WATER RESEARCH COMMISSION

ANNUAL REPORT

1 JANUARY TO 31 DECEMBER

WATER RESEARCH COMMISSION ANNUAL REPORT

83

1 JANUARY TO 31 DECEMBER

Water Research Commission
PO Box 824
PRETORIA
0001

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Hierdie verslag is ook in Afrikaans beskikbaar

The objectives of the Water Research Commission

In terms of section 2(3) of the Water Research Act 1971, (Act No. 34 of 1971) the objectives of the Commission are "to coordinate, to promote, to encourage or to cause to be undertaken, as determined by the Minister specifically or in broad outline, research in respect of:—

(a) the occurrence, preservation, conservation, utilization, control, supply, distribution, purification, pollution or reclamation of water supplies and water;

(b) the use of water for:—

(i) agricultural purposes;
(ii) industrial purposes; or
(iii) urban purposes".

Section 3(1) of the above-mentioned Act describes the functions of the Commission and stipulates *inter alia* that the Commission shall "accumulate, assimilate and disseminate knowledge in regard to the results of such research and the application thereof, and promote development work for the purpose of such application."

Contents

Water Research Commission
PO Box 824
PRETORIA
0001
2 May 1984

Dear Mr Hayward

We take pleasure in submitting to you, herewith, the report of the Water Research Commission. This report covers the period 1 January 1983 to 31 December 1983.

The balance sheet and statement of revenue and expenditure for the financial year 1 January 1983 to 31 December 1983, as certified by the Auditor General, are furnished in Chapter 17 of this report.

Yours respectfully

MR Henzen
CHAIRMAN

JF Otto
VICE CHAIRMAN

The Honourable SAS Hayward, MP
Minister of Environment Affairs and Fisheries
PO Box 23
CAPE TOWN
8000

Members of the Water Research Commission at end of term on 31 July 1983

DR MR HENZEN
Chairman:
Chief Executive Officer

MR JF OTTO
Vice Chairman
Director General:
Department of Environment Affairs

DR JP KRIEL
Former Secretary for Water Affairs and now consultant:
Special water studies for the
Department of Environment Affairs

DR N STUTTERHEIM
Chairman: Council of the University of the Witwatersrand
Chairman: Telephone Manufacturers of South Africa

MR EJ HALL
Former City Engineer of Johannesburg and now consultant with a firm of consulting engineers

PROF DJ SCHOEMAN
Dean: Faculty of Engineering
University of Pretoria

DR CF GARBERS
President:
Council for Scientific and Industrial Research

DR DW IMMELMAN
Director General:
Department of Agriculture

MR JG DU PLESSIS
Deputy Director General:
Department of Environment Affairs
(Co-opted member)

MR JG BRAND
City Engineer of Cape Town
(Co-opted member)

Members of the Water Research Commission as from 1 August 1983

DR MR HENZEN
Chairman:
Chief Executive Officer

MR JF OTTO
Vice Chairman

DR JP KRIEL

DR N STUTTERHEIM

PROF DJ SCHOEMAN

DR CF GARBERS

DR DW IMMELMAN

MR JG DU PLESSIS

MR JG BRAND
(Co-opted member)

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The year in review

South Africa, as a whole, is known as a dry country and a country of extremes as far as rainfall is concerned. The average annual rainfall of 483 mm/a compares poorly with a world average of 860 mm/a, and varies from 50 mm/a on the west coast to 1 250 mm/a in the Drakensberg in the east, and to as much as 3 650 mm/a in the mountains of the Western Cape. Calculations indicate that the Republic's water balance will become critical shortly after the turn of the century and that the water demand will exceed the water supply. Seen against this background, it is essential that top priority should at all times be given to optimal utilisation of South Africa's water resources and that water research plays a key role.

The harsh realities of the country's water situation should always be borne in mind and the severe drought experienced during the year again brought these realities to the fore. The most important of these is the realisation that survival in South Africa is synonymous with the availability of adequate water supplies. Furthermore, the necessity for planning and for water research has been reconfirmed. In this regard reference should be made to an address by The Honourable SAS Hayward, Minister of Environment Affairs and Fisheries, during a demonstration of a technique for the treatment of textile effluents, developed with financial assistance from the Commission. Referring to the drought, the water situation and increasing water pollution, the Minister said that unless research was done at national level to prevent water pollution and to yield maximum production per unit volume of water, a serious shortage in water supplies will result. It is along these lines that the Commission is fulfilling its task of coordination and promotion of water research and is striving to attain the highest possible utilisation of available water supplies.

During the year several research projects were completed and some of the results have already been applied successfully in practice. This technology transfer has been facilitated by the incorporation of the partnership principle in research contracts, in other words, with the involvement of the end user in the execution of the research. Research results have also been released by way of publications (e.g. manuals, guides, etc), whilst demonstrations of the developed technology were successfully held and generated great interest amongst users. A list of publications and reports released during 1983 appears in the Appendix.

New research projects

In 1983 the Commission supported 70 projects including 21 new projects which commenced during the year. The new projects are the following:

- Research on the characterisation, evaluation and regeneration of active carbon for water reclamation and water purification. (Contract with the CSIR — National Institute for Water Research; the Rand Water Board; and the Klipfontein Organic Products — a division of Sentrachem).

- Research on the effect of adsorption-oxidation process configurations on the quality of reclaimed water. (Contract with the CSIR — National Institute for Water Research).

- Hydrological research in catchments of the Eastern and Southern Cape. (Contract with the University of Rhodes — Department of Geography).

- Research on the evaluation of hydrological flood estimation techniques for small ungauged catchments. (Contract with a firm of consulting engineers, Steffen, Robertson and Kirsten).

- The establishment of hydrological data banks. (Contract with the Department of Environment Affairs — Division of Hydrology).

- Evaluation of electrodialysis reversal for the desalination of effluents and brackish water. (Contract with ESCOM).

- Research on the contribution of mine dumps to mineral pollution in the Vaal Barrage. (Contract with the Department of Environment Affairs, and a firm of consulting engineers, Steffen, Robertson and Kirsten).

- Research on the inhibition of bacterial oxidation of pyrite and concomitant acid mine water. (Contract with the Chamber of Mines, and the University of Stellenbosch — Department of Microbiology and Virology, and the Institute for Polymer Science).

- Research to investigate leak detection in water supply distribution systems. (Contract with the CSIR — National Building Research Institute).

- Wind tunnel studies on the effect of the orientation of air cooled systems. (Contract with ESCOM and the CSIR — National Mechanical Engineering Research Institute).

- The development of computer evaluation techniques for dry cooling systems. (Contract with ESCOM and the University of Stellenbosch — Bureau for Mechanical Engineering).

- The development of a national data bank for ground-water data (Contract with the University of the Orange Free State — Institute for Groundwater Studies).

- Research on enhancement of biological phosphate removal from sewage water by altering process feed composition. (Contract with the City Council of Johannesburg).

- Research on sludge bulking in the activated sludge process. (Contract with the University of Cape Town — Department of Civil Engineering).

- An investigation into the condition of soils irrigated over a protracted period and an evaluation of applicable selection criteria, and reclamation and control measures. (Contract with the Potchefstroom University for CHE — Department of Pedology)

- Programme for atmospheric water supply at Nelspruit (Contract with the Company for Research on Atmospheric Water Supply (CRAWS) with subcontracting of Simpson Weather Associates and Cansas International Corporation (Pty) Ltd).

- Water management and effluent treatment in the textile industry: scouring and bleaching effluents. (Contract with the University of Natal, Pollution Research Group, Department of Chemical Engineering).

- Research into the treatment of industrial effluents with high salinity and organic contents. (Contract with the University of Natal, Pollution Research Group, Department of Chemical Engineering).

- Research on and an investigation into the use of physical/chemical techniques for water and wastewater management in the meat processing industry. (Contract with a firm of Consulting Engineers, Binnie and Partners).

- An investigation into rainfall recharge to ground water. (Contract with a firm of consulting engineers, Steffen, Robertson and Kirsten).

- Research on the auto-analysis of sulphate and alkalinity in water. (Contract with the University of Pretoria — Department of Chemistry).

Establishment and utilisation of centres of expertise

The Commission does not carry out research itself, but contracts other organisations for this purpose. Various mechanisms and strategies have been developed, and centres of expertise in particular, are used for this purpose. In this way existing centres have benefited greatly and have expanded as a result. In cases of the absence of a centre or nucleus of expertise in a specific area of the water field, the Commission will take the necessary steps and contribute substantially to the development of such a centre. In this way the required expertise is established and utilised in the best possible manner for research of national importance in the water field.

Of the 70 projects supported by the Commission in 1983, fifty-nine are undertaken in terms of dual contracts (i.e. between the Commission and one party only), ten in terms of tripartite and one in terms of quadripartite contracts. The parties involved represent only main contractors and not sub-contractors; nor do they include various industries on whose sites research was undertaken and who, as "partners", were responsible for important inputs in the way of facilities, manpower, etc.

