waste Discharge Charges System adds impetus to the need for such a study. The objective is to develop Technical Guidelines through which the insights gained in the study can be transferred to other applications.

Estimated cost: R570 619  
Expected term: 2008 - 2010

**Programme 5: Improved ability to predict and quantify effects**

**Evaluation and validation of geochemical prediction techniques for underground coal-mines in the Witbank/Highveld region**

Pulles, Howard & de Lange

**No. 1249**

The Witbank/Highveld coal-field in Mpumalanga is the most important coal-mining area in South Africa. While this coal-field makes a significant contribution to the economic development of the country it is also the source of potentially the most serious water quality problem facing the region over the longer term. There is thus an urgent need to develop and test tools with which to predict the progression of acid mine drainage (AMD) over time, and to develop, test and apply management options that will alleviate the situation. This project, together with Project Nos. 1263 and 1264 will investigate the management of groundwater flow in collieries at various stages of closure, with the aim of minimising the salt load emanating from them, evaluating alternative geochemical prediction techniques to use in the longer term, comparison of alternative management options, and the mapping of modal proportions of primary and secondary minerals. The contribution of this project will be to evaluate alternative geochemical prediction techniques for the prediction of water quality at underground coal-mines, based on on-site investigations and predictions, and to develop the ability to provide a long-term prediction of water quality and the effect of alternative management strategies on this water quality.

Estimated cost: R1 416 100

Expected term: 2001 - 2009

**Development of water balances for operational and post-closure situations for gold-mine residue deposits to be used as input to pollution prediction studies for such facilities**

Pulles, Howard & de Lange

**No. 1460**

The area covered by slimes dams is in the order of 400 km<sup>2</sup>. Previous research has indicated a varying but significant potential for pollution underneath these dumps. The overall water balance of a dump is the main driving force behind this pollution. The water balance of tailings and rock dump facilities is not very well understood at present, both locally and internationally. This seriously limits our ability to make reliable predictions of post-closure pollution potential and to properly evaluate environmental management/rehabilitation strategies. This project aims to develop a procedure and methodology that can be used in developing water balances for gold-mine waste residue deposits. These water balances play a critical role in geochemical modelling of such deposits.

Estimated cost: R913 500

Expected term: 2003 - 2009

**Prediction of how different management options will affect drainage water quality and quantity in the Mpumalanga coal mines up to 2040**

Golder Associates Africa

**No. 1628**

Coal-mining in the Mpumalanga coal-field is a mature activity. Many mines have already closed and several more are heading for closure during the next 20 years. The acid mine drainage (AMD) that emanates from closed and operating mines has a huge impact on the water quality of the area. Because of the lag effect, it is likely that this impact will increase in future. Several investigations over the last decade were aimed at obtaining an improved understanding of how different management options would affect the quantity and quality of AMD emanating from mines. This project will mainly build on available information to predict how the quantity and quality of acid mine drainage emanating from coal mines in the Mpumalanga Highveld will change over the next 40 years, for a range of different management scenarios.

Estimated cost: R1 500 000

Expected term: 2005 - 2009

**Origin of sodium and its applications to water quality prediction in the South African coal mine environment**

University of Fort Hare (Department of Geology)

**No. 1663**

In addition to experiencing an AMD problem, the Mpumalanga coalfields also experience an increase in the sodium concentration of mine drainage from north to south. This phenomenon adds to the unacceptability of mine drainage. This project aims at finding an explanation for the phenomenon and, to a lesser degree, to propose treatment, prevention and management strategies to address the problem.

Estimated cost: R337 600

Expected term: 2006 - 2009

**Environmental sustainability of inland industrial complexes**

CSIR, Eco Innovation, University of KwaZulu-Natal, University of Stellenbosch, University of Cape Town

**No. 1833**

Significant economic activity and prosperity of South Africa is associated with a few large industrial complexes. Since these areas are important nodes of economic growth, it is in the interests of the country that they continue to generate wealth, but do so in a sustainable way. This project will examine several inland industrial complexes as case studies with a view to establishing factors/solutions that can enhance their long-term environmental sustainability, promote high percentages of reuse of industrially generated waste streams, and lay foundational blocks in raising awareness on the significance of symbiotic industrial ecology for future economic sustainability

through optimal utilisation of resources. More than one industrial complex will be selected since certain factors may be unique to a given complex.

Estimated cost: R3 000 000

Expected term: 2008 - 2011

#### **Programme 6: Beneficiation and treatment of industrial and mining effluents**

##### **'Health-for-purpose' in wetlands treating waste streams**

University of Cape Town

**No. 1725**

Wetlands used for the treatment of high COD and BOD effluents need to be managed to avoid imbalance and overload. The presence of key degrading organisms in a specific biodegradative community offers the potential to develop a 'fingerprinting' technology for identifying the presence and monitoring the 'health' of such a community. The study hypothesises that the impact of pollutant addition on natural microbial populations can be demonstrated by molecular methods to monitor the survival and, more importantly, the health of the microbial population responsible for the biodegradation of the impacting pollutant. The study aims to: develop molecular fingerprints of microbial communities and key degradative enzymes involved in the degradation of specific pollutants; develop methods to demonstrate microbial population changes resulting from the impact of polluting wastewater; and investigate the effects of specific interventions on the 'health-for-purpose' of the wetland microbial population.

Estimated cost: R1 465 000

Expected term: 2007 - 2011

##### **Beneficiation of agri-industry effluents**

University of Cape Town

**No. 1726**

This study focuses on extractive treatment of agro-industrial effluents (specifically effluents produced by the fruit and wine industries and the simultaneous recovery of high-value by-products). The study builds on research which focused on the characterisation of specific wastes with respect to potential economic value and separation and bioconversion technologies. The study aims to characterise the wastes from the fruit and wine industries; develop and customise new extraction processes to obtain antioxidants; investigate and optimise fermentation of residuals after extraction; and investigate and determine the economic and commercial aspects. The outcome of this research potentially lends itself to a broad range of applications not yet developed in South Africa.

Estimated cost: R825 000

Expected term: 2007 - 2010

##### **Novel technology for the recovery of water and solid salts from hypersaline brines: Eutectic freeze crystallisation**

University of Cape Town

**No. 1727**

With increasing use of recycling technology and water recovery by industry, there is an increase in the generation of inorganic brines and concentrates. This study will conduct a proof-of-concept study for South African conditions and brines on the novel technology of eutectic freeze crystallisation as a means to recover water and salts from hypersaline brines. This technology is reported to be significantly cheaper than the present benchmark of evaporative crystallisation. The research team will cooperate with the Dutch developers of the technology.

Estimated cost: R793 305

Expected term: 2007 - 2010

##### **Towards passive treatment solutions for the oxidation of sulphide and subsequent sulphur removal from acid mine drainage**

Rhodes University

**No. 1834**

The treatment of acid mine drainage typically consists of a series of unit processes which include the pre-treatment (neutralisation and metal removal) followed by the removal of salinity and residual pollutants. Several passive and semi-passive unit processes have been developed locally for the neutralisation of acid mine drainage water as well as the subsequent sulphate reduction. Biological sulphate reduction is now well understood and several innovative technologies have been developed and are currently still being developed including the IMP and the Rhodes BioSure™ process. The subsequent sulphide oxidation step is also well researched and applied in active treatment systems. However, limited passive biological sulphide oxidation and subsequent sulphur removal solutions exist. This solicited project aims to further develop the tubular fixed biofilm reactor developed by Rhodes University to remove sulphur in a passive system. This study will focus on the design, development and operational configurations for the tubular sulphur biofilm reactor. The technology will be demonstrated on laboratory and pilot scale.

Estimated cost: R1 500 000

Expected term: 2008 - 2011

## THRUST 5: SANITATION AND HYGIENE EDUCATION

### Programme 1: Advocacy, health and hygiene education

#### Assessment of the effect of drinking water quality on the health of people living with HIV/AIDS

University of Venda (Department of Microbiology)

**No. 1653**

The spread of the human immunodeficiency virus (HIV), which causes Acquired Immunodeficiency Syndrome (AIDS), is taking place at an alarming rate. The situation for HIV/AIDS-infected individuals is exacerbated by the fact that a large proportion has no access to safe water or adequate sanitation. The lack of safe water compounds health risks to HIV/AIDS individuals leading to increased vulnerability, decline in productivity and income and consequently a general decline in their socio-economic status. HIV/AIDS is not a water-borne disease therefore there appears to be little relation to each other but a poor microbiological quality of their drinking water could have detrimental impacts on the health of HIV/AIDS-infected individuals. This project aims to do a health impact assessment study based on the microbiological quality of drinking water used by rural households that have at least one HIV/AIDS-infected individual. The presence of selected pathogenic and opportunistic bacteria and viruses in drinking water with those present in stool samples of both people living with HIV/AIDS and healthy individuals will be correlated to identify the relationship between point-of use drinking water quality and health indicators (such as diarrhoeal morbidity and mortality).

Estimated cost: R800 360

Expected term: 2006 - 2009

#### Develop the guideline: *Management of Microbial Water-Borne Diseases Vol 5: What We and Our Children Ought to Know*

University of Venda

**No. 1672**

This volume will include home hygiene and a link to sanitation, different water sources and handling of water from the sources. Disinfection and its side effects, the boiling of water and when not to boil, danger of burn wounds, etc. The origin and transmission of diarrhoeal diseases, prevention and care, will be included, as well as emergency treatment of diarrhoeal cases and special care of the immuno-compromised. Handling of containers in households, storage, contamination, etc. will also be included. All of these need to be described in a simple, demonstrative way taking into account the posters, pamphlets and reports already available at the WRC, Department of Health and DWA, as well as other such documents developed by water suppliers, NGOs, Department of Education (school curricula), etc., to get the most suitable and effective method of transferring the message to the community. Cultural differences and preferences have to be taken into consideration.

Estimated cost: R400 000

Expected term: 2006 - 2009

#### A guideline document for emergency disinfection of drinking water

Tshwane Institute of Technology

**No. 1737**

Untreated or inadequately treated water is still drawn directly from rivers, ponds, streams and boreholes in some South African rural communities for domestic use. Various water-related infectious diseases including diarrhoea are often contracted, in some cases causing the death of the immuno-compromised individuals. In some instances, following natural disasters, a local authority may urge consumers at risk of contracting water-borne diseases to follow emergency disinfection measures. Messages and recommendations regarding the 'emerging' disinfection of untreated water do not take into account the variation in the quality of the source water. General guidance and recommendations on the use of a disinfectant or boiling of the water is usually given. In some instances this could add to the detrimental health effects of the water. The aim of this study is to consolidate available literature and information and develop a user-friendly guideline for emergency disinfection of untreated water.

Estimated cost: R600 000

Expected term: 2007 - 2009

#### Assessment of water, sanitation and hygiene services in relation to home/community-based care services for HIV/AIDS-infected individuals in rural and peri-urban areas of South Africa

University of Venda

**No. 1738**

This project will be done in collaboration with the Department of Health (DoH) and will provide an extension of the project funded by DoH. The HIV/AIDS epidemic has a devastating effect on the health and well-being of the South African nation, but it also presents grave consequences for the socio-economic development of South Africa. Safe water and sanitation are basic needs and a human right, especially for people affected by HIV/AIDS, as it will help them to live longer in good health and with increased dignity. This project will highlight the issues underlying the broad context for water supply, sanitation, and hygiene behaviour, and the need for systematic attention to these. This will be done in collaboration with DoH and the Medical Research Council. The aim of this study is to provide insight into the extent to which water, sanitation and hygiene issues/practices are important and relevant for service providers and people living with HIV/AIDS, especially with regard to home/community-based care.

Estimated cost: R500 000

Expected term: 2007 - 2009

**How does the HIV and AIDS epidemic in South Africa impact on the water, sanitation and hygiene sectors?**

University of the Western Cape

**No. 1813**

In South Africa HIV/AIDS tends to be treated predominantly as a health issue with intervention efforts narrowly focused on prevention and treatment. Issues like accessibility to clean water for people living with HIV and AIDS (PLWHA) in both urban and rural areas, and related issues like sanitation and hygiene have not received a lot of policy debate, support and attention in South Africa. Safe water and sanitation constitute the most basic needs and human right issues, especially for PLWHA as it will help them to live longer in good health and increase their dignity. Therefore, information on water, sanitation and hygiene is important for making the right decisions. Access to basic sanitation and effective solid waste management is essential in reducing morbidity and mortality, particularly for those with a reduced immune function such as PLWHA. Access to clean water is essential in promoting effective health and hygiene practices amongst PLWHA. Effective health and hygiene requires an enabling environment that includes not just safe water supply, but effective wastewater disposal and solid waste management. The raising of health and hygiene awareness amongst affected households will be of little value unless safe water supplies are available to these households, so that they can practise good hygiene. Hygienic behaviour in turn reduces opportunistic infections and lengthens the time period between HIV infection and full-blown AIDS, thereby extending the period in which HIV sufferers can be both domestically and economically active. A complicated web of relationships exists between water and HIV and AIDS and cannot be underestimated. An investigation of the linkages and perspectives between PLWHA, water, hygiene practices and sanitation will enhance the development of integrated approaches. The central objective of this research study is to provide insight into the extent to which water, sanitation and hygiene sectors must strategise for services provided to people living with HIV and AIDS. Further the study intends to look at 3 distinct cross-sections; urban, peri-urban and rural areas across 3/4 selected provinces. The rationale being that the impact of intervention measures ought to differ across the 3 segments and across provinces.

Estimated cost: R700 000

Expected term: 2008 - 2010

**Programme 4: Technical sustainability of sanitation services**

**Sustainable options for community level management of grey-water in settlements without on-site waterborne sanitation**

University of Cape Town (Department of Civil Engineering)

**No. 1654**

This study builds on a current WRC study aimed at quantifying the amount of grey-water generated in non-sewered areas. This study identifies the quantities and quality of grey-water generated, and also identifies some of the technical challenges. From this study it has been identified that there are strong social and behavioural aspects which influence the way grey-water is managed and disposed. This study will investigate ways of overcoming social and related obstacles in order to create sustainable management options relevant to the local communities and identify ways of mitigating environmental impacts. It is anticipated that the output in the form of a sociological model will be applicable for extension to the rest of South Africa. This will be supported by preparation of educational material for community-level training concerning grey-water management options and techniques.

Estimated cost: R750 000

Expected term: 2006 - 2009

**Understanding the sludge accumulation in VIPs and other on-site sanitation systems and strategies to manage desludging in the future when pits are full**

Partners in Development

**No. 1745**

Current emphasis in sanitation rollout and the millions invested therein have a bias towards putting in sanitation facilities in the form of dry VIP toilets. Though this is one of the essential components of sanitation delivery and the easier component, less emphasis is afforded to aspects such as ownership, participation, hygiene education and ongoing maintenance which are basically the more challenging and also essential elements for sustainability in sanitation. It can be estimated that more than 1 million VIP systems will be built to meet backlogs. This is a huge investment by the Government; however, very little foresight and strategies have been developed as to how to manage these systems into the future. The research aims to tackle these questions of sustainability and, through the knowledge which is generated, make the sector better prepared to deal with the challenges. This study will develop an understanding of the sludge accumulation in VIPs and strategies to manage desludging in the future when pits are full.

Estimated cost: R1 600 000

Expected term: 2007 - 2010

### **Develop more robust and lighter VIP structures**

University of Pretoria

**No. 1781**

The premise of this study is based on the difficulties experienced in relocating VIP superstructures to new pits or to allow access for desludging. Thus, it would be ideal to develop a structure which can deal with these aspects where it can be sustainable, provide longer design life, be a durable, lightweight superstructure (with a total weight in the region of 500 kg) and which can be built and moved by rural households to new sites or to ease desludging. There are many advanced modern composites such as combinations of fibre-reinforced high strength concrete and plastics, which, if made appropriate, could contribute to sustainable sanitation provision. Various combinations of composites can be developed in the most cost-efficient manner, which can be durable and affordable. The aim is thus to create designs which facilitate the reuse of superstructure building materials which, in turn, facilitate labour-intensive processes, as well as provide easier building techniques such that home-owners can rebuild their superstructures over a new pit without the services of a highly-skilled builder.

Estimated cost: R1 100 000

Expected term: 2007 - 2010

## NEW PROJECTS

### **THRUST 1: WATER SERVICES - INSTITUTIONAL AND MANAGEMENT ISSUES**

#### *Programme 1: Cost recovery in water services*

#### **Critical assessment of raising basic level of water services**

Nemai Consulting

**No. 1892**

The Government has indicated that its short-term goal is to meet the basic water and sanitation requirements of the nation, as well as to attain full water-supply coverage by 2008 and sanitation coverage by 2010. Government has also indicated that the long-term goal is to improve on the basic level of service, often termed 'climbing the ladder'. It is most obvious that climbing the ladder, which is possible, will nevertheless provide numerous challenges and require greater resources. Asking relevant questions and gaining an indication of specific challenges will assist the sector in starting a debate on how best to tackle the 'ladder-climbing' issue and to formulate new strategies and the necessary mind-shift. Essentially, moving to higher levels of service (i.e. above RDP levels) could have only limited health benefits but very significant economic benefits (jobs, income, etc.). The question is rather whether there should be a distinction between moving up the ladder in those areas

where this can be afforded (through local finance) and those areas in which basic needs coverage has not yet been achieved and on which national finance should be concentrated. The question concerning what the priority should be ought to be posed. As the number of people without basic access to water declines, there are reduced demands in terms of attending to requirements of these groups and potentially greater benefits in refocusing attention increasingly on moving people up the ladder. The study will investigate where the break-point should be and whether the sector has already reached this stage. This desk-study, supported by analysis, will assist the sector in achieving preparedness for the future.

Estimated cost: R600 000

Expected term: 2009 - 2011

#### *Programme 2: Institutional and management issues - Water services*

#### **Guidelines on determining the vulnerability and risks of water services infrastructure**

Emanti Management

**No. 1893**

Any infringements to our water infrastructure could disrupt the direct functioning of key business and government activities, facilities, and systems, as well as have cascading effects throughout a nation's economy and society. Enhanced security features should drive all new designs and retrofits for water utility systems. Vulnerability and risk assessments can help guide and prioritise enhancements. There is a need for methodology and guidelines for application of risk management to strategic asset management (AM). Much has been done in the area of risk assessment for different sectors but no specific tools or guidelines have been developed or applied as an agreed national guideline for water utilities. The tools and guidelines may be used at a strategic level but may also be applied to specific individual assets to determine what measures may be taken to mitigate unacceptable risk. The tools and guidelines will enable design, operational and maintenance measures to be reviewed in order to mitigate risk.

Estimated cost: R996 800

Expected term: 2009 - 2011

**Development of protocols and guidelines for municipalities to undertake studies to determine the impact or influence of climate change on water service delivery**

University of the Witwatersrand

**No. 1953**

The recent damages to water and municipal infrastructure due to weather-related/natural disasters raise many concerns for municipalities as to how to respond and plan for such occurrences brought about by climate change and its influences on nature. While the delivery of basic water services, (6 kℓ per household per month free), is driven by a national development goal, the responsibility of ensuring this right is ascribed to local government. For this, the local municipality needs to ensure that water supplies meet the consumption demand, present and future. Technical and financial planning is therefore required to ensure that an undisrupted service is provided. The impact of climate change needs to be included in this planning. All municipalities need to consider how climate change will affect their water services and to show how the departments most need to act or react. They must understand what climate change means for their work and future investments. In addition, a review of changes in weather and extreme weather events over the past few decades can help identify who and what is most vulnerable to some aspects of climate change. Various departments within the municipal government also must become aware of the need to consider climate change in their plans – for instance for water supply. Poor response to dealing with the outcomes of these climate changes will only escalate and increase the problems for municipalities. Municipal officials are unlikely to act if they have little idea of what climate change means for their city. To address this, the study will review and develop an understanding of the regional climate change knowledge and its relevance to municipalities in South Africa.

Estimated cost: R700 000

Expected term: 2009 - 2011

***Programme 3: Innovative management arrangements - Rural water supply***

**Social scarcity of water and water use**

African Centre for Water Research

**No. 1940**

There are several ways of defining water scarcity. One view is that it is the point at which the aggregate impact of all users impinges on the supply or quality of water under prevailing institutional arrangements, to the extent that the demand by all sectors, including the environment, cannot be satisfied fully. Water scarcity is a relative concept and can occur at any level of supply or demand. Scarcity may be a social construct (a product of affluence, expectations and customary behaviour) or the consequence of altered supply patterns stemming from climate change. Scarcity has various causes, most of which are capable

of being remedied or alleviated. A society facing water scarcity usually has options. Water is essential for all socio-economic development and for maintaining healthy ecosystems. Water has traditionally been considered a physically scarce resource. Thus, growing scarcity and competition for water stand as a major threat to future advances in poverty alleviation, especially in rural areas. This study will explore the dimensions and relationship between social scarcity and water services or use. It will unpack the causes, understand how water can be used to break the cycle of poverty and establish how the recommendations from this study be incorporated into the macro-planning process.

Estimated cost: R500 000

Expected term: 2009 - 2011

**Investigating the social vulnerability of people and their livelihoods and their response to water infrastructure**

Umvoto Africa

**No. 1888**

Socio-economic vulnerability is seen as the integration across a range of stresses (not just biophysical, but also including exposure to uncertainties from interactions with markets, political and social exclusion and so on) and across the range of human capacities (i.e., not just food security, income or health). In relation to the livelihoods of the poor, one aspect of poverty is that poor people are often less able to cope with, adapt to or recover from these stresses. Even small variations in climatic conditions, market prices, etc., that less-poor people are able to cope with, can jeopardise the prospects of poor families lifting themselves out of their poverty and, in the worst cases, can even threaten their very existence. The result is often a risk-minimising approach to livelihoods, where the poor are more concerned with securing the minimum they need to survive than with taking advantage of development opportunities that could entail some risk. The study aims to establish the dynamic interaction between expectations, standards and actual service delivery. The central questions to be answered will be: How do people respond to different systems of water delivery, management and technologies? How is water used? What is the role of women?

Estimated cost: R500 000

Expected term: 2009 - 2011

**Investigating operational and indigenous knowledge of water use and waste management, and establishing ways to integrate them into water service management**

Nemai Consulting

**No. 1941**

Indigenous (or indigenized – practices and water use that have been introduced into the country and have been adopted and adapted by society) water management knowledge has played a significant part in the lives of many communities, to sustain their water needs against the harsh forces of nature, as well as the forces of segregation and apartheid. In the late 90's, the Department of Science and Technology initiated a number of projects aimed at capturing indigenous knowledge and practices in South Africa. One of the areas dealt with water management. The introduction of modern technology and systems has meant that this knowledge and its application have dwindled, and more crucial is that there is a lack of transfer of this knowledge to the new generation. Though Government has taken many measures to secure the provision of water to all persons in South Africa, many communities remain vulnerable due to a number of reasons. One of these crucial reasons is that of climate change and the challenges it will bring. Added to this, many of our initiatives in the water sector have actually marginalised or eroded this indigenous knowledge base to extinction. Thus, it becomes imperative and important to record these practices and establish how these practices could be beneficial to the management of water services in the future.

Estimated cost: R600 000

Expected term: 2009 - 2011

***Programme 4: Regulation in the water services sector***

**Investigating the mechanism and processes used in setting water services tariffs**

Nelson Mandela Metropolitan University

**No. 1871**

This scope of this study will be to investigate how different municipalities are setting water tariffs, establishing the process and principles which are used. This study will examine the existing water services tariff models (fixed tariff, volumetric tariff, increasing block tariff, etc.), their relevance and problems. Using this as a basis the research will interrogate the effectiveness of the processes used and the whole tariff chain and its impact on the affordability of water. Key considerations should cover aspects such as adequacy of revenues from those tariff levels; O&M cover ratios and full cover ratios with its comparisons. The study will also critically examine the current fashion of using increasing block tariffs and uniform prices in developing areas. Considerations must be given to water tariff design so as to provide a basis for judging its appropriateness. The study will have a bias towards small to medium municipalities,

as well as those in rural areas. Based on this a guideline and recommendations will be developed to assist water services institutions and the regulation of tariffs.

Estimated cost: R600 000

Expected term: 2009 -2010

**THRUST 2: WATER SUPPLY AND TREATMENT TECHNOLOGY**

***Programme 1: Drinking water treatment technology***

**Assessment of the prevalence of organic compounds in raw and treated water for potable purposes, their fate in current treatment plants, and compilation of a guideline on best available technology for the removal thereof**

University of Johannesburg

**No. 1883**

The number of organic chemicals discharged into the environment is escalating at a frightening pace. The United States EPA has drinking water regulations for more than 90 contaminants. The lack of knowledge about local natural organic matter (NOM) composition and interaction with the treatment steps hampers the understanding of removal mechanisms and the development of reliable qualitative and quantitative models. A large number of organic chemicals have not been adequately investigated with regard to the efficiency of their removal by local water treatment processes currently in use. Further, small and rural water treatment plants are often at a disadvantage regarding both their design and operation. Except for a few exploratory and regional studies on the occurrence of NOM, pesticides, algal toxins and endocrine-disrupting chemicals (EDCs), little has been done to determine the prevalence of organic contaminants in South African water sources being used for potable water supply – or the efficiency of SA plants in removing these contaminants. This project will investigate the prevalence of both natural and anthropogenic organic contaminant chemicals in SA water sources used for drinking water, determine the efficiencies of removal – especially by small treatment systems – and their effects in the distribution system, and suggest improvements to the treatment processes and operational procedures in order to safeguard the people against these contaminants.

Estimated cost: R1 800 000

Expected term: 2009 - 2012

### **Wastewater reclamation for potable reuse**

Umgeni Water  
No. 1894

Water is a scarce resource, especially in South Africa where runoff exceeds rainfall and is unevenly distributed. South Africa has been classified as water stressed and water should therefore be conserved. The pressure exerted on surface and groundwater supplies should be reduced or at best maintained, rather than increased as the country's human population and industrial development increase. Wastewater reuse offers such a possibility, and reclaiming domestic wastewater from Darvill Wastewater Works for potable reuse using membrane bioreactor technology is therefore being investigated. This project is intended to pave the way for technology enabling South African water suppliers to produce consistent, acceptable drinking water quality through used-water reclamation. Initial feasibility work will be followed by a demonstration plant designed and operated over a long-term trial to establish operating guidelines that ensure reliable product water will be generated at all times.

Estimated cost: R650 000  
Expected term: 2009 - 20112

### **The establishment and piloting of the Technical Assistance Centre for small water and wastewater treatment plants**

Chris Swartz Water Utilisation Engineers  
No. 1896

There currently exists a serious and acute need in South Africa to provide assistance to small water and wastewater treatment plants for proper and efficient operation and maintenance of these systems, to ensure compliance and sustainability in this important water sector. In order to address the serious challenges that are currently experienced with the compliance and sustainability of the small water and wastewater treatment systems in the country, it is proposed that a Technical Assistance Centre be established. This should be a collaborative effort between the DWA, WISA (implementing agent of DWA), the WRC, the DBSA and SALGA. Direct benefits of the Centre will be a significant improvement in compliance of treatment plants, improved leadership and facilitation of planning and development activities in the water sector, enhanced service delivery, positive economic impact through reduction in break-downs and downtime, and, overall, more sustainable development and improving quality of life in rural South Africa. This will be in line with DWAs strategy on *Water for Growth and Development*. The Eastern Cape and Western Cape have been chosen as the pilot provinces for the launch of this project.

Estimated cost: R275 000  
Expected term: 2009 - 2010

### **Programme 2: Water treatment technology for rural communities**

#### **Compilation of guidelines for the selection and use of home water treatment systems and devices**

Tshwane University of Technology  
No. 1884

At least 5.7 million people in South Africa still have no access to treated, potable water within reasonable distances from their dwellings and many thousands more take water from water sources and use it untreated because of problems experienced with adequate and reliable potable water supply. Surface waters have steadily become more polluted – especially with regard to microbiological quality, which exacerbates the situation of the immuno-compromised when drinking inadequately treated or poor-quality water. A number of home treatment systems and devices are being used internationally by small, rural communities without potable water services (decentralised systems). These units vary from the most simple – such as using material as filter – to the most sophisticated systems treating grey-water to potable standards. Although various systems and devices have been extensively reported on in the literature, and some exploratory work has been performed in South Africa, little is known locally about the existing options – and little has been done to assist local communities or their advisers in making informed choices on whether such a system or unit will be appropriate to their situation, or which unit should be selected. This project will meet the need to source and investigate appropriate units, to determine their efficiencies of contaminant removal under local conditions as well as their sustainability potential, and to provide guidance on the selection and use of these units under local conditions.

Estimated cost: R1 200 000  
Expected term: 2009 - 2012

### **Programme 3: Drinking water quality**

#### **β-N-methylamino-L-alanine bioaccumulation and bio-magnification: Health risks and water treatment possibilities**

Nelson Mandela Metropolitan University  
No. 1885

β-N-methylamino-L-alanine (BMAA) is a neurotoxic, non-proteinogenic amino acid produced by the majority of cyanobacterial isolates. Free-living freshwater cyanobacteria from all five taxonomic sections were found to contain BMAA, in a study conducted by the team, which concluded that most if not all cyanobacteria produce BMAA. Cyanobacteria frequently found in drinking water sources have been found to produce BMAA. In addition to potential risk from free or cyanobacteria-associated BMAA, the potential for exposure to significant doses due to consumption of bioaccumulated BMAA from sources higher up the food chain is much greater. However, no

information on bioaccumulation or bio-magnification in aquatic ecosystems exists. The scope of the study is to investigate the potential risk by evaluating bioaccumulation, bio-magnification and toxicological effects of these in aquatic ecosystems. The aim is to investigate the potential for health risk to consumers via indirect exposure to cyanobacterial BMAA and to evaluate treatment processes for BMAA removal from water.

Estimated cost: R1 800 000

Expected term: 2009 - 2011

#### **Rapid enzymatic detection of organochlorine pesticides in water**

Rhodes University

**No. 1902**

Endocrine-disrupting substances in the environment have become a concern over the past few years. The organochlorine pesticides (OCPs) (one of the groups of insecticides) are known to be EDCs and among the most persistent organic pollutants present in the environment, and tend to accumulate in organisms. A study done by the team has shown that the detection of various OCPs in isolation and in combination using a rapid alkaline phosphatase assay is indeed feasible in the South African context. The aim of this proposal is to optimise this alkaline phosphatase bioassay using the latest substrate technology for increased sensitivity, to determine the potential for interference by metals and organophosphate pesticides, and to investigate the feasibility of application into an affordable (cost-effective) biosensor system.

Estimated cost: R600 000

Expected term: 2009 - 2011

### **THRUST 4: INDUSTRIAL AND MINE-WATER MANAGEMENT**

#### *Programme 4: Minimising waste production*

##### **Development of a zero-effluent mathematical model for wastewater minimization in a pharmaceutical facility**

University of Pretoria

**No. 1898**

This new investigation is intended to be a spin-off project from WRC Project No. K5/1625, which was successfully completed in September 2007, whose aim was to develop a complete process integration framework for wastewater minimisation in multipurpose batch plants using a rigorous mathematical optimisation framework. During the course of project K5/1625 another opportunity, which is particular to industries that utilise water as a major ingredient in their final product, became apparent. The pharmaceuticals industry features very high in this category. Using careful analysis with proper understanding of these processes, a mathematical technique can be derived that could lead to almost zero-effluent operation. Preliminary

results, using data from Johnson and Johnson (Pty.) Ltd., suggest that it is very possible to achieve this goal. This project aims to develop the model further and optimise it at a full-scale plant. In addition to the environmental benefit of water conservation, this research will result in significant savings in revenue. This is mainly due to the fact that the operations of interest generally produce wastewater containing product that can be recovered. Currently more than 500 t/a of product is dispensed with as effluent, which translates to more than R7 m. in lost revenue. This project thus aims to set up optimal water requirements and effluent generation in batch chemical plants, as well as designs to achieve the targets. Users of this product will also be able to assess the financial benefit of the application, without interfering with the existing plant operations. It is anticipated that a novel mathematical technique for zero-effluent in multipurpose batch plants will be developed and that this tool can be used by the chemical industry, regulators and DWA in assessing and improving the efficiency and environmental performance of batch chemical plants. There is also a possibility for a patent to be applied for, as this is promising to be a revolutionary idea that might rekindle global interest in this area.

Estimated cost: R466 480

Expected term: 2009 - 2011

#### *Programme 5: Improved ability to predict and quantify effects*

##### **Field-testing methods to determine the evaporation rates on brine solutions produced from mine water treatment**

Golder Associates Africa (Pty.) Ltd.

**No. 1895**

Several coal mining groups in Mpumalanga have found that they will have excess water which needs to be treated, either currently or in the near future. Strict water quality targets must be met for either potable use or discharge to the environment. The most cost-effective technology currently available to achieve the targets is usually reverse osmosis, which produces a concentrated brine requiring an environmentally sound and stable disposal method. In Mpumalanga, evaporation ponds are the preferred brine disposal method. A good estimate of the evaporation rate is required to size a brine disposal pond. The salinity of the water results in a reduction in the evaporation rate. It is suggested that the evaporation rate for water at the disposal area is multiplied by a factor of 0.7 to determine the evaporation rate of brine. However, the evaporation rate varies from location to location and depends on the composition of the solution being evaporated. Very little literature is available on the evaporation rate of brine solutions, and this study will benefit the water engineering community of South Africa and result in more reliable information for use in the design of the brine disposal facilities by filling this knowledge gap.

Estimated cost: R452 100

Expected term: 2009 - 2010

## **Programme 6: Beneficiation and treatment of industrial and mining effluents**

### **Nanotechnology in water treatment**

University of the Western Cape

**No. 1897**

The National Nanotechnology Strategy has identified water treatment as a prime area of focus. Nanotechnology could lead to advanced water treatment technologies. Promising techniques include photo- and electrocatalytic materials, leading to the destruction of contaminants, and new nanostructured materials such as filtering membranes or adsorbents that could purify even the worst wastewater. This project aims to develop a suite of nanotechnology-based water treatment technologies through stages of fundamental research, process engineering and pilot plant evaluation. The investigations will include nanostructured ion-exchangers and adsorbents, development of in situ generated ozone to sterilise water, nanospray desalination and electrospun nanofibres for application as filters. Fundamental research will be conducted to understand the molecular mechanisms by which the technologies proceed and the processes will then be optimised for industrial application using first laboratory-scale rigs and then on-site pilot plants.

Estimated cost: R1 483 000

Expected term: 2009 - 2012

### **Laboratory and pilot scale development of the Ambient Temperature Ferrite Process (ATFP)**

Phatamanzi Water Treatment

**No. 1891**

The Western Utilities Corporation has selected a CSIR desalination process for the treatment of acid mine drainage in Ekurhuleni. The process removes sulphate from the water by precipitating barium sulphate. Only the sulphate associated with calcium (saturated calcium sulphate) can be removed using this technology, and therefore as a pre-treatment it is necessary to raise the pH of the water to precipitate magnesium hydroxide and calcium sulphate as well as all metals. Previous projects made use of several steps for removing the metals, magnesium and calcium sulphate from the water. The number of unit operations required in this process added significantly to the capital costs, and the focus of this project is to reduce these costs by replacing several steps with the ambient temperature ferrite process (ATFP). The main objective is to prepare the ATFP for inclusion in the CSIR process. The project has been divided into four parts, each with specific objectives, but resulting in a final design algorithm for the ATFP for all applications. The four parts to this project will investigate each unit operation of the process so that better understanding of the interrelationships between the unit operations can be developed, and to prove that ferrite is a suitable process for metal removal from AMD.

Estimated cost: R1 776 957

Expected term: 2009 - 2010

### **Pilot application of a dual stage membrane bioreactor for industrial effluent treatment**

Alt Hydro cc

**No. 1900**

Over the past decade solutions are increasingly sought using membrane bioreactor technology. This is mainly due to recent refinements and lowering of costs associated with this technology. Significant improvement in process efficiency associated with the treatment of industrial effluent using a novel dual-stage side-stream membrane bioreactor has been previously reported. This dual-stage approach to wastewater treatment using this membrane bioreactor configuration greatly enhanced performance and increased the long-term adaptability and stability of the developed and retained microbial populations within the system by facilitating a continuous microbial ecology management strategy. Compared to conventional suspended culture wastewater treatment processes, this system facilitated a 75% improvement in acclimation efficiency of the resident microbial consortia, which translated directly to considerable improvements in the resultant effluent quality and consistent operation of the treatment process. However, variations in wastewater streams make it imperative to assess the performance of the system on-site and at the pilot-scale level, in order to accurately gauge the impact of real wastewater challenges on the robustness of the process technology. This pilot project therefore aims to develop on-site wastewater treatment solutions for industries typically targeted by DWA as it increases its monitoring and legislative framework capacity. As legislative enforcement is addressed, increasingly, industrial offenders responsible for further burdening already overloaded municipal WWTP infrastructure are now being forced to seek on-site wastewater solutions prior to discharge. This technology aims to address these increasingly prevalent needs by providing a mobile, adaptable solution to specific industry needs.

Estimated cost: R950 000

Expected term: 2009 - 2011

## **THRUST 5: SANITATION AND HYGIENE EDUCATION**

### **Programme 1: Advocacy, health and hygiene education**

#### **Survey of hand-washing hygiene behaviour**

Sustento Development Services

**No. 1886**

Hand-washing is universally accepted and promoted for health interventions, but an assessment has not been completed in South Africa to benchmark or measure the impact of programmes designed to improve hand hygiene behaviour. The unique nature of the South African environment must be better understood in order to develop more appropriate and effective hand-washing messages and programmes. It is imperative to develop a methodology to measure the effectiveness of

the efforts being made and to determine what activities are most successful in changing behaviour. Hand-washing must be indicated by a community's willingness to actually do it - even though they might seem to admit that they think it is important. These results will be used to guide the development of future hand hygiene and public health programmes to deliver improved performance more efficiently. The study will measure whether a hygiene education intervention is having effect on both the quality and the frequency of hand-washing behaviour and which hygiene and hand-washing promotion activities appear more effective at stimulating and sustaining behavioural change.

Estimated cost: R520 670  
Expected term: 2009 - 2011

### **Programme 2: Peri-urban sanitation research**

#### **Establishment of sanitation technology demonstration centre**

CSIR

**No. 1890**

Knowledge and dissemination of sanitation technologies have been found to not be effectively transferred through guidelines. In fact, guidelines and reports have more meaning for technical practitioners; however, the key decision makers rarely have a good understanding of the reality of the technology and its benefits. In South East Asia, the concept of sanitation technology centres and sanitation marts have proved successful in promoting technology and its acceptability. A sanitation demonstration concept consists of a site where full-scale models of technology are available for viewing (a sort of a museum), which enables one to learn and understand, as well as appreciate, the function and benefits of the technologies available. In South Africa, there is a lack of such a facility or facilities which communities, councillors and emerging professionals can access to appreciate technologies. Thus there is a need for a sanitation technology demonstration centre which can house and accommodate all existing and new sanitation technology products in existence. This will assist and facilitate decision makers and communities to have direct access to view and learn about the technology options. The study will establish a sanitation technology centre, where to-scale models of different types of sanitation technologies will be constructed for training and display. The sanitation technology platform will form part of a wider housing-services technology demonstration centre.

Estimated cost: R596 600  
Expected term: 2009 - 2011

### **Programme 3: Institutional and management aspects of sanitation service delivery**

#### **An approach to reduce risks and hazards from human waste generated by informal settlements**

Cape Peninsula University of Technology

**No. 1901**

Human settlement strategies continue to seek alternative approaches to confronting the growth of informal settlements while rapid urbanisation of poverty poses serious challenges to municipalities. Housing delivery has failed to address downstream water pollution. This study will identify realistic opportunities for informal settlements' residents to contribute to on-site improvements of basic waste disposal systems, in partnership with municipalities. The capacity of informal residents to contribute to protecting their immediate environment will be explored.

Estimated cost: R587 800  
Expected term: 2009 - 2011

### **Programme 4: Technical sustainability of sanitation services**

#### **Piloting and testing the pour flush latrine technology for its applicability in South Africa**

Partners in Development

**No. 1887**

Recent research studies concluded by the WRC have raised many concerns about the long-term sustainability of dry sanitation technologies. The studies have found that the technology has led to unintended consequences due to misuse by users, as well as the lack of understanding of the science of dry sanitation systems. A combination of these factors and the stringent design requirements are proving it difficult to access pits for pit emptying. This is further compounded by user behaviour which is resulting in the intrusion of solid waste, plastics and other undesirables into the pits, resulting in difficulties around pit emptying and the rapid filling of pits. This coupled with the fact that there is no easy mechanical or physical *modus operandi* for servicing full pits. All of these issues are raising many new challenges which jeopardise the sustainability and the target set by government for coverage of sanitation. Amongst the suite of technologies, pour-flush latrines, which are used widely as a basic sanitation norm in South East Asian countries, have the potential to resolve many of these issues. However, very little promotion and application has been done in South Africa. This research study aims to create an understanding of the technical, social and environmental challenges associated with its application.

Estimated cost: R1 000 000  
Expected term: 2009 - 2011

# CONTACT PERSONS

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### **Ms A Moolman** (until 31 March 2010)

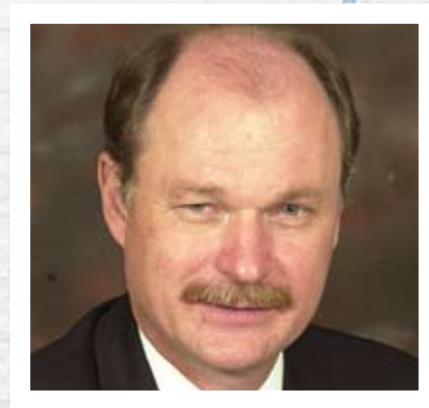
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# KSA 4: WATER UTILISATION IN AGRICULTURE



*Dr Gerhard Backeberg:  
Director*

## SCOPE

The strategic focus in this KSA is on increasing the efficient use of water for production of food, fibre, fuel-wood and timber; ensuring sustainable water resource use; reducing poverty and increasing the wealth of people dependent on water-based agriculture. The needs and requirements of present and future generations of subsistence, emergent and commercial farmers is addressed through creation and application of water-efficient production technologies, models and information systems within the following interrelated sub-sectors of agriculture, namely:

- Irrigated agriculture
- Dry-land agriculture
- Woodlands and forestry
- Grasslands and livestock watering
- Aquaculture

The challenge for applied research and knowledge dissemination is to exploit opportunities and to provide solutions to practical problems which are experienced in the process of utilisation, development and protection of water resources, thereby contributing to productivity growth in agriculture.

## OBJECTIVES

The primary objective is to increase household food security and to improve the livelihoods of people on a farming, community and regional level through efficient and sustainable utilisation and development of water resources in agriculture.

The secondary objectives are to:

- Increase biological, technical and economic efficiency of water use

- Reduce poverty through water-based agricultural activities
- Increase profitability of water-based farming systems
- Ensure sustainable water resource use through protection and reclamation practices

## THRUSTS AND PROGRAMMES

### THRUST 1: WATER UTILISATION FOR FOOD AND FIBRE PRODUCTION

**Scope:** The direction and driving force for research activities and outputs are determined by the strategic focus to improve the knowledge of the processes of production of field, horticultural and industrial crops. Water productivity can be increased by producing more with the same use of water or by producing the same with less use of water. This requires understanding of water dynamics in the soil-water-plant-atmosphere continuum, the equipment which is used and the method of production which is followed. Research on all these aspects can contribute to higher water use efficiency in agriculture. Various processes and factors, which are site-specific, have an influence on the quality of water for crop, livestock and fish production. Significant shortcomings exist in the assessment of the fitness-for-use of water sources and identifying water-related production problems. The emphasis in this programme is on the efficient use of water and management of water quality for irrigation of crops, livestock watering and aquaculture in rivers, ponds and dams. This thrust includes two programmes:

- Water-efficient production methods in relation to soils, crops and technology in rain-fed and irrigated agriculture
- Fitness-for-use of water for crop production, livestock watering and aquaculture

## **THRUST 2: WATER UTILISATION FOR FUELWOOD AND TIMBER PRODUCTION**

**Scope:** The direction and driving force for research activities and outputs are determined by the strategic focus to improve the knowledge of the processes of production of trees in woodlands, plantation forestry and trees planted in combination with food and forage crops. In catchment areas where trees are a prominent feature of land use, runoff and deep percolation of water can be reduced. Management of these so-called streamflow reduction activities necessitates an understanding of the water use by trees and the competitive or complementary relationship of water use by trees and water use by staple food and forage crops. Due to research specialisation, separate attention is given in this programme to increase the efficiency of water use by trees in woodlands and plantations for fuel-wood and timber production. This thrust includes one programme:

- Water-efficient production methods and systems in agro-forestry, woodlands and forestry plantations

## **THRUST 3: WATER UTILISATION FOR POVERTY REDUCTION AND WEALTH CREATION IN AGRICULTURE**

**Scope:** The direction and driving force for research activities and outputs are determined by the strategic focus to improve the knowledge of the management processes undertaken by people who are using water. Poverty, hunger and malnutrition amongst rural people are widely recognised as major problems. These members of rural communities, consisting mainly of women, children and the elderly, are also disadvantaged or marginalised for various social, economic and political reasons. A wide-ranging programme is required to support the sustainable development of rangeland livestock, rain-fed and irrigated crop production. Efficient use of water through a combination of agricultural activities can contribute to improving living conditions. Empowerment of rural people can be promoted further through participatory action research which improves knowledge, farming skills and leadership capabilities. Commercial farming is a major user of water resources and faces a particular challenge to ensure that this share of water is used effectively and efficiently. There is invariably a close link between efficient use and allocation of water and whole-farming profitability. Water management on farms is also time-dependent and based on incomplete knowledge of changes in the weather, prices and technology. Under these circumstances modelling is a powerful tool to provide decision-support and management advice. The focus in this programme is therefore on developing procedures, methods and models to provide advice to farmers on best management practices and the optimal combination of crop and livestock enterprises within the constraints of water, land and capital resources. This thrust includes two programmes:

- Sustainable water-based agricultural activities in rural communities
- Integrated water management for profitable farming systems

## **THRUST 4: WATER RESOURCE PROTECTION AND RECLAMATION IN AGRICULTURE**

**Scope:** The direction and driving force for research activities and outputs are determined by the strategic focus to improve the knowledge of the natural processes and people-induced impacts of resource use. With cultivation and irrigation, larger quantities of salts present in the soil and lower strata could be mobilised. Increasing salinity levels and higher water tables threaten the sustainable use of soil and water. Knowledge and tools to manage the quantity and quality of water resources for agricultural production are therefore required. The focus of research is on developing methods and models to manage water distribution and prevent water resource degradation. Agricultural decisions to use land and to conserve rainfall or to abstract water from rivers, dams and boreholes, has wide-ranging impacts on the natural environment. Intensification of crop and livestock production processes can potentially contribute to higher levels of chemical residues of fertilisers, pesticides and herbicides in surface and groundwater. Precautions must be taken as part of the agricultural production process to protect the terrestrial and aquatic ecosystems. This requires an understanding of the negative impacts of agriculture and guidelines for an assessment and mitigation of those impacts. This thrust includes two programmes:

- Sustainable water resource use on irrigation schemes and within river catchments
- Impact assessment and environmental management of agricultural production

## **RESEARCH PORTFOLIO FOR 2009/10**

In this KSA a holistic systems approach is followed for knowledge creation and dissemination to enable people to utilise water in a sustainable way for food production and improved livelihoods. Key issues being addressed are the productivity of water use for crops and livestock, poverty reduction and wealth creation in rural areas and prevention of resource degradation. These efforts are aligned to the DWA strategy *Water for Growth and Development* (Version 6), the National Agricultural Research and Development Strategy and to the Comprehensive Africa Agricultural Development Programme of NEPAD. Work will continue to fill knowledge gaps that exist in the utilisation of water in agriculture, under the following themes of the research portfolio:

- Irrigation and water use efficiency
- Fitness-for-use of water in agriculture
- Water use efficiency in agro-forestry and woodlands
- Aquaculture in rural livelihoods
- Rainwater harvesting and conservation
- Adaptive research of technologies in rain-fed and irrigated agriculture
- Technology transfer of water management models
- Impact of land-use management on point and diffuse pollution in agriculture

During the past 7 years a strategic shift has been made to achieve a balance between research projects in irrigated and rain-fed agriculture, agro-forestry and aquaculture; to promote farmer involvement in poor rural communities through participatory action research; and to take research projects further to practical application of results with technology transfer projects. An overview of completed and ongoing projects indicates the direction and priorities for future research. In 2009/10, emphasis was placed on the water use of trees/crops and the area which is suitable for biofuel production based on bio-climatic criteria; water use and nutritional value of food crops of economic importance in the diets of the rural poor; impacts of micro-organisms found in irrigation water on food safety; modelling of water use, bio-mass production and economic value of indigenous trees under plantation conditions; incentives and organisational structures for empowerment of women and including emerging farmers in rain-fed and irrigated agriculture in the mainstream of the economy; culture-based fisheries in small and large dams for fish production and household food security; GIS-based methods to monitor the extent of salinisation and standards to evaluate the feasibility of drainage; precautionary measures for wastewater use; assessment of the impact of agricultural chemicals on water resources; restoring the grazing capacity of rain-fed natural grasslands for livestock production with biogas generation; and adaptive practices to reduce vulnerability of farming systems to climate change.