The table presents the involvement of the various research sectors represented by the contracting parties and the extent to which they are involved in the

execution of the research. This shows, *inter alia,* that universities are involved in 44% of the total number of contracts.

Table: Involvement of research sectors in the execution of seventy research projects

Research sector	*No. of times involved*	%
Universities	36	44
CSIR	13	16
Other statutory organisations and industry	11	13
Consulting engineers	9	11
Municipalities	7	9
Government departments	6	7
Total	82	100

Highlights of some activities

The Commission's activities encompass a broad span in the field of water and a multidisciplinary approach has been adopted in the execution of its duties. Although the activities of the Commission are reported in the various chapters, some important developments are high-lighted here.

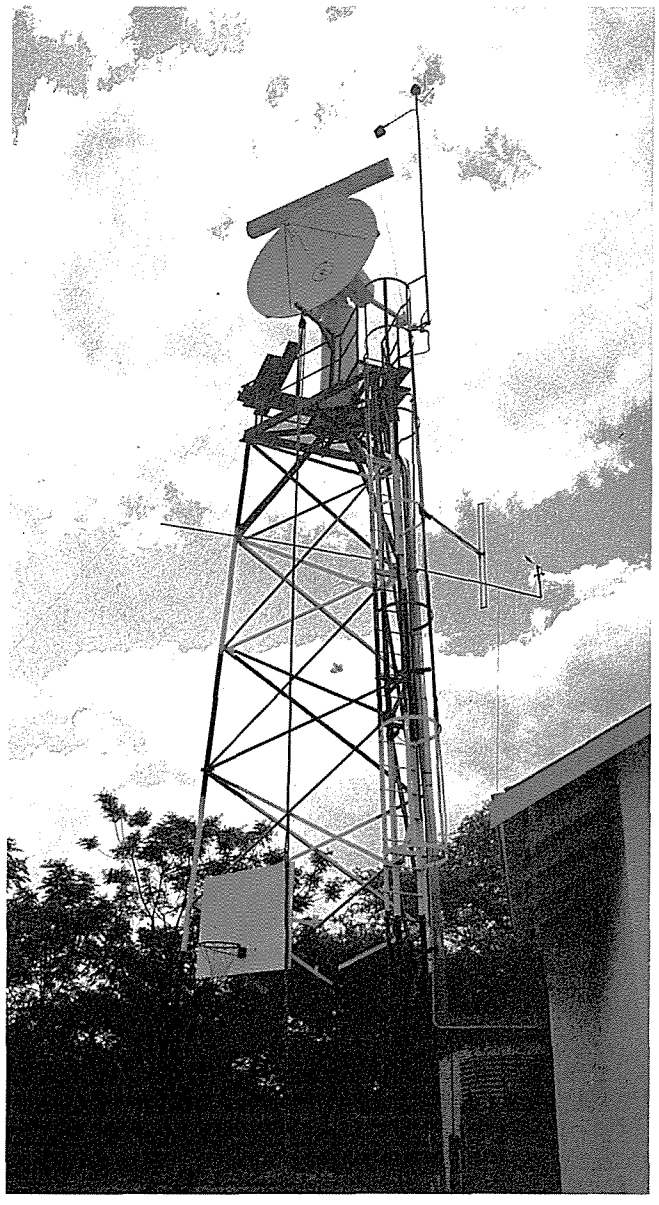
New impetus on rainfall stimulation research

The Commission has established a non-profit company, called Company for Research on Atmospheric Water Supply (CRAWS), to undertake the rainfall stimulation research under the Commission's direction.

CRAWS which has been registered under Section 21 of the Companies Act, will be responsible for conducting the research programme in the Nelspruit area with funds made available by the Commission. This company has contracted overseas consulting meteorologists, namely Simpson Weather Associates of Virginia, USA, as the principle investigators who will undertake the research, and Cansas International Corporation who will operate the field and aviation equipment under the direction of the principal investigators. The team of scientists that has been assembled for this programme includes some of the most eminent names in weather modification.

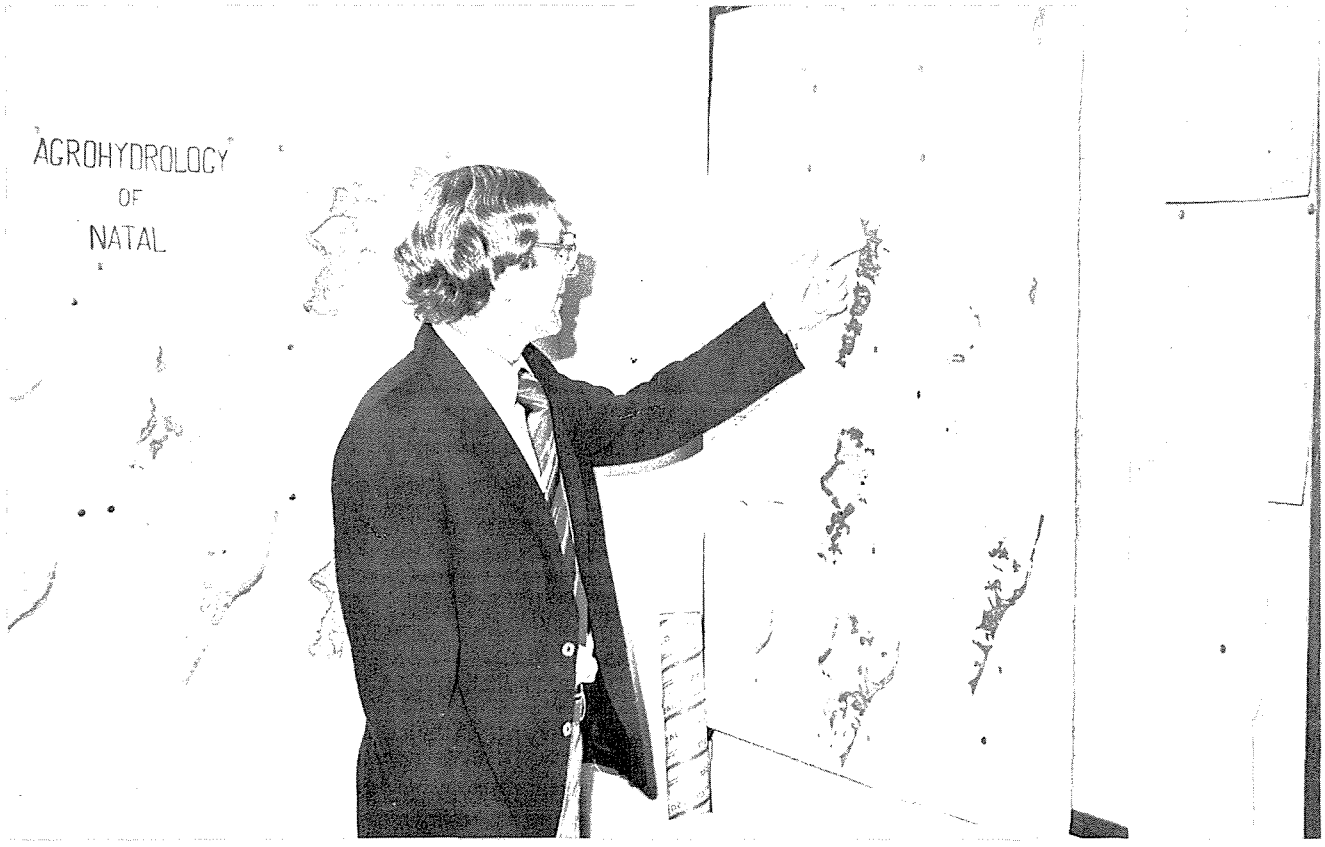
The equipment consists of two aircraft (a Lear Jet for high altitude cloud penetrations and the other an Aero Commander for cloud base observation), equipped with highly sophisticated cloud physics instrumentation with on board computers, as well as a radar and computer system on the ground together with a ground network of weather stations.

During July 1983, Simpson Weather Associates convened a workshop in Charlottesville, Virginia with the purpose of identifying issues which must be addressed in the design of the exploratory research programme to determine the potential for the stimulation of rainfall in summertime convective clouds near and east of the escarpment of the Eastern Transvaal. To aid in achieving this purpose, experts in the field of cumulus cloud modification were invited to attend the workshop and they assisted in the preparation, design and refinement of the exploratory research and development plan for the Nelspruit area for the next four years.



The radar antenna used in the research on weather modification in the Nelspruit area.

This new research programme follows on a previous project for rainfall stimulation in the Nelspruit area, which was carried out in terms of an agreement between the Laeveldse Koöperasie Beperk and the Commission. The Commission is also supporting another research project on rainfall stimulation in the Bethlehem area which is being conducted by the Weather Bureau of the Department of Transport.