## BUDGET FOR 2009/10

The approved funding of the research portfolio for 2009/10 led to committed funding of R22 162 051, including R3 946 820 for new projects.

## CORE STRATEGY

### Strategic context

The strategic context for research on water utilisation in agriculture, as presented in previous years, has been given renewed impetus by a 2008 report of the National Agricultural Marketing Council (NAMC), which serves the strategic positioning of South African agriculture. It is reported that food production has not kept pace with consumer demand, mainly driven by population growth and increasing per capita income, leading to food price increases. Several factors have contributed to the poor performance, including adverse climatic conditions, lack of availability and quality of water, and low profitability with lack of investment because of high input costs and insufficient progress to increase productivity. The report highlights the importance of making available adequate water and fertiliser production inputs and the need to improve

agricultural support through research in order to increase food production. The water resource base is therefore of key importance in agriculture. Together with other renewable and interdependent natural resources, it forms the ultimate support of the productive economic activity of people.

Water utilisation can best be quantified as rainfall-dependent, surface water- and groundwater-dependent use. Approximately 12% and 62% of rainwater in South Africa is used annually for dry-land cropping and by natural grasslands, woodlands and forests, respectively. Rainwater runoff and deep percolation become available as surface- and groundwater, of which approximately 62% is used for irrigation. It is abundantly clear that the biggest share of water is used for both extensive and intensive production in agriculture.

The significance of agriculture and the impact of research in the development process encompass the following:

- Everybody in society consumes food. Technological progress in agriculture therefore has widely distributed benefits.
- Agriculture is the key to poverty reduction in rural areas. Water resource use and production should be analysed as a value-adding process (from farmer to consumer) and the business and employment opportunities which are created must be recognised.
- Research increases the productivity of natural and human resources. This improves the competitive advantage of agriculture in a global economy.

In South Africa, at most 35% of the economically active population are directly or indirectly dependent on agriculture, although this percentage is declining each year. This consists primarily of small-, medium- and large-scale enterprises, which provide employment opportunities for formal and casual labour. Furthermore, 42.7% of the population are rural survivalists with traditional agrarian lifestyles. Estimates also show that 48.5% of the population are living below the poverty line and the numbers of rural poor are gradually decreasing.

As is typical of an industrialised economy, the relative contribution of agriculture, forestry, hunting and fishing is low, at between 2 to 3% of gross domestic product (GDP). The forward linkages to processing industries and backward linkages to input suppliers in agriculture are, however, of considerable importance for economic activity in urban and rural areas, increasing the contribution to 20 to 30% of GDP. Until 2006, agriculture was also a net exporter of food, contributing 10% of total exports of which 50% are processed products. During 2007 imports exceeded exports, mainly due to import of processed food products.

The above-mentioned current reality of agriculture in South Africa is also clearly stated by the Department of Water Affairs in the strategy on *Water for Growth and Development in South Africa* (Version 6). Effective change in water use behaviour to

promote water savings for growth could be achieved through incentives to improve irrigation efficiency and conservation practices. These include water measuring and user charges as tools to manage demand, upgrading irrigation technology and trading of water use entitlements. Revitalisation of irrigation schemes in the former homelands is required for household and community level irrigation. Furthermore it is important to provide water for food production in home gardens in rural villages or towns and peri-urban areas. This can be done through development of small-scale infrastructure for different forms of rainwater harvesting and storage which promotes rural development.

Critical issues in the forthcoming years and the next 2 decades are increasing the pressure on agriculture and forestry, in particular food and fuel-wood production, due to population growth, urbanisation and increasing consumer income levels. Expansion of agricultural production on land suitable for cultivation will be constrained by the availability of water. Increasing hazards of rainfall variability, with western parts of South Africa getting drier and eastern parts wetter over the long term, are caused by climate change. This requires adaptive management practices to reduce the vulnerability of people in rural areas and prevent disasters of crop failures, income loss and widespread famine. At the same time, there is a high ratio of people to cultivated land and a dependence on agriculture in rural areas to increase material income and improve social wellbeing, particularly of the poor. All of this will bring pressure on the water resource base.

It must be recognised that the use and development of water resources by people has both beneficial consequences, as mentioned above, and detrimental consequences. Negative impacts of water use include soil erosion, sedimentation, water-logging and salinisation. Important issues, which must receive attention, are the nature of resource degradation, underlying causes and feasible reclamation practices. Consequently, although the quantity and quality of water resources available for agricultural use are limited, it is important to note that this is not a constraint for economic development. The requirement is that water resources must be utilised productively and greater efforts must be made to increase productivity growth and thereby the competitiveness of agriculture.

With this background it is important to emphasize that the strategic focus of water research in this KSA, which was also found to be relevant by the 2006 External Institutional Review, will continue to be on:

- Increasing the efficiency of water use for food, fibre, wood and timber production (i.e. improving the knowledge of biological, technical and economic processes of production)
- Ensuring sustainable water resource use in rain-fed and irrigated areas (i.e. improving the knowledge of natural processes and people-induced impacts of resource use)
- Increasing the household food security and profitability

of farming and thereby the livelihoods of people dependent on agriculture (i.e. improving the knowledge of management processes by people who are using water)

In drawing up plans to implement these strategies, cognisance has to be taken of the national needs, technological trends and stakeholder expectations.

### Needs analysis

Previously identified needs, re-affirmed by recent reports and reviews, continue to give direction to applied research.

During 2000 the Presidential Imperative Programme on Integrated Sustainable Rural Development was announced. The goal of the programme is to promote development and improve the quality of life of marginalised groups and communities. The objectives are to alleviate poverty through enhanced production, productivity, creation of employment opportunities and a more equitable distribution of resources. Outputs which are envisaged include agricultural production systems and sustainable utilisation and management of natural resources and the environment.

At the end of 2001 the Strategic Plan for South African Agriculture was released by the National Department of Agriculture, Agri SA and the National African Farmers Union (NAFU), and is currently being revised. The strategic goal is to generate equitable access and participation in a globally competitive, profitable and sustainable agricultural sector, contributing to a better life for all. This strategic goal is expected to guide all relevant partners in their quest to deliver and implement a range of programmes in accordance with basic premises of amongst others:

- Fair reward for effort, risk and innovation
- Security of tenure for present and future participants
- The sustainable use of natural and biological resources
- Sound research, science, knowledge and technology systems
- Market forces which direct business activity and resource allocation

The outcomes which are envisaged to flow from successful implementation of programmes include:

- Increased creation of wealth in agriculture and rural areas
- Increased sustainable employment
- Increased income and foreign-exchange earnings
- Reduced poverty and inequalities in land and enterprise ownership
- Improved farming efficiency
- Improved national and household food security
- Increased investment in agricultural activities and rural areas

One of the three core strategies which are discussed in the strategic sector plan for agriculture is sustainable resource management which also impacts on water systems. Central to this strategy is, *inter alia*, the promotion of sustainable use of soil and water through increased crop and livestock productivity and intensified farming systems, while farmer participation is a key success factor. Degradation of soil and water resources is considered to be a serious threat and therefore programmes must be designed to overcome the causes of degradation. Such soil and water conservation programmes will focus on areas where there is a reasonable chance of success, as determined by, e.g., available technologies and access to markets, inputs and services.

On a regional level the Comprehensive Africa Agriculture Development Programme (CAADP) of the New Partnership for Africa's Development (NEPAD) (2003), places the focus on land and water management as one of four pillars for priority investment. It is stated that 'water and its managed use has been an essential factor in raising the productivity of agriculture and ensuring predictability in outputs. Water is essential to bring forth the potential of the land and to enable varieties of both plants and animals to make full use of other yield-enhancing production factors. By raising productivity, water management (especially when combined with adequate soil husbandry) helps to ensure better production both for direct consumption and for commercial disposal, thereby enhancing the generation of economic surpluses which are necessary for uplifting rural communities.'

A call is made for increased investment in land and water and the point is made that 'protecting and improving water and the soil makes good business sense'. It is indicated 'that by enabling a rapid increase in production, irrigation can make food more readily available but that its impact on reducing hunger depends on appropriate arrangements for the poor to have access to irrigated land'. The further point is made that 'while increased irrigation is not a panacea for all agricultural ills, it nevertheless makes possible other opportunities for agricultural growth such as better husbandry of soils and resources in general, and makes more worthwhile the use of fertilisers, improved plant varieties and upgraded infrastructure'.

The Development Report by the DBSA (2005) found that 'the poverty problem remains a predominantly rural phenomenon'. Furthermore farming still provides 'a major source of income for many rural communities in South Africa' and therefore contributes to poverty alleviation. This role can be strengthened by investment in the drivers of agricultural development, namely human capital, biophysical capital, rural institutions and agricultural research. The conclusion is 'nonetheless, while agriculture plays a major role in poverty alleviation, promoting the growth of smallholder agriculture alone cannot solve the poverty problem in South Africa. More attention should also be given to the promotion of non-farm activities (e.g. agro-industries), particularly those that are linked to the smallholder

agricultural sector. A strategy that strengthens farm/non-farm linkages is likely to yield better results with regard to employment and income generation'.

In the biannual *Overview of the World Food Situation* by the International Food Policy Research Institute (IFPRI) at the end of 2007, it is stated that renewed attention must be given to agriculture, nutrition and health in adjusting research agendas. Strategies must be directed at poor members of society. In this regard social security measures must be taken that focus on early childhood nutrition, particularly of poor households. With increasing risks caused by climate change, more investments must be made in agriculture to improve productivity. This includes investment in agricultural science and technology to facilitate a production response to rising food prices.

At a conference on Nutrition and Food for Special Dietary Uses in November 2008, the Minister of Health stated that 'food insecurity and high rates of malnutrition, coupled with high food prices, remain the biggest threat to nutrition in Africa'. More research is thus needed in support of programmes that will improve health through balanced nutrition and the availability of food at reasonable prices.

Finally, specific recommendations made by the then Department of Water Affairs and Forestry in 2008 to promote water for growth and development of agriculture are: measure-ment of water; correct scheduling and implementation of appropriate technologies to enhance efficiency and to reduce the amount of water used for irrigation; re-establishment of high value crops under irrigation in areas where production can be supported on a sustainable basis; revitalisation of irrigation schemes and exploring, developing and using groundwater for small-scale irrigation on household and community food plots; and investment in small projects for rainwater harvesting and conservation in rural areas.

These needs as expressed by Government, public organisations and farmer representatives at national, regional and international levels are still relevant and as in previous years, highlight the key issues which must be addressed in the WRC research portfolio:

- Increased productivity of water for crop and livestock production
- Uplifting rural economies through commercial production
- Eradication of hunger and poverty
- Improved nutrition and health
- Prevention of soil and water degradation
- Involvement of farmers in research

### Overview of technological trends

In the book *The Necessary Revolution* (2008) it is argued that 'previously taken-for-granted aspects of daily life – food, water, energy, predictable weather – seem less and less reliable'. The reasoning continues that 'if we see each problem – be it

water shortages, climate change or poverty – as separate, the solutions will be short-term, doing nothing to address deeper imbalances. The first imbalance concerns nature's capacities to regenerating resources and providing the 'eco-services' upon which human life depends – clean water, breathable air, fertile soil, pollination and a stable climate'. It is stated that the 'diminishing resources and growing waste underlie a host of economic stresses and reflect environmental and social imbalances that all but ensure that, without significant change, these problems will worsen'. Consequently a shift in thinking is required to start a revolution that can transform society. This pre-supposes that core capabilities must be acquired of observing and analysing systems in practice, collaborating across disciplinary boundaries and creating a new reality instead of finding opportunistic, 'quick-fix' solutions.

In KSA4 explicit efforts will continue to stay at the forefront of new technological developments and ensure application of existing technologies. This is achieved by purposefully leading the innovation cycle, which involves scientific research, practical application of inventions and exploitation of the commercial potential of the research output. A balance must therefore be found between research projects and technology transfer projects and also between research on appropriate technologies for irrigated and rain-fed agriculture.

With a growing demand for water in the domestic and industrial water-use sectors, the competition for water currently used for agricultural production will increase in future. Technologies, models and methods are available to improve the efficiency of irrigation water use in different stages of, e.g., canal and on-farm water distribution, field application and irrigation scheduling. With the demand for food also increasing in a globalised trade environment, agricultural production will have to be competitive in both local and overseas markets. While irrigated agriculture contributes 25 to 30% of gross production, technological and managerial innovations are required in all subsectors of agriculture to reduce costs and to increase income.

In particular, attention will continue to be given to rain-fed agriculture and the existing technologies which have been developed for water harvesting in sub-Saharan Africa. The challenge for research is therefore to adapt or develop and apply technologies which will enable water conservation in rain-fed agricultural production on dry-lands, grasslands and woodlands. In the case of irrigation, locally available technologies must be integrated and the financial benefit of efficient water use must be demonstrated over all stages of water distribution and application. Emphasis must be placed on making all technologies and models user-friendly. This requires attention to the specific needs of traditional subsistence farmers and modern commercial farmers.

The twofold effort to develop technologies for increased water-use efficiency in both rain-fed and irrigated agriculture, is also in support of global trends: As part of the water focus of the *World*

*Summit on Sustainable Development (WSSD)*, the recommended target is to increase water productivity in rain-fed and irrigated agriculture to enable achievement of food security for all people without increasing water use above levels for 2000. Furthermore, one of the four programmes identified within the New Partnership for Africa's Development (NEPAD) initiative is to expand the extent and operation of integrated land and water management, with the main emphasis on the eradication of poverty in Africa. These trends have been reinforced by the *Comprehensive Africa Agriculture Development Programme of NEPAD*, published in July 2003.

According to the National Agricultural Research and Development Strategy by the Department of Agriculture (2008), a key area for technology development is sustainable natural resource management. The statement is made that... 'Farmers maximize income and risk in a dynamic context and often under harsh conditions and serious constraints. Research must respond to these challenges through inclusion of technologies to address sustainable natural resource management. This would include technologies to address soil erosion degradation, nutrient depletion, loss of bio-diversity, prevention of invasion by alien species, maintenance of water quality and veld productivity, optimization of water use efficiency under both irrigated and rain-fed conditions, capturing and storing rainwater (rainwater harvesting) and restoration or creation of new balances in biotic communities. Geographic Information System-based technologies, natural resource inventories and adequate characterisation and monitoring are considered essential.'

### **Key stakeholders**

This KSA strongly supports South African Government strategies and initiatives where water conservation and in particular water utilisation for agriculture is of concern. Government departments, especially the Department of Water Affairs and the Department of Agriculture, are important stakeholders. These links have also been formalised by the support of selected projects of mutual interest through leveraged funding. In addition, District Municipalities, Provincial Departments of Agriculture, water user associations (WUAs), catchment management agencies (CMAs), cooperatives and agribusinesses, are all stakeholders with whom the WRC is engaging. In all cases co-operation is achieved by invitations to review research proposals and to serve on the reference groups of relevant research projects.

Key stakeholders and beneficiaries of this KSA remain as previously described. These are farmers who are represented by Agri SA and NAFU. Communication channels exist with officials in the representative organisations on a national level. A more effective range of communication strategies has been designed by formalising stakeholder relationships. It is gradually being implemented to reach farmers and their representatives on a provincial and local level. The purpose is to obtain an accurate indication of practical problems which they are facing and what

their assessment is of the priorities for research, technology transfer and extension.

## STRATEGIC INITIATIVES

### National initiatives

The KSA was involved in various key national initiatives:

- The KSA supported a workshop on *Advanced Soil Survey Techniques and Predictive Mapping* which was presented by the Department of Soil, Crop and Climate Sciences of the University of the Free State in August 2009. This was based on WRC Report TT311/07 entitled 'A procedure for an improved soil survey technique for delineating land suitable for rainwater harvesting'
- During the *47th Annual Conference of the Agricultural Economics Association of South Africa (AEASA)* on the theme 'Promoting the competitiveness of South African agriculture in a weakened global economy', September 2009, the KSA Director organised a workshop and made an opening presentation on 'Productive water use, food value chains and mainstreaming of emerging farmers'. Three papers were presented on the conceptual framework and case studies by researchers of WRC Project No. 1779 on 'Assessment of the Contributions of Water Use to Value Chains in Agriculture'.
- The Research Manager organised a workshop for members of the Network on Irrigation Research and Extension for Smallholder Agriculture (NIRESA), October 2009, at Taung in the Northern Cape Province, with participation from national and provincial government departments, the ARC, universities, private consultants and farmers
- A paper entitled 'Rainwater harvesting to improve rural livelihoods' was presented during the annual *Orange River Basin Symposium*, organised by the University of the Free State, November 2009.

### Leadership positions

- Participation continued as Treasurer and additional elected Executive Committee Member of the South African National Committee on Irrigation and Drainage (SANCID) and representative of South Africa and Southern Africa during the International Executive Council meeting held in New Delhi, India in December 2009.

### Public appreciation

The impact assessment study on the Water Administration System was completed in 2009. Discussions were initiated and agreement was negotiated that the Department of Agricultural Economics, Extension and Rural Development of the University of Pretoria undertake an impact assessment on 'Irrigation Scheduling for Efficient Water Use in Food Production'. The focus

will be on WRC-funded scheduling tools such as BEWAB, SWB, PUTU and MyCaneSim. It will be determined whether these technologies or methods were consciously applied by advisors or farmers in view of competing influences, to successfully improve irrigation scheduling of crops.

### African leadership

- The WRC nominated the KSA Director to serve on the Advisory Board of the newly established Institute for Water Economics and Governance in Africa (IWEGA), on invitation of the Centre for Environmental Economics and Policy in Africa (CEEPA) at the University of Pretoria. The mission of IWEGA is to develop knowledge and skills in Africa in water economics and governance by enhancing the capacity of African researchers to conduct research of relevance to African problems. IWEGA aims at increasing managers' and policy makers' awareness about water economics and governance for sustainable development
- The KSA Director and Research Manager participated in Working Group and Task Force meetings, the 60th International Executive Council and the International Commission on Irrigation and Drainage (ICID), December 2009, in New Delhi, India, and were respectively elected as Chairman of the Task Force on Financing Water for Agriculture and as Vice-Chairman of the African Regional Working Group.
- The Chairman of the South African Regional Irrigation Association (SARIA) organised a Symposium for members of SARIA on 16 to 18 February 2010 at the Bloem Spa Lodge and Conference Centre outside Bloemfontein. The theme of the Symposium was 'Best Management Practices for Sustainable Smallholder Irrigation Development' and was funded by DAFF through leverage funding to the WRC.

### International player

The KSA represented the WRC with contributions at three international forums:

- The International Foundation for Sustainable Development in Africa and Asia (IFSDAA) organised the *Second International Seminar* on the theme 'Land resources and land use options: Challenges for food security and sustainable development'. The IFSDAA is an initiative to complement the efforts of umbrella organisations such as the African Asian Studies Promotion Association, universities and research organisations in Europe, Africa and Asia for promotion of technology transfer and participatory exchange of knowledge and experience. The main objective of this *International Seminar* was to deliberate on issues related to land resources and land use options for sustainable development and global food security, biomass energy and livelihood. The *International Seminar* therefore provided a suitable platform to present research results of WRC projects on rainwater harvesting and conservation (RWH&C).

- For the meeting of the ICID Task Force on Financing Water for Agriculture, an international workshop on 'Development and Financing of Irrigation Schemes' was organised by the KSA Director. Various other ICID Working Groups on which South Africa is represented through SANCID were also attended by KSA members
- The Director contributed a paper on 'Institutional reform and modernisation of irrigation systems in South Africa' to the *5th Asian Regional Conference of ICID*, December 2009. This paper was largely based on published WRC research reports, highlighting that knowledge is available for water

measurement, canal water distribution and drip irrigation to improve efficient use and saving of water.

## GROWING THE KNOWLEDGE BASE

### Capacity building initiatives

Table 1 below illustrates the numbers of postgraduate students who benefited from WRC-funded research in this KSA in 2009/10.

**TABLE 1**  
**Capacity building through student involvement in KSA 4 projects in 2009/10**

Organisation/institution	No. of historically disadvantaged (HD) students	Total No. of students
Agricultural Research Council (ARC)	10	11
Aquagreen Consulting	2	5
Asset Research	3	13
CPH Water	0	1
CSIR	5	7
Institute of Natural Resources	2	2
Rhodes University	2	2
Rural Integrated Engineering	10	12
South African Sugarcane Research Institute	1	2
Sigma Beta	6	10
Tshwane University of Technology	21	26
University of Cape Town	1	6
University of Fort Hare	17	17
University of the Free State	5	9
University of KwaZulu-Natal	19	35
University of Pretoria	13	18
University of Stellenbosch	9	19
<b>TOTAL</b>	<b>126</b>	<b>195</b>

Currently 195 students are receiving training as part of KSA 4 projects, of which 126 (65%) are from previously disadvantaged (PD) backgrounds. The total number of students as well as the number of students from previously disadvantaged background has therefore increased by 23% and 12%, respectively, in comparison to 2008/09. Seventy-two (72) female students (35 Black and 37 White), or 37% of the total number, received project related training.

Ongoing efforts are being made to undertake participatory action research projects where farmers benefit directly while

the research is being done. At least 60% of the current and new projects involve some form of on-farm research which enables project-related education and training of farmers. Concerted focus on this type of research is envisaged for new projects in 2010/11 and thereafter.

A national drive was undertaken to support the implementation of the Water Administration System (WAS) for effective water loss control and increased water savings on irrigation schemes. This involved formal discussions with, and sending letters to, amongst others, officials of DWA and AgriSA; funding a

consultancy to develop training material for presenting courses on WAS to water control officers; finalising and publishing the report on the impact assessment of the research for development of WAS; and publishing articles in *The Water Wheel* (November/December 2009), *SABI Magazine* (February/March 2010) and the magazine *Agri* (Winter 2010, forthcoming), to demonstrate the practical relevance of WAS.

During April and May 2009 five workshops were organised, presented and facilitated to develop the Terms of Reference for new solicited research projects:

- *Technical and Financial Standards for Drainage of Irrigated Land*, Pretoria, April 2009
- *Water Use and Nutritional Value of Economically Important Food Crops in the Diets of the Rural Poor*, Pretoria, April 2009
- *Determining the Magnitude of Pollution by Agricultural Chemicals and Potential Risk for the Environment*, Pretoria, April 2009
- *Developing Guidelines for Reclamation of Overgrazed Natural Grasslands through Rainwater Harvesting for Livestock Production and Biogas Generation*, Pretoria, May 2009
- *Assessment of the Potential of Inland Fisheries to Produce Fish for Food Security in Rural Areas*, Pretoria, May 2009

### Knowledge dissemination

One new mechanism for knowledge dissemination was initiated with a series of articles in the SABI magazine which is distributed nationally to irrigation professionals and practitioners.

### Conference presentations and other activities by staff members

- A paper on 'Improving rural livelihoods with rainwater harvesting and conservation on communal croplands in South Africa: Opportunities and obstacles' was presented at the *Second International Seminar of The International Foundation for Sustainable Development in Africa and Asia (IFSDDA)* on the theme 'Land resources and land use

options: Challenges for food security and sustainable development', July 2009, Göttingen, Germany.

- An introductory paper was presented during the international workshop on 'Development and Financing of Irrigation Schemes' held in December 2009, for the meeting of the ICID Task Force on Financing Water for Agriculture
- A paper on 'Institutional reform and modernisation of irrigation systems in South Africa' was presented at the *5th Asian Regional Conference of ICID*, December 2009.
- Continued efforts were made to improve the public understanding of water-related issues by means of popular articles in *The Water Wheel*, and providing brief summaries of recently published WRC reports in the magazine *Agri*, which is distributed nationally to farmers and agricultural interest groups.

## IMPLEMENTATION PLAN

### Research portfolio for 2009/10

As in previous years, the primary objective is to increase household food security, improve livelihoods of people and to increase efficient growth and equitable distribution of wealth on a farming, community and regional level through efficient and sustainable utilisation and development of water resources in agriculture.

The secondary objectives are to:

- Increase biological, technical and economic efficiency of water use
- Reduce poverty through water-based agricultural activities
- Increase profitability of water-based farming systems
- Ensure sustainable water resource use through protection and reclamation practices

A description of the research thrusts and programmes which determine the course of research and allocation of financial resources is given in Table 2.

**TABLE 2**  
**Overview and description of thrusts and programmes**

#### THRUST 1: WATER UTILISATION FOR FOOD AND FIBRE PRODUCTION

Scope: The direction and driving force for research activities and outputs are determined by the strategic focus to improve the knowledge of the processes of production of field, horticultural and industrial crops.

<p><b>Programme 1:</b> <b>Water-efficient production methods in relation to soils, crops and technology in rain-fed and irrigated agriculture</b></p>	<p><b>Scope:</b> Water productivity can be increased by producing more with the same use of water or by producing the same with less use of water. This requires understanding of water dynamics in the soil-water-plant-atmosphere continuum, the equipment which is used and the method of production which is followed. Research on all these aspects can contribute to higher water use efficiency in agriculture.</p>
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<p><b>Programme 2:</b> <b><i>Fitness-for-use of water for crop production, livestock watering and aquaculture</i></b></p>	<p><b>Scope:</b> Various processes and factors, which are site-specific, have an influence on the quality of water for crop, livestock and fish production. Significant shortcomings exist in assessment of the fitness-for-use of surface and underground water sources and identifying water-related production problems. The emphasis in this programme is on the efficient use of water and management of water quality for irrigation of crops, livestock watering and aquaculture in rivers, ponds and dams.</p>
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### **THRUST 2: WATER UTILISATION FOR FUEL-WOOD AND TIMBER PRODUCTION**

Scope: The direction and driving force for research activities and outputs are determined by the strategic focus to improve the knowledge of the processes of production of trees in woodlands, plantation forestry and trees planted in combination with food and forage crops.

<p><b>Programme 1:</b> <b><i>Water-efficient production methods and systems in agro-forestry, woodlands and forestry plantations</i></b></p>	<p><b>Scope:</b> In catchment areas where trees are a prominent feature of land use, runoff and deep percolation of water can be reduced. Management of these so-called streamflow reduction activities necessitates an understanding of the water use by trees and the competitive or complementary relationship of water use by trees and water use by staple food and forage crops. Due to research specialisation, separate attention is given in this programme to increase the efficiency of water use by trees in woodlands and plantations for fuel-wood and timber production.</p>
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### **THRUST 3: WATER UTILISATION FOR POVERTY REDUCTION AND WEALTH CREATION IN AGRICULTURE**

Scope: The direction and driving force for research activities and outputs are determined by the strategic focus to improve the knowledge of the management processes undertaken by people who are using water.

<p><b>Programme 1:</b> <b><i>Sustainable water-based agricultural activities in rural communities</i></b></p>	<p><b>Scope:</b> Poverty, hunger and malnutrition amongst rural people are widely recognised as major problems. These members of rural communities, consisting mainly of women, children and the elderly, are also disadvantaged or marginalised for various social, economic and political reasons. A wide-ranging programme is required to support the sustainable development of rangeland livestock, rain-fed and irrigated crop production. Efficient use of water through a combination of agricultural activities can contribute to improving living conditions. Empowerment of rural people can further be promoted through participatory action research which improves knowledge, farming skills and leadership capabilities.</p>
<p><b>Programme 2:</b> <b><i>Integrated water management for profitable farming systems</i></b></p>	<p><b>Scope:</b> Commercial farming is a major user of water resources and faces a particular challenge to ensure that this share of water is used effectively and efficiently. There is invariably a close link between efficient use and allocation of water and whole-farming profitability. Water management on farms is also time-dependent and based on incomplete knowledge of changes in the weather, prices and technology. Under these circumstances modelling is a powerful tool to provide decision-support and management advice. The focus in this programme is therefore on developing procedures, methods and models to provide advice to farmers on best management practices and the optimal combination of crop and livestock enterprises within the constraints of water, land and capital resources.</p>

#### THRUST 4: WATER RESOURCE PROTECTION AND RECLAMATION IN AGRICULTURE

Scope: The direction and driving force for research activities and outputs are determined by the strategic focus to improve the knowledge of the natural processes and people-induced impacts of resource use

<p><b>Programme 1:</b> <b>Sustainable water resource use on irrigation schemes and within river catchments</b></p>	<p><b>Scope:</b> With cultivation and irrigation, larger quantities of salts present in the soil and lower strata could be mobilised. Increasing salinity levels and higher water tables threaten the sustainable use of soil and water. Knowledge and tools to manage the quantity and quality of water resources for agricultural production are therefore required. The focus of research is on developing methods and models to manage water distribution and prevent water resource degradation.</p>
<p><b>Programme 2:</b> <b>Impact assessment and environmental management of agricultural production</b></p>	<p><b>Scope:</b> Agricultural decisions to use land and to conserve rainfall, or to withdraw water from rivers, dams and boreholes, have wide-ranging impacts on the natural environment. Intensification of crop and livestock production processes can potentially contribute to higher levels of chemical residues of fertilisers, pesticides and herbicides in surface and groundwater. Precautions must be taken as part of the agricultural production process to protect the terrestrial and aquatic ecosystems. This requires an understanding of the negative impacts of agriculture and guidelines for an assessment and mitigation of those impacts.</p>

#### KSA alignment with DWA's objectives

The research thrusts and programmes in KSA 4 have been purposefully designed and structured to achieve mainly:

- Efficient use of water in rain-fed and irrigated agriculture including forestry
- Reducing poverty and increasing profitability levels amongst households and firms in rural communities
- Promoting the protection and reclamation of water resources

Consequently, there are a range of projects in the above-mentioned KSA 4 research portfolio that directly contribute to the related objectives of DWA's Strategic Plan for 2007/08 to 2009/10. Furthermore, the DWA strategy *Water for Growth and Development* contains high-level recommendations which are targeting agriculture. These are increasing growth through savings by reducing inefficient water use for irrigation, and promoting development through small-scale projects in rainwater harvesting. In both cases research reports are available and research projects or technology transfer projects are continuing to support implementation and service delivery. This refers to application of models, guidelines, manuals and tools for efficient water management and effective reduction of water losses for irrigation on scheme, farming, field and crop level. The technologies and procedures already practically applied and proven as useful are the direct and indirect measuring and metering of water; the Water Administration System (WAS) for river and canal water management; the FARMS set of models for calculating capital and operating costs of irrigation equipment and simulating the risk of cash income for various crop combinations; the installation

and maintenance standards of flood, sprinkler, micro- and drip-irrigation methods; the soil water balance (SWB) model, irrigation water management (BEWAB), and MyCanesim model for real-time irrigation scheduling; and the SAPWAT procedure for estimating irrigation requirements of crops.

Guidelines and training material have been developed for revitalisation of irrigation, and knowledge transfer has been undertaken involving agricultural colleges as well as provincial Departments of Agriculture in Limpopo, KwaZulu-Natal and the Eastern Cape, where most smallholder schemes are located. Based on 15 years of research investment, technology transfer, capacity building and knowledge dissemination has been done for infield rainwater harvesting and conservation in the Free State Province and extension manuals have been developed. These principles and practices are applicable in different regions of all other provinces, although the complexities of each farming region will have to be considered and adjustments will have to be made accordingly.

### RESEARCH PROJECTS FOR 2009/10

The findings of projects completed during the year under review are given, as well as a summary of current projects and the motivation and objectives of new projects which commenced between 01 April 2009 and 31 March 2010.

## COMPLETED PROJECTS

### THRUST 1: WATER UTILISATION FOR FOOD AND FIBRE PRODUCTION

#### *Programme 1: Water-efficient production methods in relation to soils, crops and technology in rain-fed and irrigated agriculture*

##### **Adapting the Wetting Front Detector to the needs of small-scale furrow irrigators and providing a basis for the interpretation of salt and nutrient measurements from the water sample**

University of Pretoria (Department of Plant Production and Soil Science)

**No. 1574**

The Wetting Front Detector (WFD) was originally developed as a simple irrigation scheduling tool to fill a perceived gap in the market. A modified WFD, the Tube Detector (TD), was developed and tested in the laboratory, on-station and on-farm. The Tube Detector proved to be an extremely sensitive tool and operated exactly according to theory. Tube Detectors identified severe over-irrigation in farmer's fields, although more work is needed to fully evaluate their potential for the small-scale furrow irrigation sector. The work on soil solution monitoring was carried out both in the field and in large outdoor drainage lysimeters. Good data from SC and WFD were obtained in the orchard trials, with both devices usually indicating very similar trends. Monitoring EC using FullStops has provided valuable practical information on soil salinity, leaching fractions and nutrient leaching. WFDs can play an invaluable role as a learning tool, complementing years of farmer experience. A training package has been produced around the WFD as a learning tool.

Cost: R1 402 000

Term: 2005 - 2009

##### **Increasing water-use efficiency of irrigated sugarcane production by means of good agronomic practices**

South African Sugarcane Research Institute

**No. 1577**

The main objective of this project was to increase irrigation water use efficiency (IWUE) and profitability of irrigated sugarcane production by formulating a set of best management practices (BMPs) that will include optimal use of trash blanketing, variety, row spacing and irrigation. In order to achieve the objectives of the study a combination of field research and crop modelling was utilised. The field trials were conducted at the SASRI Mpumalanga Research Station near Komatipoort and at the SASRI Pongola Research Station, where data were obtained from crops grown on three weighing lysimeters and used to validate the Komatipoort trial results.

Irrigation calendars developed during the project show the recommended irrigation cycle lengths for different months of the year, dependent on harvesting dates. The results obtained in the field trials conducted at Komatipoort and Pongola, as well as an economic analysis based on the simulated responses to the factors investigated, provide some indication of a number of best management practices that could potentially assist in increasing IWUE and profitability of irrigated sugarcane production.

Cost: R243 200

Term: 2005 - 2009

##### **Scoping study on water use of crops/trees for biofuels**

University of KwaZulu-Natal (School of Bioresources

Engineering and Environmental Hydrology)

**No. 1772**

In 2007 the WRC instigated a study to assess both the potential growing areas and water use of potential biofuel feedstocks in South Africa. This scoping study was undertaken by the University of KwaZulu-Natal using tools and databases developed over many years. In particular, the project draws upon information from the *South African Atlas of Hydrology and Agrohydrology*. The study showed that, based on climatological drivers only, canola, sugar-beet, *Jatropha* and possibly sweet sorghum have the potential to have expanded production areas. Output from the analysis is presented in a series of maps which show that under dryland conditions only sweet sorghum may have the potential to use substantially more water than the reference vegetation. An analysis of the areas of uncertainty, complemented by a review of national and international literature, provides a summary of key research needs regarding the water use of biofuel feedstock crops in South Africa.

Cost: R250 000

Term: 2007 - 2008

### THRUST 3: WATER UTILISATION FOR POVERTY REDUCTION AND WEALTH CREATION IN AGRICULTURE

#### *Programme 1: Sustainable water-based agricultural activities in rural communities*

##### **Participatory development of training material for agricultural water use in homestead farming systems for improved livelihoods**

Rural Integrated Engineering (Pty.) Ltd.

**No. 1575**

The overall objective of this project was to improve food security through homestead gardening, by developing and evaluating the appropriateness and acceptability of training material for agricultural water use, training the trainers and training of household members in selected areas. Particular

attention was given to the development of the 800-page resource material for facilitators and food gardeners on 'Agricultural Water Use in Homestead Gardening Systems'. The development of the resource material followed a participatory approach and was field tested and refined with the assistance of food-secure and insecure households in rural villages. The resource material succeeded in drawing widely from local and international materials and experience. Its usefulness in practice has been substantiated by facilitators who were not part of its development. It is anticipated that a variety of stakeholders will draw on this resource material to develop course material for their own purposes. A significant demand for the material exists from universities and agricultural colleges that are aware of the material.

Cost: R2 750 000  
Term: 2005 - 2009

## CURRENT PROJECTS

### **THRUST 1: WATER UTILISATION FOR FOOD AND FIBRE PRODUCTION**

#### *Programme 1: Water-efficient production methods in relation to soils, crops and technology in rain-fed and irrigated agriculture*

##### **Standards and guidelines for improved efficiency of irrigation water use from dam-wall release to root zone application**

ARC (Institute for Agricultural Engineering)  
**No. 1482**

Irrigated agriculture is the single largest user of water in South Africa. With expansion of domestic and industrial water use, competition for the existing lawful use in irrigation will increase. The levels of efficiency of water use which are currently attained will be scrutinised and particular attention will have to be given to the management of water use. Broadly defined, management of water use starts at dam wall releases, through river or canal conveyance, on-farm storage and distribution, in-field application up to root zone storage. However, the problem is that at present there is no standardised terminology, comparable benchmarks or generally acceptable guidelines to improve water use and irrigation efficiency. These issues must be urgently addressed in order to provide consistent management advice and comply with the requirements of the National Water Act of 1998 regarding compulsory licensing and periodic review of licences. For the purposes of planning, design and operation of water supply systems, definitions of various efficiency terms need to be clearly stated, understood and accepted by all stakeholders. The site-specific criteria and tools which will be used to measure efficiency and practically achievable bench-marks need to be established. In order to

achieve this, the proposed research project must be undertaken on a representative number of irrigation schemes which should include but are not limited to the following: Loskop; Tabana; Middle Letaba; Crocodile/Komati; Pongola; Makhadini; Gamtoos; Sundays; Orange-Riet; Vaalharts; Breede; Hex; Hartbeespoort.

Estimated cost: R5 742 128 (incl. leverage)  
Expected term: 2004 - 2009

##### **Guidelines for irrigation management in pasture production**

CSIR (Natural Resources and the Environment)  
**No. 1650**

It is estimated that the total area utilised for irrigated pasture production is approximately 16% of the total area under irrigation. The returns generated from these enterprises make pastures one of the higher value crops produced under irrigation in this country. However, the management of the water requirements of pastures is not easy. They are often established on heavy and shallow soils that would not normally be considered for irrigation. Limited rooting depths and the need to integrate irrigation and grazing management further aggravate the position. Judicious management of irrigation is essential not only to utilise labour and water resources effectively and maintain production and profitability, but also to prevent serious degradation of land. Although management of dairy farming has now attained unprecedented levels of technology due largely to the availability of practical equipment and methods for planning, managing and monitoring most facets of dairy farming, this does not apply to the irrigation of pastures. That still tends to rely on experience and tradition despite the increasing role of pastures in milk production. It appears likely that it will be possible to develop a model or models that can be used to integrate the factors that must be taken into account when planning irrigation strategies and methods. It should also be possible to develop practical on-farm equipment and methods for recording and monitoring performance. There is, however, a dearth of reliable information and data pertaining to pasture water requirements to facilitate these developments. Alternate methods to address this problem therefore need to be investigated and applied in practice in order to increase water use efficiency at farm level. This will be done initially by assessing the application of the main irrigation methods in conjunction with accepted grazing and irrigation management strategies and identifying opportunities for improvement. The 2nd phase would target the development of databases on the fodder crops and their characteristics, climate, soils, irrigation and on the development of methodologies for measurement and monitoring. The validity and practicality of the material and equipment developed would finally be assessed in conjunction with the industry.

Estimated cost: R2 117 600  
Expected term: 2006 - 2011

### **Water use of fruit tree/orchard crops**

CSIR (Natural Resources and the Environment)

**No. 1770**

In summer and winter rainfall areas, water stress in river catchments is increasing. Limited water resources can constrain development if productivity is not improved. This is particularly important for the fruit tree industry where at least 90% of production is dependent on irrigation. However, there is a lack of comprehensive information of the water use of fruit trees or available information on water use is incomplete and contradictory. Correct knowledge is absolutely essential for drawing up on-farm water management plans for fruit production. The recently-published research reports on water use of citrus and deciduous fruit trees did not provide conclusive results. More specifically it is clear that soil-based measurements present a challenge to obtain accurate and reliable information on water use. Existing models in South Africa can also not confidently simulate water use of fruit trees for different climate, soil, water and management conditions. Therefore, the definite need exists to do intensive research on the tree-based measurements and to design tree-specific models. The purpose of this project is to develop comprehensive knowledge of water-use characteristics and the water use of selected fruit tree/orchard crops for application in fruit tree/orchard management in South Africa. This will require a review of available knowledge on water use of tropical, sub-tropical and deciduous fruit trees/orchard crops. It will be followed by the assessment, ranking and selection of fruit trees/orchard crops in terms of economic importance, current hectareage, geographic distribution and gaps in knowledge on water use. The main outputs will be reports on the empirical measurement of water use at the selected sites and the development, verification and validation of models for the selected fruit trees/orchard crops. More precise modelling approaches and knowledge of water use will improve management advice to farmers on the productive water use of fruit trees within and between seasons over the productive life of the orchard.

Estimated cost: R4 350 000 (incl. leverage)

Expected term: 2007 - 2013

### **Water use of drought-tolerant food crops**

University of KwaZulu-Natal (Crop Science)

**No. 1771**

A significant proportion of the South African population experiences food insecurity and malnutrition (micronutrient deficiency) despite living in a country that is a net exporter of food. One of the main food security challenges facing the country is the need to increase the ability of vulnerable groups to meet their minimum daily requirements for adequate nutrition. About 14.3 million people are vulnerable to food insecurity, particularly women, children and the elderly. There is therefore a need to increase the content of the South African

food basket particularly for the poorest households living in rural areas. However, drought is one of the major hurdles facing agriculture in Sub-Saharan Africa. South Africa, like many countries in the region, is prone to severe water shortages which seriously impacts on the availability of food. One way to combat inadequate availability of water is to develop or select crops that are more tolerant to water stress. Indigenous edible plants that are resilient have sustained rural populations in developing countries for centuries. These traditional crops are native to specific localities and are therefore better adapted to the local environmental conditions and cultivated without the need for much external inputs such as agrochemicals or a high water requirement. However, information on the utilization of indigenous crops in South Africa is not well documented. Moreover, no comprehensive overview of the spectrum of food crops available for food production in South Africa in relation to drought tolerance, crop adaptability, economic importance and water use characteristics has been conducted. This project seeks to understand the water use characteristics of drought-tolerant crops through the use of empirical measurement and crop growth models. The parameters needed for modelling will guide the empirical research.

Estimated cost: R4 350 000 (incl. leverage)

Expected term: 2007 - 2013

### ***Programme 2: Fitness-for-use of water for crop production, livestock watering and aquaculture***

#### **Guidelines for sustainable use of grey-water in small-scale agriculture and gardens in South Africa**

University of KwaZulu-Natal (School of Biological and Conservation Sciences)

**No. 1639**

The White Paper on Agriculture emphasises food security. Since household and urban food gardens form part of the spectrum of production systems and processes that can contribute to food security, they are supported by government. However, a shortage of water to supplement rainfall often limits the application potential of these systems. The use of grey-water may overcome this limitation by providing a dependable water source that is under the control of the household gardener. Grey-water is the untreated household effluent that is produced from baths, showers, kitchen and hand-wash basins as well as washing machines. More than half of the indoor household water use is normally used for these purposes and can thus potentially be intercepted by the householder for additional uses. Initial indications from a scoping study to evaluate the fitness-for-use of grey-water in urban and peri-urban agriculture are that there is considerable potential to use this largely untapped source to augment household food security. However, there are also risks involved with the practice that need to be better assessed and quantified under controlled conditions. These risks are largely associated with factors that affect the sustained productivity of the irrigated soil and health

considerations. A workshop is planned to prioritise these risks and finalise the appropriate experimental approach to address them before finalising the terms of reference and soliciting project proposals

Expected cost: R1 670 000

Estimated term: 2005 - 2009

#### **A quantitative investigation into the link between irrigation water quality and food safety**

University of Stellenbosch (Department of Food Science)

**No. 1773**

A large percentage of the South African population is not in good health due to HIV and TB infections, and the health status is further worsened due to under-nourishment. As such the affected members of society are especially vulnerable to diseases; in particular those caused by water and food-borne pathogens. The source of contamination of river water is failing sanitation in, e.g., informal settlements, and failing water treatment in, e.g., non-operating sewage works. This water is often used for irrigation and there is a direct relationship between irrigation water quality and food production, food spoilage and food safety. Food such as fruits and vegetables which are eaten raw, without peeling or washing, or with minimal washing, ready-to-eat and lightly cooked, are the vehicle for transmission of pathogens in the polluted irrigation water. Furthermore, there is increasing concern over the safety of pickers, handlers, packers and farmers, while there is also an increase in the susceptible individuals. A decrease in the food safety of the final agricultural product will negatively affect the trading status of agricultural products, both locally and internationally. The problem of contamination of irrigation water and food products should therefore be seen in the context of stricter local and export requirements and may threaten the continued access to export markets. Biomonitoring of irrigation water quality is currently fragmented and not regularly published. Little is therefore known on a national level regarding the contribution of irrigation water and the associated potentially-contaminated raw produce to the burden of disease. Consequently little action is taken to remedy the situation. A clearer understanding of the problem is urgently required to make inputs for policy formulation and regulation to reduce contamination of irrigation water. This project will investigate the links between irrigation water quality (microbial and nutrient chemistry) and food safety in commercial as well as subsistence agriculture and give guidance towards treatment options of irrigation water to ensure food safety. This research project will therefore evaluate the extent of the problem regarding contamination of both irrigation water and raw food products, endeavour to establish links between the two and provide recommendations on the way forward in terms of treatment of irrigation water. To achieve this, the main tasks include a baseline study on the extent (types and quantities) of contamination found in irrigation water as well as contamination found on the irrigated raw produce (fruit and

vegetables) before and after harvest at the selected sites. The final report will document the extent of contamination found in irrigation water and on the irrigated raw produce; the links between contamination on raw produce and irrigation water applied; and make recommendations for further research in respect of validation of results and treatment options.

Estimated cost: R5 232 500 (incl. leverage)

Expected term: 2007 - 2012

#### **Interaction between aquaculture and water quality in on-farm irrigation dams: Extended monitoring and mitigating procedures to manage environmental impact**

University of Stellenbosch (Division of Aquaculture)

**No. 1802**

This project will investigate the feasibility and practical implications of using on-farm irrigation water storage dams for aquacultural fish production. A recently-completed WRC project (No. 1461) found that although this dual use of water is mostly beneficial, it can also impact on water quality. This is a follow-on project that will continue with monitoring the effects of aquaculture at a number of sites, follow-up on the environmental concerns (especially enrichment or eutrophication of dam water) and investigate management and other measures aimed at reducing the enriching effects associated with intensive cage aquaculture.