Prof RE Schulze of the University of Natal with maps used in his publication ***Agrohydrology and -climatology of Natal.***

Atlas on agrohydrology and -climatology of Natal published

An atlas *Agrohydrology and -climatology of Natal* was published during the year by the Water Research Commission. The author of this publication is Prof RE Schulze of the Department of Agricultural Engineering of the University of Natal and it stems from a completed research project regarding an agrohydrological survey of Natal which was funded by the Commission.

Agrohydrology seeks to evaluate the influence of available water on the agricultural potential of a region with the objective of promoting a high efficiency in the use of water. A study of agrohydrology is particularly pertinent in Natal because it is the province with the highest rainfall in South Africa.

While scientific methods form the basis of the various analyses undertaken, the endeavour has been to present results at the level of the user, namely, the extension officer, agricultural consultant and the farmer. For this reason nomograms as well as worked examples have been given where relevant. The manual is best used as a tool for regional, comparative planning.

The atlas contains basic information as well as applied information and the following sections are covered: physical environment; precipitation; temperature and evapotranspiration; agricultural productivity potential; veld and pasture management and production; dryland crop production potential; water requirements for irrigation; and optimum areas for commercial timber production.

This atlas is meant for the practical user and in this sense it will find wide application.

First national hydrological symposium

The first national hydrological symposium, jointly organised by the Water Research Commission and the Department of Environment Affairs, was held in Pretoria on 8 and 9 September 1983. The main objective of the symposium was to provide a recognised platform for the presentation and discussion of the latest research results over the whole field of hydrology. In the keynote address by Dr G Fleming of the University of Strathclyde, Scotland, the need for an improvement in the integrated hydrological modelling approach by tieing the models in firmly to the physics of the underlying processes, was emphasized.

Hydrology in general and the hydrological research programme of the Commission in specifically, greatly benefitted by the Symposium. The proceedings will be published in 1984.

Register of South African hydrological data sources

A register for hydrological data sources in South Africa was compiled and published by the South

African Water Information Centre. (The Centre is operated on behalf of the Commission and under contract, by the CSIR).

The register was initiated as a result of a symposium on small catchment hydrology held in Pietermaritzburg during 1979. A need was expressed by the hydrologists present for a register which would assist reseachers in identifying individuals or agencies who possessed data that were of relevance to hydrological research programmes.

The Register consists of 3 sections:

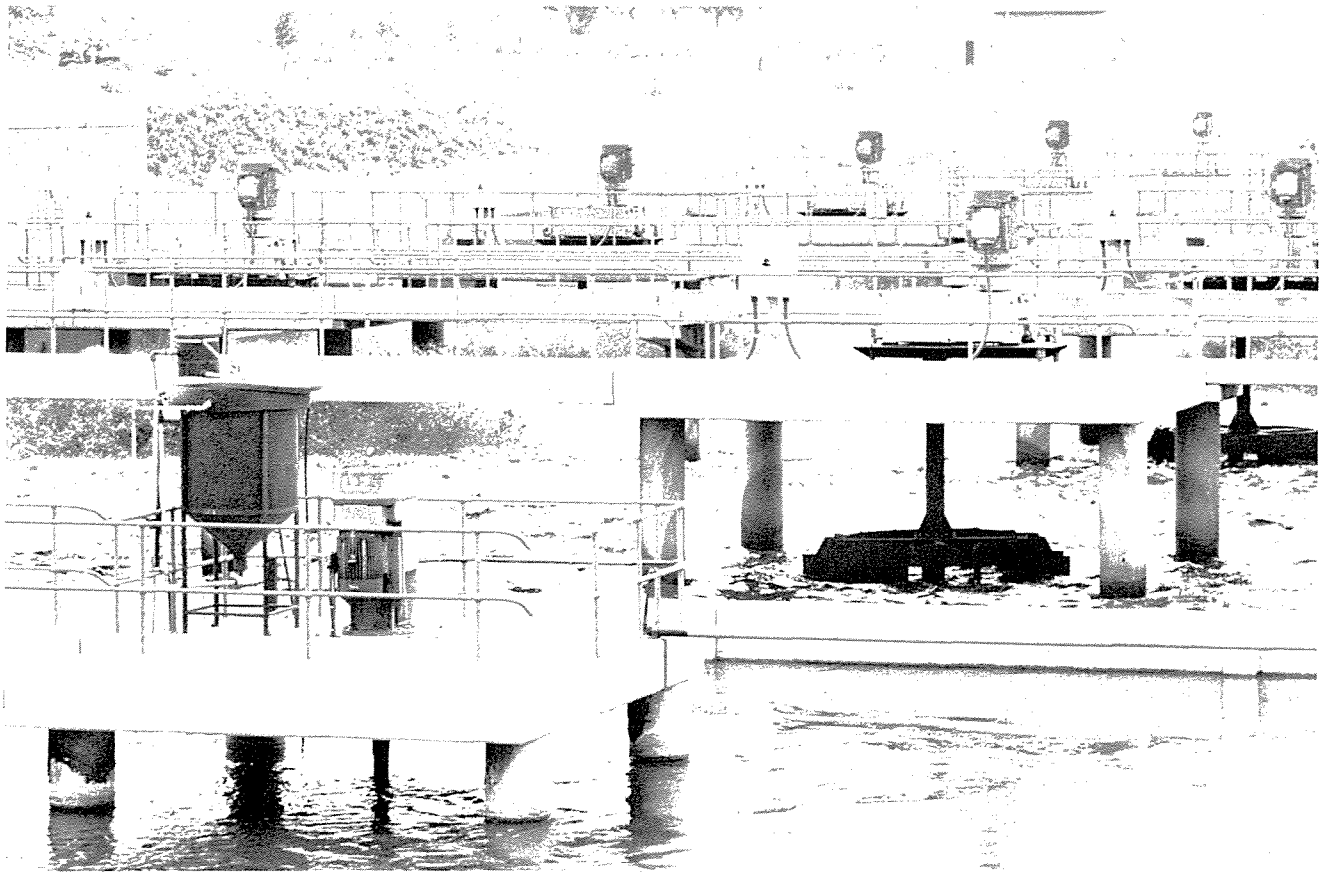
- Alphabetical list of organizations which gives a brief summary of the type of data collected, data availability, lending facilities and any other particulars which may be of interest to users.
- Tables containing detailed information about the type of hydrological variables which are collected, geographical location, water quality analysis, instruments used in data collection, etc.
- Index in which hydrological variables are listed alphabetically to allow users to refer to the above sections; an index of geographical locations is also included.

Workshops to establish the needs and priorities for irrigation research

During the year a further two of the planned six workshops for identifying research needs and priorities in connection with various aspects of irrigation were held by the Commission in collaboration with the Departments of Agriculture and Environment Affairs. Workshops held during 1982 on agronomic and soil aspects of irrigation were followed in 1983 by workshops on the engineering aspects of irrigation and drainage systems, and on water supply for irrigation purposes. During the latter two workshops the relevant task areas were scrutinised under the following headings whereafter recommendations on research requirements and their priorities were formulated.

Engineering aspects of irrigation and drainage systems.

- Flood irrigation systems
- Sprinkler irrigation systems
- Micro irrigation systems
- Drainage systems



A section of the Goudkoppies sewage works where research is carried out on biological nutrient removal in the activated sludge process.

Water supply for irrigation purposes

- Hydrological aspects
- Surface water sources
- Other sources of water supply for irrigation
- Water distribution systems

As with previous workshops, reports on the recommendations were compiled and made available to interested parties. The findings serve as a basis for a master plan for irrigation research which is being compiled by the Coordinating Committee for Irrigation Research (CCIR) and this will be used as a guide by the Commission in its financing of research. In addition, the Department of Agriculture will also plan all future departmental irrigation research with reference to the requirements as determined at the workshops and as reflected in the master research plan.

Comprehensive publication on nutrient removal activated sludge processes

A comprehensive publication, *Theory, design and operation of nutrient removal activated sludge processes* has been published. This collaborative document was prepared for the Water Research Commission by the University of Cape Town, City Council of Johannesburg and the National Institute for Water Research. The Water Research Commission has stimulated, co-ordinated and financed research and development work in the field of biological nutrient removal in the activated sludge process from about 1973. The purpose with the publication is to summarize and update the significant amount of information on processes for biological nutrient removal which has become available. The publication will be used by local authorities and others who have to meet effluent standards, in particular the effluent phosphate standard of 1 mg/l soluble orthophosphate which is to be strictly enforced in a number of critical catchments as from August 1985.

It is a self-contained document which does not require reference to other publications on wastewater treatment. It is intended primarily for the design engineer and management staff responsible for operation and control of wastewater purification works, who have had tertiary training and/or considerable practical experience in the field of wastewater treatment.

New technology for wastewater treatment in the textile industry

New technology for the successful treatment of wastewater from the textile industry has become available through a recent publication issued by the Water Research Commission. This publication viz. *Closed loop treatment/recycle system for textile sizing/desizing effluents* is the first in a series entitled

The Honourable SAS Hayward, Minister of Environment Affairs and Fisheries receiving a manual on the treatment of wastewater in the textile industry from Prof. GR Groves of the University of Natal, under whose guidance the manual was prepared on behalf of the Commission.