Estimated cost: R1 680 000

Expected term: 2008 - 2012

### **THRUST 2: WATER UTILISATION FOR FUELWOOD AND TIMBER PRODUCTION**

#### ***Programme 1: Water-efficient production methods and systems in agro-forestry, woodlands and forestry plantations***

##### **Agro-forestry systems for improved food production through the efficient use of water**

CSIR (Natural Resources and the Environment)

**No. 1480**

Less than 15% of land area in South Africa is arable. This implies that there is very limited scope for conventional food production, both on irrigated and dry-land. In addition to limited arable land, South Africa is a water-scarce country. Its rainfall is below the world average, and its distribution is somewhat unreliable. The relatively low rainfall and limited arable land make it imperative to effectively and efficiently use these natural resources for food and fibre production. This is even more important for emerging and subsistence farmers who often lack access to information and use of production technologies. Smallholder agriculture, particularly in Africa, has been faced with land degradation. This is due to a number of factors, including poor management and limited production

factors. In order to improve the status of land resources and sustain their productivity, there is a need for a 'shift' from the current production practices. Agro-forestry (AF) systems (whereby there is a deliberate planting of trees in combination with food/forage crops for the benefit of people and the environment) have been reported to be potentially productive in degraded and marginal soils. Agro-forestry is also perceived to have potential for the rehabilitation of such degraded and/or marginal lands. In South Africa, however, AF systems are relatively unpopular, yet the majority of the subsistence farmers are dependent on degraded lands for their agricultural production. A major challenge is to enable such farmers and poor communities to produce optimally under such constraints, simultaneously rehabilitating and improving the land resource. This will ensure both sustainable production and food security, while improving the livelihoods of the poor. This project aims to address a number of questions that need to be answered in order for agro-forestry to be adopted locally. Questions exist as to which AF systems are suitable, given the bio-climatic zones/specific ecosystems within South Africa; what spatial and/or temporal agro-forestry systems will be appropriate for emerging/subsistence farmers within the current resource confines; what are tangible benefits of agro-forestry in relation to:

- End users
- Environment
- Soil health
- Agricultural potential
- Specifically, the impacts (positive/negative) of agro-forestry on natural water resources for specific bio-climates in South Africa

The key to some terminology used is specified below:

- Soil health – all physical, chemical and biological components that are important to agriculture
- Efficient use of water – water consumed in relation to dry matter produced
- Water balance – water applied, infiltration, retention, runoff, percolation, etc.
- Production – quantity, quality, commercial value of food/fuel/forage products
- End users – farmers (local, small-scale), incorporating local knowledge through participative assessment

Estimated cost: R3 250 000

Expected term: 2004 - 2009

**The impact of re-establishing indigenous plants and restoring the natural landscape on sustainable rural employment and land productivity through payment for environmental services**

ASSET Research; University of Stellenbosch; CSIR

**No. 1803**

Large parts of the South African landscape, especially the former homelands, are heavily degraded and denuded

due to, amongst other factors, historical over-population, mismanagement and exploitation of natural resources. While the country does have a limited history of restoring natural capital, i.e. rangelands and grassland catchments, woodlands and natural landscapes, few comprehensive analyses have been done to assess the ecological, hydrological and socio-economic impacts of rehabilitation across a range of contrasted sites and contexts. Very few investigations have been conducted to determine the tangible contributions restoration has made and can make to rural landscapes and local economic development. This study will assess the ecological, hydrological and socio-economic impact of improving degraded landscapes across the country at a number of contrasted sites in an integrative and dynamic systems approach. This will be done using a carefully selected assemblage of parameters to study how restoration specifically improves water flow, water quality, land productivity and in some instances carbon sequestration as well as generally improving the agricultural potential of the land. In addition, the socio-economic benefits of restoring natural capital will be assessed by investigating the contribution to employment creation and income generation. The economic quantification of restoration is likely to provide critical data needed for the implementation of payment for environmental services. A model will be developed based on information gathered by this study to assist in predicting the impact of future restoration projects on complex and dynamic socio-economic and ecological rural landscapes. This model will be used to consider the most effective and best ways to embark on future restoration projects. This decision support tool will be very valuable to national programmes and projects such as *Working for Water*, *Working for Wetlands*, *Working for Woodlands* and the land-care project.

Estimated cost: R3 000 000

Expected term: 2008 - 2013

**THRUST 3: WATER UTILISATION FOR POVERTY REDUCTION AND WEALTH CREATION IN AGRICULTURE**

*Programme 1: Sustainable water-based agricultural activities in rural communities*

**The effect of the introduction of agroforestry species on the soil moisture regime of traditional cropping systems in rural areas. Phase II: On-farm trials of alternative agro-forestry systems**

CSIR (Natural Resources and the Environment)

**No. 1351**

One of the major constraints in rural farming systems of the Upper Thukela is the shortage of adequate and good quality grazing during the dry winter season. Unfortunately, supplementation of feed using commercial supplements is difficult because the supplements are expensive and not easily available in remote areas. Provision of alternative sources of

fodder such as tree leaves and pods can increase production. The introduction of tree species for fodder should decrease the grazing pressure on the existing grassland. This will result in improved basal cover, decreased soil erosion and promote greater water infiltration. The project aims are:

- To determine the effect of different agro-forestry systems on increasing fodder production in rural farming systems
- To determine the effect of agro-forestry practices on soil water availability to traditional crops (e.g. maize)
- To determine whether the inclusion of trees in traditional cropping systems can enhance the infiltration of rainfall and prevent soil loss
- To compare the water use of an indigenous fodder tree (*Acacia karoo*) and an exotic fodder tree (*Morus albus*), in order to test the hypothesis that indigenous fodder trees are more conservative water users than exotic tree species.

Estimated cost: R2 400 000 (incl. leverage)

Expected term: 2002 - 2011

**Sustainable techniques and practices for water harvesting and conservation and their effective application in resource-poor agricultural production in the KwaZulu-Natal Province**

Zakhe Agricultural College

**No. 1465**

Approximately 74% of South Africa's rainwater is used by dry-land cropping, natural grassland, woodlands and forests. It is therefore clear that the biggest share of rainwater is used for extensive agricultural production. The critical issue in the near future will be the increasing pressure on agriculture, in particular food and fuel-wood production, due to population growth. At the same time, there is increasing dependence on agriculture in rural areas, which exerts even more pressure on the rainwater resource base, particularly among the poor. The productivity of land and water in rain-fed agricultural areas can be greatly enhanced through water harvesting and conservation. Rainwater harvesting is defined as the process of concentrating rainfall as runoff from a larger area for use in a target area. Water harvesting and conservation techniques have had limited impact elsewhere, and in some cases failed, despite good techniques and design. This is due to social, economic and management factors that are often overlooked, or inadequately integrated into the development of the system. The research project on 'water harvesting and conservation' promotes techniques and knowledge that improve the agricultural productivity of water at farming level. Attention should be given to production methods for crop cultivation in combination with livestock husbandry (and where possible utilising indigenous products). The intervention should also take into account social, economic and environmental factors. The perceptions of rural households and possible adjustments to water harvesting and conservation practices in order to improve food security and rural livelihoods should be analysed.

Estimated cost: R3 000 000

Expected term: 2003 - 2009

**Best management practices for smallholder farming on 2 irrigation schemes and surrounding areas in the Eastern Cape and KwaZulu-Natal through participatory adaptive research**

University of Fort Hare

**No. 1477**

Most agricultural research is often not packaged according to the requirements of subsistence farming. In some instances research results are not adapted and therefore not directly useful for small-scale farming operations. As a result, extension, technology transfer and adoption need to receive more attention. In the past, extension services normally did not participate in the research projects, resulting in limited or no support for the intervention after the research had been completed. The need for early involvement of both farmers and extension services in this research project cannot be overemphasised as this leads to better diffusion of knowledge, thus making the intervention more sustainable. The benefits of the research intervention should be apparent to the farmers as early as possible. Motivation and promotion of awareness among the end-users with regard to the objectives of the intervention and the ways to achieve them are essential. It is acknowledged that research results available for water management in commercial farming are applicable to subsistence farming, and need not be repeated. The aim of this project is to make existing knowledge, indigenous and new technologies, useful for the particular circumstances of subsistence farming. The research project on 'best management practices for small-scale subsistence farming' therefore requires commitment and co-operation amongst researchers, farmers and the community. This will be done through participatory action research which combines research, education and action to the direct benefit of farmers and surrounding communities.

Estimated cost: R4 500 000

Expected term: 2004 - 2009

**Sustainable techniques and practices for water harvesting and conservation and their effective application in resource-poor agricultural production in the Eastern Cape Province**

University of Fort Hare

**No. 1478**

Approximately 74% of South Africa's rain-water is used by dry-land cropping, natural grassland, woodlands and forests. It is therefore clear that the biggest share of rainwater is used for extensive agricultural production. The critical issue in the near future will be the increasing pressure on agriculture, in particular food and fuel-wood production, due to population growth. At the same time, there is increasing dependence on agriculture in rural areas, which exert even more pressure on the rainwater resource base, particularly among the poor. The productivity of land and water in rain-fed agricultural areas can be greatly enhanced through water harvesting and

conservation. Rainwater harvesting is defined as the process of concentrating rainfall as runoff from a larger area for use in a target area. Water harvesting and conservation techniques have had limited impact elsewhere, and in some cases failed, despite good techniques and design. This is due to social, economic and management factors that are often overlooked, or inadequately integrated into the development of the system. The research project on 'water harvesting and conservation' promotes techniques and knowledge that improve the agricultural productivity of water at farming level. Attention will be given to production methods for crop cultivation in combination with livestock husbandry (and where possible utilising indigenous products). The intervention should also take into account social, economic and environmental factors. The perceptions of rural households and possible adjustments to water harvesting and conservation practices in order to improve food security and rural livelihoods will be analysed.

Estimated cost: R5 200 000

Expected term: 2004 - 2010

#### **Nutritional value and water use of indigenous crops for improved rural livelihoods**

University of Pretoria (Centre for Nutrition)

##### **No. 1579**

Under-nourishment is a major problem in many rural and peri-urban communities, particularly amongst children. A variety of indigenous crops can meet the taste and dietary requirements of household members. Completed research by the ARC has tested the drought tolerance of crops such as cowpea, bambara groundnut and marog (WRC Report No. 944/1/04). It is also important to determine the nutritional value and water requirements of these crops. The best combination, between indigenous crops and a range of home-grown vegetables and other foodstuffs, to achieve a balanced diet, has to be evaluated. In a study by the University of the Free State on the socio-economic acceptability of in-field rainwater harvesting and conservation for homestead food production, the minimum area necessary to meet the caloric requirements of a household was calculated (WRC Report No. 1267/1/04). Given the seasonal variability of rainfall, appropriate technology similar to that tested by the Tshwane University of Technology (Khosha, 2003) has to be evaluated to supplement water supply and stabilise food production in homestead gardens. The purpose of this project is to investigate the linkages between dietary requirements, nutritional value, water requirements and technology for production of a combination of food crops. Laboratory, on-station and participative action research will be undertaken to develop best practices in order to improve food security and well-being of households. An interim report on the outcomes of this project has been published: WRC Report No. TT 362/P/08, Nutritional Status of South Africans: Links to Agriculture and Water).

Expected cost: R5 700 000 (incl. leverage)

Estimated term: 2005 - 2010

#### **Assessment of the social and economic acceptability of rainwater harvesting and conservation practices in selected peri-urban and rural communities**

University of the Free State (Department of Agricultural Economics)

##### **No. 1648**

A large percentage of the population in South Africa can be considered to be rural survivalists and follow predominantly traditional agrarian lifestyles (Burgess, 2002). Poverty is also widespread in rural areas. Consequently, individuals and groups in these rural communities are vulnerable to natural disasters such as droughts. Given the scarcity of water, rainwater harvesting and conservation (RWH&C) is a broad-based strategy to improve rural livelihoods of resource-poor and subsistence farmers. Substantial research work on biophysical aspects of in particular infield RWH&C has been done (see WRC Report No. 1176/1/03). A start has also been made to evaluate the social acceptability and economic viability of this technique (see WRC Report No. 1267/1/04). This last-mentioned study has shown that there are many gaps in knowledge on social, institutional and economic dimensions for sustainable implementation of RWH&C. More research effort on various socio-economic aspects of RWH&C was highlighted during an international workshop organised by the International Commission on Irrigation and Drainage (ICID) and the United Nations Food and Agriculture Organisation (FAO) during 2004. In order to improve food security and material income through higher water productivity, RWH&C must be promoted in both high and low rainfall areas. Priority attention must be given to low-potential areas, which are often remote and less visible to the general public, with high rainfall variation but concentrated poverty. Furthermore it is important to use local knowledge and rely on indigenous practices or systems, and combine it with available scientific knowledge (Maxwell, 2001). Emphasis should be placed on empowerment of farmers and especially women, through training in RWH&C. Within the institutional arrangements in rural communities as determined by amongst others traditional authority and communal land tenure, secure use rights are the necessary incentives for increased food production. Depending on access to finance and alternative marketing opportunities, individual entrepreneurial initiative can lead to production of marketable surpluses above the needs for household consumption. In this process social-economic transformation and inclusion of farmers in the mainstream of the economy will be achieved if RWH&C can be shown to be socially and economically sustainable.

Estimated cost: R3 100 000 (incl. leverage)

Expected term: 2006 - 2011

**Rainwater harvesting and conservation (RWH&C) for rangeland and cropland productivity in communal areas in selected provinces in the semi-arid area of South Africa**

ARC (Institute for Soil, Climate and Water)

**No. 1775**

Almost half of South Africa's population can be classified as living in poverty while 25% of the population can be categorized as ultra-poor. Although the country is self-sufficient in food production, about 14 million people are reported to be vulnerable to food insecurity and 43% of households suffer from food poverty. The majority (65%) of the poor are found in rural areas and 78% of those likely to be chronically poor are also in rural areas. Much of South Africa is covered by large areas of rangeland (veld) that is not privately owned but used communally by farmers for grazing domestic livestock and harvesting natural products such as fuelwood. Most of the communal areas are located in the former homeland areas in provinces such as Limpopo, Eastern Cape and KwaZulu-Natal. These rural landscapes are often also characterized by abandoned croplands that are infested by weeds and grasses. In communal areas, where individuals share land and water resources, understanding the complex norms, values and behaviours is very important. The success of community-based management of resources is dependent upon the functioning of the institutional arrangements. Water harvesting and conservation practices have not only been demonstrated to increase dry-land agricultural production but also to be environmentally sustainable. This project seeks to assess water harvesting and conservation techniques/practices for improved rangeland and cropland productivity in communal areas through on-station (controlled) and on-farm (participative) research. It will investigate the institutional arrangements in these communities and assess the extent to which production was suppressed as a result of inappropriate working rules and how these can be approved. A guideline on best management practices for RWH&C for rangeland and crop lands in communal areas will be produced.

Estimated cost: R4 728 500 (incl. leverage)

Expected term: 2007 - 2013

**Development of a comprehensive learning package for education on the application of water harvesting and conservation (WH&C)**

Umlaba Consulting Group

**No. 1776**

Water harvesting and conservation practices have been tested and demonstrated to be sustainable and contribute to food security. Many of these techniques and practices have been documented in the form of research reports and information material for public interest, but not packaged as training material for the end user. In addition, advisors and farmer support personnel such as extension services are often ill-informed and inadequately trained in agricultural water

management including water harvesting and conservation. High illiteracy, particularly among the rural population, limits the ability of farmers to access information and utilise new technologies. There is, therefore, a need for accredited yet appropriate training material for certified trainers and learners (farmers). Training, education and skills development will need to follow a broad-based approach that is aligned to government initiatives such as the Joint Initiative on Priority Skills Acquisition (JIPSA) and grounded on Outcomes Based Education (OBE) and Adult Basic Education and Training (ABET) principles. This project will develop a comprehensive learning package for the application of WH&C for household food production and poverty alleviation in rural areas. It will identify the existing unit standards for training in WH&C and fill the gaps in learning material by adopting and adapting available material and developing a comprehensive package (NQF level 4/5 facilitators guide for trainers, ABET levels 1 and 2 learning material for learners and assessment guide). The learning package will be tested in the field with trainers, facilitators and learners.

Estimated cost: R1 950 000

Expected term: 2007 - 2012

**Improving plot-holder livelihood and scheme productivity on smallholder canal irrigation schemes in Limpopo Province**

Tshwane University of Technology; ARC (Institute for Agricultural Engineering)

**No. 1804**

Livelihoods of plot-holder homesteads on small-scale canal irrigation schemes in South Africa are diverse and dynamic and the importance of irrigated farming in the livelihood portfolio of these homesteads also varies. Typically, the objectives of plot-holders on small-scale irrigation schemes range from production of food solely for own consumption to fully market-oriented production. While market-oriented farmers seek to expand the scale of their enterprise, subsistence farmers (food producers for own consumption) tend to have excess land. Most of the smallholder farmers on irrigation schemes require technical improvements to the prevailing production systems to enhance the financial viability of plot enterprises and increase the efficiency of water and land use. Effective management of shared resources such as water is essential to all farmers on the irrigation schemes and is dependent on collective action. Despite the multi-faceted challenges facing smallholder irrigation schemes, very little research has been successfully conducted on integrated production systems on these schemes. At this stage these schemes are also not included in RESIS of Limpopo Province, except if farmers are prepared to switch to sprinkler irrigation. Changing to sprinkler irrigation will not necessarily increase water-use efficiency, particularly if it is done without participation by farmers. This project seeks to enhance plot-holder scheme productivity and to strengthen collective action by improving the availability of irrigation water

to farmers. It will seek to enhance the establishment of robust community-based institutional systems that reduce uncertainty and risk in land-exchange contracts. It will also endeavour to integrate crop and animal production in order to contribute substantially to local resource use, value-adding and market access on smallholder irrigation schemes. In order to achieve these objectives, the project will adopt a participatory learning and action approach to collectively analyse the existing behavioural and communication patterns. It will employ both plot and field experiments in an effort to encourage the efficient use of water and improve plot-holder productivity. The final output of this project will be a comprehensive report that documents the holistic approach followed in addressing the challenges facing smallholder irrigation farmers and lessons learnt as well as practical crop and animal production manuals for smallholder farmers and their advisers. These outputs will contribute to national programmes of high priority that address issues of poverty alleviation and food security.

Estimated cost: R1 890 000  
Expected term: 2008 - 2012

### ***Programme 2: Integrated water management for profitable farming systems***

#### **Water resource management for profitable small-scale farming along the banks of the Orange River**

University of the Free State (Department of Agricultural Economics)

**No. 1354**

The establishment of small-scale farmers on the Orange River in the Northern Cape and Western Cape Provinces was identified as a very high priority. The study is motivated by the drive to utilise the water right allocation to establish small-scale irrigated farms and operate them efficiently and sustainably. Formal and appropriate methodologies will be developed to successfully establish small-scale farmers to ensure household food security and enable production of surpluses. Farm size, type of technology, access to markets and financing methods and procedures will be clearly defined. According to the Provincial Department of Agriculture in Kimberley an appropriate economic model is needed to successfully establish small-scale farmers. This project will directly address these issues by providing guidance and developing a model for evaluating the economic performance and efficiency of the farms prior to establishment. The main aim of this project is to develop an appropriate methodology to successfully establish small-scale irrigation farmers in South Africa. Sub-aims are to:

- Develop an appropriate land tenure system for small-scale farmers
- Develop an appropriate marketing arrangement for inputs and outputs for small-scale farmers
- Develop a suitable financial arrangement for loan and credit acquisition to facilitate successful establishment of small-scale farmers

- Develop an economic model viable for successful establishment of irrigated farmers
- Determine the social acceptability of the proposed newly developed programme
- Determine the environmental impacts of the establishment of small-scale irrigated farms on undeveloped land.

Estimated cost: R970 000  
Expected term: 2002 - 2008

#### **Revitalisation of provincial fish hatcheries and training facilities to promote profitable aquaculture**

Rhodes University (Department of Ichthyology and Fisheries Science)

**No. 1580**

A baseline study on the Contribution of Aquaculture to Rural Livelihoods in South Africa has been done by Rhodes University (WRC Report No. TT 235/04). This study showed that the present factors constraining aquaculture in rural areas were mainly a consequence of a lack of policy and institutional capacity and that the development of rural aquaculture will depend principally on a public sector led intervention, inclusive of technical support and fingerling supply. The study revealed that there are many state-owned hatcheries and training facilities falling under various government departments that are unproductive, privatised, or defunct. Though not assessed these assets are worth millions of rand. Based on the survey results it was further agreed that the involvement of the private sector in rural aquaculture would be essential for sustainable growth. As policy issues were being addressed by the National Department of Agriculture, it was suggested that the WRC should support the undertaking of workshops in preparation for participatory action research (PAR) with the various public and private sector stakeholders to appraise the potential role of these hatcheries in the light of emerging policy, and where applicable to develop a framework for a community private public partnership (CPPP) to revitalise government hatcheries that are currently under-utilised. The workshops have been completed and the PAR can now proceed. The PAR is a process which includes research and implementing goals and objectives. Stakeholders in the Limpopo, Mpumalanga and Eastern Cape Provinces will be engaged and an end-point will be identified (for example, through CPPP revitalising a specific government hatchery). Once the end-point has been identified, the role of the PAR implementers would be to actively facilitate and record the process, so that it is successful and repeatable elsewhere.

Expected cost: R4 500 000 (incl. leverage)  
Estimated term: 2005 - 2010

### **Development of training material for extension in irrigation water management**

University of Pretoria (Department of Agricultural Economics, Extension and Rural Development)

**No. 1649**

The revitalisation of irrigation schemes and irrigation management transfer is accepted policy in South Africa (Department of Agriculture, 2003). Implementation of this policy can, however, not succeed without extension support. In the process of integrated development planning (IDP), extension services are also the essential link between government and rural communities who are dependent on agriculture. In both cases extensionists therefore perform an important function to promote agricultural development, which in turn leads to community development. It is generally recognised that extensionists provide the link between research output and solving the perceived problems which farmers experience. All types of farmers, but specifically emerging farmers, are dependent on extension services as a source of information and knowledge. This has been confirmed by a survey amongst emerging irrigation farmers (WRC, 2003). Discussion forums organised by the WRC in all provinces between 2000 and 2003, in which a wide range of farmers participated, have highlighted that the extension link has deteriorated in recent years and has become less effective. Presently information is available on various biophysical and socio-economic aspects of irrigation management. Irrigation-related courses are also presented by universities and colleges. However, this information is not presented in the required format and the courses are not specifically targeted to be useful for extensionists in their work environment. Extensionists therefore do not have the appropriate knowledge base and skills to do their work. In many cases this results in a lack of confidence amongst extensionists, decline in their credibility and withdrawal from the community which they must serve. There is an urgent need to restore the self-esteem of individuals and improve the service delivery of the extension profession. Extensionists require in-service training on all aspects of irrigation management, to meet the demands of subsistence, emerging and commercial smallholder farmers. Training material must be developed or adapted for this purpose. This will enable extensionists to become more effective, with the benefits not being limited to farmers only, but having a positive impact on the community in which extensionists and farmers live.

Estimated cost: R2 370 000 (incl. leverage)

Expected term: 2006 - 2011

### **Awareness creation, implementation plans and guidelines for management of sustainable on-farm and on-scheme water measurement**

WSM Leshika (Pty.) Ltd.

**No. 1778**

According to the National Water Resource Strategy of 2004, national water conservation and demand management (WC & DM) strategies are being developed. The strategy for irrigated agriculture provides a framework of regulatory support and incentives to improve efficiency, with a plan of action towards delivering amongst others the following outputs:

- Implement measures that reduce wastage
- Convince users to progressively modernise their water conveyance infrastructure and irrigation equipment.

The recently-published Water Conservation and Water Demand Management Conditions for Water Use Sector Authorisation (DWAF, 2006) imposes a duty to measure, record aspects of water use and requires that 'the licensee shall measure the amount of water supplied to each farm or user on a monthly basis using an appropriate flow measurement device'. The WRC has published reports and guidelines for the direct and indirect measurement of water on irrigation schemes in response to the practical need to measure and manage water effectively and efficiently. However, in most cases the water management system currently in operation does not incentivise water measurement, and consequently measurement of water use and volumetric charging is not widely practised. This project will facilitate a process towards effective implementation of water measurement at river, irrigation scheme and farm level in South Africa. In order to achieve this, end users of water measurement technology will be made aware and convinced to adopt the technology. Specific attention will be given to technical constraints and financial justification for implementation of the technologies for water measurement. This will require purposeful capacity building and training of end-users such as farmers while using the model of 'train-the-trainer', which has been found to be most successful. In this process a common understanding of the practical requirements of water measurement by water users, water managers and regulators will have to be reached. Therefore it is necessary to obtain support of the DoA and DWA on training for adoption of water measurement. Since water user associations (WUAs) will increasingly provide an advisory role, the managers of WUAs and leader farmers whom they serve, will be targeted in order to achieve sustainable implementation of water measurement. The intention is to interact with these stakeholders as part of the preparatory phase; determine the incentives for water measurement as part of the analysis phase; and practically demonstrate how to undertake effective water management in the implementation phase. The final output of this technology transfer project will be an overarching report that documents the implementation process, the lessons learned and guidelines towards general implementation of water measurement.

Estimated cost: R1 400 000

Expected term: 2007 - 2011

**Assessment of the contribution of water use to value chains in agriculture**

University of the Free State (Department of Agricultural Economics)

**No. 1779**

The contributions of agriculture to the economy are mainly food production, creation of employment and earning of foreign exchange. The strategic goal of the Agriculture Sector Plan in South Africa (2001) is more specifically to generate equitable access and participation in a globally competitive, profitable and sustainable agricultural industry. According to the Presidential Imperative Programme on Integrated Sustainable Rural Development, the goal is furthermore to promote development and improve the quality of life of marginalised groups and communities, amongst others by alleviating poverty through employment creation. In order to generate employment and income to reduce poverty, it is also recognised that a wide-ranging programme is required to develop agriculture. This includes improved food security through livestock husbandry and rain-fed or irrigated crop cultivation, as well as improvement of skills to earn non-farming income in agro-industries. However, in the current dual agricultural economy, the question arises: how can emerging producers be included in the mainstream of the economy? Only by obtaining access to available resources or assets in agriculture, can an impact be made to improve rural livelihoods, in particular for vulnerable groups such as the rural poor. In this regard the concept of the value chain can be used to better understand the links between farming and non-farming activities in agriculture. This project will apply value chain analysis for optimising economically-beneficial water use in agriculture in order to integrate commercial and emerging farmers in the mainstream of the economy. It will investigate whether emerging farmers, who are producing a combination of rain-fed or irrigated field and vegetable crops, can obtain better market access. On the basis of water resources which are common to all, and water as a production input in farming and non-farming agriculture, it will be determined how emerging and commercial producers can be integrated through value chains and thereby promote economic development. The main outputs will be: firstly, a conceptual framework based on the literature review of the value chain analysis with specific reference to water utilisation and competitiveness in agriculture; secondly, demonstration of the application of the conceptual framework for commercial and emerging agriculture in the horticultural and field crop industries; thirdly, empirical analysis and modelling of selected value chains in commercial and emerging agriculture with specific attention to mapping of water use at critical points in the value chain, optimisation of water use in the whole value chain, mainstreaming of marginalised participants in the economy by integration in the value chain, employment creation and poverty reduction through the value chain, and improving competitiveness in the value chain.

Estimated cost: R2 430 000

Expected term: 2007 - 2012

**The development and testing of an integrated set of models to evaluate the financial/economic impact of irrigation water curtailment decisions on participant farm case studies in the Crocodile Catchment**

CPH Water; South African Sugarcane Research Institute; University of the Free State

**No. 1805**

Numerous options are being considered to address the over-allocation of water in catchments. This ranges from improvements in the efficiency with which water is used and managed, to the reduction of alien invasive plants in catchments, to the building of new dams or transfer schemes. However, even though the measures listed above will help address the over-allocation to some extent, it is likely that existing lawful users may need to be curtailed (i.e. have their water use licences reduced) in order to address the over-allocation. The general aim of the project is to evaluate the impact of curtailment of existing lawful water use on the economic and financial feasibility of irrigation farming. In the selected catchment of the Crocodile River in Mpumalanga Province, the current water situation will be assessed to determine the causes of water stress in the catchment. This will be done by reviewing available documents and reports and through discussions with DWA and the CMA. The ACRU and Mike Basin models will be configured to represent the current water users, water resources and operating rules in the catchment. This component can be described as catchment-scale hydrological modelling. The SKELETON model will be further developed to link with the Mike Basin irrigation module. In particular the influence of the variable availability of water on optimum crop combinations and farming viability will have to be determined. This part of the modelling can be described as the farm-scale economic modelling. The integrated ACRU/Mike Basin/SKELETON model will be applied to evaluate the outcome of various curtailment scenarios. A report will be produced to document the findings for the Crocodile River specifying the potential impact of curtailments and changes in operating rules to support sustainable irrigation farming in future.

Estimated cost: R1 790 000

Expected term: 2008 - 2011

**Technology transfer on the technical aspects and cost-estimating procedures of surface and sub-surface drip-irrigation systems**

ARC (Institute of Agricultural Engineering); NB Systems; University of the Free State

**No. 1806**

Irrigated agriculture is the single largest user of water in South Africa. With expansion of domestic and industrial water use, competition for the existing lawful use in irrigation will increase. The National Water Act of South Africa (Act 36 of 1998) requires equitable, efficient and sustainable use of available water by all user sectors. Drip-irrigation is considered to be the most efficient method of irrigation. The increasing application of drip-irrigation systems necessitates the correct economic analysis and choice of not only the dripper, but also the filtration equipment to ensure that the water is used efficiently. The WRC has published 4 different reports on drip-irrigation. The results of these reports created useful information for the cost analysis, choice, operation and maintenance of drippers and filtration equipment. It is of the utmost importance that the results of these projects are disseminated by means of technology transfers and training sessions with designers and farmers. The main aim of the technology transfer project is to facilitate a process towards effective implementation and usage of surface- and subsurface drip irrigation systems in terms of technical and economic principles. To achieve this aim, the project will be undertaken in 5 distinct phases of preparation; testing and analysis; compilation of guidelines; technology transfer and a process of knowledge dissemination. The technology transfer phase will consist of organising courses for designers to train them in the selection and usage of surface- and subsurface drip irrigation systems with respect to the technical and economic principles and organising of field days for farmers, irrigation managers and trainers to present the principles of economics, operation and maintenance of drip and filtration systems and to practically demonstrate it to participants. The output of the project will be a manual with guidelines for costing, selecting, operating and maintaining surface and sub-surface drip-irrigation systems.

Estimated cost: R1 485 400

Expected term: 2008 - 2011

**THRUST 4: WATER RESOURCE PROTECTION AND RECLAMATION IN AGRICULTURE**

*Programme 1: Sustainable water resource use on irrigation schemes and within river catchments*

**Managing salinity associated with irrigation in selected areas in South Africa**

University of the Free State (Department of Soil, Crop and Climate Sciences)

**No. 1647**

Because crops use water consumptively it is an inevitable consequence of irrigation that the salts in irrigation water are being concentrated in the soil. Since crop yield, in turn, is reduced at high soil salinity levels, it is a prerequisite for sustainable irrigation (and to protect the soil resource base) that soil salinity be managed to remain at levels that support acceptable crop yield. Current practice is to achieve this by applying water in excess of crop requirement, whereby some of the accumulating salt is leached from the root zone. The practice to leach salt from soil, which ensures the sustainability of irrigation from an agricultural perspective, has the undesirable side-effect of salinisation of ground and surface waters. The negative impact irrigation return flows have on water quality is observed in practically all irrigation schemes. Because of the negative impact that 'irrigation wastewater' (leachate and drainage water) has on other water resources, there is an increasing range of initiatives that are being investigated both locally and internationally to improve the way in which to manage this impact at both farm and scheme level.

Even though there is concern about the environmental impact of irrigation, the need for increased agricultural production and assurance of supply seem to necessitate the continued expansion of irrigation on a global basis. In view of the increasing demand for water resources and irrigation's relative inability to compete with other sectors for high quality water sources, it is foreseen that in the case of South Africa the future expansion in irrigation area will increasingly have to rely on poorer quality water. By making use of poorer quality (waste) water, irrigation would also be able to free up better quality water for other productive uses. However, such a move will make even greater demands on the ability of irrigators and water managers to manage salinity and its effects on crops and environment. It is thus clear that the sustainability of irrigated agriculture will to a large extent be determined by our collective ability to manage the problems associated with salinity. Much of the success of such management strategies will depend on the success with which the 'wastewater' can be utilised within irrigated agriculture. Although much in this regard has already been learnt locally and internationally, the practical application of these lessons is lagging behind. It is thus envisaged to conduct a project that would synthesise current knowledge and select the appropriate practices for application and testing in a number of case study areas with existing

problems. It is anticipated that this evaluation would enable the development of specific guidelines for the management of the case study areas with as aim to bridge the gap between existing knowledge and its application, the formulation of generalised recommendations about the implementation of sustainable solutions to the management of salinity on irrigation schemes, the identification of incentives that can be applied to modify the behaviour of water managers at farm and scheme level and the identification of research or knowledge gaps.

Estimated cost: R2 480 000  
Expected term: 2006 - 2010

### **Programme 2: Impact assessment and environmental management of agricultural production**

#### **Modelling non-point source (NPS) pollution in agriculture from field to catchment scale**

Sigma Beta Consulting  
**No. 1516**

It is increasingly recognised that non-point source (NPS), or diffuse pollution, plays a major role in the degradation of water quality; specifically with respect to salinity, eutrophication (nutrient enrichment), sediments, pathogens, pesticides and some heavy metals. It is furthermore increasingly accepted that it is unfeasible to properly manage water quality without addressing the contribution from non-point-sources. Consequently, attention is increasingly devoted to the quantification of NPS pollution and to identify means to control it cost-effectively at source. Since most of the land area is utilised for agricultural activities, agriculture has both locally and internationally been implicated as a major source of NPS pollution. It is therefore necessary to assess the contribution that the different agricultural activities make to the different manifestations of NPS pollution, to devise the means through which these can be controlled and to determine and predict the effect that control measures will have to reduce NPS pollution. Understanding the production, delivery, transport and use components of agriculture-derived NPS loadings of water resources and having a predictive ability about the fate of agriculture-related NPS constituents are discrete research themes that will enhance the usefulness of the existing guidelines in the agricultural domain. The contribution of irrigation activities towards the salinisation of water resources has been studied for quite some time and is currently still receiving attention. Other water quality issues of concern that are potentially aggravated by agricultural activities are eutrophication (through fertiliser leaching and wash-off from human settlements), sediments (as a result of erosion), pathogens (from intensive animal production units), pesticides (through the application of insecticides, fungicides and herbicides) and some heavy metals. Although agricultural activities that give rise to the latter water quality issues have been the subject of previous studies, the present level of knowledge concerning them is not as advanced as for

irrigation-induced salinisation of water resources. The project will address those issues that require priority attention, with regard to NPS pollution.

Estimated cost: R5 000 000  
Expected term: 2004 - 2009

#### **Applications of rainfall forecasts for agricultural-related decision making in selected catchments**

University of KwaZulu-Natal (School of Bioresources Engineering and Environmental Hydrology)

**No. 1646**

The South African climate is highly variable over short and longer periods. This inter- and intra-seasonal variability is likely to be amplified by the global change in climate. Agricultural production is intrinsically linked to climate variability. Many agricultural decisions are made based on climate (short, medium and longer term) information and assumptions. Farmers need information to help them plan for planting, irrigation and harvesting of their crops. Weather forecasting can aid users to make more informed decisions and assist in planning activities. They have the potential to reduce risk in the long term and improve water-use efficiency. Forecasting involves computer models, observation and knowledge of trends and patterns. Using such tools, meteorologists can reasonably forecast weather conditions up to 5 days in advance. Longer lead-time forecasts (weeks, months) are referred to as climate forecasts. Such forecasts, usually made in terms of categories (above, near and below normal) and probabilities, are becoming more skilful as research progresses. However, gaps exist between the weather and climate forecasts and linking them to agro-hydrology and applications in agricultural decision-making. The project aims to develop techniques and models for translating forecasts of up to 1 year in advance into applications for decision support.

The WRC has funded several projects over almost 2 decades on research on climate variability with a focus on forecasting, modelling and database development. These include *inter alia*:

- Development of a Raster Database of Annual, Monthly and Daily Rainfall for Southern Africa (WRC Report No. 1156/1/04)
- A Flood Nowcasting System for the eThekweni Metro: Volume 1 and 2 (WRC Report No. 1217/1/04 and 1217/2/04)
- Spatial interpolation and Mapping of Rainfall (Simar): Volume 1 – 3 (WRC Report No. 1151/1/04; 1152/1/04 and 1153/1/04)
- Regional Model Development for Simulating Atmospheric Behaviour and Rainfall over Southern Africa (WRC Report No. 1261/1/05)
- Dynamic Modelling of the Present and Future Climate System (WRC Report No. 1154/1/04)

These and other projects have resulted in more comprehensive datasets and a better understanding of weather and climate variability and refined forecasting tools. It is therefore in the interest of the WRC to see this research utilised. The 2001 Strategic Plan for South African Agriculture states that one 'component of the comprehensive risk management strategy is an early-warning system that includes adequate access to and utilization of timely, accurate, relevant, and free information about the weather'. Since the end of 2002, the National Department of Agriculture has been advising farmers on climate conditions and practices to follow, based on a long-term climate outlook. It is envisaged that this project will develop an early warning system with different lead-times that could reduce farmers' susceptibility to adverse weather conditions. Although the project will focus on 2 or 3 critical catchments, the findings of this study will be extrapolated to other catchments.

Estimated cost: R5 700 000 (incl. leverage)  
Expected term: 2006 - 2011

**The impacts of unpaved access roads on runoff, sediment fluxes and soil water movement within timber plantations**  
Aquagreen Consulting; University of KwaZulu-Natal  
**No. 1807**

Despite wide acceptance that access roads in timber plantations are important hydrological pathways that affect the volume and distribution of overland flow and corresponding sediment fluxes, there is little quantitative information to account for this process in South African catchments. Water flowing unrestricted on unpaved road surfaces directly to the stream network is effectively lost to forestry compartments and potential uptake by tree roots, which in turn has a bearing on timber production. The main aim of the project is to evaluate the direct contribution of unpaved forestry access roads as a potentially ready source of runoff and sediment through physical on-site measurements and modelling at the plot and road segment scale. Based on field assessments done in close co-operation with the forestry industry, 2 catchments will be targeted for further monitoring and detailed modelling. Each of the catchments will represent a different bioclimatic zone, have varying ages of timber stands and have different soil types. Once the target catchments have been identified a detailed geographic information (GIS) coverage of the soils, topography, age, species and size of forestry compartments, extent of the riparian zone and the stream and road networks will be sourced or developed. Based on the findings of the modelling, verified by actual measurements, a research report will be produced on the feasibility of redirecting runoff from access roads to down-slope forestry compartments and practical strategies that could be used by the industry to accomplish this.

Estimated cost: R1 700 000  
Expected term: 2008 - 2011

**Definition of process zones and connectivity in catchment-scale NPS processes**

University of KwaZulu-Natal; ARC; University of Pretoria; Sigma Beta  
**No. 1808**

Non-point source (NPS) pollution makes a significant contribution to the water quality degradation being experienced in South Africa. Several research initiatives are underway to obtain a better understanding of the processes that are operating and to improve predictive abilities under local conditions. Specific process zones have been identified to play a dominant role in determining the magnitude of non-point source pollutants within a landscape. This project will use an existing experimental site at Wartburg to study process zones, NPS migration dynamics and connectivity so as to gain an improved understanding of the processes. This in turn will lead to the development of generalised methodologies for estimating the influence of these features on NPS loads at catchment scale.

Estimated cost: R722 540  
Expected term: 2008 - 2010

## NEW PROJECTS

### THRUST 1: WATER UTILISATION FOR FOOD AND FIBRE PRODUCTION

*Programme 1: Water-efficient production methods in relation to soils, crops and technology in rain-fed and irrigated agriculture*

**Water use of cropping systems adapted to bio-climatic regions in South Africa and suitable for biofuel production**

University of KwaZulu-Natal (School of Bioresources Engineering and Environmental Hydrology)  
**No. 1874**

In South Africa, the establishment of an economically viable biofuels industry is increasingly becoming a possibility due to technological advances; global commitment to limit greenhouse gases and to reduce global warming; the need to diversify energy supply; and the need to accelerate rural economic growth by the agricultural sector. With diminishing fossil fuel resources and increasing oil prices, attention is being focused on producing alternatives to fossil fuel, with emphasis on the production of biofuels. The Biofuels Industrial Strategy of South Africa specifies the use of certain crops as feedstocks for bio-diesel and bio-ethanol production. The consideration of a range of crops and cropping systems as feedstocks is necessary, especially those which may produce food and fodder as well as fuel. Furthermore, the evolution of 'second generation' biofuel technologies which allow for the conversion of cellulose

(biomass) for biofuel production must also be investigated in terms of water use and potential impacts on the country's food production. Studies on the water use impacts of the biofuels industry on South Africa's limited water resources are urgently required for both local and national water resource planning. A scoping study on the water use of crops/trees for biofuel production (WRC Project No. 1772) provides preliminary results on the water use and growing conditions of limited biofuel crops based on broad climatic parameters and crop bio-physical requirements. The report of this follow-on project will document the water use and optimal growing conditions for a comprehensive range of potential crops/trees. It will include detailed mapping of suitable production areas and the projected impact of biofuel production on water resources and food supply.

Estimated cost: R5 000 000

Expected term: 2009 - 2015

#### ***Programme 2: Fitness-for-use of water for crop production, livestock watering and aquaculture***

##### **An investigation into the link between water quality and microbiological safety of fruit and vegetables from the farming to the processing stages of production and marketing**

University of Pretoria (Department of Microbiology and Plant Pathology)

**No. 1875**

With decreasing water resource availability for agricultural purposes and increasing water pollution, contamination of food products may increase health risks. Poor health due to water and food contamination has negative impacts on the productivity of human resources in all sectors of the economy. This emphasises the importance of minimising food safety risks. Due to under-nutrition, consumption of fresh and raw fruit and vegetables is encouraged as a source of essential micro-nutrients. If the water and produce are not safe, or if there is a lack of effective food safety management, this benefit may be eliminated and the health of all people, but in particular the vulnerable poor people, will weaken. In addition, earning of foreign exchange is a key contribution of agriculture to the economy. Microbial contamination of food products for local and export markets will have negative impacts on trade relationships. Losing market access due to perceived high risks of contaminated produce could have severe constraining implications for future economic development. For food safety management, European and American models are currently applied. These are not necessarily appropriate for South Africa and consequently the risk may not be correctly assessed. In addition, CODEX standards are presently adopted and officials are not able to benchmark these with locally verified data. Therefore, this research project on microbial contamination of fruit and vegetables will enable the drafting of relevant national microbial standards which comply with

international requirements. The knowledge obtained through the project will also contribute to effective management of water resources and food products to improve food safety. Better understanding of the nature and extent of the problem of microbial contamination of food, in the context of South Africa as a developing country, will support accurate health risk assessment and subsequent community health management.

Estimated cost: R4 419 200

Expected term: 2009 - 2015

#### **THRUST 2: WATER UTILISATION FOR FUELWOOD AND TIMBER PRODUCTION**

##### ***Programme 1: Water-efficient production methods and systems in agro-forestry, woodlands and forestry plantations***

##### **Water use and economic value of the biomass of indigenous trees under natural and plantation conditions**

CSIR Natural Resources and the Environment

**No. 1876**

Specific findings, recommendations and gaps in knowledge regarding the water use efficiency (WUE) and economic potential of indigenous tree systems were identified in a previous WRC project (K5/1462) which was finalised in March 2008. These included the need for improved understanding of the WUE of a wider selection of indigenous tree species growing under a range of bio-climatic conditions in South Africa. This information is needed to explore the possibility of expanding and growing the local forestry industry using indigenous tree species. Potential benefits of this expansion include the expected lower water use rates of indigenous species, and the high economic value of biomass products. Furthermore, it is important to place the water use of exotic commercial plantations in perspective, through comparisons with indigenous tree-production systems. There is also a need to establish a baseline water use by indigenous trees under natural conditions to facilitate the evaluation of likely water resource changes associated with a change in land use. Improved knowledge in these aspects will contribute to improving or enhancing rural livelihoods through the use of indigenous tree-production systems. In addition, possibilities exist to provide alternative wood-production systems to replace alien invasive plants, as the process of alien plant eradication continues. Ultimately, the research output should enable formulation of recommendations regarding the use of indigenous natural and plantation tree systems, with emphasis on WUE, site-species matching and economic viability to support sustainable rural development.

Estimated cost: R4 999 100

Expected term: 2009 - 2015

### **THRUST 3: WATER UTILISATION FOR POVERTY REDUCTION AND WEALTH CREATION IN AGRICULTURE**

#### ***Programme 1: Sustainable water-based agricultural activities in rural communities***

##### **Empowerment of women in rural areas through water use security and agricultural skills training for gender equity and poverty reduction**

University of KwaZulu-Natal (School of Environment Sciences)  
**No. 1878**

The joint document published in 2008 by the Department of Agriculture and Land Affairs, the Land and Agrarian Report Project (LARP), among other things, prioritises the revival of agricultural production by 10 to 15% in former homelands where valuable fertile land lies fallow. This plan is complemented by the objectives of the Department of Water Affairs, which seeks to, among others, ensure reliable and equitable supply of water for sustainable economic and social development including the eradication of poverty. A key feature for sustainable rural productivity will clearly be to develop capacity of the principal users of the land who are women. It has been reported that women constitute 70% of the agricultural labour force and are the main food producers for rural households in South Africa. However, there is sufficient evidence to suggest that poor rural women are considerably more disadvantaged because of gender bias in land allocation, access to credit, marketing channels and agricultural services in general. Women living in traditional rural areas form part of the most economically and socially disempowered groups in South Africa. This project focuses on the skills and training needed by rural women in order to sufficiently equip them to address the challenges of food insecurity and poverty. Although reports on agricultural training and skills development are widely available and have been well documented, very few, if any, are specifically tailored to meet the skills and training requirements of women in rural areas, within cultural and traditional realities. The report will identify skills required by women in agriculture (farming and non-farming activities within the food-value chain). The report will furthermore highlight the incentives of secure water and land entitlements which enable women to increase food security and reduce poverty at the household level.

Estimated cost: R3 000 000  
Expected term: 2009 - 2014

#### ***Programme 2: Integrated water management for profitable farming systems***

##### **Analysis of food-value chains in rain-fed and irrigated agriculture to include emerging farmers in the mainstream of the economy**

University of KwaZulu-Natal (Institute of Natural Resources)  
**No. 1879**

The inclusion of subsistence and emerging farmers in the mainstream of the economy is a nationally identified priority. Structural and cyclical obstacles must be overcome to accomplish this. These are mainly the dualistic nature of the agricultural economy and the recent occurrence of food shortages with high input costs. Although expectations are high for subsistence farmers to enter the market, experience shows that technical and business skills are required to obtain access to assets in agriculture by entering food-value chains. With high poverty levels and increasing unemployment, there is also a need to ensure growth with equity and therefore impacting on a wider group of people to promote rural economic development. Achieving this is a real possibility, since on the demand side there are different value chains, with consumers demanding food in different marketing outlets. On the supply side there are a large number of rural inhabitants, which includes groups who can be broadly categorised as subsistence, emerging and commercial farmers, who can potentially respond and enter any one or a combination of these value chains. The productive use of water in the value chain for both rain-fed and irrigated food production is of particular importance. The project will investigate factors such as needs and aspirations, technical capabilities, risks of crop production, food price expectations, water use security and incentives to increase water productivity which influence the decision of what value chain to enter and the degree of success obtained. The report will highlight innovative ways to promote integration of subsistence, emerging and commercial farming in food-value chains for crop and animal products with use of rain- and irrigation water.