A guide for the planning, design and implementation of wastewater treatment plants in the textile industry.

The guide is the result of four years of partnership research between the Commission, the Pollution Research Group of the University of Natal and the textile industry represented by Messrs David Whitehead and Sons. Several other research projects by the University of Natal on the treatment of various effluents from the textile industry are still in progress and guidelines which will form part of the above-mentioned series will be published, covering wool washing, dyeing/printing and scouring/bleaching processes. The main objectives with the research are to optimise processes for increasing the efficient use of water, i.e. to affect maximum production per unit volume of water by ensuring maximum re-use of water and the re-use and recovery of chemicals and to reduce pollution.

This technical Guide provides for the planning, design and implementation of the ultrafiltration system for the treatment and recycle of textile sizing/desizing effluents. It has been shown to be both practical and economic. The ultimate aim with the research is the full-scale application on the developed technology. In this regard David Whitehead and Sons is considering the erection of a full-scale plant for the treatment of sizing/desizing effluent at their factory in Tongaat.

The Guide was officially presented to the Minister of Environment Affairs and Fisheries, Mr SAS Hayward, at an open day and demonstration at Messrs David Whitehead and Sons, Tongaat on 11 August 1983.

Research on the contribution of mine dumps to the mineral pollution of the Vaal Barrage.

The combating of mineralisation of the water sources in the Pretoria-Witwatersrand-Vaal triangle (PWV) area has been taken a step further by a new research project initiated by the Commission. In terms of a contract with the Department of Environment Affairs and a firm of consulting engineers, Steffen, Robertson and Kirsten, research will be done on the contribution of mine dumps on the Witwatersrand to the mineral pollution of the Vaal Barrage.

During a previous study on water pollution and reuse in the PWV area which was also sponsored by the Commission, it was found that more than fifty per cent of the mineral load reaching the Vaal Barrage originated from non-point sources. The relative contribution of stormwater and seepage from mine dumps to the mineral pollution, is unknown.

The project entails an intensive study of three mine dumps over a period of three years. The mine dumps were selected in consultation with the Chamber of Mines. Surface runoff and underground seepage are monitored and to this end special boreholes have been sunk and measuring structures and recorders erected.

Research on leak detection in water supply distribution systems

A project was initiate by the Commission for research to be carried out by the National Building Research Institute (NBRI) of the CSIR into leak detection in water supply systems. At the conclusion of this contract a manual on leak detection and repair programmes for use under South African conditions will be published. The project is complementary to research aimed at meaningful reductions in the amount of water supplied to urban areas in which the Commission has for a number of years been involved.

Local authorities in South Africa rely almost entirely on tell-tale surface wetness to detect and locate leaks. Preliminary enquiries indicate that this state of affairs exists mainly due to two reasons: firstly to the high cost of the specialized electronic detection devices which have only recently been perfected and become available locally; and secondly to a lack of knowledge and expertise on precisely how to implement a leak detection and repair programme under local conditions.

This new investigation will establish such a programme in a selected area to demonstrate the operation of the equipment; the planning and conduct of a leak detection and repair programme; and the cost/benefit relationship of such a programme.

A further investigation into the desalination of effluents

An important addition to the Commission's research projects in connection with desalination is a project on the desalination of effluents by means of the electrodialysis reversal process.

The first phase of the project deals with the desalination of cooling tower blow-down and is being conducted by ESCOM. This type of effluent is representative of a broad spectrum of industrial effluents and the results and findings of investigations into the desalination of these effluents will be widely applicable. The electrodialysis reversal process has not previously been used on cooling tower blow-down or similar effluents.

In terms of the agreement with ESCOM the Commission provides the equipment for the investigation, consisting of a module of a unit with a capacity of approximately 100 m^3/d whilst ESCOM is responsible for operation and monitoring. As a result of the experience gained with this experimental scale unit, ESCOM has installed a full scale unit at its Kriel power station for the pre-treatment of boiler water.

It is planned that the unit be used for research on the desalination of underground mine water once the investigations into cooling tower blow-down have been completed.

Chairman and Commission members appointed for a new term

Dr MR Henzen, Chairman of the Water Research Commission, was appointed for a further three-year term in this office from 1 August 1983. Dr Henzen, who also acts as Chief Executive Officer, has been Chairman since 1979 when he succeeded Dr GJ Stander who retired in that year.

At the same time it was announced that the members of the Water Research Commission for the next three-year term will be the following: Mr JF Otto (Director General of Environment Affairs and Vice Chairman of the Water Research Commission); Mr JG du Plessis (Deputy Director General, Department of Environment Affairs); Dr CF Garbers (President: CSIR); Dr DW Immelman (Director General of Agriculture); Dr JP Kriel (Former Secretary of Water Affairs and currently consultant: Special water studies for the Department of Environment Affairs); Prof DJ Schoeman (Dean of the Faculty of Engineering at the University of Pretoria); and Dr N Stutterheim (amongst others Chairman of the Council of the University of the Witwatersrand and Chairman: Telephone Manufacturers of South Africa). Mr JG Brand (City Engineer of Cape Town) is a co-opted member of the Commission.

Mr EJ Hall, former City Engineer of Johannesburg, retires after serving two consecutives terms as Commission member. In a tribute the Chairman, Dr

Henzen, said that Mr Hall was an esteemed member of the Commission, not only on grounds of his insight and wide experience, but also because, as City Engineer of the largest city in the country, he had an intimate knowledge of the pressing problems of local authorities with regard to water supply and sewage treatment which were invaluable at the deliberations of the Commission. Dr Henzen also pointed out that Commission members were appointed on the basis of their exceptional experience and knowledge of a specialised field concerning water and water research, and in this respect Mr Hall had made a significant contribution.

Professor Vorster retires

Prof PJC Vorster, Chief Adviser at the Water Research Commission, left the Commission on 28 February 1983 when he retired due to ill health. Prof Vorster studied at the University of Pretoria and at Imperial College of Science and Technology in London. He was the first professor and head of the Department of Agricultural Engineering at the University of Natal and also later Dean of the Faculty. In 1974 he became Chief Adviser at the Commission. Prof Vorster made important contributions to the activities of the Commission. This was especially evident in the fields of irrigation and hydrological research where his leadership resulted in a large number of projects being initiated by the Commission.

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Research on surface hydrology

Because hydrology is such a wide field the Water Research Commission views it in the light of the following three main aspects:

- Hydrometeorology which deals with atmospheric water as far as precipitation and water vapour are concerned.
- Surface hydrology which deals with water occurring on and near to the land surface which includes streamflow, impounded water, catchments and soil moisture.
- Ground water which deals with water occupying the interstices of deeper soil layers and underlying rocks.

Hydrometeorology is dealt with in Chapter 3, Ground water in Chapter 4, while this chapter deals with Surface Hydrology. It is recognised that these divisions are artificial because they are highly interdependant and many research projects have, of necessity, to address all three aspects. The allocation of the projects to the different sections is based largely on the projects' specific objectives and not necessarily on the scientific methodology.

The Commission's surface hydrology projects cover the following interrelated areas, viz.

- regional studies where the primary aim is to determine the temporal and spatial distribution of surface water resources;
- the development and evaluation of analytical, empirical, statistical and numerical techniques as aids to surface water resource assessment, planning and management including flood occurrences and their control; and
- process studies that are designed to improve the numerical methods and thus facilitate ultimately the prediction of the effects of changes in land-use and management on water resources in both rural and urban environments.

Two of the research projects on surface hydrology sponsored by the Commission terminated during the year, while three new contracts were negotiated.

Completion of Projects

Hydrological Research in the Ecca and Wilderness Catchments

This project was successfully completed by the Hydrological Research Unit of the Department of Geography, Rhodes University. The objective was to investigate the applicability and the use of selected rainfall-runoff models in semi-arid research catchments in the Eastern Cape and sub-humid catchments in the Southern Cape.

For the semi-arid research use was made of the catchments of tributaries of the Ecca River near Grahamstown and the data collected were used for the evaluation of a range of conceptual mathematical models of the hydrological response of catchments to rainfall. Conceptual modelling using the particular models of this study emerges as a viable technique for water resource studies and, despite their limitations, more than ten models have now been developed to a useable stage.

A weir which was used for hydrological research in the Ecca catchment.

Research on continuous streamflow modelling of South African rivers.

This project was carried out by the Department of Civil Engineering of the University of Natal. The objectives of the project centred around the development of a conceptual model using only the properties of the existing runoff records which is an unusual approach to model development.

Guide for the report *Surface water resources of South Africa*

A report *Surface water resources of South Africa* was prepared by the Hydrological Research Unit in terms of a previous research contract with the University of the Witwatersrand. This six volume series report which was released in 1982 presents guidelines for estimating water resources in South Africa. There was, however, a need for a "users guide" as well as additional information, particularly that concerning run-of-river problems and evaporation. These have subsequently been prepared in terms of a consultancy contract with Prof DC Midgley, former Director of the Hydrological Research Unit.

The guide which appears in the form of a manual for the use of the report series and the addendum containing the additional information are to be printed in 1984.

New projects on surface hydrology

An Evaluation of Hydrological Flood Estimation Techniques for Small Ungauged Catchments

A contract was negotiated with a firm of consulting engineers viz. Steffen, Robertson and Kirsten (Civil) Inc in terms of which they will undertake research on the evaluation of hydrological flood estimation techniques for small ungauged catchments. In the past there has been a great deal of research into the development of new techniques and the improvement of old ones, without an adequate, objective quantitative evaluation of their relative performances. The intention of this project is to do such an evaluation. It is expected that the results would enhance confidence in the techniques or expose weaknesses and provide potential users with a clear idea of which technique to use for their particular purpose and the expected accuracy.

Hydrological Research in Catchments of the Eastern and South-Western Cape

This project concerns an extension of the work in the semi-arid and sub-humid environments (Ecca and Wilderness respectively) and is also to be undertaken by the Hydrological Research Unit of the Department of Geography of Rhodes University. It is essentially an extension of the research on model development

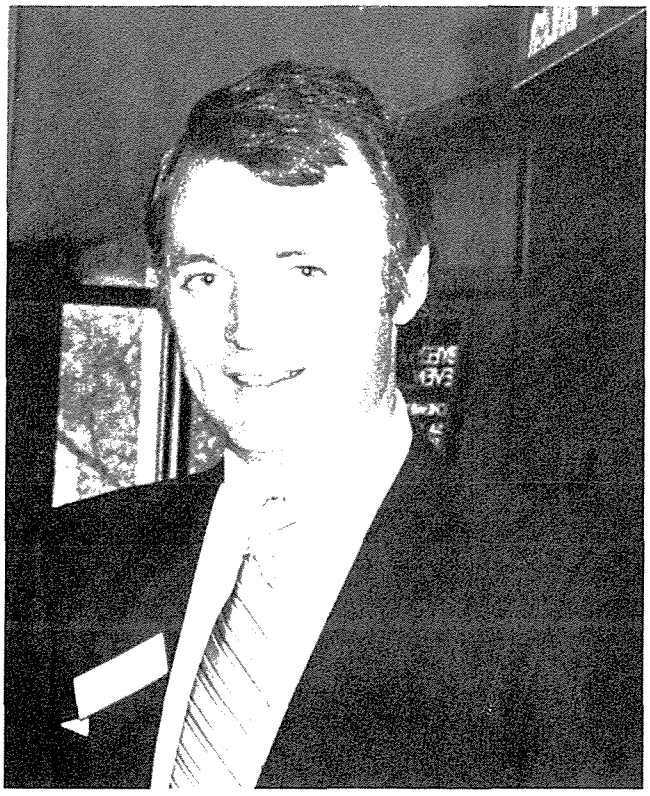
and testing with emphasis being given to those areas where weaknesses were found in present models and their use.

Establishment of Hydrological Data Banks

This project is being undertaken by agreement with the Directorate of Water Affairs of the Department of Environment Affairs. Difficulty is being experienced in obtaining suitable hydrological data for both research and applied purposes. This project plans to establish computer based hydrological data banks to overcome these difficulties. Data banks for the storage, control, evaluation and dissemination of hydrological data in computer compatible form are to be created. The Commission has provided assistance by recruiting and seconding suitable personnel to the Department to undertake this work.

Visiting scientist

Dr G Fleming of the Department of Civil Engineering of the University of Strathclyde in Glasgow, Scotland who is a leading authority on sediment yield and hydrological modelling, was invited to South Africa as a consultant to the Water Research Commission. He helped with the development of a masterplan for sediment research and also delivered the keynote address at the South African National Hydrological Symposium organised by the Commission and the Department of Environment Affairs.



Dr G Fleming from Glasgow Scotland who acted as a consultant for the Commission on sediment yield and hydrological modelling.

List of research projects on surface hydrology

- Hydrological investigation of rural catchments in Natal with specific reference to flood events. (Contract with the University of Natal — Department of Agricultural Engineering).
- Hydrological research in Zululand. (Contract with the University of Zululand — Department of Geography).
- Research on urban hydrology and drainage. (Contract with the University of the Witwatersrand — Department of Civil Engineering, Water Systems Research Programme).
- Research on continuous streamflow modelling of South African rivers. (Contract with the University of Natal — Department of Civil Engineering).
- Hydrological research in the Ecca and Wilderness catchments. (Contract with Rhodes University — Department of Geography).
- Hydrological research in catchments of the Eastern and Southern Cape. (Contract with Rhodes University — Department of Geography).
- Research on an evaluation of hydrological flood estimation techniques for small ungauged catchments. (Contract with a firm of consulting engineers, Steffen, Robertson and Kirsten).
- The establishment of hydrological data banks. (Contract with Department of Environment Affairs — Division of Hydrology).

3

Research on ground water

Ground water is important in South Africa because about 2/3 of the surface area of the country relies heavily on ground water for household use, stock watering, irrigation on a limited scale and supplying relatively small municipalities. However, the total volume of ground water used is only about 10% of the total water used in South Africa, which contrasts strongly with parts of Europe and the USA where ground water constitutes about 80% of the total water used.

The reason that ground water makes up a relatively small percentage of total water usage, is that South Africa does not have extensive highly permeable aquifers similar to those found in Europe and the USA. Our ground water is generally found in fractured hard rock which means that the storage and the rate at which it can be extracted is somewhat limited, that is, it cannot be pumped out fast enough to supply large urban areas or large irrigation schemes.

There is little doubt that South Africa has the potential to make much more use of ground-water resources. However, there are a number of problems to be faced in the regional development of ground-water resources. The situation is that there are many uncertainties about the extent of the ground-water supplies, the variations in quality of the water and the rate at which the ground water is recharged by rainfall in different areas. Finding suitable areas of high permeability and recharge in South Africa requires extensive field work over large areas, and once a suitable area has been found, it is necessary to do further research to determine the extent of the supply and the rate at which it is replenished. For this reason, the ground-water research programmes financed by the Commission in the past have been designed mainly to improve techniques of determining the exploitation potential of ground water in areas of limited surface water supply. A great deal more research on the development and application of these techniques is necessary before the extent of our ground-water resources can be adequately determined.

Shortly after the Commission was created, several research projects were initiated dealing with the determination of the exploitation potential of ground water in the Northern Cape, Southern Orange Free State and in the area of the Doornberg fault zone. Research was also carried out on the potential of the sand deposits in the Cape Flats as a source of water supply and as a storage reservoir for surplus water from the Eerste and Kuils Rivers. These projects have since been completed.

Ground-water models as an aid to study South African aquifers

At the moment the Institute for Groundwater Studies of the University of the Orange Free State is engaged in a project which deals with the applicability of ground-water computer models as aids to the study of South African aquifers. The use of ground-water models for the evaluation and management of ground-water resources is becoming popular in developed countries and the Commission has given a high priority to research that will increase the level of expertise at modelling ground-water systems under South African conditions. The Institute is work-

ing in three separate areas where each area requires a different type of model. These areas are the Sishen Aquifer, the Crocodile River system and the Atlantis Aquifer.

New research projects

Two new research projects were negotiated by the end of 1983.

- **National data bank for ground-water data**
  The Institute for Groundwater Studies will develop a national data bank for ground-water data in terms of an agreement between the Commission and University of the Orange Free State. The investigation will be carried out in close collaboration with the Division of Geohydrology of the Department of Environment Affairs. Once the data bank has been established it will be housed in the Division.

- **An investigation into rainfall recharge to ground water**
  This investigation will be carried out by a firm of consulting engineers Steffen, Robertson and Kirsten in terms of a contract with the Commission. The accurate determination of ground-water recharge by rainfall is important in order to assess the long term yield of the aquifers, either under safe-yield constraints or under conditions where the abstraction rate exceeds the replenishment rate. The primary objective of this study is to examine the potential recharge in three areas, which are hydrogeologically dissimilar and contain a number of different but commonly-found surface soil-types, using several different numerical models. The end result will be the identification of the best methodology required to enable aquifer recharge estimates to be made with greater confidence and with more general application throughout Southern Africa.

List of research projects on ground water

- The applicability of ground-water models as an aid to the study and evaluation of South African aquifers. (Contract with the University of the Orange Free State — Institute for Groundwater Studies).

- The development of a National Data Bank for ground-water data. (Contract with the University of the Orange Free State — Institute for Groundwater Studies).

- An investigation into rainfall recharge to ground water. (Contract with a firm of consulting engineers, Steffen, Robertson and Kirsten).