Estimated cost: R2 999 989  
Expected term: 2009 - 2014

## **THRUST 4: WATER RESOURCE PROTECTION AND RECLAMATION IN AGRICULTURE**

### ***Programme 1: Sustainable water resource use on irrigation schemes and within river catchments***

#### **Methodology to monitor the status of water logging and salt-affected soils on selected irrigation schemes in South Africa**

ARC (Institute for Soil, Climate and Water)

**No. 1880**

Major capital investments have been made in irrigated areas of South Africa. Declining productivity due to salinisation will have an impact on individual farms and the sustainability of food production is potentially threatened. Therefore, it is important to monitor degradation and plan rehabilitation at scheme level. Since the late 1980s no national effort has been made to quantify the extent of water logging and salt accumulation across irrigation schemes. Indications are that water quality is declining and these problems are actually escalating. In order to identify soils for drainage and reclamation, the extent of water logging and salt accumulation has to be determined. National monitoring of water logging and salt accumulation is a high priority but currently no verified methodology is available to undertake this task. Data of soil conditions for different irrigation schemes is located at different organisations and the ARC-ISCW needs to be supported to act as custodian of baseline soils data. The GIS database and mapping is a new tool that is available for national application with the Agricultural Information System (AGIS). The general aim of this project is to develop and test a methodological approach for identification, classification and monitoring the extent and degree of water logging and salt accumulation at scheme, farm and field level. Guidelines will be produced for application at national scale which will ensure sustainable utilisation of soil and water for irrigation.

Estimated cost: R3 693 800

Expected term: 2009 – 2014

### ***Programme 2: Impact assessment and environmental management of agricultural production***

#### **Impact of wastewater irrigation by wineries on soils, crop growth and product quality**

ARC (Infruitec, Nietvoorbij)

**No. 1881**

The Department of Water Affairs is considering the issuing of a general authorisation (GA) for the irrigation of agricultural crops, e.g. vineyards, with treated and augmented winery wastewater. This GA entails that the wastewater be treated to a specified quality standard, before storage in irrigation dams and mixing with raw irrigation water. In order to attain the specified wastewater quality standards, it is envisaged that wineries will

adopt cleaner production approaches and replace chemicals that are detrimental to soils and crops with chemicals that will produce a wastewater rich in essential plant nutrients. Irrigation with the wastewater would thus be comparable to fertigation. While the effects of most of the winery constituents on soils and crops are fairly well known and their effect on soils and crops can thus be predicted with a fair degree of confidence, the same cannot be said for the organic content of wastewater, as measured by its chemical oxygen demand (COD). This project will consequently investigate the sustainable use of winery wastewater for irrigation of vineyards with respect to the effect it will have on soils, vineyard performance and wine quality. While the study will focus specifically on the effect of COD, it will also consider the effect of salinity, pH, sodium adsorption ratio (SAR), nitrogen, phosphorus and potassium contained in the wastewater. The research output will promote the beneficial reuse of winery wastewater, and the reclamation and protection of soil and water resources. This will inform legislation on wastewater management regarding regulations that promote the beneficial use of wastewater for productive purposes and lead to improved industry guidelines and practices for managing winery wastewater.

Estimated cost: R3 500 000

Expected term: 2009 - 2014

#### **Adaptive interventions in agriculture to reduce vulnerability of different farming systems to climate change in South Africa**

University of KwaZulu-Natal (School of Bioresources Engineering and Environmental Hydrology)

**No. 1882**

South Africa has a high risk agro-hydrological environment which is likely to be exacerbated under conditions of climate change. It is widely recognised that ongoing changes in climatic conditions will generally have an adverse effect on, amongst others, agricultural production, biodiversity and water resources. Agriculture is a key sector in the economy with regard to rural livelihoods and food security and it is therefore vital to proactively assess potential impacts of climate change on this sector. The National Disaster Management Framework of South Africa, a legal instrument specified by the Disaster Management Act, No 57 of 2002 recognises a diversity of risks and disasters that occur in Southern Africa, and gives priority to developmental measures that reduce vulnerability of disaster-prone areas, communities and households. In addition, the National Climate Change Response Strategy for South Africa, compiled in 2004, aims to address issues identified as priorities for dealing with climate change in each sector in the country. These documents informed the recently completed Climate Change Sector Plan for Agriculture compiled by the Department of Agriculture. The plan seeks to address institutional arrangements, vulnerability assessments, adaptation and mitigation as well as response and recovery of the agricultural sector as a result of climate change. Research

related to vulnerability and adaptation is identified in the plan as a priority. There is a lack of integrated knowledge regarding the vulnerability of agriculture in terms of climate change and water availability. The project aims to investigate the impact of projected climate change on agriculture; assess the vulnerability of crops, rangelands and farming households and enterprises; identify and suggest appropriate adaptive techniques and practices in selected catchments and farming areas. The report will provide an assessment of the vulnerability of different farming systems to climate change. It will evaluate

alternative adaptation practices and techniques (indigenous and science-based knowledge) and if necessary develop and test innovative, appropriate and sustainable interventions, including internal management measures and external policy measures.

Estimated cost: R4 000 000

Expected term: 2009 - 2014

## CONTACT PERSONS

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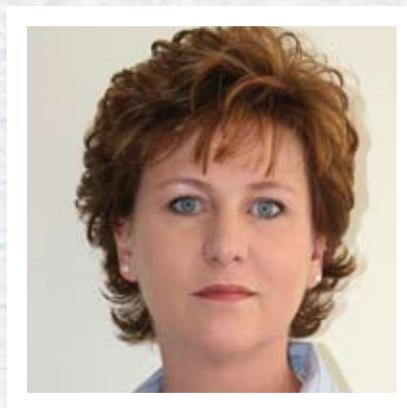
### **THRUST 4: WATER RESOURCE PROTECTION AND RECLAMATION IN AGRICULTURE**

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## KSA 5: WATER-CENTRED KNOWLEDGE



*Dr Heidi Snyman:  
Director*

### SCOPE

The Water-Centred Knowledge KSA addresses the management of water-centred knowledge (created via the support of the WRC as well as other sources) and the effective dissemination thereof.

The KSA enhances the effectiveness of the WRC in knowledge management, through the optimal use of enabling systems and tools. The Water-Centred Knowledge KSA:

- Leads and supports the core process of funding (the creation of new knowledge) by improving the use of support systems and evaluation tools, building research information databases and networks, and providing supporting information regarding research
- Develops knowledge linkages, and thereby ensures the development of a leadership role for the WRC at a national and global level
- Increases public understanding of water-related issues
- Leads knowledge transfer and commercialisation through proper management and protection of the intellectual property generated through WRC funding

This KSA also supports the sector, and the other KSAs in particular, by:

- Leading, improving and participating in knowledge-dissemination initiatives (established and new mechanisms, tools and procedures)
- Building and strengthening knowledge links with Africa and globally
- Developing and maintaining state-of-the-art communication systems with the water sector/stakeholders
- Promoting the WRC through engaging with all stakeholders and customers, either directly or through the media

### OBJECTIVES

The mandate of The Water-Centred Knowledge KSA is to drive knowledge dissemination in the sector by:

- Providing strategic support to the WRC and ensuring effective knowledge management internally and externally
- Understanding and developing the tools required for assessing research capacity and the long-term impact of water research
- Leading and directing water-centred knowledge dissemination through innovative mechanisms
- Actively supporting the water sector in its strategic knowledge-dissemination initiatives
- Managing the WRC-related intellectual property, media relationship and public relations/communication.
- Leading and maintaining research management systems and tools to allow effective research and funding cycles

### FUNCTIONAL AREAS

The achievement of the above objectives will be supported by a framework comprising a number of functional areas (which form a number of management areas/functional groups). One new functional area has been added to the portfolio, i.e., Functional Area 2: Water Knowledge Cycle – Strategic Research Advice.

#### **FUNCTIONAL AREA 1: RESEARCH FUNDING COORDINATION AND SUPPORT**

The scope of this functional area is the coordination of the research funding cycle and the provision and improvement of the tools, systems and procedures involved therein. This area focuses on increasing the user-friendliness of the Fund

Management System (FMS) for both external and internal users.

#### **FUNCTIONAL AREA 2: WATER KNOWLEDGE CYCLE – STRATEGIC RESEARCH ADVICE**

This new focus area will ensure that the WRC understands all the elements of the water knowledge cycle in the South African water sector. This functional area focuses on researching various elements, drivers and trends affecting the dynamics of the water-centred knowledge cycle, from issues related to research capacity and overall funding of research by the sector, to the effectiveness of research and its impact on policy and technology used by the sector. In the long-term this functional area may also provide advice regarding sector needs and global trends, i.e., foresight and scenario studies.

#### **FUNCTIONAL AREA 3: KNOWLEDGE SHARING AND PROMOTION**

This functional area oversees the flow of water-centred knowledge to and from the WRC by improving access to external information and water-centred knowledge, acting as a resource centre to meet the information requirements of the WRC and the water sector in general. This functional area leads the participation of the WRC in knowledge-sharing and knowledge-dissemination activities (e.g. workshops, exhibitions) organised by the WRC and other organisations within the sector – locally, in Africa, and globally. It strengthens the WRC's ability to exchange information and data on new developments in water management issues, while continuing to disseminate technical reports and technology transfer documents. Functions of this area include:

- Compiling, editing and publishing periodicals such as *Water SA* and *The Water Wheel*
- Developing and maintaining knowledge-dissemination processes
- Arranging events and exhibitions at high-profile, water-centred conferences nationally and, if necessary, internationally

#### **FUNCTIONAL AREA 4: LOGISTIC SUPPORT**

This functional area provides the logistics required for the flow of information in and out of the WRC. It serves as a resource centre and library, and as the quality control, printing and distribution focal point of the WRC. There is also a growing focus on e-publishing and e-business.

#### **FUNCTIONAL AREA 5: INTELLECTUAL PROPERTY (IP) MANAGEMENT AND TECHNOLOGY TRANSFER**

This area addresses all issues related to technology transfer and commercialisation. It supports the WRC drive to enhance innovation and provides the tools and processes for protecting technological developments. The functions of the area include:

- Increasing the awareness of stakeholders (internal and external) of the policies and guidelines with respect to WRC management of intellectual property
- Ensuring that all WRC intellectual property rights are protected

- Transferring of technologies through appropriate commercialisation routes.

#### **FUNCTIONAL AREA 6: BUSINESS SYSTEMS**

This functional area will continue developing the interface between service providers and the WRC, and between users of WRC knowledge products and the WRC. The KSA initiated the development of an Electronic Water Knowledge Hub that will progress through several development phases.

## CORE STRATEGY

### **Strategic context**

Considering the sector trends both globally and nationally, the role of KSA 5 is becoming increasingly strategic. The South African water sector faces serious challenges that threaten its sustainability and hence the ability to manage the resource. These sector threats include the:

- Dwindling human resource capacity in the Department of Water Affairs (DWA) and local government – this means that qualified but less experienced people need to acquire a level of competence in a short period of time without the luxury of continuous mentorship
- Limited research capacity in certain of the water-related research areas and reduced ability to deliver – this will cause a medium- to long-term shortage of knowledge in these areas with knock-on effects on the quality of decisions made
- Shortage of South African students studying towards a higher degree in water knowledge – a balance is required between the need to continue research (creating knowledge) to ensure a sustainable water sector and the need to build capacity to export to other African states
- Uptake of knowledge in the sector – the combination of the global skills shortage and increasing local demand causes less experienced and qualified people to stretch their capabilities further. It is no longer uncommon to see an engineering graduate from a technical university performing the tasks previously only performed by a university-graduate engineer. It is thus important to ensure that knowledge is packaged in a way that the incumbent can appreciate the value of the knowledge and apply it appropriately.

The WRC will thus continue to generate water-related knowledge-based products which contribute to addressing the knowledge gaps in the water sector through research. This water-related knowledge aims to inform decision makers and water practitioners. Historically, these users would source and repackage the information to suit their unique requirements. Global and local trends have proved that this is no longer the case. The repackaging of information and the taking of knowledge to the user is becoming more and more important. The role of KSA 5 is therefore becoming increasingly

important for the continued relevance of the WRC and for the sustainability of the sector. The emphasis will now also move to understanding, developing and applying methodology to ensure that the water-related knowledge generated by the WRC is absorbed and applied to solve the water challenges that South Africa experiences.

The **Water-Centred Knowledge** KSA aims to lead and support the other KSAs by developing instruments or tools that will support the knowledge process within the WRC. This includes packaging, distribution, communication, translation, enhancing public and user awareness and protection of the intellectual property. This KSA will aim at enhancing knowledge regarding all elements required for effective and sustainable generation and dissemination of water-centred knowledge. This will be done by building the capability to lead and manage strategic research advice within the KSA.

### Needs analysis

#### Internal stakeholders

The needs of these stakeholders (research managers and staff of the WRC) have been identified as: having an effective management system for research funds, an electronic document management system, and a dynamic interface with the local and global water sector.

#### External stakeholders

The KSA defines its external stakeholders as the creators (i.e., researchers, students and consultants) and users of water-centred knowledge (including researchers, students, government, educators, service providers, decision-makers, policy-makers, farmers, the media and community-based organisations in the water sector). This wide group of stakeholders requires the knowledge that is provided to be more relevant and accessible to them.

#### Other stakeholders

This group includes knowledge partners such as DWA, WISA, WIN-SA, WISA and SAICE. These organisations require water-centred knowledge, and the WRC can improve its knowledge dissemination by creating appropriate links with them, thus making water-related documents, data and knowledge more accessible to internal and external users.

#### Public understanding of science

South Africa cannot progress to sustainable water resource management without the co-operation of the public, and the latter cannot co-operate unless they have sufficient knowledge and are able to contribute meaningfully. The basis for understanding is the acquisition of knowledge. The **water sector** in general also faces the challenge of being able to link up and work globally and regionally.

### Overview of technological trends

The global technological trends relating to knowledge management are highly influenced by the rapid developments in information technology tools and systems. The technological developments related to the Web are increasingly moving towards knowledge dissemination and sharing. Tools such as blogs, 'really simple syndication' (RSS) and chat rooms are fast becoming the norm in the research community. The technological evolution in the field of knowledge recording, storing, presentation, application and creation has progressed to such an extent that systems designed as recently as 5 years ago are now virtually obsolete. These technological advances provide the tools to shape the knowledgeable water community in South Africa and the region.

## STRATEGIC INITIATIVES

### National initiatives

- Supporting *National Water Week*: KSA 5 supported the re-launch of the Adopt-a-River programme during the *National Water Week*, March 2010, at Eerste River, Western Cape.
- KSA 5 produced a special edition of *The Water Wheel* entitled: 'Water Kidz', a collection of articles aimed at high-school learners covering a variety of water-related topics.
- Supporting Skills Development in the Sector: The KSA 5 Director serves on the Skills Development Strategic Task Team of the Water Sector Leadership Group
- Financial Investment in the South African Water Sector: The KSA 5 Director facilitated a workshop hosted by the Development Bank of Southern Africa (DBSA) on *Investing in the Water Sector*, in June 2009, Midrand
- National Food and Water Quality: The WRC CEO and KSA 5 Director participated in the Round Table Discussion on Water and Food Quality, hosted by the CSIR. The food and beverage industry called for a discussion on water quality issues and how these relate to the food and beverage industry and specifically food quality throughout the chain of production and distribution.
- Water Sector Leadership Group: The KSA 5 Director participates in the Water Sector Leadership Group chaired by the Director-General of DWA
- A Sector Initiative on Improving National Water Information and Data Management: KSA 5 in collaboration with DWA Water Resources Information Management and WIN-SA started an initiative to improve information and data management in the sector. An initial workshop was held at Irene on 2 September 2009 to start sector wide discussions on improving knowledge, information and data sharing; creating closer links between knowledge rich institutions; centralising or enhancing access to data for further 'mining' and interpretation and developing mechanisms to enhance the flow of information in and between institutions.

- Meeting the new parliamentary portfolio committee: It is of strategic importance to form a dynamic relationship with the new portfolio committees related to water. This KSA therefore supported the WRC with specifically targeted interactions to strengthen the strategic relationship. To date, the successful interactions were:
- The KSA 5 Director attended the Joint Meeting of the Portfolio Committee on Water and Environment Affairs and Portfolio Committee on Agriculture, Forestry and Fisheries for the departmental briefing on the budget and strategic priorities for 2009/11 on 10 June 2009
- KSA 5 exhibited in the foyer during the Parliamentary Budget Vote debate, 24 June 2009
- A Research Manager from KSA 1 and the Knowledge Dissemination Officer from KSA 5 attended and briefed the Portfolio Committees during the Public Hearings on Climate Change, 17-18 November 2009

### African initiatives

- NEPAD Centres of Excellence: KSA 5 continues to support the NEPAD programme on the African Network of Centres of Excellence in Water Science and Technology. A WRC Director facilitated the *Consultative Workshop on Establishing the Southern Africa Network of Centres of Excellence in Water Science and Technology* held at the Birchwood Hotel and Conference Centre, April 2009. The deliberations were informed by the draft report on the institutional evaluations developed by IRD and WRC as well as key stakeholders such as NEPAD, SADC Science desk, AUC – HRST, AMCOST Bureau, representatives of the various ministries and institutional representatives. The delegation decided that Stellenbosch University will take the role of Administrative Coordinator for the NEPAD Southern Africa Network of Centres of Excellence in Water Science and Technology. All other partners are co-equals and Centres of Excellence in their own right with a leadership structure that is equal and represent the southern African region. The establishment of the West African Network of Centres of Excellence in Water Science and Technology was also started. A member of the IRD, Dr. Jean-Marie Fritsch and the KSA 5 Director visited the Kwame Nkrumah University of Science and Technology in Kumasi, Ghana in July 2009 to evaluate this institution for its suitability for inclusion into the West African node.
- Water Research Fund of Southern Africa (WARFSA): The KSA has been involved with the Water Research Fund of Southern Africa (WARFSA) for a number of years. WARFSA was established with the purpose of building research capacity among regional institutions and individuals as well as promoting the utilisation of research results in the planning and management of water resources in the sub-region. WARFSA is currently inactive and our efforts are focussed on reviving the programme.
- *2nd Africa Water Week – AMCOW: The 2nd Africa Water Week* held at Gallagher Estate, Midrand, in November 2009, was hosted under the aegis of the African Ministers' Council

on Water (AMCOW) and the strategic direction of the African Union Commission, and in partnership with the United Nations entities, African Development Bank, African Network of Basin Organizations (ANBO), African Network of Civil Society Organizations on Water and Sanitation (ANEWS), development cooperation partners and their agencies, the EU and G-8 countries, the Government of South Africa. The WRC assisted DWA with the technical programme and lead the technical session entitled: 'Mitigating and adapting to the impact of climate change'.

- Towards an Ethiopian Water Research Institution: The WRC hosted an Ethiopian Delegation consisting of members from the Ethiopia Ministry of Water Resources, Water Resources Research & Development Directorate, in February 2010. The Ethiopian government are investigating the possibility of duplicating the institutional model of the WRC in Ethiopia.

### International initiatives

This KSA supports many global initiatives managed by other KSAs. Examples include media support and exhibitions for international events. KSA 5 also assists with logistics for international delegations visiting South Africa. In addition, the KSA played a leading role in some international activities:

- KSA 5 facilitated the process for the WRC to become a member of the World Water Council (WWC) on 23 June 2009. The WWC is an international multi-stakeholder platform established in 1996 on the initiative of renowned water specialists and international organizations, in response to an increasing concern about world water issues from the global community. Its mission is 'to promote awareness, build political commitment and trigger action on critical water issues at all levels, including the highest decision-making level, to facilitate the efficient conservation, protection, development, planning, management and use of water in all its dimensions on an environmentally sustainable basis for the benefit of all life on earth'.
- The KSA 5 Director, in her capacity as the President of the Water Institute of Southern Africa (WISA) delivered the opening Address of the *WISA Membrane Technology Conference*, May 2009, Stellenbosch, South Africa.
- The KSA 5 Director served on the technical committee and presented a keynote address at the *12th IWA-Sludge Conference – Sustainable Management of Water & Wastewater Sludges*, Harbin, Heilongjiang Province, China, August 2009. The paper was entitled: 'The economic, social, environmental and health impact of implementing sludge guidelines in a developing country: South Africa'.
- The KSA 5 Director contributed to the technical committee for the *1st IWA Development Conference: Emerging Solutions to Water and Sanitation Challenges*, November 2009, Mexico City, Mexico. She co-authored a paper entitled: 'Innovative Approaches to Sludge Management in South Africa – Technological Development to Advanced Guidelines'

## Innovation

The WRC filed three patent applications in 2009, two of which are national phase applications (South Africa and Australia) based on the PCT (Patent Cooperation Treaty) entitled **Treatment of wastewaters using dual stage membrane bioreactors**. The third patent was only filed in South Africa and is entitled **Reverse flow microfiltration**. This technology emanates from an innovation from a recently completed WRC project (No. K5/1598), led by Professor Lingam Pillay of the Durban University of Technology. The main aim of this project was to develop a robust, inexpensive and sustainable water treatment unit for rural areas, based on the woven fibre microfiltration fabric. The treatment unit is being piloted in the northern part of the Eastern Cape and has been demonstrated to approximately 30 local and district municipalities in a WRC workshop held in one of the villages undertaking the pilot trials.

## Commercialisation

- The **Treatment of wastewaters using dual-stage membrane bioreactors** patent is currently being piloted. The licence agreement with AtHydro was signed in March 2010.
- On 29 October 2009, Ikusasa Water launched the **Capillary Ultra Filtration** membrane technology in Somerset West. The ultrafiltration membrane technology produces high quality water by conventional treatment without the use of chemicals. However, most membranes used in South Africa are imported at great cost. This is a joint research project, funded by the WRC, which was initiated in 1996 and succeeded in developing suitable and cost-effective, locally-produced, ultra-filtration membranes and filtration systems for use in water treatment and industrial water management.

## GROWING THE KNOWLEDGE BASE

### Capacity-building initiatives

KSA 5 supported the Research KSAs (1-4) in many workshop activities. The following specific workshops were championed:

- **Knowledge Flows:** The WRC hosted a number of experts on 8 February 2010 to conceptualise the broad research focus for water-centred knowledge (research capacity, knowledge uptake and use) for South Africa. The initiative was very well received and formed the bases for future discussions.
- **Data and Information Management:** Over 50 sector role-players attended and participated in a workshop held in Irene on 2 September 2009 organised by KSA 5. The aims of the workshop were to:
  - Establish the sector knowledge and information requirements
  - Establish the sector requirements regarding

monitoring and other data such as water balance data

- To develop the terms of reference on the way forward for knowledge sharing and data management
- Establish a National Water Knowledge Reference Group tasked to steer the implementation of the National Water Information and Data Management strategy
- **WRC 101 for Project Leaders:** The WRC noted an encouraging trend of proposals being submitted by research groups who have previously not applied for WRC funding. Established research groups also have new project leaders managing WRC projects. The WRC, like any other research funding organisation, has project management and administrative requirements which could seem overwhelming. In response, the WRC developed an informative 1-day course/workshop for aspiring and new project leaders to understand the WRC research cycle, find the research priorities of the WRC and the fund allocation for each of the priorities, prepare a comprehensive proposal, manage the technical, administrative and financial aspects of a WRC project, understand the contractual and financial audit requirements and know what resources are available to enhance the success of the project. The 1st *WRC 101* was hosted on 17 February 2010 at the OR Tambo Southern Sun in Kempton Park. The event was 100% oversubscribed necessitating a repeat early in the new financial year.

## Knowledge dissemination

### Open days

- **External open day:** The WRC held an open day at Kosovo Township in Cape Town to demonstrate the newly-constructed vacuum sewerage option that was built to provide better sanitation services to the community. The open day concentrated on the engineering, logistical and social difficulties in implementing technologies in informal settlements. 17 people participated in the Open day on 17 June 2009.
- **Internal open day:** The WRC staff visited the Vaal Dam and Rand Water's Zuikerbosch water treatment plant in Vereeniging on 25 February 2010. The tour was aimed at educating the staff about the water treatment processes.

### Exhibitions

The WRC exhibited and distributed material at the following conferences:

- **Parliamentary Portfolio Committee on Water and Environmental Affairs,** Parliament, July 2009, Cape Town. The Water Research Commission disseminated and exhibited materials during a workshop held for the Portfolio Committee on Water and Environmental Affairs, which was attended by approximately fifty people. Information packs were also prepared for the committee members.
- **Agricultural Alumni Association of the University of Venda,**

University Of Venda, August 2009, Khoroni Hotel, Thohoyandou. The event was organized by the Agricultural Alumni Association of the University of Venda, and chaired by a WRC Director. WRC banners and book materials were exhibited throughout the symposium, and WRC materials were exhibited during the gala dinner

- *Water Loss 2009 Conference*, April 2009, Cape Town. The Conference was the 4th event in a series of IWA water loss reduction specialist conferences, following 'Leakage 2007' that was held in Bucharest, Romania. It was brought to the African region in order to address the need for water loss reduction in Africa as well as to strengthen the ties between IWA and African water utilities. The conference was attended by approximately 420 delegates.
- *Drinking Water Conference*, May 2009, Port Elizabeth. Minister Sonjica launched the 'Blue Drop Report' at this event, attended by approximately 575 delegates.
- *The Budget Vote*, 24 June 2009, Old Assembly Chambers, Parliament, Cape Town. The Minister of Water and Environmental Affairs, Ms Buyelwa Sonjica, hosted a Parliamentary Budget Vote on 24 June 2009. The WRC was invited to exhibit in the foyer during the Budget Vote.
- *Sasol Techno X 2009*, August 2009, Sasolburg. The WRC exhibited at this event, which was initiated to create an interest in science, technology and maths amongst learners, teachers and the public in general. The exhibits were aimed at stimulating visitors through user-friendly, hands-on, interactive and interesting experiences with the focus on Gr. 7-12 learners and students. Approximately 15 000 learners attended.
- *International Mine-Water Conference*, October 2009, Pretoria. The *International Mine-Water Conference* was hosted jointly by the Water Institute of Southern Africa's Mine-Water Division and the International Mine-Water Association. The technical programme covered unique local and international developments in the field of mine-water management. The WRC exhibited at this conference and approximately 350 delegates attended.
- *IMESA*, 28-30 October 2009, Cape Town. The *IMESA Conference* was held in Cape Town during October 2009. The main aim was to offer the delegates an opportunity to share ideas and constructively debate the challenges facing engineers in the municipal environment. Approximately 500 delegates attended and the WRC exhibited some of their latest research reports.
- *2nd Africa Water Week*, November 2009, Midrand. The main focus of the *2nd Africa Water Week* was on implementation and partnership as Africa sprints toward the 2015 MDG targets. The WRC shared a stand with the Department of Water Affairs. Approximately 600 delegates attended.
- *Groundwater Conference*, November 2009, Somerset West. The theme for the biennial 2009 *Groundwater Conference* was 'Pushing the Limits'. The WRC exhibited at this conference attended by approximately 300 delegates.
- *North-West University Symposium*, November 2009, North-West University, Vanderbijlpark. The WRC was invited to

display WRC material at the above symposium. The WRC reports on display were mainly focused on the Upper Vaal Catchment in its broadest sense, with reports covering water impacts in the industrial, domestic and agricultural fields, as well as health reports. Approximately 80 delegates attended the symposium.

- *Provincial Water Indaba*, November 2009, Cape Town. The WRC exhibited at this event, attended by approximately 300 delegates.
- *Provincial Water Indaba*, December 2009, Bloemfontein. The WRC exhibited at the Free State indaba, attended by approximately 300 delegates.
- *Young Water Professionals Conference 2010*, January 2010, Pretoria. The conference aimed to provide a forum for young researchers and professionals in water and waste-water science, research, engineering, technology, management and other areas of the water sector to present their work and meet their peers in multidisciplinary fields of water research to further career development. Participants were also able to discuss current and future water-management concerns. Approximately 300 young water professionals attended the conference.

#### **Enhancing access to WRC publications**

The KSA continues to advertise and disseminate WRC publications at exhibitions, through press releases, briefs and the 'New from the WRC' feature in *The Water Wheel*. The WRC also continues to update and develop a series of brochures advertising relevant research reports related to a specific topic. The following brochures were published during the 2009/10 financial year: Drinking Water (version 2), Sanitation (version 2), Membranes, Environment and Mine-Water.

**Digitising all WRC research reports:** Many young researchers and managers only search the electronic media for relevant material. All WRC material that is not available electronically is therefore "lost" or not accessible to these important stakeholders. KSA 5 led a large drive to digitise all WRC research reports since 1971. More than 1000 research reports were scanned in this financial year. In addition all these documents are searchable PDF files and are their full content is thus searchable on the internet. This essentially opened up the full resource potential of the WRC knowledge products.

**New WRC website:** The WRC website was re-engineered and launched on the 17th September 2009. The WRC website is now a fully functional content based, searchable website containing all WRC documents including annual reports, knowledge reviews, *The Water Wheel*, *Water SA*, Technology Transfer reports and all other research reports. In addition, these are all searchable and contained in the knowledge hub. Searchers can be refined and expanded according to the user's needs. The new website is part of a larger drive to develop an Electronic Water Knowledge Hub (EWKH) which will be a world class digital water information centre. In the 2010/11 financial

year KSA 5 will lead research and development of Phase II of the EWKH development. During the various envisioning sessions performed during Phase 1 of the WRC EWKH, the following additional functionality was highlighted for consideration in Phase II development of the WRC EWKH:

- Implement shopping cart functionality for downloading of documents
- Online ordering of (and paying for) hard copies of documents
- Participate in discussion forums and blogs
- Subscribe to electronic notifications / feeds
- Social network integration
- Write questions to an expert and view the answers
- Rate a publication / research report
- Participate in the water community
- Find experts / researches and view their profiles
- Collaborate with others on research projects
- Implement a picture and video gallery
- Link with the project management and FMS.

### **Briefs**

Thirty briefs (25 technical and 5 policy briefs) were developed and printed in the 2009/10 financial year.

#### **Technical briefs:**

- Aquifer vulnerability to contamination (1432/1/07)
- Guide to catchment-scale assessments for surface water (TT 352/08)
- Review of indigenous rainwater harvesting and conservation practices (TT 392/09)
- Tools for effective management and rehabilitation of wetlands (WET-series)
- Assessing the impact of water-related membrane research (TT 366/08)
- Market risk, water management and the economy (1250/1/08)
- Water law of SA (KV 203/08)
- Best management practices on selected irrigation schemes (TT 344/08)
- Improved inspection of wastewater treatment works (TT 375/08)
- Cyanobacteria – detecting toxin-producing strains (1502/1/07)
- EDCs health risk assessment framework (KV 206/08)
- Process design manual for small wastewater treatment works (TT 389/09)
- Aligning SA's water and trade policies (1564/1/08)
- Impact of irrigation usage on groundwater resources (1507/1/08)
- Enhancing crop irrigation demand estimation (TT 391/08)
- Assessing River Health Programme research (TT 360/08)
- Climate change and water (1430/1/05 + KV 207/08)
- Sustainable sanitation through algal ponds (TT 390/09)
- Downstream influences of spills and releases from dams (1314/1/07)

- Impact of gender in the rural water sector (TT 407/09)
- Non-potable water use in SA (1701/1/09)
- Agricultural water management (TT 267/08)
- EDCs in drinking water – the concern (1532/1/08)
- Fluoride in drinking water (1094/1/08)
- On-site training of operators of small rural water treatment plants (TT 348/08)

#### **Policy briefs:**

- Climate change and water (KV 207/08)
- Water law of SA (KV 203/08)
- Impact of gender in the rural water sector (TT 407/09)
- Non-potable water use in SA (1701/1/09)
- EDCs in drinking water – the concern (1532/1/08)

#### **Effective interaction with the media**

The following press releases were made during the 2009/10 financial year:

- Institutional reform and modernisation of irrigation systems in South Africa (December 2009)
- Young Water Professionals meet in Pretoria, 19-20 January (December 2009)
- Delegates to the UNFCCC take South Africa's views to COP15, 2009 (December 2009)
- Irrigation Scheduling through on-farm demonstration (October 2009)
- Cutting edge research leads to commercialisation of ultrafiltration membrane technology (October 2009)
- Poor technology choice can affect our water quality and supply (October 2009)
- Water Safety plans bringing an assurance of drinking water quality (September 2009)
- Guidelines for improved disinfection of small (September 2008)
- Increasing food security through rain water harvesting, opportunities and challenges (November 2009)
- Water Resources of South Africa 2005 (September 2009)
- Support for small water treatment plants (September 2009)
- Nanotechnology – a revolutionary water treatment solution (March 2010)
- Are we on track with sustainable sanitation services (March 2010)

Several WRC initiatives were reported on in the media in 2009/10. These included, among others:

- The WRC report 'Water Resources of South Africa 2005 (WR2005)' attracted large media interest:
  - The WRC project leader, Mr Brian Middleton, appeared on *Radio 702* on the programme *Talk at nine*, which focused on 'SA's Declining Water Reserves' on 25 September 2009
  - The *Cape Times* reported on the WR2005 study on 1 October 2009: 'South Africa's natural water resources are declining'
  - The *Saturday Star* reported 'Alarm bells are ringing for SA water supplies' on 27 September 2009
  - A *Mercury* newspaper article on 'Water shortage'

- quoted the WR 2005 study on 1 October 2009
- The WR2005 study was also mentioned in the *Borehole Water Journal* (Vol. 78 Q4 2009) in an article entitled 'Latest study reveals less water than estimated'
  - The commercialised capillary ultrafiltration technology developed through WRC funding received positive media exposure:
    - The Cape Town based newspaper, the *District Mail* reported 'Local firm pioneers water "Ultrafilters" in South Africa' on 5 November 2009
    - An article titled 'Cape-based ultrafiltration membrane plant commissioned' was published in *Engineering News*
    - *Metrobuild* magazine published an article under the topic 'Water Engineering' entitled 'Ultrafiltration membrane technology comes of age' in the November 2009 issue
  - A WRC Director was invited to a television interview for the programme *African Diaspora*, which considered aspects of water management pertaining to policies in the continent and in relation to existing institutional arrangements and their effectiveness in achieving the MDG's. The programme was televised on 23 August 2009 at 4:30 on *SABC International*.
  - An article entitled 'New look municipal account on its way to you' was published in *Tshwane News* on 31 July 2009. This reported on the product of a completed WRC project that focused on municipal accounts.
  - An article published in *Business Day* on 3 June 2009 reported on the project 'Mercury pollution in South Africa's water sources', co-funded by the WRC.
  - The KSA 5 Director, in her capacity as President of WISA, was interviewed by SABC TV during the *Drinking Water Conference*, Port Elizabeth, May 2009
  - An article based on a paper authored by a WRC Director and Mr Felix Reinders of the ARC on 'Institutional reform and modernisation of irrigation schemes in South Africa' was published in the *Farmer's Weekly* on 22 January

2010 entitled: 'Agricultural development depends on water saving'. This was followed by a cover story entitled 'Irrigation: making every drop count' on 29 January 2010.

- An article entitled 'Time to focus on underground pollution' written by the Editor of *The Water Wheel* was published by The Southern Africa Water Wire/Inter Press Service
- A WRC Research Manager, as Chair of the Young Water Professionals Organising Committee was interviewed on an hour-long *SABC International* television programme *African Views* on 20 January 2010.
- A WRC Research Manager was interviewed on 'Availability of water in South Africa' on the radio station *Umhlobo Wenene* on 1 February 2010
- A WRC Director was interviewed telephonically on the midday radio show on in *Channel Africa* about 'the WRCs media breakfasts on Climate Change and Nanotechnology' on 18 February 2010
- The KSA 5 Director was interviewed on *Radio Rippel* on 15 March 2010 with regard to the WRC's role in *National Water Week*

#### **Media education on key subject matter**

The media often contact the WRC with requests for information, and it is clear from the questions asked that the media are not aware of the role and mandate of the WRC and that they find the information provided too technical. Journalists' deadline constraints when a story breaks are short, so there is not much time to read up in detail. The KSA therefore identified technical water issues that could become relevant in the short- to medium-term and hosted two events targeting environmental journalists and other interested members of the media, with intention of initiating informal interactions with the media on a specific topic. Two such 'media breakfasts' were held: one on climate change on 1 March 2010 and one on nanotechnology on 15 March 2010.

**TABLE 1**  
**WRC reports distributed to stakeholders in 2009/10**

FWR	189
Institutes	2701
Municipalities	325
Private	9013
Schools	205
State Library	476
University/University of Technology	2639
WRC	2528
WRC Board	169
<b>TOTAL</b>	<b>18145</b>

**TABLE 2****WRC reports distributed to stakeholders in 2009/10**

REPORT	TITLE	KSA	TOTAL
TT 375/08	Guideline for the inspection of wastewater treatment works	3	320
TT 391/08	Integrating and upgrading of SAPWAT and PLANWAT to create a powerful user- friendly irrigation planning tool: Program Version 1.0	3	316
1576/1/08	Real time irrigation advice for small-scale sugarcane production using a crop model	4	316
TT314/07	On-farm application of in-field rainwater harvesting techniques on small plots in the central region of South Africa – Vol 2: Extension manual.	4	206
TT 367/08	Developing a land register and a set of rules for application of infield rainwater harvesting in three villages in Thaba Nchu: A pilot project	4	197
TT 247/05	An illustrated guide to basic water purification operations	3	180
1461/1/08	Assessment of the interaction between cage aquaculture and water quality in irrigation storage dams and canal systems	4	173
TT 376/08	Rivers and wetlands of Cape Town	1	163

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**FUNCTIONAL AREA 4: LOGISTIC SUPPORT  
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**Hendrick Manaiwa** (from 1 January 2010)

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# CATALOGUE OF AVAILABLE TT REPORTS

## **Integrated management of water hyacinth in SA**

**Marcus Byrne, Martin Hill, Mark Robertson, Anthony King, Ashwini Jadhav, Naweji Katembo, John Wilson, Ryan Brudvig and Jolene Fisher**

Water hyacinth, *Eichhornia crassipes* (Martius) Solms-Laubach (Pontederiaceae) is South Africa's most damaging floating aquatic weed. Despite notable successes with the biological control of other floating aquatic weeds, and a concerted biological control effort against water hyacinth, its populations continue to reach newsworthy proportions on major rivers and dams. Hill and Olckers (2001) ascribed the variable success of the biological control programme on water hyacinth in South Africa to variable climatic conditions, eutrophication of aquatic ecosystems, interference from integrated control operations, the hydrology of infested systems and techniques for establishing biological control agents. The research presented in this report addresses the effect of temperature and nutrients on the growth of water hyacinth and some of its biological control agents and investigates the interaction of herbicide application with biological control. This has been done in light of discovering a sublethal dose of herbicide which will retain water hyacinth plants in a system to maintain populations of the agents. In addition, a management plan has been developed to guide water managers as what action should be taken in terms of combining biological control with herbicidal control under different climatic and nutrient conditions.

TT 454/10

ISBN: 9781770059757

overseas price: \$35.00 (Exclude postage)

## **Ecohydraulics for South African Rivers:**

### **A review and guide**

**James C.S. and King J.M. (Editors)**

This project was aimed at synthesizing existing knowledge on ecohydraulics in South Africa and then packaging it in the form of a Review and Guide document. The Guide provides theories and techniques related to ecohydraulics as well as the ecological context and perspective for the application of ecohydraulics. Thus building capacity amongst engineers and ecologists and contributing towards the effective management of our aquatic environment. The Guide will also provide an overview of the current state of ecohydraulics research in South Africa, serving as a useful point of reference for identifying and prioritising future research needs for ecohydraulics in South Africa. It is of importance to note that the techniques and theory presented in this document deal exclusively with ecology and ecohydraulics within a river context, with the intention that environmental hydraulics in its broader sense,

which typically include biological and chemical aspects in lakes, estuaries and wetlands, will be addressed in subsequent research projects. Furthermore, it is necessary to point out that the hydraulic theory that is presented in this document assumes that the user of this Guide will have a graduate level of understanding of river hydraulics. However, the content is presented in such a way as to ensure that water resource practitioners and managers as well as researchers across a wide spectrum of disciplines, should find the document informative and useful.

TT 453/10

ISBN: 9781770059603

overseas price: \$35.00 (Exclude postage)

## **Water quality overview and literature review of the ecology of the Olifants River**

**Ralph Heath, Trevor Coleman, Johan Engelbrecht**

In the light of the ongoing water quality problems in the Olifants River, Mpumalanga, a review of water quality studies done on the system was commissioned to provide this information for other studies on this system. An overview of the economic activities in the catchment provides the background for the water quality problems to which the system is exposed. Resource Quality Studies, Dept. of Water Affairs, started monitoring the catchment in 1983 and have monitored a number of parameters in their routine monitoring programme. The review also covers water quality results from specific studies in the catchment.

There is little historical data available regarding heavy metal and pesticide inputs to the Olifants River. Some short-term studies have been completed through the Water Research Commission. A recent DWA investigation found the sediment to be substantially more contaminated than the water. A number of recommendations for monitoring the influence of the pollutants on the river ecosystem as well as the management of water from defunct and extant mines are made.

TT 452/10

ISBN: 978177005

overseas price: \$35.00 (Exclude postage)

### **Application of ecological informatics modelling techniques for predicting harmful algal blooms**

**Carin Elizabeth van Ginkel, Sandra du Plessis, Johannes Jacobus Bezuidenhout**

The study showed that eutrophication and the associated problems is a real threat to South African fresh water resources but that modelling methods can assist in managing the problem. The list of recommendations needs to be taken further by a number of stakeholders, e.g. the Department of Water Affairs, future CMA's, Universities and other researchers in order to:

- a) Determine the necessary variables and monitor these for future modelling exercises.
- b) Include total microcystin monitoring in impacted fresh water resources at least during the summer periods to enable resource managers to issue warnings to all potential impacted stakeholders.
- c) Initiate and test available management options to minimise serious eutrophication levels in South Africa.
- d) Manage the risk imposed by the cyanobacterial blooms and the associated toxins produced in the water resources, on drinking water facilities and the health of recreational users.
- e) Develop short-term forecasting tools, for the algal blooms of *Microcystis* and *Ceratium*, with on-line water quality monitoring for early-warning and real-time forecasting for reservoir managers.
- f) Investigated the cause and effects for changing composition of the phytoplankton of these five reservoirs.
- g) Monitor at different depths to determine the best depth for abstraction for treatment purposes.

The successful use of the hybrid Evolutionary Algorithm Method to develop predictive tools for algal blooms indicated the necessity to develop capacity (both human and equipment) in South Africa to use the Hybrid Evolutionary Algorithm (HEA) RULE set development in all research spheres, as the method is applicable to any type of numerical data and can be applied to any research field.

TT451/10

ISBN: 9781770059535

overseas price: \$35.00 (Exclude postage)

### **Integrated water quality management: A new mindset**

**Lee Ann Boyd; Robyn Lesley Tompkins; Ralph Gregory; Melville Heath**

The conceptual model is based on the premise that good water quality is in everyone's best interests. This "Change of Mindset" IWQM management approach "breaks down" the management of water quality into smaller management units. At the same time, both the horizontal and the vertical reporting framework is established. This structure is aimed at addressing the problem of implementation of quality standards across the country, and

also improving enforcement by reducing the volume of reports that should highlight problem areas and allow for prioritisation of regulatory or remedial action. A further benefit of the IWQM management framework is that responsibility for water quality is based on significantly smaller geographical areas, and accountability to the adjoining areas (horizontal accountability) and to the next level of management (vertical accountability) is established with the creation of the management unit. This allows accountability for water quality to be focused on smaller management units, rather than diffused up ever higher levels of management. Finally, the IWQM approach allows water quality information to be packaged for a broader audience, as reporting is simplified to provide information on whether or not a management unit is within the specifications of its critical control points (CCPs) or not; rather than extensive technical reports to national level through the management chain.

TT 450/10

ISBN: 9781770049529

overseas price: \$35.00 (Exclude postage)

### **Financial and economic feasibility of drainage**

**Robert Jack Armour and Machiel Frederick Viljoen**

It was strongly suggested and agreed upon at a final Reference Group meeting for WRC project 1352, that the project team prepare a consultation proposal to meet with relevant stakeholders for technology transfer of the results produced in the project. This is due to the fact that this research successfully integrated and linked models and results from different disciplines (soil science, hydrology and agronomy) with economic models at micro (per hectare, sub-WUA and WUA) level and social welfare models at the regional level. This enabled the researchers to determine the long term impact (cost and benefits) of different salinity management options and provided valuable information required for decision making at different levels.

In this regard the results show that for the different levels:

- Drainage installation and consequent leaching, is a better option financially, environmentally and socially than changing to more salt tolerant crops at farm, WUA and regional level;
- The project results clearly show that to reduce the risk of income loss due to irrigation salinity, drainage and leaching are necessary;
- At regional level the direct and indirect effects of modeled improved drainage (and subsequent investment in higher value crops) proved far greater than the costs of the drainage; produced the highest index for socio-economic welfare (ISEW); and an increase of employment in irrigation farming and related industries over the long term.

To reinforce the message of the technology transfer results to be presented, brochures will be handed out at the technology transfer meetings and a web-page will be introduced that will include links to the relevant WRC reports, the user friendly

technology transfer report, and other updated and interesting salinity and drainage related information.

TT 448/09

ISBN: 9781770059511

overseas price: \$35.00 (Exclude postage)

#### **Impact assessment of the water administration system**

**David Winter**

Since 1985 the Water Research Commission has been working closely with the DWAF together with NB Systems in developing water management systems that simplify the task of managing canal water for irrigation purposes. This has resulted in the production of a broad range of research reports that have been focused on the development of the Water Administration System (WAS).

The WAS program is designed to be a water management tool for irrigation schemes, Water User Associations (WUA's), Catchment Management Agencies (CMA's) and water management offices that need to manage their water usage, distribution and accounts. It is an integrated database-driven system with many water management capabilities that include handling any number of farmers, abstraction points and measuring stations on canal networks, pipelines and rivers. The system involves simplified and controlled ways of managing water allocations, use, distribution and billing.

The main objective for developing the WAS program was to minimise water losses for irrigation schemes that work on the demand system and that distribute water through canal systems. The program consists of seven modules that are integrated into a single program that can be used on a single PC or multi-user environment. These seven modules can be implemented partially or as a whole, depending on the requirements of a specific scheme or office.

TT 447/09

ISBN: 9781770059504

overseas price: \$25.00 (Exclude postage)

#### **The investigation of the positive and negative consequences of the introduction of zero-phosphate detergents**

**Christopher William Spencer Dickens, Jeremy Kenneth Dickens, Philip Mark Graham, Leo Malcolm Quayle, Susan Delia Freese, Dean Edward Simpson, James Nelson Blignaut & Angelika Sylvia Goliger**

TT 446/10

ISBN: 9781770059467

overseas price: \$35.00 (Exclude postage)

#### **Assessing the impact of in-field rainwater harvesting and conservation research**

**James Nelson Blignaut and Xolani Rudolf Sibande**

The Water Research Commission (WRC) has been supporting the Agricultural Research Council (ARC) at Glen near Bloemfontein and various other organisations over the past 15 years to conduct research and development for in-field rainwater harvesting (IFRWH) techniques and the dissemination of knowledge among the members of 42 villages surrounding Thaba Nchu. The WRC approached ASSET Research to conduct an investigation, using the McMaster University's research impact assessment tool, as to the uptake and impact of IFRWH in those villages.

TT 444/08

ISBN: 9781770059436

overseas price: \$25.00 (Exclude postage)

#### **Wetland valuation Volume IV: A protocol for the quantification and valuation of wetland ecosystem services**

**JK Turpie and M Kleynhans**

VOLUME 11: WRC REPORT TT443/09

WETLAND VALUATION VOLUME IV: A PROTOCOL FOR THE QUANTIFICATION AND VALUATION OF WETLAND ECOSYSTEM SERVICES

This study builds on three earlier volumes on wetland valuation and includes a review of current understanding of wetland ecosystem services to provide a protocol for the quantification and valuation of wetland ecosystem services. The report is written for planners and decision-makers wishing to understand the purpose and potential for use of wetland valuation in a variety of decision-making contexts, and to guide them in the setting of terms of reference for specialist studies. In addition, the report aims to guide student and professional resource economists in their understanding of the purpose of and trade-offs in valuation studies, the choice of their detailed methodological approach and the role of biophysical specialists in wetland valuation. Although the report provides advice on how to achieve relatively rapid estimates of wetland values, it does not offer a shortcut tool for rapid valuation by non-professionals.

TT 443/09

ISBN: 9781770059351

overseas price: \$30.00 (Exclude postage)

#### **Wetland Valuation Volume III: Assessment of the livelihood value of wetlands**

**JK Turpie**

VOLUME 10: WRC REPORT TT 442/09

WETLAND VALUATION VOLUME III: A TOOL FOR THE ASSESSMENT OF THE LIVELIHOOD VALUE OF WETLANDS

Millions of South Africans are directly dependent to some extent on natural systems to sustain their livelihoods, and wetlands are considered particularly valuable in terms of the variety and abundance of services they provide. Understanding the degree to which wetlands contribute to people's livelihoods may be vital in steering decisions that minimize negative impacts or enhance the benefits that wetlands have for communities, such as their contribution to household income. This study developed a simple index for the assessment of a wetland's importance to people's livelihoods through understanding the level of dependence of surrounding communities on a wetland. The tool outlines the way in which the index parameters are estimated at a rapid, intermediate, or comprehensive level, depending on the budgetary constraints or the level of confidence required. Since the index produces a result which is in comparable units, the results can be used to assess the relative importance of a wetland compared to others in the catchment or even nationally, and to rank, or prioritize, different wetlands in terms of management priorities.

TT 442/09

ISBN: 9781770059344

overseas price: \$30.00 (Exclude postage)

**Wetland Valuation Volume II: Case Studies**  
**JK Turpie**

VOLUME 9: WRC REPORT TT441/09

WETLAND VALUATION VOLUME II: WETLAND VALUATION CASE STUDIES

This report, one of the outputs of the Wetland Health and Importance (WHI) research programme and one of four on the value of wetland ecosystems, documents five case studies selected to fill some important gaps in wetland valuation in South Africa, as well as to provide examples of studies carried out at different levels.

TT441/09

ISBN: 9781770059337

overseas price: \$32.00 (Exclude postage)

**Wetland Valuation Volume I: Services & Their Valuation**  
**Jk Turpie, K Lannas, N Scovronick and A Louw**

VOLUME 8: WRC REPORT TT440/09

WETLAND VALUATION VOLUME I: Wetland ecosystem services and their valuation: a review of current understanding and practice

This report, one of the outputs of the Wetland Health and Importance (WHI) research programme and one of four on the value of wetland ecosystems, reviews the wetland valuation literature to ascertain how wetland valuation has been approached internationally, and how international and local experience can guide best practice for approaching wetland valuation in South Africa. Wetlands are recognised

as being valuable ecosystems which provide water, food and raw materials, services such as flood attenuation and water purification, and intangible values such as cultural and religious value. Despite this, and legislation to protect them, they are increasingly threatened, with more than half the world's wetlands having been lost already. Wetlands may be degraded due to market failure (where markets do not reflect true values or costs) and government failure (perverse incentives, lack of well-defined property rights leading to open access and ignorance of decision makers as to the value of wetlands). Economic valuation helps to compare the real costs and benefits of ecosystem use and degradation, and allows more balanced decision-making regarding the protection and restoration versus degradation of wetlands.

TT 440/09

ISBN: 9781770059320

overseas price: \$30.00 (Exclude postage)

**Assessment of two wetlands in the Kamiesberg uplands**  
**Donovan Charles Kotze, Heather Louise Malan, William Nolan Ellery, I Samuels and L Saul**

VOLUME 7: WRC REPORT TT439/09

ASSESSMENT OF THE ENVIRONMENTAL CONDITION, ECOSYSTEM SERVICE PROVISION AND SUSTAINABILITY OF USE OF TWO WETLANDS IN THE KAMIESBERG UPLANDS

There is a long history of use of the wetlands in the Kamiesberg area. Even for the present generation they represent an important resource to a community that is relatively poor. This study, a joint initiative between the WRC-funded Wetland Health and Importance Research group and the Agricultural Research Council (ARC): Range and Forage Unit, reports on an investigation of the geomorphology, vegetation and utilisation by humans, of two wetlands (Langvei and the Ramkamp) which are situated just outside of Leliefontein in the Kamiesberg area of the Northern Cape. The historical settlement patterns and land-use in the area are described, and the information collected was used to establish the environmental condition of the wetlands, the ecosystem services they are likely to deliver and how sustainable the use of those systems is likely to be. Sustainability was assessed both from a sociological, and an ecological, point of view.

TT 439/09

ISBN: 9781770059313

overseas price: \$30.00 (Exclude postage)

### **Assessing the sustainability of wetland use**

**Donovan Charles Kotze**

VOLUME 6: WRC REPORT TT438/09

WET-SUSTAINABLE USE:

A system for assessing the sustainability of wetland use WET-SustainableUse has been developed to assess the ecological sustainability of wetland use, focusing on grazing of wetlands by livestock, cultivation of wetlands and harvesting of wetland plants for, for instance, crafts and thatching. WET-Sustainable Use asks to what extent the use of the wetland has altered the following five components of the wetland's environmental condition: (1) the distribution and retention of water, (2) the erosion of sediment, (3) the accumulation of soil organic matter (SOM), (4) the retention of nutrients and (5) the natural species composition of the vegetation in the wetland. WET-SustainableUse assists the user in answering these questions by providing a set of indicators for each of the five components, and a structured way of scoring these indicators and deriving an overall score for each component.

TT 438/09

ISBN: 9781770059306

overseas price: \$30.00 (Exclude postage)

### **Assessing cumulative impacts on wetlands at catchment scale**

**WN Ellery, S Grenfell, M Grenfell, C Jaganath, HL Malan and DC Kotze**

VOLUME 5: WRC REPORT TT437/09

A METHOD FOR ASSESSING CUMULATIVE IMPACTS ON WETLAND FUNCTIONS AT THE CATCHMENT OR LANDSCAPE SCALE

This volume, part of the series on Wetland Health and Importance, describes methods which enable the assessment of the effects on wetland functionality of the cumulative impacts of human activities at a landscape scale. It uses two metrics - the land cover change impact metric and the loss of function metric to produce a functional effectiveness score that is translated to functional hectare equivalents. The land cover change is based on the recognition that wetland structure and function are fundamentally affected by the hydrological regime. The loss of function metric describes the relationship between the magnitude of impact and wetland functionality for a total of 6 ecosystem services: A) flood attenuation, B) stream flow regulation, C) sediment trapping, D) nitrogen removal, E) phosphate removal or F) toxicant removal. These metrics are based on limited field testing and need verification.

TT 437/09

ISBN: 9781770059290

overseas price: \$30.00 (Exclude postage)

### **Aquatic invertebrates – indicators of human impacts in SA wetlands assessment of temporary wetlands**

**M Bird**

VOLUME 3: WRC REPORT TT435/09

AQUATIC INVERTEBRATES AS INDICATORS OF HUMAN IMPACTS IN SOUTH AFRICAN WETLANDS

The recent emphasis on wetland protection and management has created an urgent need to develop assessment tools to establish and monitor human impacts in wetland ecosystems so as to prioritise wetlands for conservation and rehabilitation actions and to monitor the effects of these actions. Biological assessment or "bioassessment" is one of the means of investigating wetland condition and involves the evaluation of a wetland's ability to support and maintain a balanced, adaptive community of organisms having a species composition, diversity and functional organisation comparable with that of minimally disturbed wetlands within a region. Potential indicator groups for bioassessment purposes include macrophytes, algae and diatoms, aquatic invertebrates, birds and fish. This volume describes the use of macro-invertebrates for the assessment of the condition of a wetland.

E Day, JA Day, V Ross-Gillespie and A Ketley

TT 435/10

ISBN: 9781770059276

overseas price: \$30.00 (Exclude postage)

VOLUME 2: WRC REPORT TT434/09

THE ASSESSMENT OF TEMPORARY WETLANDS DURING DRY CONDITIONS

This volume, part of the series on Wetland Health and Importance, describes methods which enable the user to assess the condition of temporary wetlands when they are dry. In extreme cases, a seasonal wetland may not be obvious, and methods are provided to aid in the recognition of wetlands in such cases. The soils underlying most wetlands are exhibit characteristic colouration and this is described. Certain invertebrates, in particular Branchiopod crustaceans, characteristically inhabit this type of wetland and methods for the determination of the presence of these are described. In addition, certain plants are characteristic of this type of situation, and these are also described. However, no single indicator provides adequate information about wetland presence, type, hydroperiod, biodiversity, function and principle ecological and hydrological drivers. In extreme cases the most cryptic of wetlands may show none of the indicators.

TT 434/09

ISBN: 9781770059269

overseas price: \$30.00 (Exclude postage)

**Vol 1: Handbook To The Wetland Health & Importance  
Research Programme  
E Day and HL Malan**

VOLUME 1: WRC REPORT TT 433/09  
TOOLS AND METRICS FOR ASSESSMENT OF WETLAND  
ENVIRONMENTAL CONDITION AND SOCIO-ECONOMIC  
IMPORTANCE: HANDBOOK TO THE WHI RESEARCH PROGRAMME

Volume 1 of this series, one of the outputs of the Wetland Health and Importance (WHI) research programme, distils the major findings of the different components of the project and their implications for future work in the management or assessment of wetland environmental condition and socio-economic importance in South Africa. This series of 11 volumes addresses the assessment of wetland environmental condition using aquatic invertebrates and macrophytes as well as the assessment of temporary wetlands during dry conditions. There is a metric for the broad-scale assessment of impacts and ecosystem services and methods and case studies on the assessment of socio-economic and sustainability studies. (Volume 4 publication expected late 2010.)

TT 433/09  
ISBN: 9781770059252  
overseas price: \$30.00 (Exclude postage)

**“Going with the franchising flow”: An exploration of  
partnerships for the operation and maintenance of water  
services infrastructure  
Kevin Wall & Oliver Ive**

The rapid rate of construction and commissioning of new water services infrastructure is severely challenging the public sector institutions in South Africa responsible for operating and managing this infrastructure. Innovative approaches are required. But even if all the existing water services institutions were coping with the responsibility, there would be good reason to investigate alternative institutional models, on the grounds that it needs to be found out if alternatives could be more cost-effective, and/or could offer a range of other advantages (including greater local economic development). There is an alternative institutional model that is suited more for the ongoing operation and maintenance of water services systems than for investment in new infrastructure – and, importantly, that is friendly to small business and local economic development. This alternative is the franchising partnership. Franchising is a way of accelerating the development of a business, based on tried and tested methodology. The franchise system firstly correlates and systematises the business, and then facilitates the setting up of the business and supports and disciplines it thereafter. The key is the incentive, to franchisor and franchisee alike, to improve efficiency, and to provide improved service reliability and quality control.

TT 432/10  
ISBN: 9781770059627  
overseas price: \$30.00 (Exclude postage)

**Agricultural water use in homestead gardening systems  
Christiaan Matthys Stimie, Marna de Lange, Charles  
Terrence Crosby and Erna Kruger**

The overall objective of this project was to improve food security through homestead gardening, by developing and evaluating the appropriateness and acceptability of training material for agricultural water use, training of household members in selected areas. Particular attention was given to the development of the 800 page resource material for facilitators and food gardeners on “Agricultural use in Homestead Gardening Systems”. The development of the resource material followed a participatory approach and was field tested and refined with the assistance of food secure and insecure households in rural villages. The resource material succeeded in drawing widely from local and international materials and experience. Its usefulness in practice has been substantiated by facilitators who were not part of its development. It is anticipated that a variety of stakeholders will draw on this resource material to develop course material for their own purposes. A significant demand for the material exists from universities and agricultural colleges that are aware of the material.

TT 431/1-3/09  
ISBN: 9781770059177  
overseas price: \$40.00 (Exclude postage)

**Agricultural water use in homestead gardening systems  
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TT 430/09  
ISBN: 9781770059177  
overseas price: \$40.00 (Exclude postage)

**Towards the realization of free basic sanitation: evaluation, review and recommendation**  
**Nozibele Mjoli, Gillian Sykes and Tracy Jooste**

Access to a basic sanitation service as a right is enshrined in the Constitution of South Africa (Act 108 of 1996). In terms of Section 24(a), 'everyone has a right to an environment that is not harmful to their health or well-being.' This clause has been interpreted as a right to basic sanitation for all. Municipalities have a constitutional mandate of ensuring access to water and sanitation services for all including the poorest households. Despite the drafting of a Free Basic Sanitation (FBSan) strategy by the Department of Water Affairs & Forestry (DWAf) in mid-2004, the process of approval for this strategy has been slow due to the realization by government that provision of free basic sanitation service was more complex than free basic water. Municipalities are faced with a challenge of balancing financial resource allocation to the eradication of basic sanitation infrastructure backlog by 2010 and provision of free basic sanitation services to the poor. Therefore, there is a need to identify successful and cost effective approaches of implementing subsidies for basic sanitation infrastructure and provision of free basic sanitation services. Financial models and innovative strategies are required to assist the municipalities to provide sustainable free basic sanitation services to poor households and to finance ongoing O&M for these services. Good practice must be identified and scaled-up where possible. The aim of this study was to assess the experience of municipalities in the implementation of FBSan services and to develop economic and financial models for sustainable FBSan service. Based on the findings of the study recommendations were made for improving the delivery of FBSan services to poor.

TT 420/09  
ISBN: 9781770059009  
overseas price: \$ 30.00 (Exclude postage)

**The basement aquifers of Southern Africa**  
**Titus RA, Beekman HE, Adams, S and Strachan L**

The report consists of several reviewed papers. The papers were sourced from various researchers that have worked on basement aquifers in southern Africa. The resulting synthesis document will be used by the hydrogeological community as a basic reference to basement aquifers. The paper titles and authors are:

- Basement aquifers of southern Africa: Overview and Research Needs - Shafick Adams
- A tectonic and geomorphic framework for the development of basement aquifers in Namaqualand: a review - Rian Titus, Andreas Friese, Shafick Adams
- Groundwater exploration and development - Karim Sami
- Groundwater exploration and development of basement aquifers in Botswana - Flenner Linn
- Groundwater chemistry of basement aquifers: A case study of Malawi - James Chimphamba, Cosmo Ngongondo,

Prince Mleta

- A methodological approach to recharge estimation of semi-arid basement aquifers – the central Namaqualand case - Shafick Adams, Rian Titus, Yongxin Xu
- Basement aquifer Groundwater recharge, storage and flow - Jürgen Kirchner
- Factors that control sustainable yields in the Archean basement rock aquifers of the Limpopo province - Martin Holland, Kai Witthüser
- Hydrogeochemistry of fluoride and salinization mechanism of groundwater in the Singida region, central Tanzania - Hudson H. Nkotagu
- Hydrogeochemical processes that influence the groundwater chemistry of basement aquifer systems, Namaqualand - Rian Titus, Shafick Adams, Kai Witthüser, and Yongxin Xu
- Towards sustainable utilization of basement aquifers in southern Africa - Eberhard Braune, Shoni Mutheiwana
- Current practices and future needs for managing basement aquifers in Zimbabwe - Sam Sunguro, Hans Beekman
- Challenges of basement aquifers in southern Africa - Christopher J. Lovell
- Groundwater management in southern Africa - Mutsa Masiyandima
- Aspects of groundwater management that is pertinent to basement aquifers in the southern African development community (SADC) - Kevin Pietersen

TT 428/09  
ISBN: 978 1 77005 8989  
overseas price: \$ 25.00 (Exclude postage)

**Enabling effective learning in catchment management agencies: A philosophy and strategy**  
**D Roux, K Murray, E van Wyk**

It is the responsibility of catchment management agencies (CMAs) to manage water resources in their respective water management areas. The nature of the functions they have to perform and the complicating and complex internal and external realities within which they operate create very demanding circumstances. It is therefore imperative that CMAs are effective learning organisations. This means they should adept at acquiring knowledge, creating knowledge, transferring knowledge and, importantly, adapting when necessary.

This document provides some historical background to the knowledge movement and describes different types of knowledge. It also provides an encyclopedia of terms that define various commonly-used terms and concepts in this field.

TT 421/09  
ISBN: 978 1 77005 8958  
overseas price: \$20.00 (Excl postage)

### **A Planning framework to position rural water treatment in South Africa for the future**

Chris Swartz

A number of recent WRC Projects (738, 1531, 1599) Showed that serious problems exist with the treatment of drinking water for non- metropolitan areas. These problems are acute in rural areas, and include lack of capacity, poor operation and maintenance, lack of management involvement, commitment and resources, as well as a general lack of knowledge and understanding of the importance of effective drinking water treatment.

TT 419/09

ISBN: 978 1 77005 8897

overseas price: \$25.00 (Excl postage)

### **Review of regulatory aspects of water services sector**

**Daniel Malzbender, Anton Earle, Hamed Deedat, Brian Hollingworth, Palesa Mokorosi**

The purpose of regulation is to ensure that the service providers or operators of water services deliver in accordance with the law and the policy of the government. This research examined the international literature and case studies where the concept of a "regulator" is more understood as referring to an entity that is separated from the line departments of government. Whether the institutional form is government as regulator or an independent entity as regulator conceptually makes no difference to its objectives or its basic task. The international focus on independent regulators relates largely to effectiveness. The limited survey conducted as part of this research suggests that within South Africa, stakeholders, outside of national government, appear to favour an independent regulator because, it is said, that DWAF will be unable to fulfill simultaneously the three roles it defines for itself as regulator, supporter and enabler. The unfavorable side of an independent regulator is the cost and the requirement for skills that are in short supply. The research found that the legislation, regulations and policy that a regulator would have to apply are already well defined. Further, it was found that there are a number of core skills such as finance, economics and engineering that are required irrespective of the range of aspects that will be regulated. Depending on the functions and mandate, regulation will require between 48 and 80 direct staff and cost between R40 and R67million per annum. A similar estimate for an independent regulator suggests staff of between 65 and 112 and annual costs of between R63 and R99 million per annum.

TT 417/09

ISBN: 978 1 77005 8866

Overseas price: \$20.00 (Excl postage)

### **Effective groundwater management in Namaqualand: Sustaining supplies**

Kevin Pietersen, Rian Titus and Jude Cobbing

The purpose of this guide is translate the scientific and technical knowledge gained through research on the hydrogeology of basement aquifers into a user-friendly format for the Department of Water Affairs and Forestry (DWAF), local authorities and the end-users. The guide is not intended for operators of water supply schemes, but rather for water resource planners. The guide has two overarching sections that deal with the issues of groundwater exploration and exploitation in a systematic manner. It is subdivided as follows:

1. What is groundwater?
2. The importance of groundwater in Namaqualand
3. Namaqualand aquifer systems
4. Locating groundwater resources in Namaqualand
5. Selecting drilling targets
6. Borehole design
7. The drilling process and the importance of data collection
8. Determining the sustainable yields
9. Understanding the water balance
10. Managing the water resource
11. Water quality considerations

TT 418/09

ISBN: 9781770058880

overseas prices: \$25.00 (Excl postage)

### **Manual for Index of Habitat Integrity (Section 2, Model Photo Guide) Module G Volume 2**

Mark Graham; Marina Delana Louw

The manual consists of the following modules:

Module A: Ecoclassification and Ecstatus models

Module B: Geomorphological driver assessment index (GAI)

Module C: Physio- Chemical Driver Assessment index (PAI)

Module D: Fish response assessment index (FRAI) Volume 1 &2

Module E: Macro-Invertebrate response Assessment Index (MIRAI) (Volume 1)

Module F: Riparian vegetation response assessment index (VEGRAI)

Module G: Index of Habitat integrity.

TT 378/09

ISBN: 978 1 77005 8019

Overseas price: \$20.00 (Excl postage)

### **Basic sanitation services in South Africa: Learning from the past, planning for the future.**

David Still, Nick Walker and Derek Hazelton

The purpose of this study has been to investigate whether the improvements made are working, and whether they are financially sustainable. In its coverage the study is biased towards rural sanitation, as the overwhelming majority of South

Africans without proper sanitation live in rural areas. The study finds that with few exceptions the practice since 1994 has been to provide funds for the initial capital costs of sanitation projects and not for operation and maintenance. The reason for this is that funding for new infrastructure is typically provided to municipalities by central government as grant funding, while the funding for operation and maintenance is required to come from the municipal coffers. Strictly speaking the funding for operation and maintenance is covered by the Equitable Share grant, in terms of which most poor municipalities receive an operations subsidy of between R20 and R60 per month for sanitation for every poor family in their area. However the equitable share is an unconditional grant and in practice this is not seen by local government as funding that has to be spent on operation and maintenance of services. Research indicates that the funding is typically used to finance the municipal overhead costs, as well as to finance other infrastructure projects not covered by the MIG grant. This practice, of building sanitation infrastructure while not allowing for adequate maintenance in the future, whether it is basic VIP sanitation or full waterborne sanitation, is shortsighted and will result in South Africa facing a sanitation crisis in the medium term.

TT 414/09

ISBN: 978 1 77005 8804

overseas price: \$30.00 (Excl postage)

#### **Development of a toolkit for strategic asset management**

**Peter Dunn, Ronnie McKenzie, Caryn Seago**

A key element for ensuring greater understanding of strategic asset Management and its needs is a toolbox of advocacy and awareness materials targeting customers, officials and policy makers. This element has been identified as a priority action which received little attention in many international initiatives, and that which has as a result led to poor uptake. It is therefore key that the linkages of SAM are made to the daily operations of water services, maintenance, planning and strategic decision making.

TT 413/09

ISBN: 978 1 77005 8750

overseas price: \$10.00 (Excl postage)

#### **Productive use of domestic piped water for sustaining livelihoods in poor households**

**Nicky Naidoo, Ciaran Chidley, Gene Main & Michele Vrdoljak**

The major question raised by the research is whether water for productive use should be subsidised. This research report has demonstrated that water is being used for productive use and the various uses to which this water is being put. The research report also highlights that poor households using water for productive use 122% more than poor households that do not. The levels of water debts are high and that 40% of the households surveyed indicate that they pay for water,

when possible, demonstrates both that water affordability can be low amongst the poor and that the provision of more water to households for beneficial use may experience financial sustainability challenges.

This research indicated that the majority of water users surveyed have stated that they would use water if it were available. It is suggested that wanting to use water in such a manner and actually using the water are not the same thing. This research also indicates that households with higher levels of service use more water for productive use than those with lower service level standards.

TT 412/09

ISBN: 978 1 77005 8743

overseas price: \$25.00 (Excl postage)

#### **Nitrate in groundwater**

**Gideon Tredoux, JFP Engelbrecht & Sumaya Israel**

Groundwater constitutes the main water resource in the rural areas and on farms. Surveys show that nitrate in groundwater is common in arid and semi-arid regions of southern Africa often exceeding drinking water specifications. High nitrate levels is the most frequent reason for groundwater sources to be declared unfit for drinking, i.e. exceeding 10 mg/L as N (Marais, 1999). Hence, a large percentage of newly drilled boreholes are rejected for human consumption due to excessive nitrate but communities in many rural areas still consume water with nitrate N exceeding the World Health Organization limit of 10 mg/L. Such non-potable groundwater gives rise to a health threat. Based on the latest information, groundwater in South Africa has high nitrate values, often exceeding 50 mg/L (as N), mostly in a band 100 to 250 km wide, stretching from east to west along the northern boundary of the country, across the four northernmost provinces. Anthropogenic inputs constitute the major source of high groundwater nitrate but research has shown that in certain cases nitrate also originates from the natural soil organic nitrogen pool. The indications, also from our neighboring countries, are that the present situation is unsustainable and anthropogenic nitrogen inputs need to be managed and reduced. Managing anthropogenic nitrogen inputs presents a great challenge for the sustainable use of groundwater.

TT 410/09

ISBN: 978 1 77005 8736

Overseas price: \$15.00 (Excl postage)

#### **Water resources of SA: 2005 study: Executive summary**

**Middleton B.J., Bailey A.K.**

The knowledge and processes involved in accounting for water resource availability continues to benefit from new insights, knowledge and data. The Water research Commission has been very instrumental in providing support and a platform for water practitioners to take part in regular research to develop water

resource assessment techniques, collate the data and assess the nation's available water resources at varying intervals since the late 1970s. The last water resource assessment research project was carried out in 1990. This old study addressed surface water availability assessments and used time series data which ended in 1989. To date the outputs of this 1990 project are at the centre of national and regional water resource planning. This research project, which is commonly referred to as WR2005 is the best attempt to capture the latest available water assessment techniques, improved hydrological simulations, integrate water resource data which included data on groundwater, surface water, wetlands, water quality, soils, land use, improved catchment delineation, population, return flows, and several other variables that have a bearing on the quantification and assessment of the available water resources.

TT 380-82/08

ISBN: 978 1 7700 58132

overseas price: \$70.00 (Excl postage)

**Civil society dialogue in water resources management: Lessons from four local-level experiences of river systems**  
**Ernita van Wyk, Tamsyn Sherwill, Charles M. Breen and A.B. Nkhata**

Increasingly civil society is expected to participate in and even lead processes that direct behaviors' in relation to the sustainable use of natural resources. Within this context, civil society groups and organizations are encouraged to enter into dialogue with others to expose issues constructively and to promote shared understanding and learning. The ability of such groups to use dialogue to reflect and learn and to apply the learning to subsequent actions becomes an important way of coping with change and uncertainty. Civil society groups have a particular opportunity in that, even though they may be structured informally, formal and even statutory, they are able to operate as communities of practice and to conduct their business with a degree of flexibility and innovation.

The rules that guide natural resource allocation and use follow a common property regime. This means that the resource and its users are co-dependent in complex ways so that the rules for resource protection and use have to be continually reinforced or renegotiated over time. Within such a regime, civil society groups who act to influence the resource or society in relation to the resource, do so within the context of shared rules defined by the values that society attaches to the resource and the services that emanate from the resource. Thus in order for civil society groups to sustain their operations in ways that are seen as legitimate, such groups, their rules and actions, must be sanctioned by society.

TT 383/09

ISBN: 978 1 77005 8224

overseas price: \$25.00 (Excl postage)

**Guidelines for the utilisation and disposal of wastewater sludge, Volume 4, Requirements for the beneficial use of sludge at high loading rates**

**Jacoba Elizabeth Herselman, Lucian Willem Burger and Priya Moodley**

Seeking innovative solutions for the handling of wastewater sludge requires a paradigm shift in our perception and understanding of wastewater sludge as a resource and not a waste product. Such a shift creates an opportunity for local authorities to generate a range of economic and social spin-offs to the benefit of their local communities. The Water Research Commission (WRC), and the Department of Water Affairs and Forestry (DWAF) developed this guideline series to support sustainable wastewater sludge management in South Africa. The aim of the project was to develop a series of guidelines to encourage the beneficial use of wastewater sludge but also provide solutions in cases where beneficial use is not feasible. Rather than develop a single guideline to address the range of sludge management options (beneficial and non-beneficial uses), 5 separate Guideline Volumes were developed. Volume 1 and 2 were published in 2006 as part of project K5/1453 while Volume 3, 4 and 5 were completed through a follow-up project K5/1622.

TT 350/09

ISBN: 9781770057104

overseas price: \$25.00

**WET-Origins**

**William Ellery, Michael Grenfell, Suzanne Grenfell, Donovan Kotze, Terence McCarthy, Stephen Tooth, Piet-Louis Grundling, Heinz Meckedahl, David le Maitre, Lisa Ramsay**

Three main branches of research into wetlands were identified during a workshop held in early 2002, wetland rehabilitation, wetland health and integrity and wise use of wetlands. The wetland rehabilitation was prioritised for two reasons. Firstly, it is estimated that South Africa has lost approximately 50% of its wetlands, and wetlands are increasingly being recognised as providing valuable services. And secondly, there has been substantial government expenditure on wetland rehabilitation through the Working for Wetlands project, which is linked to the Expanded Public Works Programme. This project was co-funded by Working for Wetlands to 50% of the budget. The main objectives were: The project leader must help to make these objectives meaningful.

- Prioritisation of wetland areas for conservation and rehabilitation
- System rehabilitation
- Methodologies for rehabilitation (what about them???)  
Improve or develop???
- Synergy with other programmes (establish??)
- Institutional arrangements (establish or strengthen??)
- Performance auditing

## **WET-Management Review**

**Donovan Kotze, Charles Breen, Innocent Nxele, John Kareko**

1. TT 321/09 WET-RoadMap: A Guide to the Wetland Management Series
2. TT334/09 WET-Origins: Controls on the Distribution and Dynamics of Wetlands in South Africa
3. TT335/09 WET-Management Review: The Impact of Natural Resource Management Programmes on Wetlands in South Africa
4. TT336/09 WET-RehabPlan: Guidelines for planning Wetland Rehabilitation in South Africa
5. TT337/09 WET-Prioritise: Guidelines for prioritizing Wetlands at National, Regional and Local Scales
6. TT338/09 WET-Legal: Wetland Rehabilitation and the Law in South Africa
7. TT339/09 WET-EcoServices: A Technique for Rapidly Assessing Ecosystem Services Supplied by Wetlands
8. TT340/09 WET-Health: A Technique for Rapidly Assessing WET-Health
9. TT341/09 WET-RehabMethods: National Guidelines and Methods for Wetland Rehabilitation
10. TT342/09 WET-RehabEvaluate: A Manual for the Performance Evaluation of Wetland Rehabilitation Projects

This series of documents provides all the information that is needed for the rehabilitation of wetlands, consultants or for private land. Owners who wish to monitor the state of, and / or rehabilitate, wetlands on their property, or for use by programmes such as Working for Wetlands.

TT 335/09

ISBN: 978177005 6343

overseas price: \$30 00 (Excl postage)

## **WET-RehabPlan**

**Donovan Kotze, William Ellery, Mark Rountree, Michael Grenfell, Gary Marneweck, Innocent Nxele, Charles Breen, John Dini, Allan Bachelor, Erwing Sieben**

This project was co-funded by Working for Wetlands to 50% of the budget.

1. TT321/07 WET-RoadMap: A Guide to the Wetland Management Series
2. TT334/09 WET-Origins: Controls on the Distribution and Dynamics of Wetlands in
3. TT335/09 WET-Management Review: The Impact of Natural Resource Management Programmes on Wetlands in South Africa
4. TT336/09 WET-RehabPlan: Guidelines for planning Wetland Rehabilitation in South Africa
5. TT337/09 WET-Prioritise: Guidelines for prioritizing Wetlands at National, Regional and Local Scales
6. TT338/09 WET-Legal: Wetland Rehabilitation and the Law in South Africa
7. TT339/09 WET-EcoServices: A Technique for Rapidly Assessing Ecosystem Services Supplied by wetlands

8. TT340/09 WET-Health: A Technique for Rapidly Assessing WET-Health
9. TT341/09 WET-RehabMethods: National Guidelines and Methods for Wetland Rehabilitation
10. TT342/09 WET-RehabEvaluate: A Manual for the Performance Evaluation of Wetland Rehabilitation projects

TT 336/09

ISBN: 978 1 77005 6350

overseas price: \$25.00 (Excl postage)

## **River ecoclassification manual for ecostatus determination (Version 2): Module G: Index of habitat integrity Section 1:**

### **Technical Manual**

**Kleynhans CJ, MD Louw & M Graham**

The habitat integrity of a river refers to the maintenance of a balance of a balanced composition of physico-chemical and habitat characteristics on a temporal and special scale that is comparable.

## **Protocol for the assessment of the status of sustainable utilization and management of groundwater resources with special reference to Southern Africa.**

**E Braune, B Hollingworth, Y Xu, M Nel, G Mahed & H Solomon**

The development role for groundwater in Africa and Southern Africa is still poorly understood, resulting in under utilisation and poor management of the important resource. The international experience is that turning around this situation will require strategic action across sector and international boundaries. The study confirmed that SADC has made excellent progress to address groundwater in its comprehensive regional water resources policies and strategies. Groundwater is explicitly referred to in the SADC Protocol on Shared Watercourses. It is also featuring in the SADC Regional Strategic Action Plan for Integrated Water Resource Management and the Regional Water Policy and it has its own Groundwater Management Programme for the roll-out of this plan. When it comes to implementation in individual countries, the performance in groundwater resources management in SADC must still be generally rated as "below expectation", compared to relevant international best practice. The importance of groundwater in this region, the cooperative regional IWRM structures and institutions that already exist and the understanding there is already for groundwater at the highest decision-making levels, offers a major opportunity to initiate a systematic, region-wide, and ultimately continent-wide, programme and approach, as foreseen by AMCOW, for building the capacity required to ensure that groundwater resources are utilized and managed sustainably in the SADC region. It is felt that the South African capacity for IWRM and, in particular for groundwater resources management, can make a much greater contribution than at present to developments in southern Africa and that the Water Research Commission should strategically position itself for such a role.

Report No: TT318/08 ISBN: 978 1 77005 712 8  
Overseas price : \$20 00 (excl postage)

**An introduction to dense non-aqueous phase liquids (DNAPLs) in South Africa: A community guide**

**Usher BH; Pretorius JA; Gebrekristos RA**

This document is aimed specifically at the lay person, to make them aware of DNAPLs and its occurrences, sources and behaviour. This document forms part of a series of documents, produced by Water Research Commission project K5/1501 "Field investigations to study the fate and transport of dense non-aqueous phase liquids (DNAPLs) in groundwater". The documents in this series include:

- Executive Summary of the Project (only available on CD accompanying all reports listed below)
- Manual for Site Assessment at DNAPL Contaminated Sites in South Africa (WRC Report 1501/2/08)
- Groundwater monitoring guidelines for DNAPLs in South African Aquifers (WRC Report 1501/3/08)
- Guidelines for the acceptance of Monitored Natural Attenuation processes in South Africa (WRC Report 1501/4/08)
- Handbook for DNAPL Contaminated Sites in South Africa (TT 326/08)
- An Introduction to DNAPLs in South Africa: A Community Guide (WRC Report TT 326/08)
- Field and laboratory investigations to study the fate and transport of DNAPLs in groundwater (1501/5/08)

Report No: TT 325/08 ISBN: 978 1 77005 658 9  
Overseas price : \$25 00 (excl postage)

**Handbook for DNAPL contaminated sites in South Africa**

**Usher BH; Pretorius JA; Gebrekristos RA**

Report No: TT 326/08 ISBN: 978 1 77005 659 6  
Overseas price : \$30 00 (excl postage)

**A guide to catchment-scale eutrophication assessments for rivers, reservoirs and lacustrine wetlands.**

**J N Rossouw, W R Harding, O S Fatoki**

A study commissioned in 2000 by the WRC found that South Africa's policy and approach to eutrophication control has been inadequate over the previous 20 years. A strong need was identified to remobilise and redevelop our capacity to manage eutrophication. A workshop followed in 2001 to discuss research and capacity building within the field of eutrophication where assessment of the eutrophication problem was identified as the highest priority research area. This project produced a Guide to assess eutrophication related water quality using the same protocol as the DWAF Guide to catchment scale water quality assessment studies. The Guide is structured around six management questions that are designed to establish the eutrophication status and management

options at catchment scale. The best eutrophication assessment practice was, furthermore, captured in a Web-based nutrient enrichment assessment protocol (NEAP). Course material making use of these two products was developed to fast track capacity building concerning eutrophication assessment. The primary target audience of the short course material is water resource practitioners, water resource managers and freshwater scientists

Report No: TT 352/08 ISBN: 978 1 77005 715 9  
Overseas price : \$30 00 (excl postage)

**Technical instruments to support water quality use allocation**

**JN Rossouw, W Kamish and AHM Gorgens**

The National Water Act prescribes the minimum components of a catchment management strategy. Prime amongst these are the formulation of water allocation principles and a Water Allocation Plan for each Water Management Area. This project focused on a very particular part of the allocation challenge, namely the allocation of "Water Quality Use". It aimed to develop a conceptual framework for water quality use allocation procedures, and to develop and disseminate Technical Guidelines for water quality use allocation procedures. The project employed a process of "learning-by-doing" by applying the framework in a stressed catchment with water quality concerns. The ACRU Salinity model was applied to the Berg River catchment because it also offered a ready-made water quality information system (WQIS) previously developed under WRC Project No 951.

Report No: TT 363/08 ISBN: 978 1 77005 653 4  
Overseas price : \$20 00 (excl postage)

**Towards a socio-ecological systems view of the Sand River catchment, South Africa: An exploratory resilience analysis.**

**S R Pollard, H C Biggs, D Robert**

South Africa is in the process of implementing IWRM, which by definition is a process based on managing the behavior of people and their response to a finite resource. In addition, wetland systems are under increasing pressure to support subsistence livelihoods, and their sustainability is being compromised. New thinking and understanding on the functioning of complex socio-ecological systems (SES) and how these contribute to the resilience of these systems could give managers a tool for improved management of these systems. This consultancy investigated how this new thinking may be employed in this situation.

Report No: TT 364/08 ISBN: 978 1 77005 747 0  
Overseas price : \$20 00 (excl postage)

**Fire management in the Cape Peninsula: lessons for catchment management agencies from the Ukuvuka Campaign**

Fowkes SM

The Ukuvuka initiative was a short term collaborative campaign designed to inject finance, skills, innovation and passion to address a core issue of common concern to the partners – changing fire-related behaviour. Ukuvuka ran from 2000 to 2004 and was supported by the three spheres of government, business (a short-term insurance company, a bank, an oil company and a daily newspaper) and NGOs. The trigger for the initiative was the immediate crisis of fires in the mountains of Cape Town's Cape Peninsula.

The purpose of this report is to make a contribution to the policy implementation challenge by sharing some practical insights and experiences from that crisis initiative. The report focuses particularly on applying the lessons to the water sector, specifically the formation of Catchment Management Agencies (CMAs.)

Report No: TT324/07 ISBN: 978 1 77005 656 5

Overseas price : \$10 00 (excl postage)

**High-yielding groundwater areas around the Nelson Mandela Bay Municipality**

Murray R; Goedhart M; Baron J

Prime groundwater development areas were identified and grouped into five hydrogeological domains. Within each of the domains specific groundwater exploration target areas were identified and prioritised. No ground-truthing was done to verify the target areas. It is likely that some of the areas may be unsuitable for groundwater development for a variety of reasons, and it is equally likely that there are a number of other areas that could be developed for large-scale groundwater supply.

The total groundwater potential for each domain was estimated using the GRA II data sets and by assuming the number of high-yielding boreholes that could be obtained in each domain. This latter approach is based largely on estimates of the number of prime drilling targets that can be located. It was not based on a remote sensing analysis and the identification and weighting of individual drilling targets. Thus in some areas there may be fewer prime drilling targets, and in other areas, more. The purpose of this exercise was to provide a first-order estimate of the groundwater potential, and thus it will not be correct, but it should serve as a good starting point. A summary of the groundwater potential of all five domains is presented:

- Groundwater Exploitation Potential (normal years) = 48 Mm<sup>3</sup>/a
- Groundwater Exploitation Potential (dry years) = 32 Mm<sup>3</sup>/a
- Borehole yield without artificial recharge and continuous abstraction= 28 Mm<sup>3</sup>/a
- Borehole yield with artificial recharge and 6-month/a

abstraction= 41 Mm<sup>3</sup>/a

- Existing use= 9 Mm<sup>3</sup>/a

Report No: TT 327/08 ISBN: 978 1 77005 671 8

Overseas price : \$20 00 (excl postage)

**National Microbial Monitoring Programme for Groundwater: Implementation Manual**

Murray K, du Preez M; Meyer R; van Wyk E; Parsons R; Flanagan L; Taylor M

The general purpose of this manual is to describe how the national microbial monitoring programme (NMMP) for groundwater should be implemented on a national scale. This national monitoring programme for groundwater supplements the National Microbial Monitoring Programme for surface waters. However, it should not be regarded as an extension of it. Monitoring groundwater is fundamentally different from monitoring surface water and accordingly has a completely different design.

This manual gives guidelines, procedures and methods for microbial monitoring of groundwater as well as how and when such data can be reported.

Accordingly, this manual is aimed at a variety of people and organisations. It is initially aimed primarily at DWAF officials who will have the primary responsibility to implement national water-related monitoring programmes. However, it is also aimed at Catchment Management Agencies (CMAs) and water management institutions to which monitoring responsibilities may be delegated.

Report No: TT 312/07 ISBN: 978 1 77005 594 0

Overseas price : \$20 00 (excl postage)

**Integrated water resource management plan guidelines for local authorities: (IWRMP)**

Burke J

The principle of integrated water resource management is endorsed by the National Water Act, Act 36 of 1998 and the National Water Resource Strategy (2004). Simply put, integrated water resource management in Local Authorities is about striking the right balance between a Local Authority's developmental role and the need to maintain environmental integrity in fulfilling the Constitutional obligations of sustainable development, socioeconomic development and a safe and healthy environment. Striking this balance is a challenge and requires cooperation between all tiers of government as well as between government and the private sector, but there are no hard and fast rules as the environment is a dynamic system, continually adapting itself to a new balance, following the effects of both human and natural influences on it. Implementation of the Local Authority Integrated Water Resource Management Plan will be a positive step forward in

ensuring that Local Authorities achieve sustainable integrated water resource management in line with the catchment vision set by the Catchment Management Agency

Report No: TT 304/07 ISBN: 978 1 77005 548 3  
Overseas price : \$30 00 (excl postage)

**A task oriented approach to participation**  
**PLEASE DOWNLOAD FROM <http://www.wrc.org.za/>**  
**Burt JC; du Toit DR; Neves DT**

The NWA puts emphasis on the decentralization of water resource management to the catchment level. This necessitates an adoption of participatory management approaches that can support a multi-stakeholder dialogue of diverse interest groups such as water user associations (WUAs), community based organisations, NGOs, water resource managers, policy-makers and planners.

Therefore, there is a need for appropriate tools that can be used to support meaningful participation of the public at different levels of decision-making. This project answers the following questions:

- What is the appropriate CMA level of organisation that will be effective in ensuring that voices of marginalized groups are also taken into consideration in the governance of CMAs?
- How can civil society be best organized to play a meaningful role in the management of water resources at a catchment and sub catchment level?

Report No: TT 289/06  
ISBN: 1 77005 502 9  
Overseas price : \$15 00 (excl postage)

**Water as a human right, made easy! Workbook 1**  
**PLEASE DOWNLOAD FROM <http://www.wrc.org.za/>**  
**Dericj du Toit, Teresa Sguazzin**

Report No: TT 269/07  
ISBN: 978 1 77005 435 6  
Overseas price : \$15 00 (excl postage)

**Human Rights project WORKBOOK 2**  
**PLEASE DOWNLOAD FROM <http://www.wrc.org.za/>**  
**Derick du Toit, Teresa Sguazzin**

A key concept evident in the South African Constitution is that National Government is committed to providing adequate food and water '... to meet basic human needs'. Arguably the most crucial resource, in terms of human need, is water. This commitment in providing water for basic human needs is captured by the National Water Act (1998) in the concept of the 'Basic Human Needs Reserve' (BHNR). The notion of the BHNR essentially elevates the status of water for basic human needs to that of a human right. Although an orientation that accepts access to water as a human right is enshrined in South African law, it represents a very new concept in water management in South Africa (and the world). One of the

major obstacles hampering implementation is a lack of familiarity and understanding of the notion of the BHNR by the very people tasked with the responsibility for ensuring that it is honoured, i.e. local government. An informal, preliminary survey conducted by AWARD indicates that most members of local government have not heard about the BHNR.

Report No: TT 296/07  
ISBN: 978 1 77005 513 1  
Overseas price : \$15 00 (excl postage)

**Guide for local government cooperation with catchment management agencies**  
**Mazibuko G; Pegram GC**

The recent demarcation process and the on-going specification of the powers and functions between the district, local and metro councils have further clarified the roles and functions of local government. Local government is constitutionally responsible for the implementation and control of a range of activities that affect water resources. This research will amongst others provide recommendations on the requirements for co-operative governance and the most appropriate approaches and mechanisms to foster co-operative governance between CMAs and local government, to achieve a range of objectives under differing circumstances.

Report No: TT 270/06  
ISBN: 1 77005 460 X  
Overseas price : \$15 00 (excl postage)

**Artificial groundwater recharge: Wise water management for towns and cities**  
**Rickey Murray**

Report No: TT 219/03  
ISBN: 1 77005 092 2  
Overseas price : \$15 00 (excl postage)

**Surface water: Groundwater interaction in a South African context: A geohydrological perspective**  
**Roger Parsons**

In response to a greater awareness of the role of groundwater in sustaining the environment and recognition of a unitary and interdependent hydrological system, surface-groundwater interaction has emerged as an issue requiring greater attention. This publication aims to establish the correct and consistent use of hydrological terms which is key for developing a better understanding of surface water-groundwater interaction

Report No: TT 218/03  
ISBN: 1 77005 084  
Overseas price : \$25 00 (excl postage)

**An explanation of a set of national groundwater, plus 2 Hydrogeological maps (SA Price: R114.00)**  
**Vegter JR**

Advances in hydrogeology over the past years, and the increasing demand on groundwater resources, have given rise to the need to portray hydrogeological information in such a manner that planners and various groundwater users can make decisions by means of a quick and accurate overview of the most up-to-date information. Hydrogeological maps are seen as a powerful tool to meet this objective.

Report No: TT 74/95 ISBN: 1 86845 183 6  
Overseas price : \$70 00 (excl postage)

**Explanation of the 1:500 000 hydrogeological map 2326 Pietersburg (SA Price: R50.00)**  
**Water Systems Management & DWAF**

This is a high quality hydrogeological map of the Pietersburg map sheet at a scale of 1:500 000 and a set of explanatory notes which provide guidelines as to the need for detailed groundwater investigations and what hydrogeological conditions are expected to occur.

Report No: TT 75/95  
ISBN: 1 86845 188 7  
Overseas price : \$35 00 (excl postage)

**Dealing with reservoir sedimentation (SA Price: R171.00)**  
**Basson GR & Rooseboom A**

Dam siltation has always been and still is a serious problem in South Africa. This report presents different techniques for controlling and managing dam siltation in South Africa.

Report No: TT 91/97  
ISBN: 1 86845 255 7D  
Overseas price : \$70 00 (excl postage)

**Sluicing flumes: A new structure for discharge measurement in sediment laden rivers**  
**Rossouw J, Loubser C, Rooseboom A & Bester A**

This report confirms the flumes' good characteristics with respect to handling heavy sediment loads.

Report No: TT 103/98  
ISBN: 1 86845 368 5  
Overseas price : \$35 00 (excl postage)

**Dealing with reservoir sedimentation Dredging (SA Price R200.00)**  
**G R Basson A & Rooseboom**

In this report the reservoir sedimentation theory and dam

dredging techniques from around the world are evaluated. A criterion for selecting dredging techniques which emphasise on cost cutting measures is presented.

Report No: TT 110/99  
ISBN: 1 86845 493 2  
Overseas price : \$60 00 (excl postage)

**A global overview of inter basin water transfer schemes, socio economic and socio political implications, and recommendations for their management**  
**Snaddon CD, Davies BR & Wishart MJ**

This report combines two source documents. The first is the report on the research done during the project and the second is a worldwide synthesis of information on inter basin transfer (IBTs) with contributions from scientists in the USA and Australia.