4

Research on hydrometeorology

In view of the fact that South Africa's water supply is derived from the atmosphere and is subject to highly variable conditions in the atmosphere, the Commission supports research that concentrates on those aspects of atmospheric sciences that have an impact on our water resources. Two of the research projects deal with rainfall stimulation, one with drought occurrences and one with the revision of the temporal and spatial distribution of precipitation statistics.

Research on rainfall stimulation

It has been estimated that the demand for water in South Africa will exceed the total available supply in 30 to 40 years' time. Timeous research on the possible alternative sources of water is therefore essential and rainfall stimulation represents one of the few possible alternatives that could provide more water of good quality.

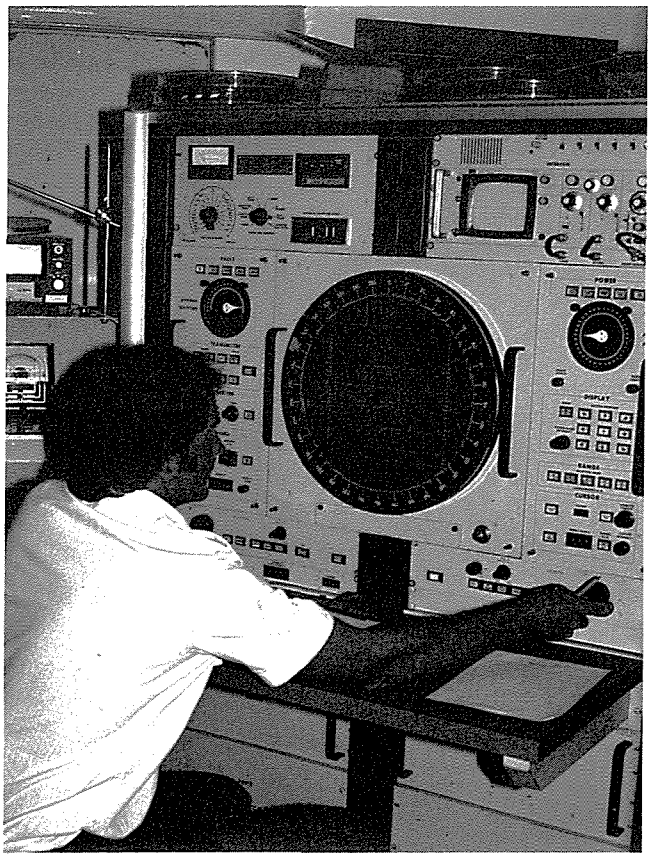
Rainfall stimulation research is being carried out in many countries including the USA, Russia, Italy, Spain, Australia and Israel but it is only in Israel where operational rainfall stimulation is being done on a large scale. According to research for over 21 years in Israel, it has been concluded that the rainfall over wide areas can be increased by about 15%, but the Israeli experiments are perhaps the only experiments that are generally accepted by the scientific community as being successful.

They have just completed their analysis of the impact of the cloud seeding programme on their agricultural sector and it would appear that the benefits to agriculture alone exceed 11 times the cost of the operation.

The research done in other countries clearly shows that the microphysical characteristics of clouds change markedly from one area to another. As a result, it is necessary to determine what the dominant local rainfall mechanisms are before one can get some idea of whether or not sufficient potential for beneficial modification exists to warrant the development of a seeding technology that is applicable for the local clouds. All the research that has been done to date clearly demonstrates that there is no short cut to this process and an investment must be made to understand the microphysical processes of the local clouds.

The rainfall stimulation research projects supported by the Commission are being carried out in two phases where the first phase is aimed at obtaining the answers to questions such as the following:

- What conditions in a cloud system make it suitable for treatment and what are the major rainfall producing mechanisms?
- If suitable conditions occur, how often do they occur and where do they occur?
- How should a suitable cloud be treated, that is, where in the cloud should treatment take place, at what stage of the cloud's development should it be treated, what seeding agent should be used, and how much seeding agent should be used?



Radar studies of clouds are carried out as part of the research on rainfall stimulation in the Nelspruit area.

The answers to these questions will allow an assessment to be made of the potential for artificial increase of rainfall.

If the first phase of research is successful then the second phase which involves cloud seeding in an experiment to change the rainfall will be investigated. In this phase the objective would be to determine the effect of the seeding on the rainfall, streamflow and the soil moisture regime.

The Commission is currently sponsoring two rainfall stimulation research projects, both in their first phase of research.

Rainfall stimulation in Nelspruit area

Cloud studies are being undertaken to assess the potential for rainfall stimulation in the area, and as has been said in Chapter 1, a non-profit company called *Company for Research on Atmospheric Water Supply* (CRAWS) has been registered, in order to carry out the research programme at Nelspruit.

Rainfall stimulation in Bethlehem area

This research project is being conducted by the Weather Bureau of the Department of Transport. This is a well established project and the contribution of the Commission is by way of secondment of some research staff and the Weather Bureau provides the infrastructure and the bulk of the financial support.

During the year the Commission brought Dr William A Cooper, from the Department of Atmospheric Sciences at the University of Wyoming, to South Africa to work on the Bethlehem project as a visiting scientist. His experience in the field of weather modification was of great value to the project and he also visited the Nelspruit project. A second component of the Bethlehem project is a study by the Hydrological Research Institute of the Department of Environment Affairs which involves the assessment of the effects of rainfall stimulation on runoff. The University of South Africa is participating in the statistical analysis of the data.

Preliminary investigation of clouds in the South West Cape

In July 1983 the research teams at Bethlehem and Nelspruit combined forces to do a very preliminary investigation of the clouds in the winter rainfall region in the South West Cape. It is stressed, however, that this investigation was designed to collect cloud physics information to obtain a first impression of the suitability of the clouds for beneficial modification and there are no plans for a more intensive research programme at this stage.

Precipitable water moving over South Africa

A report entitled *Precipitable water over South Africa* by Prof O McGee of the Department of Geography, University of Natal was released by the Commission during the year. Prof McGee was contracted to undertake studies that would give some indication of the percentage of precipitable water moving over South Africa that falls as rain. The study confirmed that the potential supply of atmospheric water is very large and research towards increasing the efficiency of the rainfall processes is desirable.

Research on drought occurrences

The Commission is presently financing a project on drought occurrences in South Africa and the research is being undertaken by the Department of Civil Engineering at the University of Stellenbosch. The objectives are to define droughts, to determine the frequency with which droughts of various intensities occur, to develop methods of drought prediction and to determine the pattern of growth and spatial extent of droughts from historical records.

Research on precipitation statistics

The research on the revision of temporal and spatial distribution of precipitation statistics in South Africa is being conducted by the Department of Agricultural Engineering of the University of Natal. The main objective is to re-evaluate the distribution of mean annual precipitation and other statistics relating to precipitation in the light of updated data.

List of research projects on hydrometeorology

- Research on the artificial stimulation of rainfall at Bethlehem (Contract with the Department of Transport — Weather Bureau).
- Programme for atmospheric water supply at Nelspruit (Contract with the Company for Research on Atmospheric Water Supply (CRAWS), subcontracting Simpson Weather Associates and Cansas International Corporation (Pty) Limited).
- Research on drought occurrences (Contract with the University of Stellenbosch, Department of Civil Engineering).
- Research on the revision of the temporal and spatial distribution of precipitation statistics in Southern Africa (Contract with the University of Natal — Department of Agricultural Engineering).

5

Research on irrigation

In South Africa, with its limited water resources and where irrigation is responsible for approximately 70 per cent of the annual water consumption, it is imperative that the maximum possible yield per unit of irrigation water be obtained. This goal is accorded high priority by the Commission in its financing of irrigation research.

The reduced water quotas made available to irrigation farmers during the drought of 1983, have emphasized once again the importance of irrigation research since it was realised that the application of research results could promote the optimal utilisation of available water. The maintenance of the productivity of available irrigation land is also of great importance, not only from a production point of view, but also to prevent the wastage of irrigation water on unproductive land.

Master plan for irrigation research

Successful irrigation research demands the best possible application of funds and manpower and this can only be achieved if research is at all times directed at the highest priorities. Furthermore, all organisations involved in irrigation in South Africa should also be involved in the identification of research needs in irrigation and the allocation of priorities.

This approach led to the establishment, in collaboration with the Departments of Agriculture and Environment Affairs, of a Coordinating Committee for Irrigation Research (CCIR). This Committee regards the development of a master plan for irrigation research as an important basis for the systematic undertaking of such research in South Africa. It was decided that the compilation of such a master plan would be facilitated by a number of workshops which were to be arranged on various aspects of irrigation. As discussed in Chapter 1, two of these workshops were held in 1983 and dealt with engineering aspects of irrigation application and drainage systems, and water supply aspects of irrigation.

It must be emphasized that the master plan for irrigation does not imply rigidity in the initiation of research projects. It will need to be progressively modified with changing circumstances and expertise.