Report No: TT 120/00  
ISBN: 1 8645 583 1  
Overseas price : \$20 00 (excl postage)

**Groundwater development in South Africa and an introduction to the hydrogeology of groundwater regions**  
**Vegter JR**

This report presents a historical overview from the introduction of the first drill in 1880 a manually powered diamond rig up to the present. The following topics are covered:

- Groundwater exploration and exploitation
- Investigation and research; and
- The evaluation of groundwater legislation

Report No: TT134/00  
ISBN: 1 86845 642 0  
Overseas price: \$25 00 (excl postage)

**Hydrogeology of Groundwater: Region 1 Makoppa Dome**  
**JR Vegter**

Report No: TT135/00  
ISBN: 1 86845 643 9  
Overseas price:\$ 20 00 (excl postage)

**Hydrogeology of Groundwater: Region 3 – Limpopo Granulite-Gneiss belt**  
**JR Vegter**

Report No: TT136/00  
ISBN: 1 86845 644 7  
Overseas price: \$20 00 (excl postage)

**Hydrological information and techniques to support the determination of the water quality component of the ecological reserve for rivers**  
**Hughes DA; Munster F**

Report No: TT 137/00  
ISBN: 1 86845 646 3  
Overseas price: \$20 00 (excl postage)

**Hydrogeology of Groundwater: Region 7 – Polokwane/Pietersburg Plateau**  
**JR Vegter**

Report No: TT 209/03  
ISBN: 1 86845 027 2  
Overseas price: \$20 00 (excl postage)

**Hydrogeology of Groundwater: Region 19 – Lowveld**  
**JR Vegter**

Report No: TT 208/03  
ISBN: 1 86845 026 4  
Overseas price: \$20 00 (excl postage)

**Hydrogeology of the main Karoo basin: Current knowledge and future research needs**  
**AC Woodford and L Chevallier**

This document is aimed primarily at the groundwater practitioners working in Karoo fractured-rock aquifers, especially those involved on rural water supply projects and WRC-funded research projects. The level of information presented is also useful to other professionals with only limited groundwater knowledge

Report No: TT 179/02  
ISBN: 1 86845 851 2  
Overseas price: \$40-00 (excl postage)

**Evaluation of the role of water user associations in water management in South Africa**  
**Pegram G; Mazibuko G**

The new institutional reforms in water resource management prescribed in the National Water Act of 1998, delegate many water resource management functions (particularly resource protection and allocation) to organisations within Water Management Areas (WMA), namely Catchment Management Agencies (CMAs) and Water User Associations (WUAs). WUAs are statutory bodies intended to operate at a restricted localised level aimed at facilitating co-operative associations of individual water users, who wish to undertake water-related activities for their mutual benefit. This study is aimed at clarifying the roles of WUAs, evaluating the functioning of a number of established WUAs against this framework and the particular needs of the local conditions, and formulating guidelines for the institutional

and management arrangements.

Report No: TT 204/03  
ISBN: 1 8645 982 9  
Overseas price : \$25 00 (excl postage)

**Guidelines for integrating the protection, conservation and management of wetlands into catchment management planning**  
**Dickens C; Kotze D; Mashigo S; MacKay H; Graham M**

The South African legal environment provides for the sustainable use of the country's water resources. Yet, all is not well with the wetland resources of this country. Already suffering from years of abuse and over-utilisation, wetlands remain under threat as part of the water resource. These guidelines provide management agencies with much needed information for the management of wetlands. The impact of these guidelines is expected to be significant, especially for professional staff and interested members of society working at ground level

Report No: TT 220/03  
ISBN: 1 77005 096 5  
Overseas price : \$30 00 (excl postage)

**An assessment of the water policy process in South Africa (1994 to 2003)**  
**de Coning C; Sherwill T**

The political changes which have taken place in South Africa during the last decade have had profound impacts on the development of new water policy, and have opened the way for significant shifts in policy and legislation generally, in relation to sustainable management of natural resources. The implementation context will strongly influence the future development and strategic direction of water policy in South Africa, but there is still limited understanding of the inter-relationships between policy development and implementation, with the added shaping forces of politics, economics and social factors.

This project aims to provide, through critical review and analysis, an understanding of where we have come from and where we are going to in terms of water policy, in order to support ongoing development and implementation throughout this and future policy cycles.

Report No: TT 232/04  
ISBN: 1 77005 180 5  
Overseas price : \$15 00 (excl postage)

**Sediment control at river abstraction works in South Africa:  
Vol 1  
Brink CJ; Basson GR; Denys F**

This report presents a review of the international and South African state of the technologies available for controlling sediments at river abstraction works. Optimum abstraction locations, flushing channel designs and suitable pumping designs. Guidance for planning and design of river abstraction works is one of the main highlights of this report.

Report No: TT 259/06

ISBN: 1 77005 410 3

Overseas price : \$85 00 (excl postage)

**Considerations for the design of river abstraction works in  
South Africa: Vol 11  
Basson GR**

Report No: TT 260/06

ISBN: 1 77005 411 1

Overseas price : \$40 00 (excl postage)

**Guide for local government cooperation with catchment  
management agencies  
Mazibuko G; Pegram GC**

The recent demarcation process and the on-going specification of the powers and functions between the district, local and metro councils have further clarified the roles and functions of local government. Local government is constitutionally responsible for the implementation and control of a range of activities that affect water resources.

This report provides recommendations on the requirements for co-operative governance and the most appropriate approaches and mechanisms to foster co-operative governance between CMAs and local government, to achieve a range of objectives under differing circumstances. The guide is a user friendly document for all levels of local government.

Report No: TT 270/06

ISBN: 1 77005 460 8

Overseas price : \$15 00 (excl postage)

**Guide for catchment management agency cooperation with  
local government**

This is a working guide for Catchment Management Agencies to cooperate with local governments in their areas of operation to achieve common objectives in the management of water resources and hence the development of their respective areas.

Report No: TT 271/06

ISBN: 1 77005 439 1

Overseas price : \$15 00 (excl postage)

**A synthesis of the hydrogeology of the Table Mountain  
Group - Formation of a research strategy  
Pietersen K; Parsons R**

A project was initiated during 2000 to synthesize the current knowledge about the Table Mountain Group (TMG) aquifer systems. This resulted in a document on the "Synthesis of the Hydrogeology of TMG – Formation of a Research Strategy." The document is subdivided into technical papers and appropriate case studies. This exercise resulted in the understanding that to realize the potential, of this groundwater supply, many uncertainties and barriers need to be overcome, including: deficient understanding of the occurrence, attributes and dynamics of TMG aquifer systems; lack of understanding of environmental impacts of exploitation; and uncertainties about how best to manage the resource within a multi-objective environment. Research of a multi-disciplinary nature is thus needed to find appropriate answers to questions concerning the water resource potential and optimal management of TMG aquifers, in the interest of furthering integrated water resource management in the region.

Report No: TT 158/01

ISBN: 1 86845 804 0

Overseas price : \$40-00 (excl postage)

**Learning about participation in IWRM: A SA review: Book 1  
and 2**

(also available in Venda, Sotho and Zulu)

**Burt J; du Toit D; Pollard S**

Report No: TT 293/06

ISBN: 1 77005 506 1

Overseas price : \$20-00 (excl postage)

**Research on Berg river water management: Summary of  
water quality information system and soil quality studies:  
(Integrated Catchment Management: ICM)  
Gorgens AHM; de Clercq WP**

This report describes the development of an integrated information system specifically for water quality (WQIS) for the Berg River that is both integrated and interactive. The WQIS has been developed in close cooperation with its intended technical users to provide water resource operational and planning decision support. The WQIS has a user-friendly GIS-based Graphical User Interface and incorporates interfaces with DUFLOW and CE-QUAL-W2. It was applied to the proposed Skuifraam Dam in the Upper-Berg to illustrate its utilisation to support decision-making for various in-dam water quality management scenarios.

Also reported are field-scale process studies and large-scale soils data interpretation, with a strong focus on salinisation processes. The main products are a soils map and a salinity hazard map that were compiled for the Berg River catchment.

Report No: TT 252/07  
ISBN: 1 77005 367 0  
Overseas price : \$30-00 (excl postage)

**Developing and trialing guidelines for participatory water resources management**

**Rowntree K; Motteux N;**

South Africa's National Water Act of 1998 makes the management of any water resource a partnership between local water users, regional catchment managers, and DWAF. The Act encourages communities to become actively involved in developing and managing their water resources. The three sets of guidelines - Participatory Guidelines, Environmental Guidelines, Planning and Economic Guidelines – are aimed at IWRM practitioners who work with stakeholder communities. The guidelines help practitioners make participatory water resource management a reality.

Report No: TT 258/07  
ISBN: 1 77005 064 7  
Overseas price : \$20-00 (excl postage)

**A study of Roman water law, with specific reference to water allocations and prior appropriation**

**Burger A**

In view of the common law of South Africa being Roman-Dutch and Roman law, the question was asked: Can the Roman law provide some guidance for water law and water allocations in South Africa in as much as the Roman law represents principles developed and successfully applied for almost a thousand years. The principles of Roman law were developed over a very long period in the vast Roman Empire, which covered a number of different countries with widely different climates. The final version of the Roman law is contained in the Corpus Juris Civilis compiled under the direction of the Emperor Justinian around 534 AD. The law of all European, and many other countries grew out of Roman law. It is, with Roman-Dutch, the common law of South Africa. That part of the Roman law constituting the principles of the water law is set out in this article. Before a law has withstood the test of years of practice, one cannot say whether it is a successful law or not. The Roman interdicts offer practical, tested guidance for resolving conflicts arising in water-stressed situations typical of arid and semi-arid areas. This makes the body of Roman water law worthy of attention and further study for application in South Africa, particularly as we approach full-scale implementation of the National Water Act.

Report No: TT 279/06  
ISBN: 1 77005 469 3  
Overseas price : \$20-00 (excl postage)

**Hydrogeology of Groundwater Region 26: Bushmanland**  
**Vegter JR**

This report forms part of a series on the hydrogeology of the various groundwater regions in South Africa. Region 26 (Bushmanland) is the fifth region that will be published; there are 64 Groundwater Regions. The Regions previously published are: 1 (Makoppa dome), 3 (Limpopo Granulite-Gneiss belt), 7 (Polokwane/Pietersburg Plateau) and 19 (Lowveld). The hydrogeology of the Bushmanland Region is described using available data and gives a good overview of the groundwater conditions in this region.

The main findings indicate that with decreasing rainfall and an increase in thickness of the superficial deposits there is a corresponding though not uniform deterioration in groundwater conditions from east to west. The report lists the conditions at which potential water strikes can be encountered. The data revealed that weathering enhances secondary porosity only where the water levels are less than about 30 metres deep. Water is generally struck in fractured fresh rock below the weathered zone and not in the transition between weathered and fresh rock as is the case in the higher rainfall areas. Seventy-four percent of groundwater samples, out of 968 samples, tested were unsuitable for domestic use. The constituents of concern in the groundwater are, in order of frequency of occurrence: fluoride, nitrate, chloride, sodium and sulphate. In most instances if a borehole produces significant water then the poor quality of the water becomes a limiting factor for development.

Report No: TT 285/06  
ISBN: 1 77005 495 2  
Overseas price : \$40-00 (excl postage)

**Groundwater research needs in the Eastern Karoo Basin of South Africa**

**Murray EC; Cobbing JE**

The main aim of the report is to outline the current groundwater research needs in the densely populated, impoverished eastern regions of the Eastern Cape Province. Groundwater is the main source for community water supply in the rural areas. Little groundwater research has been done to date in the eastern regions of the Eastern Cape Province – an area that comprises the Eastern Karoo Basin (the geological term for this region). The focus area of this document is Water Management Area 12, incorporating most of the former Transkei and Ciskei 'homelands'. This document describes how new research will coincide with national and provincial development priorities. It takes into account past research, proposes broad research areas, and finally, it lists what are considered to be the most important geohydrological research projects completed to date. It was developed after widespread consultation that included officials from the Department of Water Affairs and Forestry (DWAF) in the Eastern Cape Province,

and a number of locally-based groundwater and engineering consultants.

Report No: TT 286/06

ISBN: 1 77005 497 0

Overseas price : \$25-00 (excl postage)

### **Integrated water resource management plan guidelines for local authorities (IWRMP)**

**Burke J**

From a groundwater perspective, Groundwater Resource Directed Measures (GRDM) is more important than the Reserve on its own. While the Reserve only addresses the role groundwater plays in meeting basic human needs and sustaining aquatic ecosystems such as rivers and wetlands, GRDM allows the use and protection of the entire groundwater resource to be addressed holistically. Four levels of GRDM assessments are recognised – desktop, rapid, intermediate and comprehensive – each providing an increased level of confidence.

The objectives of this project were:

- To review and implement methods developed to set RDM for groundwater through an appropriate case study;
- To refine and adapt methods as a result of lessons learnt during the pilot study; and
- Align methods with other components of RDM (e.g. estuaries, rivers and wetlands).

The E10 catchment containing the Olifants River was selected as the pilot study area. A Groundwater Resource Directed Measures assessment was undertaken. Additional data and information was collected, through a hydro census, for the study area where data was lacking. The research resulted in the development of the GRDM manual that can be used as a guide by both experienced and inexperienced geohydrologists to undertake and review GRDM assessments. Accompanying software was developed to assist with the assessments

Report No: TT 299/07

ISBN:978 1 77005 510 0

Overseas price : \$30-00 (excl postage)

### **Groundwater sampling: a comprehensive guide for sampling methods: Second edition**

**Weaver JMC; Cave L; Talma AS**

This revised edition incorporates a number of additional sections, such as sampling for isotopes, down-hole logging, etc. Some chapters have been substantially revised to include advances in field instrumentation, such as pH meter technology and increased attention to organic compounds. A short chapter on the sampling of wetlands, springs and groundwater seeps has also been included. Other chapters have undergone only minor changes, since what was relevant in 1992 is today still relevant.

Groundwater quality data collected according to these described techniques can then reliably be used to evaluate hydro geochemical conditions

Report No: TT 303/07

ISBN: 978 1 7005 545 2

Overseas price : \$20-00 (excl postage)

### **River Ecoclassification Manual For Ecstatus Determination (Version 2)**

Module A:Ecoclassification And Ecstatus Determination

**C J Kleynhans, M D Louw**

Report No: TT 329/08 ISBN: 978 1 7005 677 0

Overseas price : \$20-00 (excl postage)

### **River Ecoclassification Manual For Ecstatus Determination (Version 2)**

MODULE D: Volume 1: Fish Response Assessment Index (FRAI)

**C J Kleynhans**

Report No: TT 330/08

ISBN: 978-1-77005-678-7

Overseas price : \$30-00 (excl postage)

### **River Ecoclassification Manual For Ecstatus Determination (Version 2)**

Module D vol 2: Reference frequency of occurrence of fish species in SA

**C J Kleynhans, M D Louw, J Moolman**

Report No: TT 331/08

ISBN: 978-1-77005-681 7

Overseas price : \$25-00 (excl postage)

**River EcoClassification Manual For Ecostatus Determination (Version 2)**

MODULE E: Volume 1: Macroinvertebrate Response Assessment Index (MIRAI)  
Thirion C

Report No: TT 332/08  
ISBN: 978-1-77005-679-4  
Overseas price : \$25-00 (excl postage)

**River EcoClassification Manual For Ecostatus Determination (Version 2)**

MODULE F: Riparian Vegetation Response Assessment Index (VEGRAI)  
Kleynhans CJ; MacKenzie JA; Louw MD

Report No: TT 333/08  
ISBN: 978-1-77005-680-0  
Overseas price : \$30-00 (excl postage)

**Module G: EcoClassification and Ecostatus determination in River EcoClassification: Index of Habitat Integrity (Section 1, Technical manual)**

Kleynhans CJ

Report No: TT 377/09  
ISBN: 978-1-77005-800-2  
Overseas price : \$25-00 (excl postage)

**Module G: EcoClassification and Ecostatus Determination in River EcoClassification: Manual for Index of Habitat Integrity (Section 2, Model Photo Guide).**

M Graham; M D Louw

Report No: TT 378/09  
ISBN: 978-1-77005-801-9  
Overseas price : \$20-00 (excl postage)

**Environmental flow assessments for rivers: Manual for the building block methodology - Updated version**

J M King, R E Tharme and MS De Villiers

Environmental (or instream) flows are flows that are left in, or released into, a river system with the specific purpose of managing some aspect of its condition. As the condition of river systems deteriorates globally, environmental flows are increasingly appearing in legislation. The science of advising on environmental flows is relatively young (about 50 years), but more than 100 methodologies in existence.

South Africa formally addressed the topic in the 1980s, and during the 1990s made considerable progress at a national level. Recognising that international approaches to environmental flow assessments did not meet South Africa's needs entirely, development of a local approach was initiated. Through a decade of extraordinary cooperation and willingness

to contribute, the national body of aquatic scientists, water managers and engineers developed the BBM to the point where it is now one of only a few advanced environmental flow methodologies in the world with a formal manual. In addition, the BBM (Building Block Methodology) has advanced the field of environmental flow assessment in an entirely new direction, being a holistic methodology that addresses the health (structure and functioning) of all components of the riverine ecosystem. The BBM is essentially a prescriptive approach, designed to construct a flow regime for maintaining a river in a predetermined condition. This manual describes its basic nature and main activities, and provides guidelines for its application.

Report No: TT 354/08  
ISBN: 978-1-77005-721-0  
Overseas price : \$40-00 (excl postage)

**Assessing the Impact of Research Funded by the Water Research Commission in Support of the River Health Programme**

D J Roux, L Hill and W Strydom

The River Health Programme is a multi-institutional national programme which has 3 custodians, the DWAF, the DEAT and the WRC. The WRC, with its mandate for research, was very closely involved during the developmental stages, and published the first few State of the Rivers reports (SoR). Once the programme was running the WRC withdrew support from the publication of the SoR, but has remained involved at the levels of national coordination and research as required. The report covers the history and development of the River Health Programme (RHP) from the concept of using biological systems for monitoring environmental quality, which was new when the programme was first conceived, through the early growth phase to its becoming established as a national programme.

Report No: TT 360/08  
ISBN: 978-1-77005-742-5  
Overseas price : \$20-00 (excl postage)

**Local institutions for water governance: the development of a water users association and catchment forum in the Kat River Valley, Eastern Cape**

J Burt, A McMaster, K Rowntree & R Berold

This report describes the development of water resource management organisations (institutions) in the Kat River Valley from 1997 to 2006. The two organisations described here - the Kat River Valley Water User Association and the Kat River Catchment Forum - are given separate narratives for the sake of clarity, although they developed in close association. The developments described here were taking place at a time of great change in South Africa's political and institutional structures, both locally and nationally. The Kat River Valley was one of the first catchments in the country to set up

water management structures. At the time there was no clear direction from the Department of Water Affairs and Forestry about requirements for the water users association process, nor was there a clear policy in relation to catchment forums. Researchers, practitioners and the members of the various institutions had to learn as they went along. This report offers a reflection on what worked and what did not. The authors hope that the story will be useful to others who are grappling with how to implement the National Water Act in a way that honours the Act's principles of equity, sustainability and efficiency.

Report No: TT 295/07  
ISBN: 978 1 7005 586 5  
Overseas price : \$20-00 (excl postage)

**Estuaries and integrated development planning: A managers' guide**  
**Hay D**

Estuaries are valuable economic, social and ecological resources supplying a range of goods and services to society. As public resources their management requires active co-operative management. While local government has a key leadership role to play in their management, their Integrated Development Plans (in the Eastern Cape) indicate that in most instances they are not taken into account. A social and political process of engaging local government on estuary management is proposed. The approach focuses on the economic value of estuaries and how local government can optimise the benefits that accrue from estuaries for itself and for its residents. As part of this engagement an estuary management training course has been developed for municipalities and tested in three areas.

Report No: TT 294/07  
ISBN: 978 1 77005 541 4  
Overseas price:\$15-00 (excl postage)

**An introduction to aquifer dependent ecosystems in South Africa**  
**Colvin C; Le Maitre D; Saayman; Hughes S**

Aquifer Dependent Ecosystems (ADE) occurs throughout the South African landscape, but their identification is often difficult although this is relevant for water management and allocation. ADEs have been categorised by 8 principal aquifer types (based on lithology) and 7 habitat types. At a coarse national scale it is possible to identify areas with a high probability of supporting terrestrial and aquatic ADEs and to assess their vulnerability to disturbance. High areas of risk are linked to shallow discharge zones where over abstraction is taking place and mining and irrigated agriculture dominate land-use. South Africa is moving towards IWRM and ADEs need to be considered in this context. The successful protection of ADEs requires cooperative governance of land, water and the environment.

Report No TT 301/07  
ISBN:978-1-77005-532-2  
Overseas price : \$ 25-00 (excl postage)

**Learning and teaching about water in our classrooms: A series of lesson plans for Grades 8-12**  
**Peddie C; Hibbert D; Conway-Physick C**

In support of learning and teaching about water-related issues, the Water Research Commission of South Africa and Share-Net ( a project of the Wildlife and Environment Society of South Africa) have developed a series of lesson plans on water. These lesson plan packs, from Grade 8 to 10, are linked to the South African National Curriculum. All the lesson plan packs (Grade R-8) are available on [www.envirolearn.org.za](http://www.envirolearn.org.za). Other useful websites are the Water Research Commission: [www.wrc.org.za](http://www.wrc.org.za) and the Wildlife and Environment Society of SA [www.wessa.org.za](http://www.wessa.org.za)

Report No: TT 346/08  
ISBN: 978 1 77005 693 0  
Overseas price : \$30 00 (excl postage)

**Learning and teaching about water in our classrooms: A series of lesson plans for grades R-7**  
**Clare P; Hibbert D; Conway-Physick C**

Report No: TT 345/08  
ISBN: 978 1 77005 650 3  
Overseas price : \$30 00 (excl postage)

**WET-Roadmap: A guide to the wetland management series**  
**Dada R; Kotze D; Ellery W; Uys M**

This programme, co-funded by Working for Wetlands, aims to establish national wetland rehabilitation procedures by establishing a framework within which wetlands requiring rehabilitation may be prioritised and continually assessed. It will develop a diagnostic framework for assessing the underlying causes of degradation and develop national guidelines for rehabilitation including a review of the methods available. It will also develop synergy with other research being done on wetlands, examine the institutional arrangements around wetland management, and develop a long- term monitoring system that will allow strategic adaptive management of wetlands.

Report No: TT 321/07  
ISBN: 978 1 77005 632 9  
Overseas price : \$10 00 (excl postage)

### **Guidelines for the planning, design and operation of fishways in South Africa**

**Ralph Heath, Anton Bok, Pieter Kotze, Paul Fouche, Hylton Lewis, Jan Rossouw, Mathew Ross**

The need to manage water has led to the construction of barriers in rivers, effectively fragmenting the habitat and curtailing the passage of migratory biota.

This project will develop protocols for assessing the extent of blockage to free passage, and so prioritizing river systems for remedial measures, for the assessment of sites for use in the EIA and the RDM process. Understanding of the biological / hydraulic requirements of the relevant biota will be developed and this, together with data from existing fish-ways, will be used to develop cost-effective designs for local biota.

Report No: TT 287/07

ISBN: 978 1 77005 577 3

Overseas price : \$30 00 (excl postage)

### **Hydrology and water quality of the Mgeni catchment** **Kienzle SW; Lorentz SA; Schulze RE**

The ACRU hydrological model was configured for the Umgeni catchment upstream of Inanda Dam to simulate daily streamflow for 137 sub catchments for a 34-year period from 1 January 1960 to 31 January 1993. Simulated streamflows were verified against observed data for a limited number of sub-catchments. All verifications gave a coefficient of determination above 78%. In all cases simulated streamflow was within 6% of the observed values. It was found that the simulated impact of present land uses compared with pristine conditions can be highly significant.

Report No: TT 87/97

ISBN: 1 86845 297 2

Overseas price : \$30 00 (excl postage)

### **The biological and chemical database. User manual (SA Price: R28.50)**

**Dallas H & Janssens P**

A Biological/Chemical Database was developed as part of this project, incorporating virtually all the ecological studies done on South African rivers which include both taxonomic and chemical data. Using SASS4 (South African Scoring System, version 4), several of the water quality variables in the DWAF guidelines for environmental water quality were tested for each of the four regions (mountain, foothills, transitional and low land rivers).

Report No: TT 100/98

ISBN: 1 86845 421 5

Overseas price: \$50 00 (excl postage)

### **Guides to the freshwater invertebrates of Southern Africa**

The principle aim of the series of ten books is to synthesize much of the existing knowledge on the identification of freshwater invertebrates into a standard format that is accessible to users who wish to identify taxa beyond their field of expertise.

This series will include an introductory volume containing general information and a key to the families of invertebrates.

- Volume 1: In preparation
- Volume 2: Guides to the freshwater invertebrates of Southern Africa: Crustacea I (SA price: R50.00)

**Day JA, Stewart BA, De Moor IJ & Louw AE**

Report No: TT 121/00

ISBN: 1 86845 581 5

Overseas price : \$25 00 (Postage inclusive)

- Volume 3: Guides to the freshwater invertebrates of Southern Africa: Crustacea II (SA price: R50 00)

**Day JA, Stewart BA, De Moor IJ & Louw AE**

Report No: TT 148/01

ISBN: 1 86845 703 6

Overseas price : \$25 00 (Postage inclusive)

- Volume 4: Guides to the freshwater invertebrates of Southern Africa: Crustacea III (SA price: R50 00)

**Day JA, Stewart BA, De Moor IJ & Louw AE**

Report No: TT 141/01

ISBN: 1 86845 676 5

Overseas price: \$25 00 (Postage inclusive)

- Volume 5: Guides to the freshwater invertebrates of Southern Africa: Non Arthropods (SA Price: R114-00)

**Day JA & IJ deMoor**

Report No: TT 167/02

ISBN: 1 86845 827 X

Overseas price: \$50 00 (Postage inclusive)

- Volume 6: Guides to the freshwater invertebrates of Southern Africa: Arachnida & Mollusca: Araneae, Water Mites & Mollusca (SA Price: R50-00)

#### **Day JA & J de Moor**

Report No: TT 182/02

ISBN: 1 86845 875 X

Overseas price: \$50 00 (Postage inclusive)

- Volume 7: Guides to the freshwater invertebrates of Southern Africa: Insecta; Ephemeroptera, Odonata & Plecoptera (SA Price: R114-00)

#### **IJ de Moor, JA Day & FC de Moor**

Report No: TT 207/03

ISBN: 1 86845 875 X

Overseas price: \$50-00 (Postage inclusive)

- Volume 8: Guides to the freshwater invertebrates of Southern Africa: (SA Price: R100-00)

#### **de Moor IJ; Day JA; de Moor FC**

Report No: TT 214/03

ISBN: 1 77005 055 8

Overseas price: \$50-00 (Postage inclusive)

- Volume 9: Guides to the freshwater invertebrates of Southern Africa: Diptera (SA Price: R100-00)

#### **JA de Moor, AD Harrison & IJ de Moor**

Report No: TT 201/02

ISBN: 1 86845 900 4

Overseas price: \$50-00 (Postage inclusive)

- Volume 10: Guides to the freshwater invertebrates of Southern Africa (SA Price: R100-00)

#### **Stals R; De Moor IJ**

Report No: TT 320/07

ISBN: 978 1 77005 629 9

Overseas price: \$50-00 (Postage inclusive)

#### **The Kruger National Park Rivers Research Programme C Breen, M Dent, J Jaganyi, B Madikizela, J Maganbeharie, A Ndlovu, J O'Keeffe, K Rogers, M Uys & F Venter**

The Kruger National Rivers research programme is a co-operative undertaking by resource-use managers, funding agencies and researchers. It addresses the water quality and water quantity requirements of the natural environments of rivers, particularly those flowing through the Kruger National Park.

Report No: TT 130/00

ISBN: 1 86845 622 6

Overseas price: \$35-00 (excl postage)

#### **State of the Rivers Report**

##### **DWAF, WRC, CSIR, Mpumalanga Parks Board & Dept of Environmental Affairs**

Between 1996 and 1999, the River Health Programme (RHP) conducted surveys on the three major river systems of Mpumalanga, the Crocodile, Sabie Sand and Olifants Rivers, including some of their tributaries.

The RHP collected and assessed a substantial body of data on the ecological health of these rivers during the surveys.

The following reports are available:

- 1) State of the Rivers Report: Letaba and Luvuvhu River Systems 2001 (TT 165/01)
- 2) State of the Rivers Report (TT 147/00)
- 3) State of the rivers report: Umngeni River and neighbouring rivers and streams (TT 200 /02)

Report No: TT 147/00

ISBN: 1 86845 689 7

Overseas price : \$20 00 (excl postage)

#### **Ecological risk assessment guidelines (South African price: R50 00)**

##### **Claassen M, Strydom W F, Murray K & Jooste**

Ecological risk assessment is a structured approach that describes, explains and organizes scientific facts, laws and relationships and provides a sound basis to determine sufficient protection measures and to develop utilization strategies. The risk assessment process has the potential to improve communication between scientists, managers and the public, thereby promoting mutual understanding and collaboration. Appropriate use of this guideline document will thus promote cooperative governance and sustainable development

Report No: TT 151/01

ISBN: 1 86845 721 4

Overseas price : \$25 00 (excl postage)

#### **The botanical importance rating of the estuaries in former Ciskei/Transkei**

##### **Colloty BM, Adams JB & Bate GC**

Botanical importance refers to the contribution of the plants to the conservation status of an estuary. In this study botanical importance is the sum of functional importance, species richness, community richness and community type rarity.

Report No: TT 160/01

ISBN: 1 86845 790 7

Overseas price : \$20 00 (excl postage)

### **Guidelines for Legionella levels in water: A code of practice**

**Pauline Coubrough**

The guidelines are intended for use in South Africa, taking in account South African environmental conditions. International guideline documentation, results from outbreaks that have occurred throughout the world, and the National Legionella Action Group's research findings were used in the formulation of the guidelines.

Report No: TT 174/02

ISBN: 1 86845 846 6

Overseas price : \$15 00 (excl postage)

### **Predicting water quality and biotic response in ecological reserve determinations**

**Malan H; Day JA**

The management of water quality in the environmental Reserve is more complex than that of water quantity. The principal aim of this project is to examine the relationship between water quality and water quantity with particular reference to instream flow requirement assessments, and to produce a framework for the assessment of water quality in IFR studies. Secondary aims are to investigate how the Biobase database may be used in the assessment of water quality guidelines.

Report No: TT 202/02

ISBN: 1 86845 923 3

Overseas price : \$30-00 (excl postage)

### **Prioritisation of South African estuaries based on their potential importance to estuarine-associated fish species**

**Maree RC; Whitfield AK; Quinn NW**

This report presents a ranking of South African estuarine systems based on their importance to estuarine-associated fish species, and aims to facilitate the identification of South African estuaries with a high conservation priority, by placing all South African systems in a regional and national context.

Report No: TT 203/03

ISBN: 1 86845 979 9

Overseas price: \$10-00 (excl postage)

### **Freshwater fish and human health: Overview guide**

**Heath R; du Preez H; Genthe B; Avenant-Oldewage A**

This programme focuses on the development of a series of guidelines and protocols to promote and advocate the safe use of water with the aim to build awareness and to transfer technology to the public to minimise water-related health risks. This programme is intended to meet the needs of practitioners and will consider aspects of water use and health, hygiene, hazards and risks as well as epidemiological studies, communication protocols and education guidelines.

These projects are concerned with translating scientific data into accessible formats.

Report No: TT 212/04

ISBN: 1 77005 046 9

Overseas price: \$20-00 (excl postage)

### **Freshwater fish and human health: Reference guide.**

**Heath R; du Preez H; Genthe B; Avenant-Oldewage A**

Report No: TT 213/04

ISBN: 1 77005 047 7

Overseas price: \$25-00 (excl postage)

### **Environmental water quality in water resources management**

**Palmer T; Berold R; Muller N**

The release of harmful and potentially harmful substances into the environment has caused water quality problems worldwide. Toxicology offers a cost-effective way of measuring the likely impact of an effluent on the environment, in that it will identify whether the effluent is toxic, including any synergistic and antagonistic effects. This will allow for both the determination of the suitability of the effluent for discharge to be determined for licensing purposes, and for specific industries to monitor their compliance with license conditions.

Most toxicity tests measure acute effects and the chronic values are calculated empirically. The measurement of sub-lethal methods will, thus, provide accurate values on which to base decisions, so enhancing the capacity of managers to protect the water resource.

During this project new methods will be developed for quantifying the chronic effects of toxic effluents at sub-lethal concentrations.

Report No: TT 217/04

ISBN: 1 77005 083 3

Overseas price: \$10-00 (excl postage)

### **The effect of water quality variables on aquatic ecosystems review**

**Dallas HF; Day JA**

Water is a scarce resource in South Africa, and increasing population pressure has meant that the resource is heavily exploited and carries an increasing pollution load. Aquatic ecosystems are able to remediate a certain amount of pollution, but once this level has been exceeded then the ecosystem, together with its ability to remediate pollution declines. Chapters 2 and 3 of the review provide a general introduction to the issue of water quality in relation to aquatic ecosystems. Chapters 4 to 12 synthesise what is

known about the effects on aquatic ecosystems of specific physical attributes and chemical constituents. Specifically, these include temperature, turbidity, pH, total dissolved solids and dissolved oxygen. Organic enrichment, including bacterial contamination, as well as the effects of enrichment by specific nutrients are covered, as are biocides and trace metals. The last eight chapters examine the effect of different types of whole effluents or other specific disruptions resulting from human activities, including agriculture, aquaculture, engineering and construction with specific reference to river regulation, forestry, industrial effluents, mining and urban runoff.

Report No: TT 224/04

ISBN: 1 77005 131 7

Overseas price: \$30-00 (excl postage)

### **Towards the conservation and sustainable use of Eastern Cape estuaries**

**Breen C et al.**

The ACRU hydrological model was configured for the Umgeni catchment upstream of Inanda Dam to simulate daily streamflow for 137 sub catchments for a 34-year period from 1 January 1960 to 31 January 1993. Simulated streamflows were verified against observed data for a limited number of sub-catchments. All verifications gave a coefficient of determination above 78%. In all cases simulated streamflow was within 6% of the observed values. It was found that the simulated impact of present land uses compared with pristine conditions can be highly significant.

Report No: TT 237/04

ISBN: 1 77005 235 6

Overseas price: \$20-00 (excl postage)

### **Spatsim, an integrated framework for ecological reserve determination and implementation**

**Hughes DA; Palmer CG**

Water quality is currently trailing water quantity in the ecological Reserve methodology. Further development of the methods used is necessary to enable the water quality component to be considered adequately. The aims of this project are to develop acceptable time-series data for selected water quality variables, encapsulate the expert water quality knowledge in an organised way and encode these for inclusion into the DSS currently being developed as part of a parallel project, and co-ordinate this with other water quality projects working on the Reserve. This will ensure that decisions taken on water quality in the Reserve determination process are done in a standard way and in parallel with those on water quantity.

Report No: TT 245/04

ISBN: 1 77005 296 8

Overseas price: \$25-00 (excl postage)

### **Managing sedimentary processes in SA estuaries:**

#### **A guide**

**Hay D; Huizinga P; Mitchell S**

Ingress of marine sediments into estuaries was the single most important issue in estuary management identified in the western part of the Eastern Cape during the early stages of the EC Management Programme. The local authority for the Port Alfred / Boesmans River area has committed funds to develop the predictions of the effect of interventions on the problem. If the predictions indicate that an intervention may be successful, then the EIA around the planned intervention will be undertaken within this project. Thereafter, the implementation of any technology will be for the expense of the local authority.

Report No: TT 241/05

ISBN: 1 77005 272 0

Overseas price: \$20-00 (excl postage)

### **The SA diatom collection:**

#### **1. An appraisal and overview of needs and opportunities**

**Harding WR; Archibald CGM; Taylor JC; Mundree S**

The South African Diatom Collection (which extends beyond South Africa's borders) was established over the period 1950 to 1995 by a number of collectors and is amongst the larger collections worldwide. A number of case studies were carried out which showed the relevance of the OMNIDIA software package (use of diatom-based water quality indices) for South African conditions. The general conclusion is that the data and information contained in this collection will add value to, and have a place in, the current suite of assessment tools currently being used for the management of the surface water resource in South and Southern Africa.

Report No: TT 242/04

ISBN: 1 77005 275 5

Overseas price: \$25-00 (excl postage)

#### **2. Benthic diatoms in the rivers and estuaries of South Africa**

**Bate GC; Smailes PA; Adams JB**

This follow-on project (from the project entitled Identification of diatoms and their use in the assessment of water quality) will address 3 aspects of the use of diatoms in monitoring for water quality. The determination of the relationship between dominant diatom assemblages and freshwater quality will continue. The same will be done for estuarine diatoms, where the relationship between water quality and dominant assemblages will be defined. Thirdly, a manual of South African diatoms will be produced. The product of this project will enable the use of diatoms, long recognised as being sensitive indicators, in water quality management at the technician level, not achieved elsewhere before.

Report No: TT 234/04  
ISBN: 1 77005 182  
Overseas price: \$35-00 (excl postage)

### **3. A methods manual for the collection, preparation and analysis of diatom samples.**

**Taylor JC; Harding WR; Archibald CGM**

Report No: TT 281/07  
ISBN: 1 77005 483 9  
Overseas price: \$20-00 (excl postage)

### **4. An illustrated guide to some common diatom species from South Africa.**

**Taylor JC; Harding WR; Archibald CGM**

Report No: TT 282/07  
ISBN: 1 77005 484 7  
Overseas price: \$30-00 (excl postage)

### **The state of yellowfish in South Africa (SA price R50-00)**

**Wolhuter LE; Impson ND**

Report No: TT 302/07  
ISBN: 978 1 77005 543 8  
Overseas price: \$30-00 (excl postage)

### **Cross-sector policy objectives for conserving South Africa's inland water biodiversity**

**Roux D; Nel JL; MacKay HM; Ashton PJ**

Report No: TT 276/06  
ISBN: 1 77005 459 6  
Overseas price: \$25-00 (excl postage)

### **Conservation planning for river and estuarine biodiversity in the Fish to Tsitsikamma water management area**

**Lindsay NJ, Smith-Adao L, Roux DJ, Adams J, Cambray JA, de Moor FC, Kleynhans CJ, Kotze I, Maree G, Moolman J, Schonegevel LY, Smith RJ, Thirion**

This study piloted the development of a planning framework for systematic conservation of inland water biodiversity in South Africa. The tool for river prioritization and selection was tested, refined and demonstrated in the Fish to Tsitsikamma Water Management Area, and provides a process for implementing biodiversity conservation in practice.

Report No: TT 280/06  
ISBN: 1 77005 473 1  
Overseas price: \$30-00 (excl postage)

### **Integrated algal ponding systems and the treatment of domestic and industrial wastewaters: Part 4: Report 7**

**Rose PD; Hart OO; Dekker LG; Clark SJ**

Inadequate sanitation is a leading cause of water pollution and consequently illness in many underdeveloped countries, including South Africa, for example the Eastern Cape Province, where cholera has reportedly become endemic. As modern wastewater treatment processes are often energy-intensive and expensive, they are not suitable for use in these areas. There is thus a need to develop more sustainable wastewater treatment technologies for application in smaller communities. The integrated algal ponding system (IAPS) was identified as a possible solution to this wastewater management problem and was investigated for adaptation to local conditions at the Rhodes University Environmental Experimental Field Station in Grahamstown.

The system was monitored over a period of nine years, with various configuration adjustments of the high rate algal pond (HRAP) unit operation investigated. Under standard operating conditions, the system was able to achieve levels of nutrient and organic removal comparable with conventional wastewater treatment works.

The mean nitrate level achieved in the effluent was below the 15mg.l<sup>-1</sup> South African discharge standard, but nitrate removal in the IAPS was found to be inconsistent. Although the system was unable to sustain chemical oxygen demand (COD) removal to below the 75mg.l<sup>-1</sup> South African discharge standard, an average COD removal rate of 87% was recorded, with the residual COD remaining largely in the form of suspended algal biomass.

Previous studies in the Eastern Cape Province have shown that few small wastewater treatment works produce effluent that meets the microbial count specification. Therefore, in addition to the collation of IAPS data from the entire nine year monitoring period, this study also investigated the use of the HRAP as an independent unit operation for disinfection of effluent from small sewage plants. It was demonstrated that the independent high rate algal pond (IHRAP) as a free standing unit operation could consistently produce water with *Escherichia coli* counts of 0cfu.100ml<sup>-1</sup>. The observed effect was related to a number of possible conditions prevailing in the system, including elevated pH, sunlight and dissolved oxygen.

It was also found that the IHRAP greatly enhanced the nutrient removal capabilities of the conventional IAPS, making it possible to reliably and consistently maintain phosphate and ammonium levels in the final effluent to below 5mg.l<sup>-1</sup> and 2mg.l<sup>-1</sup> respectively (corresponding South African discharge standards are respectively 10mg.l<sup>-1</sup> and 3mg.l<sup>-1</sup>).

The quality of the final effluent produced by the optimisation of the IAPS would allow it to be used for irrigation, thereby

providing an alternative water source in water-stressed areas. The system also proved to be exceptionally robust and data collected during periods of both high-intensity and low-intensity management regimes were broadly comparable.

In summary, the results of the nine-year study have demonstrated reliable performance of the IAPS and its use as an appropriate, sustainable wastewater treatment option for small communities. For producing a treated water suitable for irrigation, some significant strengths of IAPS compared to other wastewater treatment technologies are the relatively low capital and operating (e.g. energy) costs, stable performance and low management demands. The system should find ready application in the RSA.

Report No: TT 193/07

ISBN: 978 1 77005 890 5

Overseas price:\$35-00 (excl postage)

#### **Part 4: Process Scale-up in the Treatment of Mine Drainage Wastewaters and the Disposal of Sewage Sludge**

**Neba A; Whittington-Jones KJ; Rose PD**

Acidic wastewaters from mining operations (acid mine drainage, AMD) and various industrial and metal-refining processes often contain high levels of sulphates and heavy metals. WRC studies have shown that AMD volume flows may reach hundreds of megalitres per day for decades, with acute and long-term impacts on the public water resource system, the environment, and community health, and consequences thus for the economic and social development of the water-scarce Gauteng region.

The development of suitable biological treatment processes has to date been constrained by reactor design appropriate to the large volume flows and the availability of cost effective carbon sources. Recent WRC projects have researched algal ponding technologies and applied these low-cost processes to the treatment of mining and tannery wastewaters. This has led to the development of the biological sulphate-reducing (biodesalination) BioSURE® process using sewage solids as the carbon source for sulphate reduction and algal activity for precipitating heavy metals and neutralising of acidic drainage streams. In early 1998 a pilot plant was constructed and commissioned at Grootvlei Mine in a collaborative research venture involving the WRC (Project No. 869), ERWAT and Grootvlei Mine. Detailed study of the basic process mechanisms was undertaken in WRC Project No.972. In project 1078 the outstanding components of the pilot plant were constructed to enable evaluation of the complete integrated process over an appropriate time period. In this one-year project 1291, the specific aim was to provide managerial inputs into operationalization and optimisation of the BioSURE® plant constructed at Ancor Sewage Works by ERWAT and Grootvlei Mine, and thus to assist in process decision-making

relating to the full-scale engineering of the process and to provide specialist support to WRC research partners in their implementation of process scale-up for technology transfer,

The above aims were in general achieved and reported on during the course of the project. The operationalisation of the BioSURE® process in this project has contributed significantly to the development of the current situation, where a full-scale plant is being constructed at Ancor Sewage Works to treat AMD from Grootvlei Mine.

The final report on this project 1291, along with the final report on project 1169, is to be published as Report 12 in the series "Salinity, Sanitation and Sustainability" (ISBN series 1-86845-853-9, Volume 4, Part 4 "Treatment and Disposal of Sewage Sludges"). The report will include early results (to December 2004) from the full-scale plant currently being built and commissioned at ERWAT'S Ancor Sewage Works.

Report No: TT 198/07

ISBN: 978 1 77005 895 0

Overseas price:\$30-00 (excl postage)

#### **Management of water-related microbial diseases: Volume 2: What causes the problem? - A what to do for water suppliers following diarrhoea incidents?**

**M Steynberg; B Genthe; A van Middelkoop**

Internationally there is growing concern about the general failure of authorities to understand the public health impact of waterborne and related infectious diseases. The water supplier is responsible for protecting the health of the public by providing water that is considered to be safe. When cases of diarrhoea occur in the community, the public is also very quick to blame the water. Confidence in the quality of the water can then only be restored if the allegation has been investigated to the satisfaction of the public.

This handbook provides practical guidelines on how to conduct such an investigation. The methods and materials are not original, and can be found in many books and publications that abound in the fields of water management and epidemiology. No attempt is made in this handbook to discuss all the issues surrounding the recommended procedures-the relevant literature will provide far greater insight. What sets this book apart is the fact that it pulls together the relevant methodology from traditionally remote disciplines, the methodology that is required to find out whether cases of diarrhoea could be due to water consumption.

The water quality and water treatment data routinely collected by the water supplier form an important starting point in finding out whether the water could be responsible for cases of diarrhoea. This handbook shows how to record and interpreted such routine data appropriately so that they facilitate the investigation.

The target audience for this handbook includes both the water supplier and the district health services, for example the water quality officer and the environmental health practitioner. The successful implementation of the recommended procedures depends on the involvement of both sectors. All water suppliers, however large or small, should take note of the guidelines provided in this handbook.

Report No: TT 297/07

ISBN: 978 1 77005 520 9

Overseas price:\$30-00 (excl postage)

**Management of water-related microbial diseases: Volume 4:  
How dangerous is the problem? Communicating the risk  
B Genthe; M Knoetze**

Water-related microbial disease such as cholera causes untold misery in communities across South Africa every year. As part of the effort to promote awareness and understanding of the conditions promoting infectious disease transmission, water service providers are increasingly required to have a risk communication programme in place.

Health risk communication is the exchange of information and opinions concerning risk and risk-related factors among risk assessors, risk managers, consumers and other interested parties.

It is not merely the dissemination of information. If well managed, it will ensure that the message is constructively formulated, transmitted and received and will result in meaningful actions.

This guideline document presents the fourth in a five-volume series aimed at addressing the question of how best South Africans can protect themselves from water-related microbial disease. It provides a framework of principles and guidelines for the communication of health risks, specifically for water service providers.

Communicating with the public is an essential element of health risk communication. Ineffective communication often results in conflict, which in turn leads to the erosion of public confidence, and inefficient use of water service providers' resources. The recognition that people are entitled to make decisions about issues that affect their lives can assist water service providers in forming a better understanding of, and formulating more appropriate reactions to, a particular risk. Appropriate risk communication not only promotes consistency and transparency in arriving at and implementing risk management decisions, it also fosters public trust and confidence in the safety of the water supply.

The document will provide guidelines and examples that will assist water service providers in communicating with the public when a water quality issue arises that has a potential impact on health.

It is hoped that this document will assist water service providers, government departments, water boards, municipalities and district councils in communicating with the public when a water quality issue arises that could have a potential impact on health. In this way, the guide will hopefully make a significant contribution to protecting our most vulnerable communities against water-related microbial disease.

Report No: TT 298/07

ISBN: 978 1 77005 522 3

Overseas price:\$25-00 (excl postage)

**Guidebook for the selection of small water treatment systems for potable water supply to small communities  
CD Swart, I Goldie; G Mwiing, LM Daries; BA Delcarne; JD Seconna, JC Geldenhuys**

Small water treatment plants are defined as water treatment systems that have to be installed in areas which are not adequately serviced and do not normally fall within the confines of urban areas. They are therefore mostly used in rural and peri-urban areas and include chlorination plants for water supplies from boreholes and springs, small treatment systems for rural communities, treatment plants of small municipalities and treatment plants for establishments such as rural hospitals, schools, clinics, forestry stations, etc. Most of these applications require small plants of less than 2.5 ML/d (although plants of up to 25 ML/d may sometimes also fall into this category).

The decision-maker selecting one of these small water treatment plants has a great number of local and international system designs to choose from. Especially in the case of novel and emerging systems, very little may be known of these systems in terms of cost, efficiency and the applicability to the intended application. Supplier information may be sketchy, or promising new technologies have not yet been fully evaluated under South African conditions. Socio-economic factors are also very important and should be taken into account in the selection of small water treatment systems in order to ensure sustainability.

Although some evaluation of a selected number of small water treatment plants has taken place under previous WRC projects (WRC Report No 450/1/97: Package water treatment plant selection, and WRC Report No 828/1/01: Field evaluation of alternative disinfection technologies for small water supply), a number of other small water treatment plants, available on the international market, have not yet been assessed in any way for possible (beneficial) application in South Africa. This guidebook is therefore seen as complementing existing guidelines in providing assistance in the selection and operation of specific small water treatment systems being marketed for the treatment of potable water for small communities.

A number of local and international studies have shown that

the selection of the correct water treatment system is but a first step in ensuring a sustainable supply of potable water to small communities. Following of the correct operational and maintenance procedures is of even greater importance for ensuring sustainability of water supply. Although most suppliers of small water treatment systems provide their clients with some operational and maintenance guidelines, these may not be exhaustive, or certain important generic aspects may not be covered. Information on operation and maintenance aspects will be of significant value to the owners and operators of such small water treatment systems.

The guidebook aims to provide guidelines for the identification and optimal selection of available and emerging new water treatment systems, which are currently being marketed for the supply of potable water to small communities in South Africa.

Report No: TT 319/07

ISBN: 978 1 77005 627 5

Overseas price:\$30-00 (excl postage)

**Enabling water fluoridation on small drinking water treatment plants. Part A: Guidelines for the implementation of fluoride dosing in small systems Part B**  
**R Rajagopaul; PThompson; A Hariram**

Regulations for the fluoridation of South African potable water supplies to an optimum concentration of (and not more than) 0.7 mg/l in order to limit the development of dental caries were published in the Government Gazette of 8 September, 2000. Water Services Providers (WSP's) had to register with the Department of Health (DOH) by 8 September 2001 for fluoridation of their water supplies to consumers – or apply for exemption. However, because of the larger safety risk foreseen for both plant operators and water users in smaller and rural water treatment plants, such plants supplying water to less than 60 000 people, currently receive, on application, temporary exemption from the Director-General: Health. This unfortunately excludes a large part of the population from receiving the benefits of fluoridation. By far the majority of water treatment plants fall within the category of supplying less than 60 000 people with potable water. In addition, most of the operators on these smaller plants are not at a skills level required by the regulations for the safe operation of a fluoride dosing facility. A need therefore existed to enable these smaller plants to administer fluoride safely through the correct choice and operation of instrumentation and equipment, as well as by innovative ways in which to make a plant fail-safe in terms of both technology and human shortcomings. The project aimed to enable fluoridation to be done safely on small water treatment plants by means of the evaluation, selection and implementation of safe handling and dosing equipment and monitoring instrumentation.

Potentially suitable handling and dosing equipment and monitoring instrumentation were evaluated at an Umgeni

Water treatment plant and the following products emanated from the study and evaluation: i) A full report was produced on the various fluoridation handling, dosing and monitoring equipment evaluated, including cost implications to the water treatment plant. ii) A comprehensive guideline document was compiled, outlining suitable fluoridation techniques, equipment available, correct installation and use of the equipment and general safety measures that (especially) small plant personnel need to adhere to. In the light of the fact that fluoridation will go ahead in the near future, this guideline is a very timely document, which will assist especially the small water treatment facilities – but also larger plants – in ensuring that their fluoridation requirements are met in an efficient and safe way.

Report No: TT 347/08

ISBN: 978 1 77005 700 5

Overseas price:\$30-00 (excl postage)

**On-site mobile training of water treatment operators in small rural water supplies**  
**MNB Momba, N Makala, M Dugeni**

Many small rural water treatment plants in South Africa do not produce the quality or quantity of water that they were meant to. Both technical and human factors have been reported to be the major causes of the failure of small rural water treatment plants to provide potable water to their consumers. Inadequate water treatment systems are therefore placing rural communities at risk of diseases. It has been found that most of the operators who operate rural small water treatments lack the knowledge of plant operational processes. Even when an attempt has been made to offer training, the level of the material used is well beyond the educational level of the operators. Consequently there is a need for the training to be adapted to their capability as well as to be done on-site. This guide was meant to complement the cartoon guide "An illustrated Guide to Basic Water Purification Operations" by providing a practical, mobile course oriented training manual.

Report No: TT 348/08

ISBN: 978 1 77005 704 3

Overseas price:\$20-00 9 (excl postage)

**Water services barometer study**  
**M Martin**

Community consultation in the provision of water services is both a legislative obligation and a critical success factor. Legislation and policy require government to engage with communities in the provision of Water Services. In order to inform/consult the public and obtain their participation and support, national departments such as DWAF and DPLG embarked on awareness campaigns and/or solicited public participation through meetings, leaflets and the mass media.

No single comprehensive study has been done which

provides a barometer of the general public's knowledge and understanding of the water services messages as communicated, and their involvement in, and preferences for, consultative processes. To this end, this study into the level and status of community consultation on a range of water services issues was undertaken. The study gives a 'reading' of the current state of knowledge and awareness amongst the South African public regarding five key water services knowledge areas. The analysis of the data furthermore identifies areas of strength and weakness with the view to developing recommendations for improvement.

For the purpose of this study, the term 'community consultation' was broadly defined to include all types of communication aimed at the general public, ranging from information dissemination to community participation. The study limited itself to water services messages and it focuses on two major communication campaigns of the Department of Water Affairs and Forestry that have dealt specifically with Water Services, Free Basic Water and Water and Sanitation Hygiene (WASH).

In order to assess the results/ outcomes of these water services campaigns, a barometer instrument was constructed. The barometer quantifies, with a composite score out of a possible 10, the knowledge /awareness/ desired behaviour of adult South Africans regarding key messages of the campaigns. Five key water services knowledge areas were identified from the literature review and the analysis of the e National Spatial Biodiversity Assessment (NSBA) established that 30% of grasslands in South Africa are irreversibly transformed and only 2.8% are formally conserved. The National Grasslands Biodiversity Programme (NGBBP) aims to mainstream biodiversity in production landscapes involving the coal mining and agricultural sectors, and is investigating both regulatory and market based approaches to achieve this. Offsite mitigation and mitigation banking for wetlands have been identified as concepts with the potential to achieve the desired conservation of aquatic biodiversity within the priority areas of the grassland biome.

The concept of wetland mitigation banking developed in the United States to meet the country's policy of 'no-net loss' of wetlands. It is, however, a controversial concept, with the overriding argument against adopting the mechanism being that "it encourages a commodity approach to conservation wherein wetlands are traded for cash".

Report No: TT 353/08  
ISBN: 978 1 77005 743 2  
Overseas price:\$20-00 (excl postage)

#### **Guidelines for the improved disinfection of small water treatment plants**

**MNB Momba, CL Obi and P Thompson**

The efficacy of drinking water treatment by small water

treatment plants – and particularly the disinfection aspects thereof, is fraught with several technical and management problems. This is corroborated by the extensive documentations on the supply of water of poor microbiological quality which is unsafe for human consumption in different provinces of South Africa. In order to unravel the intricacies around the operational and management parameters impinging upon the disinfection efficiency of small water treatment plants and to ensure sustainability of potable water supply to rural communities, this study was executed, involving 181 small water treatment plants across seven provinces of South Africa. The goal was to determine the nature and full extent of the disinfection problems experienced and to provide practical and user-friendly guidelines for intervention.

From extensive surveys at these plants and their disinfection systems, it was established that equipment, maintenance, operator education, operator training, operator working conditions and Management-operator interaction were normally inadequate. These aspects were quantified and graphically portrayed on the report. A detailed and user friendly guide document was further drawn up to assist in improving disinfection of final water at small water treatment plants and distribution systems. It includes practical steps and also installation and operating costs for the different disinfection systems and chemicals. This guide document is intended for use at operational and management levels by plant managers, supervisors, plant operators and plants owners, consultants and Municipal Water Local Authorities. The report and guide document will fulfill a long-standing need for more complete information on (both technical and social) aspects regarding improved final water quality produced from small water treatment systems in South Africa.

Report No: TT355/08  
ISBN: 978 1 77005 726 5  
Overseas price:\$20-00 (excl postage)

#### **Research into UD/VIDP (Urine diversion ventilated improved double pit) toilets: Prevalence and die-off of ascaris ova in urine diversion waste**

**CA Buckley, KM Foxon, DJ Hawkworth, C Archer, S Pillay, C Appleton**

Urine Diversion (UD) systems have recently received a great deal of international attention in the context of "Ecological Sanitation" or "EcoSan". EcoSan refers to a cycle, or closed-loop system, which treats human excreta as a resource. In this system, excreta are processed on site until they are free of pathogenic (disease-causing) organisms. Thereafter the sanitized excreta are recycled by using them for agricultural purposes. Despite the obvious benefits of the design, there are a number of unresolved scientific, technological, social and health-related questions about how the design works from a biological and mass transfer perspective, and what the real health and environmental risks are to the householder,

community and any outsiders involved in the pit emptying process. The processes of drying and biological degradation which take place in UD vaults were investigated, with a view to understanding the characteristics of the UD waste at the time that the vault is to be emptied. The process of degradation in a UD vault was thought to be anaerobic biodegradation, with some aerobic degradation occurring at the air interface at the top surface of the waste; however it was found that the conditions in the heaps are not conducive to anaerobic digestion. Because of the way in which the faeces and sand are added to the vault, the mixture is very non-homogeneous. Further the analysis has also highlighted the importance of the air circulation rate for achieving good drying. The fact that the Durban system is to close off the vault during the standing phase is therefore an unsatisfactory feature of the system, since it means that very little drying will occur during the standing phase. The risk assessment showed that there was a 31% reduced risk of diarrhoea in the areas where the on-site sanitation program had been implemented to areas where it had not been implemented

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Overseas price:\$20-00 (excl postage)

**Scientific support for the design and operation of ventilated improved pit latrines (VIPS) and the efficacy of pit latrine additives**

**Buckley CA; Foxon KM; Brouckaert CJ; Rodda N; Nwaneri C; Balboni E; Couderc A; Magagna D**

This project proposed to undertake field and laboratory investigations of VIPs and their contents in and around the eThekweni Municipal area in order to understand the conditions found in the pits and to propose design and operating practice that will extend the life of pits. The standard VIP design was found to be effective for the accumulation and degradation of faecal sludge. However, it was observed that the ability of a VIP latrine to function as an improved sanitation system i.e. to provide hygienic separation of human waste from human contact, to limit the transport of pathogens from human waste by vectors such as rodents and insects, to reduce nuisance associated with flies and odour and to preserve the dignity of the user, was compromised in a number of respects due to poor construction, bad user habits, and during pit emptying operations. It was observed that poor construction or lack of maintenance often resulted in essential features of the VIP latrine design being missing or damaged, including vent-pipes, flyscreens, pedestal lids, doors and back plates. Under these conditions, there were usually problems with odours and flies. Bad user habits resulted in rapid accumulation of pit contents, particularly when poorly degradable anal cleansing material such as magazines, plastic bags or stones were used. In many cases pit latrines appeared to double as waste disposal sites, resulting rapid filling of the latrines.

During pit emptying operations, significant risk of infection of workers and community members with human pathogens originating from the pit contents is expected due to difficulties in removing pit latrine contents and separating faecal sludge from solid waste. Examination of face masks worn by workers engaged in emptying pit latrines and screening the exhumed contents indicated that viable ova of a number of helminth species including *Ascaris*, *Trichuris* and *Taenia* spp (roundworm, whipworm and tape worm) may be present in pit latrine contents and that these constitute a significant health risk to workers involved in handling pit latrine contents, and community members who have access to the area around the pit latrine during and after pit emptying operations.

Finally, commercial pit latrine additives were found to contain large concentrations of active micro-organisms with the ability to utilise organic substrates. However, neither the field trials, nor the laboratory trials provided evidence that the use of these products could result in a significant reduction in either mass or volume of pit latrine contents.

Report No: TT357/08

ISBN: 978 1 77005 718 0

Overseas price:\$30-00 (excl postage)

**The status and use of drinking water conservation and savings devices in the domestic and commercial environments in South Africa**

**D Still, S Erskine, N Walker and D Hazelton**

This study included four different surveys in order to gauge the status and use of water efficient devices in South Africa. Firstly, commercial and institutional settings such as hotels and hostels were investigated; secondly the suppliers of plumbing fittings were studied; thirdly the architectural profession was surveyed; and finally the knowledge and attitude of 1428 home owners in 10 towns and cities in South Africa were tested. The findings indicate that in commercial and institutional settings, there is clear evidence that water efficient devices are becoming more common. The plumbing industry demonstrates an increasing market share of water efficient devices and this is apparent on the showroom floors of the major plumbing suppliers. This is almost in spite of the suppliers, who as a rule do not push water efficiency (as one said, it is not their job to preach to their customers, who buy mainly on functionality, style and cost). Of the 1 428 homeowners surveyed, 29% indicated that they had at least one water efficient device in the home. Typically only about 20% of the respondents in the average town believed they might possibly use too much water, but significantly more, 40% to 50%, have considered reducing their water consumption.

Report No: TT358/08

ISBN: 978 1 77005 730 2

Overseas price:\$35-00 (excl postage)

### **The view from below: Citizen Voice and regulation in water services to the poor**

**D Hemson, R Shirley & C Munthree**

Regulation in a democratic society cannot work independently of participation by citizens. Public agencies acting as regulators have to have the views of citizens to hand as it is their interests which are being protected. As the regulatory strategy in South Africa acknowledges, without this knowledge, regulation will have a limited impact. Internationally there is increasing interest in engaging poor communities and capturing citizen voice in scorecards as a step towards improving accountability between citizen and provider. Such participation should assist developing the regulatory framework in South Africa as communities understand the operation and standards of water services, voice their needs, and, as necessary, seek redress. The expression of voice is an integral aspect of a developed reflexive delivery system in which community voice operates as an important prod to municipalities acting as Water Service Authorities to respond to expressed need. Although greater attention to citizen voice is advocated, the challenge remains as to what method can be adopted to involve poor communities on the widest basis actively in people's regulation of water services?

The project has succeeded in providing a set of tools for community appraisal and engagement with the evolving regulatory system. New tools appropriate to the situation have been developed and existing community tools reshaped. These tools and community materials on water services are supported by an established training programme and strategy for spreading their use and techniques. The methods and materials have been developed in deprived and remote communities with the greatest challenges in water services and the tools have been shown to add data and value to community advocacy for better services.

Report No: TT359/08

ISBN: 978 1 77005 733 3

Overseas price:\$25-00 (excl postage)

### **Guidelines for the implementation of sanitation and hygiene education programmes in informal settlements**

**N. Naidoo and C. Chidley**

The need for this research study was largely informed by the outcomes of the Naidoo et al (2007) research study, 'The Effectiveness of Sanitation Education and Awareness Programmes in Informal Areas'. Rapid urbanisation in South Africa has resulted in the mushrooming of numerous informal settlements, however the provision of services especially sanitation services has not kept pace. According to the National Sanitation Task Team most water and sanitation projects carried out by local authorities have lacked significantly in the aspect of health and hygiene awareness. National and international experience has shown that the most successful sanitation

initiatives have been those in which emphasis was placed on generating a high level of health and hygiene awareness rather than producing a large number of latrines. In addition, hygiene education programmes lay the foundation for an integrated approach to the provision of a wider set of environmental services. The benefits of effective and sustainable hygiene education programmes in informal settlements are numerous and include reduced infant mortality from diarrhoea, reduced environmental pollution, reduced health care costs, improved conditions of living, reduced operations and maintenance etc. Hygiene education programmes are among the most cost effective ways of lowering health costs especially in high density settlements where residents are at greater risks to poor sanitation related diseases. The study has determined that hygiene education programmes should be seen as an integral component of the functions provided by the Water Service Authority (WSA). As such, hygiene education can no longer be linked to only new sanitation infrastructure programmes. Instead, hygiene education should be a continuous function, like operations and maintenance, which is an ongoing function of local government. This approach will ensure that the message of good hygiene practice is continuously re-enforced and the approach is supported by existing policy and legislation.

Report No: TT365/08

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Overseas price:\$15-00 (excl postage)

### **Membrane-related Water Research Impact Assessment**

**Frost & Sullivan**

This study was commissioned as one of the impact studies contemplated to showcase research funded by the WRC in specific water research areas. The WRC has been instrumental in building the membrane industry in South Africa. The WRC has already funded a few projects on membrane research since its inception in 1971. However, most projects were funded after the establishment of a dedicated membrane programme in the early 90's. 66 membrane projects were funded since 1993. Research on membranes have resulted in significant economic, social, environmental and health benefits. The projects in this category have further helped to develop guidelines for best practices and are expected to be important within the water industry in South Africa for some time to come. Projects in this category have often led to the commercialisation of new products. They have further resulted in guidelines that have significantly impacted membrane project operational improvement, helped to decrease fouling and created methods to extend the life of membranes. Therefore, membrane research funded by the WRC was selected as a theme to perform an impact assessment on as showcase of the research funded by WRC and its impact on the South African and international society.

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Overseas price:\$20-00 (excl postage)

**Guidelines for the Utilisation and Disposal of Wastewater Sludge, Volume 1 – 5: Impact Assessment**  
**Cornelis van der Waal**

The release of the 2006 Sludge Guideline series aims to rectify previous sludge guideline shortcomings and provide an easy to use management tool for the handling of wastewater sludge. The aim of this project was to quantify the potential impact of the 2006 Sludge Guidelines on South African society by analysing current examples of wastewater sludge best practice that are aligned with the 2006 Sludge Guidelines.

Numerous examples of wastewater sludge handling best practice were reviewed. A variety of organisations benefit economically from the re-use of wastewater sludge and distinct social impacts that stem from these economic benefits were also identified. Environmental impacts have resulted largely from unsustainable sludge handling and mismanagement practices.

The examples identified during the completion of this project clearly reflect that wastewater sludge management practices that are aligned with the 2006 Sludge Guidelines are having a significant impact across economic, social and environmental areas of South African society.

Report No: TT370/08  
ISBN: 978 1 77005 786 9  
Overseas price:\$20-00 (excl postage)

**The impact of large consumer unit size on water and sanitation services in lower income urban areas in South Africa**  
**Kim Lesley Walsh**

The purpose of this research was to assess whether being a member of a large consumer unit, defined as more than eight people sharing a stand, results in inhibited access to water and sanitation services, and whether large consumer units find water and sanitation services to be unaffordable. This research suggests that large consumer units cannot be viewed simply as a homogenous group. Different types of consumer units, and different households making up those consumer units, face different challenges with respect to water and sanitation. Nuanced policy approaches will be necessary to help to alleviate these differing challenges. Such policy approaches might include considering programmes to upgrade backyard accommodation, and meter such accommodation separately; increases in the amount of Free Basic Water allocated to large consumer units; revisions to the rising block tariff structures, or consideration of alternative tariff approaches; and education programmes around the wise use of water. Indigent policies should also be reviewed to take large consumer unit size into consideration.

Report No: TT371/08  
ISBN: 978 1 77005 788 3  
Overseas price:\$20-00 (excl postage)

**Development of a knowledge management system for operation of the algal integrated ponding system (AIPS)-A training and operations tool for small wastewater treatment plants**

**KJ Whittington-Jones, PD Rose, W Leukes, G Lok, Si Naidoo and D Lok**

TSI had been approached by the Environmental Biotechnology Research Unit (Rhodes University) in 2001, with respect to providing a solution to the loss of valuable tacit knowledge at Sewage Processing Plants around the country due to high staff turnover. A knowledge management technique, developed by Gerrit Lok, was proposed as a possible solution and a demonstration site was recommended by the Water Research Commission and Rhodes University to evaluate the applicability of this tool. The Integrated Algal Ponding System (IAPS) project, co-ordinated by the University at the Grahamstown Sewage Works was used for the demonstration of this tool. As part of its contribution towards the country's RDP, in terms of provision of low-cost sanitation for low-income consumers, the Water Research Commission (WRC) had embarked upon the IAPS project in Grahamstown. IAPS had been designed as both a demonstration plant and a research facility with the objective of promoting acceptance and advancing knowledge in the operation of low-cost photosynthetic water treatment systems.

The primary objective of this initiative was to capture the expertise, skills and knowledge developed by an individual or a team of individuals, who have performed demanding tasks at the IAPS. A secondary objective was to develop the decision support system to allow for the simulation of fault conditions with appropriate remedial actions and reference to background support material. One of the main requirements of the diagnostic system was that it should not be another so-called "expert system" but would be a "non-robotic" system. In other words, when used for problem solving, it would actually enhance the learning of the user. A "hands-on" approach was used in this study to develop a totally comprehensive tool for the layman-operator.

A Decision Support System was developed on an MS Access database using web page support for the decision tree and reasoning path. The final product was presented in the form of a CD to the client with installation and operational instructions.

Report No: TT372/08  
ISBN: 978 1 77005 791 3  
Overseas price:\$20-00 (excl postage)

**Assessment of the occurrence and key causes of drinking-water quality failures within non-metropolitan water supply systems in South Africa, and guidelines for the practical management thereof**  
**G Mackintosh and U Jack**

This project identified the minimum requirements for effective and sustainable drinking-water service delivery within non-metropolitan water distribution networks to ensure acceptable drinking-water quality. Interviews with municipalities followed by site visits provided insight into current treatment plant and distribution network operation and maintenance procedures and the key factors that result in water quality failures in non-metropolitan networks. A web-enabled risk assessment tool was developed, as were practical guidelines aimed at different levels and/or users of the water service team, supported by two web-enabled tools available via the electronic Water Quality Management System (eWQMS). The management guides provide assistance in understanding planning, legislation, drinking water quality issues, staff training and reporting. The process controller's guide has been developed to assist operations and maintenance personnel in the operation and maintenance of drinking-water treatment plants and identifies issues that need urgent attention. The distribution system personnel guide assists operations and maintenance personnel in understanding and rectifying typical failures experienced in drinking-water distribution systems.

Report No: TT373/08  
ISBN: 978 1 77005 736 4  
Overseas price:\$30-00 (excl postage)

**Technical and social acceptance evaluation of microfiltration and ultrafiltration membrane systems for potable water supply to rural communities**  
**CD Swartz, MJ Philips, J Setlolela, B R Delcarme, JD Seconna**

Conventional small rural plants have been shown to lack sustainability due to high technical abilities required to operate these plants successfully. As membranes are known to produce high quality water, require less operator attention and may be automated much easier, this project aimed at evaluating membrane technologies for treatment of surface waters, including the determination of social acceptance factors for transferring the new technologies to the community. Both bench and pilot plant trials were run and two communities studied regarding social acceptance of membrane technology. It was found that membrane technology will be eminently suitable in treating surface waters to potable standards with minimal operator input. The social studies showed that community perceptions and preferences need to be taken into account before sighting of the plant. The project provided extensive insights into rural water supply with membrane based plants and the guideline will have a significant and positive impact on doing this correctly in order to ensure the sustainable supply of safe drinking water to rural communities.

Report No: TT374/08  
ISBN: 978 1 77005 781 4  
Overseas price:\$30-00 (excl postage)

**Guideline for the inspection of wastewater treatment works**  
**Lee Ann Boyd and AM Mbelu**

The Department of Water Affairs and Forestry (DWA) monitors Waste Water Treatment Works (WWTW) as mandated through the National Water Act, 1998 (Act 36 of 1998). This is done through regular inspections of the WWTW. For an inspector to undertake inspections thoroughly and give proper guidance on any problems encountered, it is important that he/she fully understands the complex nature of the various unit processes involved in the treatment of wastewater. Equally, Process Controllers must have insight with regards to the aspects that are monitored during the inspection. This Field Guide provides Inspectors and Process Controllers with a tool to conduct inspections on a WWTW. It provides guidance on how to identify possible problem areas and makes recommendations on how to solve common problems. The guideline and electronic checklists will assist the Inspector undertaking the inspection providing guidance where a problem is identified as well as assist Process Controllers to prepare for an inspection at their WWTW and take corrective action where problems are identified.

Report No: TT375/08  
ISBN: 978 1 77005 795 1  
Overseas price:\$40-00 (excl postage)

**Community-based governance of freshwater resources in Southern Africa**  
**S Pollard, T Cousins**

One result of the process of democratisation is legal pluralism in areas of communal tenure, in that the traditional locally-derived rules and norms for natural resource management run in parallel to statutory systems. In addition, South Africa is about to implement reforms in the statutory systems aimed at bringing about equity and sustainability. Within this complex social system, this project aimed to examine governance options for community based natural resource management in communal areas.

This project contributed to the growing discourse on legal pluralism in water management through examining local or customary, laws in practice, focusing on water resource management. The research reviewed the status of community governance of water resources in four SADC countries (South Africa, Mozambique, Zimbabwe and Zambia), and documented the complementarities and tensions between statutory and customary systems in these countries. One lesson from these countries is that where the implementation of national legislation is weak, people revert to the traditional governance structures.

The reality is that legal pluralism will be part of the South African Water governance landscape for some time to come, and internationally based research has warned that the 'neglect of customary laws may cause IWRM implementation to fail, or will have negative consequences for individuals and groups who were better served by customary-based systems – especially the poor'. The report concludes that we should not be constrained by a few idealized models of centrally managed water. Preferably let us seek innovative ways to integrate, or embed, common-property regimes with the formal, statutory system.

Report No: TT328/08

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Overseas price:\$20-00 (excl postage)

**Standard methods for the recovery and enumeration of helminth ova in wastewater, sludge, compost and urine-diversion waste in South Africa**

**Priya Moodley, Colleen Archer, David Hawksworth and Lizette Leibach**

These Guidelines detail a new classification system according to the microbiological class, stability class and pollutant class and total viable Helminth Ova have been added in the microbiology class. The Guidelines do not specify the analytical methods and as a result, different laboratories adopted different methods in South Africa. This project aims to validate a new EPA method for measuring Helminth Ova in wastewater and wastewater sludge. The method and related literature with sufficient visual material will be documented and used to build capacity in South African water and wastewater laboratories to measure all Helminth Ova in wastewater sludge and wastewater samples.

Report No: TT 322/08

ISBN: 978 1 77005 648 0

Overseas price:\$25-00 (excl postage)

**Condensed laboratory methods for monitoring phytoplankton, including cyanobacteria, in South African freshwaters**

**Swanepoel A; du Preez HH; Schoeman C; J van Vuuren S; Sundram A**

The project will compile a comprehensive methods manual for the analysis of phytoplankton, cyanobacterial toxins, Geosmin and MIB for South African freshwaters. Current methods used for phytoplankton identification and enumeration, cyanobacterial toxin analysis, as well as for Geosmin and MIB analysis will be synthesized and a summarized reference document compiled.

Report No: TT 323/07

ISBN: 978 1 77005 684 8

Overseas price:\$25-00 (excl postage)

**Aqualite Water Balance Software – User Guide**

**Roland Scott McKenzie**

The methodologies used in AquaLite draw strongly on recent recommendations of Task Forces of the International Water Association (IWA). It should be noted that the methodologies for quantifying water losses contained in the AquaLite model are not the only methods used worldwide. They are, however, well accepted and used extensively in many parts of the world and are rapidly being recognised as the most appropriate and pragmatic techniques for assessing the water balance components for potable water distribution systems. AquaLite also includes the calculation of the Unavoidable Annual Real Losses (UARL) as well as the use of the Infrastructure Leakage Index (ILI) as a key performance indicator. These two parameters are currently the subject of considerable attention and debate throughout the world and are being used in many countries. When used properly they can provide very useful information on the performance of a water distribution system but must be used with care to ensure that the results are meaningful since there are situations where the estimates can be misleading.

Report No: TT 315/07

ISBN: 978 1 77005 599 5

Overseas price:\$10-00 (excl postage)

**Water Services and HIV / AIDS; Integrating health and hygiene education in the water and sanitation sector in the context of HIV/AIDS**

**(PLEASE DOWNLOAD FROM WEB: [www.wrc.org.za](http://www.wrc.org.za))**

**Clacherty A; Potter A**

This Water Research Commission study (Project K5/1634) arose from a growing realisation that, in relation to water and sanitation infrastructure development projects, there is little consistency or coherence of approach to health and hygiene education (H&HE). As a result, many interventions are ineffectual. Further, the linkages between HIV/AIDS and the improvement of water and sanitation facilities and related H&HE are poorly addressed in this country. The response involved considerable research over a period of time. It has identified factors which constrain and enable effective implementation of project-based H&HE in the context of HIV/AIDS. Based on that research and understandings of the context, it has developed and tested various institutional and financial arrangements and developed implementation models based on this work. The study places considerable emphasis on the linkages between water and sanitation, health and hygiene education and HIV/AIDS. The impact of HIV/AIDS on the lives of many South Africans is severe; it is imperative that the water services sector formulates and implements an appropriate response as a matter of urgency. It is critical that issues around HIV/AIDS are mainstreamed, both in terms of prevention as well as in reducing the impact on people living with AIDS. Caregivers, in particular, require not only knowledge of water and sanitation and related health and hygiene issues, but also

access to adequate quantities of water of good quality.

Report No: TT 316/07

ISBN: 978 1 77005 602 2

Overseas price:\$20-00 (excl postage)

Report No: TT 317/07

ISBN: 978 1 77005 603 9

Overseas price:\$20-00 (excl postage)

### **The assessment of training programmes and capacity needs for the water sector: Executive summary**

**Mjoli N; Schoeman G**

The South African Government has committed itself to an ambitious target of eliminating the water and sanitation services backlog by 2008 and 2010, respectively. However, the current skills shortage at the local government level poses a threat to the achievement of the water and sanitation delivery targets. The slow rate of delivery is largely due to inadequate technical skills in most municipalities. The problem is particularly acute within rural municipalities which have the lowest resource base and, at the same time, have the highest sanitation backlog figures.

The shortage of skills is not limited to the water services sector; the water resources management sector faces a similar problem. There is a growing concern among sector stakeholders that the current approaches to skills development are not producing the numbers of skilled people that are needed to improve the performance of municipalities. This situation calls for a review of the current practices in skills development and training provided by public and private providers in order to identify factors that are hampering accelerated skills development, despite the availability of large budgets from the skills development fund.

Report No: TT 306/07

ISBN: 978 1 77005 554 4

Overseas price:\$10-00 (excl postage)

### **Standardisation of the use of particle counting for potable water treatment in SA**

**Ceronio AD; Haarhoff J; Pryor M**

Turbidity is a gross measure of the quality of potable water. Particle counting and size analysis is fundamental to a deeper understanding of flocculation, settling and filtration processes. The primary objective of water treatment is the removal of particles. This project investigated the use of particle size analysis as a control parameter for the optimisation of water quality, and compared this to the control using zeta potential and streaming current. It studied the effects of pretreatment processes such as ozonation and coagulation on the clarity of the filtered water by measuring particle size; and considered the use of particle size analysis together with CFD for the optimisation of water treatment equipment. The report stresses the importance of standardisation of this technology and also includes a substantial amount of

fundamental principles and practices useful to potential users considering the implementation of this technology.

Report No: TT 166/01

ISBN: 1 86845 801 6

Overseas price:\$20-00 (excl postage)

### **An illustrated guide to basic water purification operations**

**Bouwer JL; Haylett**

Lack of skills because of lack of training was identified as one of the most important hindrances to the supply of good quality potable water, especially in rural areas. Suitable training material is not available and current training material is inadequately targeted for rural operator training. A cartoon based operator manual for sewage plant operator training had previously been completed and proved to be a big success. Therefore, it was seen as appropriate to complete a similar guide for operator training on, especially, small to medium sized water treatment plants

Report No: TT 247/05

ISBN: 1 77005 323 9

Overseas price:\$30-00 (excl postage)

### **Corporatisation of municipal services providers Development group; University of Western Cape**

The restructuring of municipal water departments into stand-alone companies has been a long-standing subject of debate within the industry. This study aimed to further explore the concepts of corporatisation and its relevance to the South African water sector by, combining an international literature review with local case studies and policy reviews. The research concludes that corporatisation in itself does not guarantee performance. Whilst a shift in legal form from a municipal department to a stand-alone legal entity can make a difference, this is not the only or major determinant of performance. Various objective factors and broader governance factors are likely to have a greater impact than simply the legal form of the utility. Further corporatisation may be a suitable option for some municipalities. For capacity reasons corporatisation is only likely to be feasible within the large metro poles at this stage. As the experience base grows within South Africa, and transaction costs diminish, corporatisation may become feasible for smaller local authorities. This study highlights that before embarking on a corporatisation process municipalities should assess whether they have sufficient financial, managerial and political capacity to see the process through.

Report No: TT 199/02

ISBN: 1 86845 897 0

Overseas price:\$25-00 (excl postage)

**Management of water-related microbial diseases  
DWAF; WRC**

The purpose of this guideline series is to provide awareness building and management information on the nature and prevention of important water-related microbial diseases. The purpose of volume one in the series, "Disease characteristics", is to introduce and describe the basic facts of some important water-related diseases. This guide is primarily an awareness building guide to educate the upcoming generation in the need for: (1) disinfected drinking water, (2) safe waste disposal, (3) good personal and kitchen hygiene, and (4) protection of water resources from faecal pollution.

Report No: TT 175/03  
ISBN: 1 86845 849 0  
Overseas price:\$25-00 (excl postage)

**Guidelines for the appropriate management of urban runoff  
in SA**

**Ashton PJ; Bhagwan JN**

As the aim of this study was to establish general guidelines for the management of urban runoff water quality, especially focusing on dense settlements, urban runoff quality is a country-wide problem, the causes of which must be addressed. Past attempts to intercept urban storm water and channel it through a single storm water system to receiving water have failed. As storm water quality may be worse than treated sewage effluent and sometimes even raw sewage, treatment of storm water at some stage before discharge to the receiving waters has to be considered. Present engineering storm water management options do not cater for improving storm water quality. The impact of low-cost, high-density urban land use on the catchment warrants serious attention. Appropriate sanitation and waste disposal for peri-urban areas requires fundamentally new approaches. It is imperative therefore that applied research into these areas be conducted for the protection of South Africa's limited water resources.

Report No: TT 155/01  
ISBN: 1 86845 764 8  
Overseas price:\$15-00 (excl postage)

**Expert system for design of storm water management  
systems for urban runoff quality**

**Coleman TJ**

Report No: TT 156/01  
ISBN: 1 86845 768 0  
Overseas price:\$15-00 (excl postage)

**PRESMAC: Development of a pragmatic approach to  
evaluate the potential savings from pressure management  
in potable water distribution systems in South Africa.  
(Presmac User Guide Version 1.1)**

**McKenzie R; Lambert A**

This document incorporates the user guide to the South African Pressure Management and Control (PRESMAC) model which has been developed through the Water Research Commission (WRC) funded project titled "The Water Leakage: Pressure Management Model".

The PRESMAC model represents one of several models that are being developed through the WRC in order to assist water suppliers to manage and reduce their levels of unaccounted-for water. The models are supplied free-of-charge through the WRC for use within South Africa and further details can be obtained from the WRC web site on: <http://www.wrc.org.za>.

Report No: TT 152/01  
ISBN: 1 86845 722 2  
Overseas price:\$20-00 (excl postage)

**Financial planning for infrastructure services at district  
level: A user guide to the district services model. Version 1.1**

**Palmer Development Group**

This manual outlines the philosophy behind the model, its aims, limitations and key assumptions. The structure and operation of the model is described in detail, covering the required data inputs and the meaning and presentation of the various outputs.

The District Services Model (DSM) has been designed to assist district municipalities to undertake financial analysis of infrastructure investment plans. The model performs this analysis at two levels:

Level 1: District-wide infrastructure planning, and  
Level 2: Medium-term Council budgeting.

Report No: TT 143/01  
ISBN: 1 86845 680 3  
Overseas price:\$15-00 (excl postage)

**A guide to non-point source assessment to support water  
quality management quality of surface water resources in SA**

**Pegram GC; Gorgens AHM**

The primary focus of this guide is to support water quality management of surface water resources, and particularly non-point sources management, through the provision of appropriate and cost-effective information for decision-making.

Report No: TT 142/01  
ISBN: 1 86845 677 3  
Overseas price:\$20-00 (excl postage)

**The Development of Effective Community Water Supply Systems using deep and Shallow Well Hand pumps.**  
**Hazelton DG**

Deep- and shallow-well hand pumps are used extensively for rural community water supplies over large parts of South Africa. Very often, however, these installations fail to meet the requirements even though they are considered to be one of the simplest community water supply technologies. It has, however, been demonstrated in other parts of the world that high failure rates are not inevitable and that these schemes can be transformed into reliable low-cost solutions through the adoption of the so-called village level operation and maintenance (VLOM)-concept, where appropriate design technologies and implementation policies are systematically included. The study indicated that 10% of the South African populations (2 million people) are dependent on the estimated 10 000 hand pumps which exist in this country. This can be equated to an investment of about R400 million, and the study estimates that between 40% and 50% of the hand pumps are not working at any one time.

Report No: TT 132/00  
ISBN: 1 86845 629 3  
Overseas price:\$25-00 (excl postage)

**Applicability of waste minimisation clubs in South Africa: Results from pilot studies**  
**Barclay S; Buckley C**

Industrial small-, medium- and micro-enterprises (ISMMEs) are a strategic growth sector in the RSA but cumulatively are significant sources of pollutants which detrimentally affect sewage treatment. The overall objective of the project was the development of regional waste minimization clubs, in which cleaner production practices can be cost-effectively established as a contribution to the sustainability in South Africa of ISSMEs that are both competitive and environmentally responsible.

Report No: TT 161/05  
ISBN: 1 86845 831 8  
Overseas price: \$30-00 (excl postage)

**Guidelines for the utilisation and disposal of wastewater sludge: Volume 1 of 5: Selection of management options**  
**Snyman HG; Herselman JE; Kasselmann G; Steyn CE; Wilken JW**

This work implements the major recommendation arising from the comprehensive multi-stakeholder WISA Sludge Management Group in the consultative process coordinated by the WRC to review and update the current published sludge management guidelines.

Report No: TT 261/05  
ISBN: 1 77005 422 7  
Overseas price: \$20-00 (excl postage)

**Guidelines for the utilisation and disposal of wastewater sludge: Volume 2 of 5: Requirements for the agricultural use of wastewater sludge**

**Snyman HG; Herselman JE; Kasselmann G; Steyn CE; Wilken JW**

Report No: TT 262/05  
ISBN: 1 77005 423 5  
Overseas price: \$20-00 (excl postage)

**Water purification works design (SA Price R150-00)**  
**Van Duuren FA**

This project was aimed at facilitating the optimal, most economical water purification and treatment works by providing a design guide based on water quality considerations, processes and operations. This guide indicates water quality requirements, control and management of procedures, and water demands in all sectors. It also categorises water purification and treatment processes and operations

Report No: TT 92/97  
ISBN: 1 86845 345 6  
Overseas price : \$50 00 (excl postage)

**Information transfer extraction management systems (ITEMS) (SA Price R114-00)**  
**Howard MR; Perkins M**

This project developed a computerised Information Transfer, Extraction and Management System (ITEMS) which enables users to gain access to local and international information on mine-water quality, management, treatment and research. The six modules incorporated in ITEMS, viz. literature, water quality guidelines, contaminant properties, research results, an impact assessment manual and a mine-water management manual, and the options available in each of the modules, renders ITEMS an extremely versatile information tool. The total computer file size of the databases is 87 Mbytes. ITEMS is available on CD-ROM

Report No: TT 94/98  
ISBN: 1 86845 378 2  
Overseas price : \$70 00 (excl postage)

**Solids-free sewer systems in South Africa: a community leader's guide**  
**Du Pisani JE**

This study evaluated the STED systems in South Africa. It showed that STED systems were used on over 16 000 erven in South Africa. The study showed that problems experienced with these systems were mainly due to poor operation and maintenance and some incidents of blockages were due to incorrect design and construction of the STED systems. The study concludes that with proper design, operation and maintenance, STED systems offer a cheaper alternative of

meeting the sanitation needs of. The output of this research includes two guidelines, namely Operation and Maintenance of Solids-free Sewer Systems in South Africa: Guidelines for Engineers; and Solids-free Sewer Systems in South Africa: A Community Leader's Guide

Report No: TT 96/98  
ISBN: 1 86845 401 0  
Overseas price : \$20 00 (excl postage)

**Handbook to guide communities in the choice of sanitation systems**  
**Bernhardt Dunstan & Associates**

The main aim of this study was to evaluate on-site sanitation systems from a socio-economic perspective with special reference to affordability, appropriateness and social acceptability. The study was undertaken in three case study areas, namely, Soshanguve TT, Ivory Park and Ga-Mmotla. The study concluded that in all three case study areas, communities were dissatisfied with their on-site sanitation systems. Women were unhappy about being excluded from decision-making on the selection of sanitation technologies, because as the main users, they are better qualified to select a sanitation system that could be operated and maintained by the users.

Report No: TT 104/98  
ISBN: 1 86845 425 8  
Overseas price : \$10 00 (excl postage)

**Guidelines for the design and operation of sewage sludge drying beds**  
**Ceronio AD; Van Vuuren LRJ; Warner APC**

Current information and guidelines for the design and operation of sewage sludge drying beds in the RSA are very limited. The design data available are largely empirical and give almost no insight into the effect of climate, sludge concentration, loading rates, sludge volume index, filter media, etc. on the drying bed area required. Based on the research and support of experimental work done, as well as information obtained from literature, the study produced a guideline that is specific for South African conditions called Guidelines for the Design and Operation of Sewage Sludge Drying Beds (WRC Report No TT 107/99)

Report No: TT 107/99  
ISBN: 1 86845 491 6  
Overseas price : \$25 00 (excl postage)

**Guidelines for the calibration of measuring flumes in sewers**  
**Rooseboom A; Goodey GM**

During 1992 a detailed investigation revealed that the majority of open channel flumes on South African sewer mains and at municipal wastewater treatment plants, do not comply with

the generally accepted British Standards 3680. In this project tests were performed on different flumes in order to establish the impact of differences in shape and surface roughness on calibration coefficients. These guidelines are the product of a large number of practical tests, combined with existing standards for the measuring of fluids by flumes. The result is a set of methodologies and worked examples, which clarifies and simplifies measuring flume design to the point where plant personnel in the smaller plants will also be able to follow and utilise the guidelines to the full.

Report No: TT 111/99  
ISBN: 1 86845 501 7  
Overseas price: \$25-00 (excl postage)

**Corrosion brochure for local authorities**  
**Ramothhola JS; Ringas C**

The brochure highlights cost-effective ways in which external corrosion can be minimised. The brochure can also be useful to repair teams working in the field. The brochure contains colour photographs showing the different forms of corrosion in order to assist field teams to correctly identify the cause of the failure. Appropriate repairs can then be carried out. The brochure also describes how each local authority can build up its own database, thereby assisting in the long-term strategy of each local authority by ensuring that correct corrosion prevention strategies are used.

Report No: TT 112/99  
ISBN: 1 86845 510 6  
Overseas price: \$15-00 (excl postage)

**Domestic Water Supply: Guides**

The provision of an adequate and safe water supply to all people is one of the goals of the South African Government. To ensure the safety of water supplies, a need for a user-friendly Guide to facilitate evaluation of the health-related quality of water supplies was identified as a priority by both the Departments of Health and Water Affairs and Forestry. This resulted in the production of a series of guides.

This Guide forms part of a series which is intended to provide water supply agencies, water resource managers, workers in health-related fields, as well as communities throughout South Africa, with the information they need to sample, analyse, assess and interpret the quality of domestic water supplies. The following documents from the series:

**Quality of domestic water supplies**  
**Vol: I: Assessment Guide TT 101/98**

Report No: TT 101/98  
ISBN: 1 86845 416 9  
Overseas price: \$25-00 (excl postage)

**Quality of domestic water supplies –  
Vol II: Sampling Guide1 TT 117/99**

Report No: TT 117/99  
ISBN: 1 86845 543 2  
Overseas price: \$15-00 (excl postage)

**Quality of domestic water supplies –  
Vol III: Analysis Guide1 TT 129/00**

Report No: TT 129/99  
ISBN: 1 86845 620 X  
Overseas price: \$20-00 (excl postage)

**Quality of domestic water supplies –  
Vol 4: Treatment guide TT 181/02**

Report No: TT 181/99  
ISBN: 1 86845 873 3  
Overseas price: \$30-00 (excl postage)

**Quality of domestic water supplies –  
Volume 5: Management Guide TT 162/01**

Report No: TT 162/99  
ISBN: 1 86845 809 1  
Overseas price: \$30-00 (excl postage)

**The management of urban impoundments in South Africa  
volume 2: Guideline manual  
Freeman MJ; Howard MR; Wiechers HNS**

This Urban Impoundment Management Guideline Manual is the product of a research project carried out for the Water Research Commission to investigate the water- quality problems most commonly experienced in South African urban impoundments, as well as the management techniques which can be used to address them.

The purpose of the Guideline Manual is to assist those responsible for, or with an interest in, the management of the water quality of urban impoundments. It is thus aimed predominantly at those persons in local authorities who must manage the water bodies in their areas.

Report No: TT 119/00  
ISBN: 1 86845 553 X  
Overseas price: \$25-00 (excl postage)

**The economic cost effects of salinity – integrated report  
Urban-Econ Development Economists**

As the salt content of water increases, the water becomes less suitable for most users, and additional costs are incurred. The study was undertaken because of uncertainties about some of the methodology and assumptions that were used in the desk study and the need for a versatile economic model that can be

used to quantify the effect of salinity in monetary terms and to compare the cost-benefit ratios of alternative options. A generic methodology to determine the financial, economic and social impacts associated with an increase in salt concentration were first developed, and then applied by conducting a survey to determine the impacts of increased salt concentrations in the middle Vaal River.

Report No: TT 123/00  
ISBN: 1 86845 590 4  
Overseas price: \$20-00 (excl postage)

**Defluoridation, denitrification and desalination of water  
using ion – exchange and reverse osmosis  
Schoeman JJ; Steyn A**

This project concentrated on demonstrating the feasibility of using advanced adsorption, ion-exchange and membrane technologies to remove fluorides, nitrates and dissolved suspended solids from groundwater in order to produce potable water for rural communities which are remote from first-world infrastructure. Activated alumina, ion-exchange and reverse-osmosis systems were evaluated at a number of rural sites in terms of both technical and social acceptance factors. The results achieved in these demonstration studies show that activated alumina and ion-exchange processes and advanced water treatment processes such as membrane filtration can be employed successfully for the purification of adverse-quality groundwater to potable standards in the rural areas.

Report No: TT 124/00  
ISBN: 1 86845 597 1  
Overseas price: \$20-00 (excl postage)

**Land-based effluent disposal and use: Development  
guidelines and expert systems-based decision support  
Murphy K O'H**

Effluents and soils were identified as factors which help in the process of making decisions on the applicability of a specific effluent on a specific land. The identification of the effluent takes into account health-related aspects, the risk of pollution to the water source and the effects of it on plants. The identification of the soil relates to the ability of soils to attenuate the contaminants in the effluents.

The user guide takes one through the process in order to be able to determine whether the combination is acceptable or not and whether it conforms to health guidelines. If this is acceptable, it is indicative of restrictions or protective measures. ELADS Effluents to land - application decision-support software is the expert systems-based decision-support software developed. It could be used not only for sewage effluents, but also for organic effluents, to some extent for nitrogenous effluents and effluents containing potentially toxic trace elements. It could be modified to accommodate any site, soil

or effluent-related limits specified by new regulations. (WRC Report No TT 125/00).