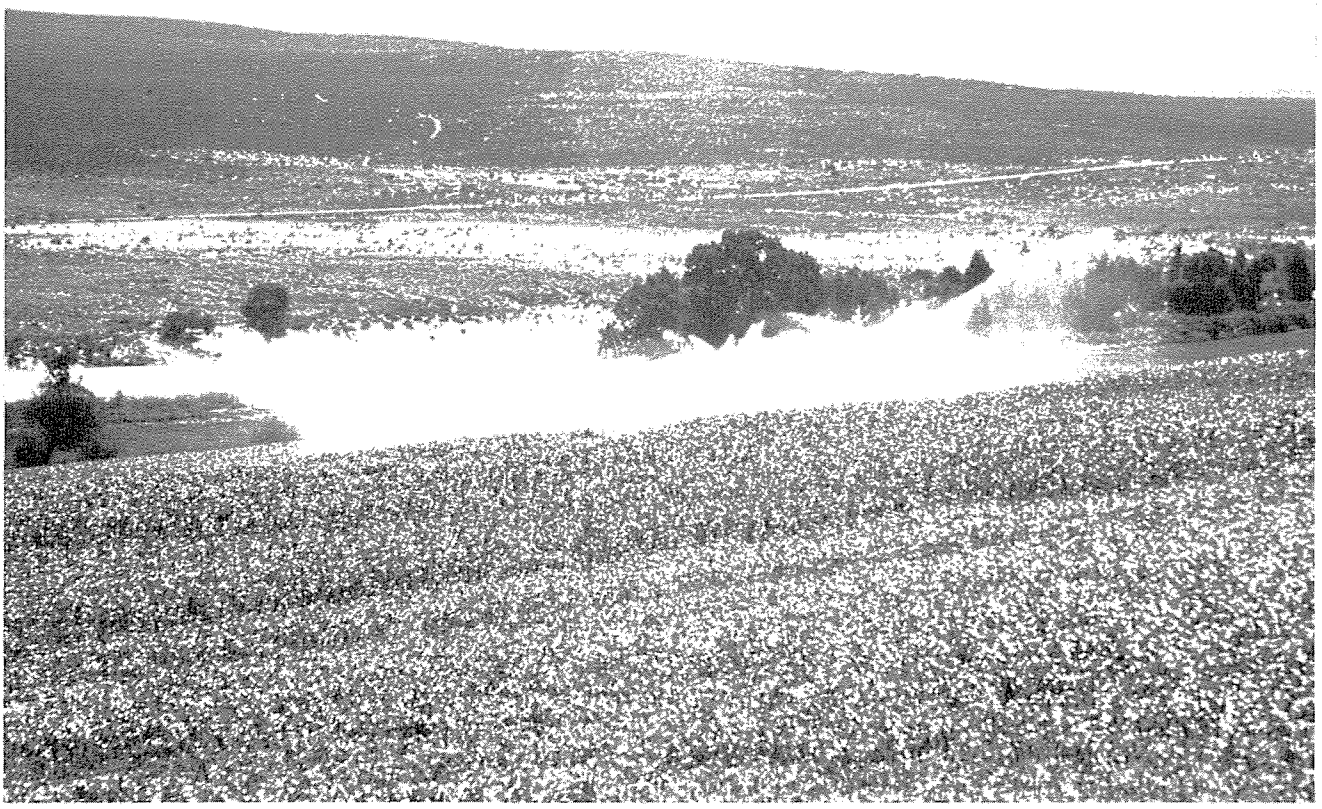
During the year the Commission financially supported ten irrigation research projects. A wide range of irrigation problems is being addressed and the projects deal with agronomic, agrometeorological, pedological and engineering aspects of irrigation. These ten projects include two that were completed and which are reported on below. Reference is also made to a new project which commenced during the year, as well as a further project which will only commence in 1984 but the contract for which was signed in 1983.

Completed research projects

- **Irrigation scheduling in the Free State region**

  This project terminated in 1982 but the final report was only distributed in 1983 and, therefore, it is covered here.

  The project was undertaken by the Department of Agrometeorology at the University of the Orange



The Commission supports several research projects on irrigation. The photograph is a typical illustration of sprinkler irrigation.

Free State and was aimed at developing a computer-based irrigation scheduling model for wheat farmers, whereby the grain yield per unit of water consumed could be maximised. Development of the scheduling technique was based on a new concept making use of two related variables, viz. the crop hydraulic conductivity and the hydraulic crop factor. The performance of the model in general was most promising but further refinement and application of the technique are currently receiving attention in a follow-up project concerning an irrigation scheduling service for wheat in the Free State region.

- **The efficiency of water extraction by different root systems**

The major objective of the project undertaken by the Department of Soil Science at the University of the Orange Free State was to determine the extent to which rooting properties of irrigated crops affect soil water uptake and water use efficiency.

Results of a previous project showed that the reduction of soil compaction through adoption of appropriate soil cultivation practices and strict control of implement traffic, beneficially influenced crop yield and water use efficiency. In this follow-up project the degree of soil compaction and reduced rooting densities of maize and wheat crops were shown to be directly related.

Mathematical relationships demonstrating the adverse effects of low values of rooting density on water movement from the soil to the root interior were established. A mathematical model was also developed for following day-to-day trends in the stress index.

The usefulness of this model as a tool for irrigation scheduling will be investigated in a new project due to commence in 1984.

New research projects relating to irrigation

During the year two agreements concerning new irrigation research projects were concluded.

An investigation into the condition of soils irrigated over a long period

The Soil Science Department of the Potchefstroom University for CHE is investigating the degree of physical and chemical deterioration of soils which have been under irrigation for a long time, in relation to similar, non-irrigated soils.

It is also the aim to evaluate the efficiency and economic justifiability of soil reclamation measures and associated management practices for soils which have suffered various degrees of degradation, largely as a result of injudicious irrigation methods.

An investigation into water use and productivity of crops under water stress, and the modelling thereof

As a result of a previous project carried out by the Soil and Irrigation Research Institute of the Department of Agriculture, certain aspects of crop behaviour under conditions of reduced water supply which require further investigation, were identified. This project consequently aims at quantifying effects of water stress on the development of the crop canopy and root system, which in turn relate to crop water use and yield. Relationships obtained during these and previous investigations will be used to develop or improve appropriate mathematical models which will be used to explore different irrigation management options for optimising crop yield and water use.

Visiting scientist

Several irrigation-related research projects supported by the Commission benefited from a brief visit to South Africa by Dr Joe T Ritchie of the United States Department of Agriculture. Dr Ritchie is a soil scientist by training and has obtained wide recognition for his work in soil-plant water relationships and crop water use modelling. Dr Ritchie also made recommendations on ways of improving the Commission's irrigation research programme.

List of research projects on irrigation

- The efficiency of water extraction from fine sandy irrigation soils by different root systems. (Contract with the University of the Orange Free State — Department of Soil Science).
- Research on the profile available water capacity of soils. (Contract with the University of Fort Hare — Department of Soil Science).
- Research on a wheat irrigation scheduling service for the Free State region. (Contract with the University of the Orange Free State — Department of Agrometeorology).
- Research on the water requirements of certain agronomic and vegetable crops. (Contract with the University of Pretoria — Department of Plant Production).
- Research on the effect of different times and intensities of internal plant moisture stress on photosynthesis, respiration and water use efficiency of certain agronomic crops. (Contract with the University of the Orange Free State — Department of Agronomy/Horticulture).
- Evapotranspiration and water use studies by means of weighing lysimeters: Evapotranspiration as a function of soil, plant and atmospheric factors. (Contract with the Department of Agriculture — Soil and Irrigation Research Institute).
- Development of the required apparatus and programmes for the monitoring and management of irrigation systems. (Contract with the University of Stellenbosch — Department of Civil Engineering).
- Research on the development of procedures for the selection of appropriate irrigation methods and for the design of irrigation systems. (Contract with a firm of consulting engineers, Murray, Biesenbach and Badenhorst).
- A detailed regional soil moisture deficit analysis for irrigation planning in Southern Africa. (Contract with the University of Natal — Department of Agricultural Engineering).
- An investigation into the condition of soils irrigated over a protracted period and an evaluation of applicable selection criteria, and reclamation and control measures. (Contract with the Potchefstroom University of CHE — Department of Pedology).

6

Research on mineralisation

The increase in the mineral pollutional loads reaching the natural water resources as a result of rapid urban, industrial and agricultural development, seriously endanger the beneficial use of these resources. Consequently the quality of these water resources become an increasingly critical factor in extending the productive use of the available supplies.

It is generally accepted that mineralisation is a serious problem facing South Africa's water resources. As a result the Commission has for many years supported research in order to establish a strategy and technology to solve problems relating to mineralisation. The focus of this research was mainly on mineralisation problems in the Pretoria-Witwatersrand-Vaal Triangle (PWV) complex. Hydrological mathematical models were developed for application and testing of various options which could be applied in practice to maintain the quality of the water supply to the area concerned at economically acceptable levels. The project has been taken over by the Department of Environment Affairs to assess the feasibility of the various options and to consider their implementation in the development of an overall water supply management strategy for the PWV area.