Report No: TT 125/00  
ISBN: 1 86845 551 3  
Overseas price: \$20-00 (excl postage)

**The level of communication between communities and engineers in the provision of engineering services**  
**Pybus P; Schoeman G; Hart T**

The purpose of this research was to test the hypothesis above and to establish how engineering information, for example, concerning the level of service, can best be given so that the community leaders can make a decision based on sound knowledge of the technicalities of the situation. In an analysis of the major factors that negatively affect communication between consultants (specifically engineering) and communities, it was found that the majority of factors stemmed from a lack of integrated and comprehensive project planning. The findings from this study are supported by an excellent set of guidelines, aimed at improving communication processes between practitioners and communities in water and sanitation development projects

Report No: TT 133/00  
ISBN: 1 86845 630 7  
Overseas price: \$20-00 (excl postage)

**Waste minimisation guide for the textile industry: A step towards cleaner production: Vol I**  
**Barclay S; Buckley C**

The Waste Minimisation Guide for the Textile Industry has been found to be a useful tool for assisting the RSA textile industry to improve its environmental performance in the following areas of application:

- The textile industry can use the Guide to self-assess and improve its implementation of waste minimisation practices and, hence, its aquatic environmental performance
- Similarly, use of the Guide will assist factories in achieving compliance with environmental management standards e.g. 150 14000, and, thereby, improving their international competitiveness
- Local regulatory authorities can use the Guide both as a training tool and as a management tool for monitoring and assessing the performance of textile manufacturers in their area of jurisdiction.

Report No: TT 139/00  
ISBN: 1 86845 659 5  
Overseas price: \$20-00 (excl postage)

**Waste minimisation guide for the textile industry: A step towards cleaner production. Vol II**

Report No: TT 140/00  
ISBN: 1 86845 659 5  
Overseas price: \$20-00 (excl postage)

**Human resources planning and management system (HRPMS) user manual**  
**Stewart Scott**

The study has developed a management tool to help managers to implement integrated human-resource planning of water service institutions. The report focuses on the human resources that are required in order to support the infrastructure, as well as the organisational structure requirements of various sizes of water service institutions. The computerised human resources planning and management system (HRPMS), which was developed for water service institutions through this study, includes facets of both a management information system (MIS) as well as a decision support system (DSS). The management component of the HRPMS includes portions of the job analysis and employee profile modules. The reporting facilities provided by the HRPMS facilitate management, planning and decision-making.

Report No: TT 146/01  
ISBN: 1 86845 686 2  
Overseas price: \$15-00 (excl postage)

**Assessment of the attended coupon-operated access-point cost recovery system for community water supply schemes**  
**Lima Rural Development Foundation**

The study highlights parameters in which attended coupon operated access point cost recovery system operates efficiently by analyzing seven existing schemes. The research to identify the operational constraints that community water supply schemes are currently facing by conducting sample surveys in the schemes.

Report No: TT 150/01  
ISBN: 1 86845 716 8  
Overseas Price: \$15-00 (excl postage)

**Development of a simple and pragmatic approach to benchmark real losses in potable water distribution systems in South Africa: BENCHLEAK**  
**Ronnie McKenzie & Allan Lambert**

The BENCHLEAK software and this User Manual are part of the ongoing process of refining and improving the methodologies for calculating and presenting performance data associated with management of public water supply systems in South Africa.

Report No: TT 159/01  
ISBN: 1 86845 773 7  
Overseas Price: \$20-00 (excl postage)

**The BENCHLEAK software is available from the Water Research Commission and further details can be obtained from the web site at: <http://www.wrc.org.za>**

Development of a Windows based package for assessing appropriate levels of active leakage control in potable water distribution systems: ECONOLEAK

**Ronnie McKenzie**

The ECONOLEAK model is aimed specifically at determining when a water supplier should invest in active leakage control for a specific zone metered area.

Report No: TT 169/02  
ISBN: 1 86845 832 6  
Overseas Price: \$20-00 (excl postage)

**The ECONOLEAK software is available from the Water Research Commission and further details can be obtained from the web site at: <http://www.wrc.org.za>**

Guidelines for the implementation of benchmarking practices in the provision of water services in South Africa

**Pybus P**

The guidelines are intended to encourage the local authorities to benchmark their activities with their peers with a view to delivering water and sanitation services in a more effective and efficient manner.

Benchmarking offers a route to more effective and efficient service delivery.

Report No: TT 168/02  
ISBN: 1 86845 842 3  
Overseas price: \$20-00 (excl postage)

**Environmentally responsible mining: Water management guidelines for small-scale mining**  
**Clacherty A; Moodie P**

This report identifies and characterises the critical water-related impacts of small-scale mining and is developing appropriate tools to assist their environmental management. The study focused primarily on the water-related issues of peat extraction, clay-mining for brick making, alluvial diamond-mining and other small-scale mining activities associated with gravels, alluvial sands and sediments.

Report No: TT 170/04  
ISBN: 1 86845 833 4  
Overseas price: \$20-00 (excl postage)

**Guidelines for the application of natural stone trickling filters with some reference to synthetic media trickling filters**

**Wates, Meiring & Barnard (Pty) Ltd**

Trickling filters are applied in many domestic and industrial wastewater treatment plants in Southern Africa. Trickling filtration technology is still evolving and this document provides current information on the design, operation and maintenance of filters.

Report No: TT 178/02  
ISBN: 1 86845 852 0  
Overseas price: \$15-00 (excl postage)

**Water and wastewater management in the oil refining and re-refining industry: NATSURV 15**  
**CSIR**

In this study the water intake, water use and pollutant loads of the crude oil refinery, synthetic fuel refinery and refining sectors of the industry were surveyed and characterised. Crude oil refineries in the RSA were found to have a relatively narrow range of specific water intake (SWI 0.51 to 0.67 m<sup>3</sup>/t) and re-refining SWIs were found to vary widely (0.06 to 7.2 m<sup>3</sup>/t), depending on the type of process used. The results obtained present a snapshot of the water and wastewater characteristics of the industry in which crude oil refining (at four refineries) is around 20 million t/a, syn-fuel refining (at two refineries) is around 9 million t/a and oil re-refining is around 120 000 t/a. In addition to the water and effluent survey data, the Guide produced contains a number of specific recommendations for reducing water use and effluent generation in the industry.

Report No: TT 180/05  
ISBN: 1 86845 508 4  
Overseas Price: \$15-00 (excl postage)

**Elementary handbook of water disinfection**  
**Carlsson FHH**

The salient features of the handbook covers:

- Description of water disinfection processes, principally chlorination and chloramination but including ozonation, peroxone, chlorine dioxide and ultraviolet treatments
- Written such that it is understandable by non-specialists in water treatment plants and informed lay-persons
- To be used as an aid in effective education and training of plant personnel while avoiding detailed chemistry
- To be used as a ready reference for daily use on water purification plants where disinfection is implemented.

Report No: TT 205/03  
ISBN: 1 86845 983 7  
Overseas price: \$20-00 (excl postage)

**Watrex expert system for water treatment plant design:  
(South African price: R500-00)  
FR Sutherland**

This is a Windows-based software package that applies expert system technologies to water treatment plant design. The software allows data acquisition, unit process design and modeling, process selection, and dynamically responding plant design, modeling and sensitivity analyses.

Report No: TT 206/03  
ISBN: 1 77005 016 7  
Overseas price:\$200-00 (Postage inclusive)

**An assessment of the trickle feed system as a tool  
for implementing the free basic water policy  
Lenehan AM; Abelitis L**

This study investigated the cost-recovery efficiency of the trickle feed system. In this system a known quantity of water is delivered each day to a storage tank at each customer's house. This allows the implementation of a monthly prepaid cost-recovery system with relatively low administration. There are potential benefits of implementing the trickle feed system in rural areas and it is currently implemented in pilot projects in Northern KwaZulu-Natal.

Report No: TT 210/03  
ISBN: 1 77005 031 0  
Overseas price:\$10-00 (excl postage)

**The measurement and reduction of urban litter entering  
storm water drainage systems  
Marais M Armitage N**

This project addresses the following aims:

- The improvement in the knowledge of the source type and amount of urban litter coming from different types of urban catchments; and
- Provision of scientific data on the efficacy of various management techniques in reducing the amount of urban litter reaching drainage systems. This information, together with the knowledge, would enable the development of Litter Management Plans (LMPs) resulting in reduced litter loadings and realizing considerable cost savings.

Report No: TT 211/03  
ISBN: 1 77005 041 8  
Overseas price:\$30-00 (excl postage)

**A guidebook on household water supply for rural areas with  
saline groundwater  
Goldie I; Sanderson RD**

This report captures and presents options of small-scale water purification technologies for potable water supply to farms,

schools, clinics and small communities from brackish surface water sources. The report produced in the form of a guide will assist decision makers in the selection of these technologies. Both membrane-and distillation-based technologies have been assessed, mostly in terms of a desk study. Recently developed local innovations are also included into this guide.

Report No: TT 221/04  
ISBN: 1 77005 107 4  
Overseas price:\$30-00 (excl postage)

**Feasibility of water fluoridation for South Africa  
Genthe B; Herold CE Haarhoff J; Hosking S; Syke G**

A team, consisting of five experts in their fields, was requested to perform a desk study to identify both the positive and negative consequences which could be expected to arise following the fluoridation of potable water supplies in South Africa. Results from the study for the first time summarize and bring together a whole spectrum of aspects to take into consideration when potable water supplies are fluoridated. The results show that further actions, including further research, are required before fluoridation can be effected with full safety and confidence in a developing country such as South Africa.

Report No: TT 222/04  
ISBN: 1 177005 108 2  
Overseas price:\$25-00 (excl postage)

**A summary of lessons and experiences from the Ethekwini  
pilot shallow sewer study  
Patti Eslick; John Harrison**

Sanitation, because of the major impact it has on health and quality of life, is a service with a high priority. Findings from a previous WRC study indicated that shallow sewer systems provide a viable intermediate sanitation alternative, with a total cost between Ventilated Improved Pit latrines (VIPs) and conventional sewerage. With this as a stimulus, the Durban Metro Water was the first local authority to indicate interest in taking the recommendations further. This study captures the lessons and experiences from the pilot implementation of the shallow sewers.

Report No: TT 225/04  
ISBN: 1 77005 135 X  
Overseas price:\$20-00 (excl postage)

**An introduction to the concepts of customer  
relations management for water services institutions  
Naidoo J; Mosdell T**

The fact that the concept of customer service has received little attention in South Africa is perhaps related to the historic situation where water supply and sanitation services were provided on a monopolistic take it or leave it basis, particularly

in the case of poorer customers. It is now recognized increasingly that successful water services provision is strongly associated with the application of good business principles. This implies a service orientation, with a primary focus on the customer. This report provides an overview of customer management, principles and methodology.

Report No: TT 227/04

ISBN: 1 77005 147 3

Overseas price:\$20-00 (excl postage)

#### **Community identified performance indicators for measuring water services**

**Schoeman G; Magongoa**

This work implements the major recommendation arising from the comprehensive multi-stakeholder WISA Sludge Management Group in the consultative process coordinated by the WRC to review and update the current published sludge management guidelines.

Report No: TT 228/04

ISBN: 1 77005 158 9

Overseas Price: \$15-00 (excl postage)

#### **Guidelines for economic regulation of water services in South Africa**

**Palmer Development group**

For the regulation of water services to become effective in South Africa, considerable work needs to be undertaken. In particular the methodology to be used in undertaking economic regulation is one of the key components. This report has investigated the subject of economic regulation and its relevance to South Africa and has defined the manner in which water services authorities should regulate water services providers, within the current legislative framework. It highlights the importance of the methodology for economic regulation and in particular regulating tariffs and associated financial parameters. This report is aimed to stimulate discussion on the subject matter, towards effective economic regulation.

Report No: TT 229/04

ISBN: 1 77005 164 3

Overseas price:\$20-00 (excl postage)

#### **Guidelines on reduction of the impact of water infiltration into sewers**

**Stephenson D; Barta B**

The effects of urban developments on storm water quality and quantity as well as groundwater infiltration into the sewer facilities cannot be left anymore to ad hoc solutions and there is an urgency for a strategic approach to these problems. This report based on identifying and quantifying the problem of ingress, provides the necessary strategy and answers to these problems.

Report No: TT 239/05

ISBN: 1 77005 264 X

Overseas Price: \$20-00 (excl postage)

#### **Benchmarking of leakage from water reticulation systems in South Africa**

**McKenzie RS; Seago C**

In the attempt to get a better handle on the level of leakage at a municipal and national level, this study was undertaken in order to assess the levels of leakage in various water utilities throughout South Africa. The standard water auditing model BENCHLEAK, previously developed through a WRC study was used for the analyses since it is relatively simple to use and follows the standard IWA and BABE leakage benchmarking methodology. Benchleak introduces the concept of Infrastructure Leakage Index (ILI) as a standard method for the purpose of leakage evaluation, as it has been found to be the most reliable and meaningful indicator.

Report No: TT 244/05

ISBN: 1 77005 282 8

Overseas Price: \$25-00 (excl postage)

#### **Water and waste-water management in the power generating industry (NATSURV 16)**

**Van Zyl HD; Premiall K**

The power-generating industry in the RSA is a substantial water user and effluent producer and impacts nationally both on water use allocations and the maintenance of resource water quality. The report provides the volumes and breakdown of water taken in and discharged by major and minor power generating plants, to determine pollutant loads and identify suitable wastewater management processes and strategies, and to a guideline document assisting both the industry and regulators in effective water and wastewater management of this sector.

Report No: TT 240/05

ISBN: 1 77005 270 4

Overseas Price: \$15-00 (excl postage)

#### **Ecological sanitation – Literature review**

**Austin LM; Duncker LC; Marsebe; Phasha MC; Cloete TE**

Urine-diversion sanitation systems have been successfully implemented in many countries; including South Africa where about 3 000 of these toilets are already in existence. However, despite much research having been carried out internationally and locally, various questions still remain, particularly on the health aspects of operation, maintenance, and excreta reuse or disposal. This report captures the state of knowledge on urine diversion toilets.

Report No: TT 246/05

ISBN: 1 77005 322 0

Overseas price: \$25-00 (excl postage)

**Guidelines for ensuring sustainable effective disinfection in small water supply systems**  
**Momba MNB; Brouckaert BM**

This is a follow-up to a previous project that evaluated a combined chlorine-monochloramine disinfection process for the inhibition of bacterial and bio film re growth in a laboratory-scale system. The emphasis is based on the maintenance of an effective residual disinfectant throughout the water system. This report provides strategies which will ensure sustainable effective disinfection in small municipal water distribution systems.

Report No: TT 249/05

ISBN: 1 77005 321 2

Overseas price: \$30-00 (excl postage)

**Water poverty mapping: Development and introduction using a case study at the local municipal scale for the Eastern Cape**  
**Cullis J**

This report demonstrates the feasibility of using water poverty mapping to define and study the nature of water poverty in South Africa as well as the basis for a clear decision tool for the allocation of scarce resources to development initiatives that will be most effective and as a way of measuring the impact of these initiatives.

Report No: TT 250/05

ISBN: 1 77005 337 9

Overseas price: \$20-00 (excl postage)

**Handbook for waterworks operation**  
**Christiaan Frederick Schutte (Editor)**

There are a number of different books and instruction guides (mostly sourced from abroad and excessively priced in South African terms) available to assist with training of water treatment works operators, but a survey of these showed that none of the existing books is suitable to be used as a basis book for reference and for training. This report is an excellent reference book for training of water plant operators, as well as for the operation of water treatment works.

Report No: TT 265/06

ISBN: 1 77005 428 6

Overseas price: \$25-00 (excl postage)

**The development of a successful unaccounted-for water management programme in the rural water supply context**  
**Ross-Jordan J**

The challenge to develop simple and effective systems that are easily understood by water committees has resulted in this report which can be used by the community as well as their

local authority to manage water losses in distribution systems.

Report No: TT 256/06

ISBN: 1 77005 392 1

Overseas price: \$20-00 (excl postage)

**The use of key performance indicators in the benchmarking of rural water supply schemes: An aid to development of meaningful local government capacity**  
**Still D; Balfour F**

New local authorities have limited knowledge on the nature of inspection needed to promote good management at community level. Therefore, the challenge was to develop simple and effective systems that are easily understood by water committees. These can be used to report to the community as well as to their local authority. This report provides a set of key performance indicators (KPIs) which have been tested on a number of RDP projects that are presently being transferred from Umgeni Water to relevant district councils in KwaZulu-Natal.

Report No: TT 255/06

ISBN: 1 77005 391 3

Overseas price: \$25-00 (excl postage)

**The WRC community based health and hygiene model and implementation kit**  
**Bolu O; Maliti N**

This research seeks to support the acceleration of sanitation service delivery without improving developmental principles such as demonstration of ownership and community based participation. The study will investigate methods of improving communities so that they can earn an income which will enable them to make a partial contribution to the costs of building toilets. The study will be undertaken in selected villages in the Eastern Cape.

Report No: TT 264/06

ISBN: 1 77005 427 8

Overseas price: \$20-00 (excl postage)

**A strategic framework for water-related human health research**  
**Venter SN; Mjoli NP**

The report is a compilation of a framework and strategy plan to guide the future funding of priority research on the improvement of water related human health in Southern Africa. The plan had to include health related aspects of all human-water interactions. The plan further identifies research gaps for future, local, research on water related human health and a list of institutions and researchers active in health research, both nationally and internationally.

Report No: TT 257/06  
ISBN: 1 77005 404 9  
Overseas price: \$20-00 (excl postage)

### **1. Waste Minimisation Clubs in SA (Facilitator's Manual)**

### **2. Waste Minimisation Clubs in SA (Training Manual)**

**Barclay S; Buckley C**

Previous WRC Project No. 973 detailed the feasibility of waste minimisation (WasteMin) clubs as a model for achieving significant improvements in environmental performance by local industry. The aim of this follow-up project No. 1171 was to develop a methodology for promoting, managing and sustaining waste minimisation clubs, by producing inter alia guides for effectively establishing and managing WasteMin clubs, specific sectoral self-assessment guides, and training material for WasteMin consultants in a franchised operation. The project's two technology transfer products are a Facilitator's Manual and a Training Manual. The Facilitator's Manual is aimed at a person or organisation that wishes to initiate a waste minimisation club and requires guidelines for undertaking such a project. It addresses aspects such as how to form a club, call meetings, determine the level of contributions from companies, identify some of the problems that can occur, and explains the various roles of the people involved. It also provides sample letters and presentations, and provides sources of information. The Facilitator's Manual draws on the experiences gained in the previous WRC project no. 973 and also that gained from facilitators of other waste minimisation clubs in South Africa, facilitated by various organisations such as consultants, University researchers and, in at least one case, by the company itself as an in-house club.

Report No: TT 283/07  
ISBN: 978 1 77005 493 6  
Overseas price: \$30-00 (excl postage)

Report No: TT 284/07  
ISBN: 978 1 77005 494 3  
Overseas price: \$20-00 (excl postage)

### **Life cycle costing analyses for pipeline design and supporting software**

**van Vuuren SJ; van Dijk M**

There are various factors that influence the hydraulic capacity and pipeline designers need to take all of these into consideration during the design. For instance the estimation of roughness parameter for a pipeline has a significant effect on the hydraulic capacity and operational costs. An underestimation of this parameter can be catastrophic when the required demand cannot be met. Findings identified that the two main contributing factors of energy losses are:

- Inherent resistance against flow exerted by the fluid (i.e. viscosity) and
- The friction losses resulting from the interface between

the fluid and the conduit boundary (i.e. shear), as well as secondary losses resulting from abrupt local changes in the system.

- The roughness parameters that are normally quoted by manufacturers tend to be low.

Report No: TT 278/07  
ISBN: 1 77005 449 9  
Overseas price: \$20-00 (excl postage)

### **A research strategy for the detection and management of algal toxins in water sources**

**Harding WR**

This analysis undertaken in support of the development of a cyanobacterial and cyanobacterial toxin research strategy in South African water sources has identified two vital planning elements, viz.

- The need to create a management and support infrastructure and
- The research aspects best suited to South African cyanobacterial research needs.

In addition, there is a clear indication that successes will be limited should collaboration with overseas specialists and organizations not be implemented. To South Africa's advantage is its current involvement in both the Global Water Research Coalition (GWRC) and CYANONET initiatives, plus willingness expressed by international specialists formerly associated with cyanobacterial work in South Africa to continue their association. Allied to this is the cosmopolitan nature of the cyanobacterial problems as experienced worldwide. This analysis was fortunate to have been commissioned during the year (2004) that saw the launch of the GWRC and CYANONET initiatives, as well as two key international conferences that allowed for the identification of globally-relevant research initiatives and emerging issues.

The strategy proposed here is based on comparing and contrasting the current directions and emerging issues in international cyanobacterial research with identified South African needs. From this analysis a suite of key research issues have been formulated.

Report No: TT 277/06  
ISBN: 1 77005 461 8  
Overseas price: \$20-00 (excl postage)

### **Guidelines for the design, operation and maintenance of urine-diversion sanitation systems**

**Austen LM**

If a dry toilet (i.e. not requiring water for its operation) is designed and constructed in such a way that the faeces vault can be quickly, easily and safely emptied, then one of the biggest maintenance problems will be obviated. If the processed excreta can also be productively and safely used for agriculture, the

technology will become even more attractive. In South Africa, where many rural communities rely on subsistence agriculture, often in poor soils, and with urban agriculture becoming more common, this is an important aspect. Urine-diversion sanitation systems address the above opportunities. They have been successfully implemented in many countries, including South Africa where more than 3 000 of these toilets are already in existence. However, despite much research having been carried out internationally and locally, various questions still remain, particularly on the health aspects of operation, maintenance, and excreta reuse or disposal. A need has thus been identified to create further competence in this area of sanitation in South Africa, and to increase knowledge concerning the technology. The technology is increasingly being introduced in a manner which consists of faulty design, poor implementation and improper use. This study developed strategies and guidelines, through monitoring and evaluating existing schemes, which would provide fundamental answers in the sustainable management of this technology.

Report No: TT 275/06

ISBN: 1 77005 456 1

Overseas price: \$15-00 (excl postage)

**A desalination guide for South African municipal engineers  
du Plessis JA; Burger AJ; Swartz CD; Musee N**

Municipalities have to develop Water Service Development Plans (WSDP's) as part of Integrated Development Plans (IDP's) as a first requirement in their budgetary process, and have to be aware of what options are available to provide adequate water services. While 25ℓ/person/day has been set as the minimum basic water supply and while many consumers receive far in excess of this amount, there are areas of the country where enough fresh water of acceptable quality is not available for household use. However, in many areas adequate quantities of saline water may be or are readily available. This is especially the case for coastal cities and towns. The cost of treating water is a fraction of the total cost of making water available to the consumer. This, together with the fact that membrane desalination technology is becoming more affordable, makes the overall water tariff less dependent on the cost of desalination. In other words, desalination may in many cases become a viable option to supply fresh water for domestic purposes. Therefore, DWAF identified a need to provide guidelines and procedures to select and evaluate suitable treatment options for desalinating sea water from both the Indian and Atlantic oceans, or brackish water from boreholes.

The specific objectives of the project were to identify the technologies which may currently be commercially implemented in South Africa to treat saline water to drinking water standards, to identify typical pre-treatment requirements, and to identify the most common technical, operating and environmental problems experienced in the selection and use of these technologies. An important aspect was also to provide estimates for capital and operating costs, as would be required

to successfully bring the water to the accepted standards for potable and domestic use. Of particular importance for the South African application was to identify the level of skills required for daily operation of the desalination plants, the level of skills required to provide technical back-up and advice, and to identify and advise on the competencies, training needs and capacity building required at operator and management levels. Lastly, the relevant local environmental legislations governing desalination were also identified.

Report No: TT 266/06

ISBN: 1 77005 431 6

Overseas price: \$30-00 (excl postage)

**Generic incident management framework for toxic blue-green algal blooms, for application by potable water suppliers**

**Du Preez H; van Baalen**

An increase in the eutrophication of surface water resources is leading to increased incidence of toxic blue-green algae growth – thereby increasing health risks when drinking water from a treatment plant which does not use activated carbon adsorption in its process train. No structured framework yet exists in South Africa to manage the supply of safe drinking water during a persistent blue-green algae bloom in the source water. The project aims to establish such a pro-active approach by means of a generic algal bloom incident management framework to effectively manage potable water supply when toxic algal blooms are present. Such a system will be widely applicable to water services providers and will reduce the risk of human incidents related to blue green algae toxins by providing this framework for informed and appropriate pro-active management measures.

Report No: TT 263/06

ISBN: 1 77005 472 3

Overseas price: \$25-00 (excl postage)

**An assessment of non-revenue water in South Africa  
Seago CJ; McKenzie RS;**

Municipal water use in South Africa has been under investigation for many years and the Department of Water Affairs and Forestry has been trying to establish the levels of wastage from all water supply systems countrywide. This has proved a very difficult task due to the absence of reliable data in many Municipalities as well as confusion regarding how such wastage should be estimated. Until the wastage can be quantified accurately, it is impossible to develop and prioritise the actions that must be taken to ensure that water is used effectively and efficiently in this water scarce country. Despite many problems associated with the gathering of data from the various water utilities, the study was able to obtain information from 62 of the largest water reticulation systems throughout South Africa. It was found that the average bulk

system input volume per property served for the 19 low income areas analysed as part of the study was approximately 37 kℓ per property per month. The losses (real and apparent) for the 62 systems analysed was estimated to be 623 million m<sup>3</sup>/annum or 29% of the total water supplied.

Report No: TT 300/07

ISBN: 978 1 77005 529 2

Overseas price: \$20-00 (excl postage)

### **1. On-farm application of in-field rainwater harvesting techniques on small plots in the central region of South Africa : Vol 1 – Main Report**

**JJ Botha, JJ Anderson, DC Groenewald, NN Nhlabatsi, TBZere, N Mdibe and MN Baiphethi**

Report No: TT 313/07

ISBN: 978 1 77005 595 7

Overseas price : \$20 00 (excl postage)

### **2. On-farm application of in-field rainwater, harvesting techniques on small plots in the central region of South Africa – Vol 2: Extension manual**

**Botha JJ; Anderson JJ; Nhlabatsi NN**

Water harvesting is the process of concentrating rainfall as runoff from a larger area for its productive use on a smaller area. A number of Water Research Commission projects on the In-field rainwater harvesting (IRWH) technique have demonstrated that rural communities can greatly benefit from this production practice. Intensive field experiments on clay and duplex soils, conducted over a period of six seasons, indicated that IRWH increased maize and sunflower yields by as much as 50%, compared to conventional production techniques (CON). Research results over a number of years have indicated that the IRWH technique is sustainable in terms of increased agronomic productivity, reduction of risk, conservation of the natural resources base, social acceptability and economic feasibility. This technology transfer project was initially planned for implementation in six rural communities around the towns of Thaba Nchu and Botshabelo in the Free State province

The technology exchange process expanded rapidly resulting in many more households and communities than initially anticipated implementing the IRWH technique that the need arose to employ a proper exit strategy that ensured continued implementation of the technique by interested communities. As the number of farmers and communities using IRWH techniques increased, a decision was taken by representatives from each group and community to form a municipal-based water harvesting interest group (MB:WHIG). This body was later named the Tswelelopele Small Farmers Cooperative (TSFC). Amongst the organisations that were co-opted into the structure were the municipality, the tribal authority and the local agriculture office.

Report No: TT 314/07

ISBN: 978 1 77005 596 4

Overseas price : \$20 00 (excl postage)

### **Technology transfer and integrated implementation of water management models in commercial farming** **AJ Pott, N Benadé, P van Heerden, B Grové, JG Annadale and M Steyn**

This integrated transfer of technology project targeted the commercial irrigation sector in particular since, according to the National Water Resources Strategy (NWRS, first edition, 2004), this sector is responsible for over 62% of South Africa's total water use. The terms of reference required the research team to (i) identify, (ii) negotiate with and (iii) select 5 to 7 Water User Associations or Irrigation Boards to participate in the technology transfer (TT) project. A key objective of the project was for the decision support models to be used sustainably after the completion of the project to increase efficiency of water use. As such, the potential participant WUAs / IBs were evaluated in terms of (i) their user needs for the respective models, (ii) the level of commitment shown and (iii) the level of infrastructure of the respective schemes. The participants were ranked in terms of these criteria, and short-listed. It is expected that the WUAs/IBs which were selected will act as centres of excellence, from which other WUAs/IBs can learn over time.

The models which were included in the TT exercise were ACRU, WAS, SAPWAT, SWB and RISKMAN. All models are driven by some form of input data, which is then transformed into information via computational processes through the models. A central approach of this integrated technology transfer project was to capture high quality data of the targeted participant Water User Associations and Irrigation Boards in a Geographical Information System (GIS). In the course of the implementation of the models, further developments were undertaken to improve the user friendliness. It was clear from earlier WRC projects that stakeholders showed a strong interest in GIS packages, largely due to the understanding that the use of GIS promotes for spatial and temporal information. This is due to the graphical (visual) nature of GIS which enables features to be viewed in a spatial context. In order to promote the buy-in from potential WUA and IB participants, a key feature of the project was the collection of data pertinent to the WUAs and IBs which would then be captured in a GIS. The data incorporated in the GIS could then be used (with other input data) to drive the models associated with the TT project.

The WUAs/IBs have shown a very high interest in the use of GIS, which is very encouraging, as the GIS data, if kept current over time, will provide valuable input data for the various models forming part of the TT project. The current user needs for some of the models is very high, resulting in the models either being used now, or the intention to use the model in the near future (e.g. WAS & SAPWAT). For some of the other models the user need is growing, and is anticipated to grow significantly

once the compulsory licensing process has been completed in many of the over-allocated catchments in the country. Models like SWB and RISKMAN will be very useful to test the hydro-economic impact of various water-use and land-use scenarios. Like-wise, the ACRU-MIKE BASIN model combination is well placed to assist water resource managers and stakeholders evaluate water management scenarios.

It is recommended that the WRC and/or DWAF provide funding to support a technical user support unit, which continues supporting the use of the models associated in the TT project. Although the technology transfer project was successful, it targeted only 7 WUAs/IBs, which is a very small percentage of the total number of WUAs and IBs in the country. At some stage all water users will require assistance in the management of their water, be it a catchment scale, scheme scale, or field scale. An organisation such as the former Computer Centre for Water Research (CCWR), would be a suitable organisation to provide support and assistance for this purpose.

Report No: TT 267/08

ISBN: 978 1 77005 703 6

Overseas price : \$30 00 (excl postage)

**Best management practices for small-scale subsistence farming on selected irrigation schemes and surrounding areas through participatory adaptive research in Limpopo Province**

**Wim van Averbek**

The project was conducted as a case study of the Dzindi Irrigation Scheme. Dzindi is a canal Irrigation scheme that was constructed shortly after World War II and is found about 6 km south west of the town of Thohoyandou, in the Vhembe district of Limpopo province. Dzindi has a total command area of 135.6 ha, which is subdivided into 106 plots of 1.28 ha each, held by a total of 102 plot holders. Fieldwork was also conducted at Khumbe Irrigation Scheme and Rabali Irrigation Scheme to determine the extent to which the situation at Dzindi was unique. Both Khumbe and Rabali are canal irrigation schemes and their characteristics are fairly similar to Dzindi. All three schemes can be described as maize (summer) and vegetables (winter) schemes, but there were differences among the schemes in the types of vegetables that featured most prominently.

The overall objective of the project was to develop and implement technologies and knowledge useful for farmers in order to improve rural livelihoods. Two types of research and development activities were conducted, namely initiatives aimed at understanding management practices and initiatives aimed at improving management activities. Methods used in data collection at Dzindi included; the use of Rapid Rural Appraisal (RRA) techniques; surveys involving probability sampling and structured interview schedules; experiments in the green house, on-station and on-farm and qualitative methods. Methods of data collection at Khumbe and Rabali

were largely limited to the use of RRA techniques.

The analysis of livelihood and farming of plot holder households revealed that for the purposes of developing best management practices, the 'one size fits all' perspective is not valid. At individual farm level best management practices need to be tailored to the objective of the farmer and the role of farming in the overall livelihood strategy of the household. The longitudinal study of the livelihood and farming of a selection of households at Dzindi showed that both were dynamic and subject to interaction. The development of livelihood types, farming styles and the relationship between farming and overall livelihood were shown to be useful approaches to make sense of the diversity that was observed. The study of the social and institutional domains of Dzindi showed that there was considerable room to improve the management of shared resources. On smallholder canal irrigation schemes, the sharing of water and the maintenance of the irrigation infrastructure influence the availability of water for irrigation at the plots. Collaboration among farmers, or the lack thereof, also affects access to markets. However, the study found that state intervention (through the compulsory introduction of the co-operative model) in areas where smallholders successfully operate their own organisations should either be avoided completely or be done in ways that allow smallholders sufficient time to internalise the new concepts and adapt them to suit their own circumstances. Land tenure and farmers' interpretation of the prevailing tenure system influence land exchange among farmers, which is important for farmers seeking to expand their operations. Collaboration among farmers is also important in terms of access to land preparation services. Research and development activities aimed at improving management practices focused on production aspects and included the integration of crop and animal production systems, improvement of the production of selected indigenous crops (African leafy vegetables) and the improvement of green maize production.

The findings of this study revealed that the development of best management practices for farmers on smallholder irrigation schemes needs to consider three important domains, namely the individual farm enterprises, the irrigation scheme as a whole and the scheme and its surrounds, because these domains interact. The development of best management practices at the level of the individual farm enterprises, within the Terms of Reference for this project, is mostly technical in nature. This suits the biological and technical disciplines in the agricultural expert system. However, social and institutional issues are of cardinal importance in the domain of the irrigation scheme as a whole and its surrounds. This raises questions about the appropriateness of the composition of the South African expert system, which has long been dominated by specialists in agricultural production and agricultural engineering.

Report No: TT 344/08

ISBN: 978 1 77005 689 3

Overseas price: \$45-00 (excl postage)

**Water-use in relation to biomass of indigenous tree species in woodland, forest and/or plantation conditions.**  
**Dye PJ; Gush MB; Everson CS; Jarman C; Clulow A; Mengistu M**

Report No: TT 361/08  
ISBN: 978 1 77005 744 9  
Overseas price: \$30-00 (excl postage)

**Nutritional status of South Africans with specific reference to malnutrition.**  
**Wenhold F; Faber M**

Report No: TT 362/P/08  
ISBN: 978 1 77005 756 2  
Overseas price: \$25-00 (excl postage)

**Developing a land register and a set of rules for application of infield rainwater harvesting in three villages in Thaba Nchu: A pilot project**  
**Manona S; Baipethi M**

The Water Research Commission (WRC) is funding a 5 year research project in rural villages around Thaba Nchu, titled Social and economic factors affecting the adoption of rainwater harvesting and conservation practices. The solicited project commenced in April 2006 and is being undertaken by the University of the Free State. The project follows on other WRC funded projects in the same area that aimed at the improvement of crop production, thus poverty alleviation, through the use of infield rainwater harvesting (IRWH) techniques developed by the Agricultural Research Council's Institute for Soil Climate and Water (ARC-ISCW). There is a need for up-scaling IRWH from the household food gardens to the communal croplands. This requires the development of a land register and clear rules to gain access to land. Umhlaba Consulting have specialist capabilities in this regard to make a contribution and thereby support ongoing research efforts.

The study revealed the complex nature of land tenure and the total collapse of land administration in the three villages. The underlying drivers of the collapse of land administration can be attributed to lack of a coherent policy and legislative framework since 1994. On the one hand government discontinued the implementation of permission to occupy (PTO) legislation and did not replace it with new legislation, while other organisations that were historically key role players in land administration were removed from the functions they played in the past.

A survey conducted among the three villages showed a widespread support for extension and/or revitalization of cultivation to arable fields, albeit with conventional technologies in mind, as shown by the appeal for the provision of machinery commonly used in conventional tillage methods. The observation was not surprising since the farmers had not been exposed to the use of the IRWH techniques

beyond the household food plots. Furthermore, land rights holders expressed sufficient support for an improved local land administration system that would support land exchange agreements. While fencing of the fields does not necessarily fall within the realm of land administration, it was seen to be a major constraint towards the cultivation of arable fields. This is largely because of the threat of damage to crops by livestock from within and the neighbouring villages.

Following from support to developing and/or strengthening local land administration, an initial framework of rules that would govern local land administration was agreed to by the three villages. This process was undertaken mindful of the lack of a supportive legislative framework and therefore lack of enforcement mechanisms. Nonetheless, the communities were willing to devise and revitalize some of the traditional and collective initiatives to ensure the launching of the local land administration system. There was consensus across all three villages on how a local land administration structure should be set up. The process of setting up of rules was seen as a dynamic and continuous process which should be facilitated by the local land administration structures over time.

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ISBN: 978 1 77005 785 2  
Overseas price: \$25-00 (excl postage)

**Training manual for small-scale rainbow trout farmers in net cages on irrigation dams water quality, production and fish health**  
**K Salie, D Resoort, D du Plessis and Ma Maleri**

This project investigated the suitability of on-farm irrigation dams for aquaculture fish production and the effect this would have on the quality of the water for irrigation purposes. A study of irrigation dams in the Western Cape and the Makhathini flats canal system in KwaZulu-Natal, indicated that water exchange rate and inflow water quality are main factors in determining the suitability of water bodies for fish production. While the water chemistry did not show effects of aquaculture or differences between production and control sites, the phytoplankton composition and biomass did. Especially during the winter dam turnover, overall biomass of phytoplankton was higher at all production sites. The additional clogging of filters as a result of changes in phytoplankton biomass was the most significant impact of aquaculture on the quality of water for irrigation. It was further found that a significant portion of the fertiliser requirements of the crops irrigated from the dams would become available because of aquaculture activities.

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ISBN: 978 1 77005 784 5  
Overseas price: \$20-00 (excl postage)

**The social/cultural acceptability of using human excreta (Faeces and Urine) for food production in rural settlements in South Africa**

**Duncker LC; Matsebe GM; Moilwa N**

Introducing and operating sanitation systems that promote the use of human excreta in rural areas require a combination of technical and managerial aspects that fit the prevailing socio-cultural context in the specific area. An in-depth understanding of the social and mental fabric concerning people's views towards recirculation of nutrients is necessary in order to understand the motivational factors behind people's acceptance or rejection of using human excreta for food production. No research has been conducted so far in this field of study in South Africa, and therefore the scoping study is required to investigate the status quo, determine the views and attitudes of people towards the use of human excreta in food production, and to guide relevant future interventions and actions regarding use of human excreta. Use of human excreta for agricultural purposes may not only have direct benefits of protecting and improving natural resources such as water and soils and enable households to increase food crops, but also indirect benefits of improved food security resulting in improved health of the individual, greater productivity, increased economic output and opportunities, and a decreasing burden on social services.

Report No: TT 310/07

ISBN: 978 1 77005 592 6

Overseas price: \$25-00 (excl postage)

**A Procedure for an improved soil survey technique for delineating land suitable for rainwater harvesting**

**Hensley M; Roux PAL; Gutter J; Zerizghy MG**

Subsistence farmers in rural semi-arid areas with low cropping potential are a category of poor people in South Africa that the Government urgently wants to assist. Their well-being is jeopardized by a low income and inadequate food security. To address this problem a number of research projects, managed and funded by the Water Research Commission (WRC), have been launched during the last ten years by the ARC-Institute for Soil Climate and Water (ISCW) located at Glen. Success in this regard was achieved, shown by the fact that large numbers of households in the region now successfully use IRWH to grow maize and vegetables in their backyards. The time is now ripe for expanding the application of IRWH to the relatively large unused cropland areas available to these subsistence farmers. The need then arises to identify and delineate the portion of each village area that is suitable for IRWH. Because of the relatively small area of cropland allocated to each household it is essential that the soil survey be conducted on an intensive basis, at a scale of at least 1: 10 000, but preferably larger. Intensive soil surveys at this scale, carried out using the traditional grid technique, are costly. It was hypothesised that it should be possible to develop a more effective survey procedure to select suitable land for IRWH by maximising the application of tacit knowledge and employing

modern and innovative technology. Aware of this need the WRC has wisely created this research project to test this hypothesis.

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Overseas price: \$20-00 excl postage

**A Manual for cost benefit analysis in SA with specific reference to water resource development: Second Edition (Updated and Revised)**

**Mullins D; Mosaka DD; Green AB; Downing R; Mapekula PG**

This guideline is in the format of a manual for conducting Cost-Benefit Analysis (CBA) in South Africa with specific reference to evaluating the development and management of water resources. This evaluation of projects is often a difficult task since costs and benefits do not occur only once but appear over time. The CBA method, provides a logical framework by means of which projects can be evaluated, serving as an aid in the decision making process. This manual is specifically aimed at the decision maker in the public sector, but can also be used outside the public sector.

It is interesting to note a few highlights of the CBA Manual. A broader approach is followed to incorporate the relationships between CBA and other aspects of the economy. In this regard the following aspects have been included:

- The relationship between the principles of CBA and welfare economics;
- CBA as one component of the range of decision making support instruments;
- The equity and efficiency principles;

Thus it deals specifically with the uses, limitations and basic principles of CBA in order to explain the underlying conceptual framework to the reader. This manual advocates that the CBA concept needs to be widened to include the broader social costs and benefits derived from a project. Furthermore it is also accepted that CBA is only one of several instruments for evaluating proposed projects. One of the main objectives therefore was to incorporate an income weighting system. This system provides for the recognition of some of the macroeconomic policies of the government e.g. combating poverty and promoting regional development.

Report No: TT 305/07

ISBN: 978 1 77005 598 8

Overseas price: \$30-00 (excl postage)

**Technology transfer for implementation of the FARMS system**

**Botha PW; Oosthuizen LK; Meiring JA**

Over the last 10 years, three WRC funded research projects were undertaken to develop user-friendly models to provide decision-support for farmers. The aims of this technology

transfer project were firstly, to train agribusinesses, bureau services and advisors in the main irrigation areas of South Africa to implement the Risk Man (Risk Management), IrriCost (Irrigation Cost Estimator) and FARMS (Farm Level Agricultural Management Simulator) computer software for decision-taking support in the field of risk management, irrigation cost estimation and whole farm planning respectively; and secondly, to give these organisations and individuals the necessary support in order for them to apply the abovementioned computer software on a continuous basis.

New technology must pass through several stages before it is accepted. The five stages of adoption are awareness, interest, evaluation, trial and adoption. The implementation strategy with this technology transfer project consisted of a combination of methods, messages and approaches followed by the research team. The first step was to identify target groups to whom the three programs were demonstrated. The demonstrations were attended by the contact person of that area together with potential adopters of the technology. These demonstrations were used to create awareness and interest in the use of the models. The next step was to arrange workshops for interested persons for specific models to make further progress with the technology adoption process. The website was used to provide additional information about forthcoming courses and continuous support on larger scale adoption and application.

Report No: TT 274/05  
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Overseas price: \$20-00 (excl postage)

#### **Building capacity in irrigation management with wetting front detectors**

**R Stirzaker; CSIRO; Stevens J; Annandale J; Maeko T; Steyn M; Mpandeli S; Maurobane W; Nkgapele J; Jovanovic N**

Scheduling of irrigation does not only ensure that adequate volumes of water are applied. It also ensures that many people who rely on the limited water resource can share. Much as irrigators are aware of the importance of scheduling, very few practice it. A wide range of reasons for not scheduling exists, the common ones being the high level of management required and the costs involved. With simple and cheap scheduling tools, water savings will be achieved and farmers will soon realise the importance of irrigation scheduling and its benefits. The project is aimed at improving adoption of irrigation scheduling through the introduction of a cheap and simple technique. It also evaluates factors affecting the acceptability of this irrigation scheduling technology by resource-poor and commercial farmers.

Report No: TT 230/04  
ISBN: 1 77005 138 4  
Overseas price \$25-00 (excl postage)

#### **Using Sapwat to estimate water requirements of crops in selected irrigation areas managed by the Orange Vaal and Orange – Riet water users association**

**Van Heerden PS, Crosby CT & Crosby CP**

This report serves as a user manual for the application of SAPWAT. Furthermore, it demonstrates that the estimation of irrigation requirements can be credible and that the requirements that the National Water Act (36 of 1998) sets for future water management can be met.

Report No: TT 163/01  
ISBN: 1 86845 812 1  
Overseas price \$30 00 (excl postage)

#### **Micro-irrigation for smallholders: Guidelines for funders, planners, designers and support staff in SA**

**Du Plessis FJ; Van Averbek W; Van der Stoep I**

The objective of this project was to assess how small-scale farmers experience the concept of micro-irrigation systems and how they cope with problems. The aim was to identify those aspects that eventually determine the success or failure of small-scale crop production, utilising these systems. During the course of the project it became apparent that external factors, generic to any small-scale farming system and seemingly unrelated to micro-irrigation, had a significant influence, and that it would, therefore, be almost impossible to evaluate the former without taking the latter into account. The aim of the guideline report is to help prevent mistakes of the past and, hopefully, it will contribute to policy-making on a small scale regarding the utilisation of micro-irrigation. Thus, the successful use of the systems is ensured.

Report No: TT 164/01  
ISBN: 1 86845 824 5  
Overseas price \$15-00 (excl postage)

#### **Contribution of aquaculture to rural livelihoods in South Africa: A baseline study**

**Rouhani QA; Britz PJ**

At present there is a lack of information on the importance of fish production systems in agricultural activities, the contribution it makes to household food security and constraints or opportunities which exist for expansion. This study should highlight specific topics for research projects that need attention. Particular emphasis will be placed on research of water-related issues that will lead to an improvement of rural livelihoods.

Report No: TT 235/05  
ISBN: 1 77005 186 4  
Overseas price \$25-00 (excl postage)

**Guidelines for irrigation water measurement in practice**  
**Vd Stoep I; Benade N; Smal HS; Reinders FB**

Effective management of water resources can be vastly improved if water use is measured accurately. This applies in particular to efforts to influence the quantity of water demanded by levying tariffs on the volume of water actually consumed. However, on most irrigation schemes water flow is not measured and water tariffs are presently still levied on an area and not a volumetric basis. This report is as a result of a comprehensive study of water measurement in irrigation.

Report No: TT 248/05  
ISBN: 1 77005 324 7  
Overseas price \$25-00 (excl postage)

**Irrigation scheduling using the Soil Water Balance (SWB) model as a user-friendly irrigation scheduling tool**  
**Annandale JG; Steyn JM; Benade N; Jovanovic NZ; Soudy P**

Most commercial farmers recognise that effective irrigation scheduling is a prerequisite to save on irrigation water and to improve on water-use efficiency. However, only a small percentage of irrigation farmers currently uses any scientific irrigation scheduling aid. One important reason may have been the lack of quick, simple and reliable irrigation scheduling techniques. This aspect has been addressed to a large extent by the development of the SWB model. Although the model follows a scientifically based mechanistic approach, a user-friendly interface makes it accessible to any person with basic computer training.

Report No: TT 251/05  
ISBN: 1 77005 339 5  
Overseas price \$20-00 (excl postage)

**Principles, approaches and guidelines for the participatory revitalisation of smallholder irrigation schemes: A rough guide for irrigation development practitioners: Vol 1**  
**Denison J; Manona S**

The guidelines document best South African and international practice and are intended for Government decision-makers, technical and extension staff, consultants, development practitioners and scheme leadership.

The 'Rough Guide' (Volume 1) is a quick reference guide that covers policy implications and revitalisation objectives, as well as recommended principles, approaches and methodologies for scheme diagnosis, participative planning, feasibility evaluation and formulation of farmer support programmes.

Report No: TT 308/07  
ISBN: 978 1 77005 568 1  
Overseas price \$25-00 (excl postage)

**Principles, approaches and guidelines for the participatory revitalisation of smallholder irrigation schemes: Concepts and cases: Vol 2**  
**Denison J; Manona S**

The guidelines document best South African and international practice and are intended for Government decision-makers, technical and extension staff, consultants, development practitioners and scheme leadership.

'Concepts and Cases' (Volume 2) contains the theoretical rationale for the guidelines. Four major South African revitalisation initiatives are compared with international initiatives and success factors are identified. Eight farmer support approaches are documented, providing lessons of best practice as well as alternatives for programme design, and new approaches are presented. These are a tailored consultative planning approach, a land-leasing strategy for irrigation schemes and the formulation of four basic farming styles to guide planning.

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