The Commission currently supports several research projects dealing directly or indirectly with mineralisation, e.g. the desalination projects. In this chapter, however, reference is made to research projects involved in the mineralisation in the Eastern and South-Western Cape and mineralisation in the PWV complex.

Mineralisation in the Eastern and South-Western Cape

Serious problems are experienced with mineralisation in the Great Fish, Sundays, Berg and Breede Rivers and the Commission is currently sponsoring two projects in this regard.

A study by the Department of Geography of Rhodes University concerns integrated studies of the generation of runoff solutes and sediment in tributary catchments of the Great Fish River. The aims of the project are to collect continuous data on the principal processes associated with the mineralisation of runoff in the existing semi-arid Ecca research catchments near Grahamstown; to test and improve existing hypotheses regarding natural mineralisation; to incorporate these hypotheses in the improvement of the existing hydro-salinity models; and to develop and test new models to meet future application requirements.

The second project is conducted in terms of a tripartite contract between the University of Stellenbosch (Geology Department), the Department of Environment Affairs and the Commission and involves geohydrological investigations in the Poesjenels River catchment in the Breede River Valley with special reference to mineralisation. The overall objective is to develop practical mathematical models to study the interaction of the components of a river system and to simulate the effects of measures for the control of mineralisation.

The Commission supports research on the contribution of old mine dumps to the mineral pollution of the Vaal Barrage.

Mineralisation in the PWV area

During the year a further two projects were launched concerning mineralisation of water resources in the PWV area. One project deals with the contribution of mine dumps on the Witwatersrand to the mineral pollution of the Vaal-Barrage, as reported on in Chapter 1.

The second project deals with the inhibition of bacterial oxidation of pyrite and the formation of acid mine waters. This research will be done in terms of a tripartite agreement with the University of Stellenbosch (Department of Microbiology and Virology and the Institute for Polymer Science) and the Chamber of Mines. The formation of acid mine waters is a problem which occurs widely in coal and gold mining areas and leads to serious mineral pollution of water resources. The problem is caused by the natural oxidation of pyrite and is accelerated by the action of certain bacteria.

List of research projects on mineralisation

- Research on integrated studies of the generation of runoff, solutes and sediment in the tributary catchments of the Great Fish River. (Contract with Rhodes University — Department of Geography).
- Research on detailed geohydrological investigations in the Poesjenels River catchment in the Breede River valley, with special reference to mineralisation. (Contract with the Department of Environment Affairs — Division of Geohydrology, and the University of Stellenbosch — Department of Geology).
- Research on the contribution of mine dumps to mineral pollution in the Vaal-Barrage. (Contract with the Department of Environment Affairs, and a firm of consulting engineers, Steffen, Robertson and Kirsten).
- Research on the inhibition of bacterial oxidation of pyrite and concomitant acid mine water. (Contract with the Chamber of Mines and the University of Stellenbosch — Department of Microbiology and Virology, and the Institute for Polymer Science).

7

Research on eutrophication

One of the best-known symptoms of pollution of the water environment is eutrophication, i.e. the enrichment of water with plant nutrients (mainly nitrogen compounds and phosphates) to such an extent that excessive growth of algae and nuisance aquatic plants occur. Such a situation often detrimentally affects utilisation of the water environment. It could lead, for example, to problems in potable water supply (such as the fouling of filters and the creation of bad odours and tastes); release of toxic substances by specific types of algae; a decrease in the flow rate of irrigation canals as a result of wall growth; limitations on the recreational utilisation of water; and aesthetic disturbance of the water environment.

Since its inception the Commission has supported research for combating eutrophication. In this regard two approaches are applied, firstly to eliminate plant nutrients at source, as far as possible. In this connection the Commission supports several projects aimed at the development and improvement of techniques for the removal of plant nutrients from effluents. (This is reported on in Chapter 8). The second approach is to develop methods for the management of the water environment and indeed in such a way that the influence of eutrophication will be minimised or eliminated. In this respect the Commission is currently involved in various activities, including a project on eutrophication in the Hartbeespoort Dam and one on the impact of phosphate limitation on the trophic status of impoundments.

Research on eutrophication in the Hartbeespoort Dam

This project forms part of an extensive research programme on eutrophication in the Hartbeespoort Dam, being undertaken by the National Institute for Water Research in close collaboration with the Department of Environment Affairs, the Committee for Inland Water Ecosystems of the CSIR and the Commission. The main objective of the project is to develop management strategies for eutrophic impoundments on the basis of a quantitative knowledge of their ecological performance, with special attention to the impact of the 1 mg/ℓ phosphate standard for effluents, as well as artificial destratification and several biological management possibilities.

The impact of phosphate limitation on the trophic status of impoundments

This research project aims at evaluating and predicting the impact of phosphate limitation on the trophic status of South African impoundments. The research is being done jointly by the Hydrological Research Institute of the Department of Environment Affairs and the Institute for Environmental Sciences of the University of the Orange Free State.

The results of this project will indicate the extent to which phosphate limitation in effluents will combat eutrophication. It will also serve as a basis for decisions on whether any alterations to the standard and current practices regarding the discharge of phosphates to the water environment (by phosphate based detergents, for example) should be considered.

A typical example of eutrophication: excessive growth of hyacinths in the Hartbeespoortdam.

Visiting scientists in connection with eutrophication

The Commission invited Prof G Fred Lee and Dr R Anne Jones of the Department of Civil Engineering, Texas Tech University, Texas, USA, to South Africa to present a course on the control of eutrophication and for discussions in this regard. These two scientists have become well-known as a result of the development of techniques for the prediction of the impact of various management practices for eutrophication control. The course was attended by some sixty scientists, engineers and planners and met with great success. Their approach and techniques are now to be evaluated and used, *inter alia,* in the project on the impact of phosphate limitation on the trophic status of impoundments. Prof Lee and Dr Jones also visited several eutrophication projects in South Africa and held discussions with those involved.

Dr Anne Jones and prof Fred Lee of Texas, USA were invited by the Commission to conduct a course on the control of eutrophication.

Inland water ecosystems

The Commission has again made a block grant to the Committee for Inland Water Ecosystems (CIWE) of the Cooperative Scientific Programmes of the CSIR. The CIWE is involved in stimulating and coordinating problem-directed research regarding management and utilisation of the Republic's water resources. This block grant is considered annually and awarded on the basis of a report submitted to the Commission by CIWE which deals with progress in projects in which the Commission has a direct or indirect interest.

List of research projects on eutrophication

- Eutrophication research in the Hartbeespoort Dam (Contract with the CSIR — National Institute for Water Research).
- Evaluation of the impact of phosphate limitation on the trophic status of South African impoundments. (Contract with the Department of Environment Affairs — Hydrological Research Institute, and with the University of the Orange Free State — Institute for Environmental Sciences).

8

Research on the treatment of municipal wastewater

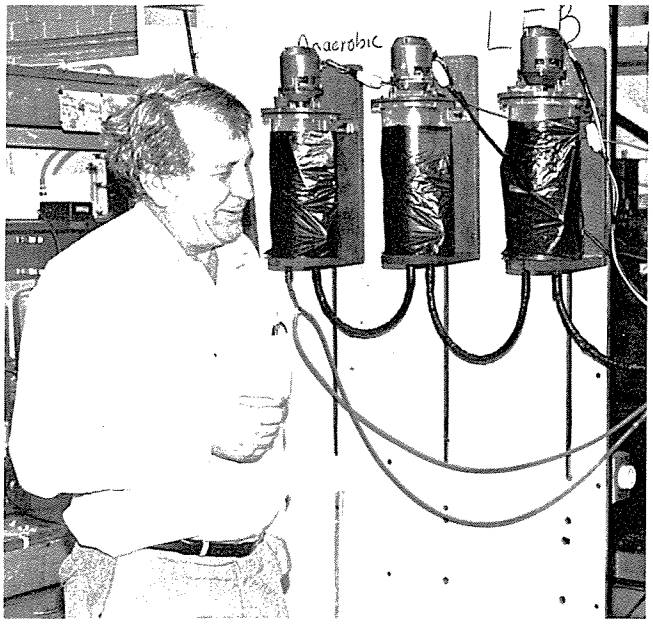
Local authorities play a key role in the optimisation of water utilisation in the Republic. They have a specific responsibility regarding the prevention of pollution by domestic sewage and industrial effluents, as well as by solid and toxic wastes and sludges. In order to produce acceptable effluents within legal quality requirements, practical and cost-effective technology is required and in this connection the Commission collaborates with local authorities and sponsors various research activities.

The Commission's research related to local authorities covers a broad spectrum of projects. This chapter, however, only deals with one research field i.e. research related to the treatment of sewage for the removal of nutrients, including plant nutrients which give rise to eutrophication.

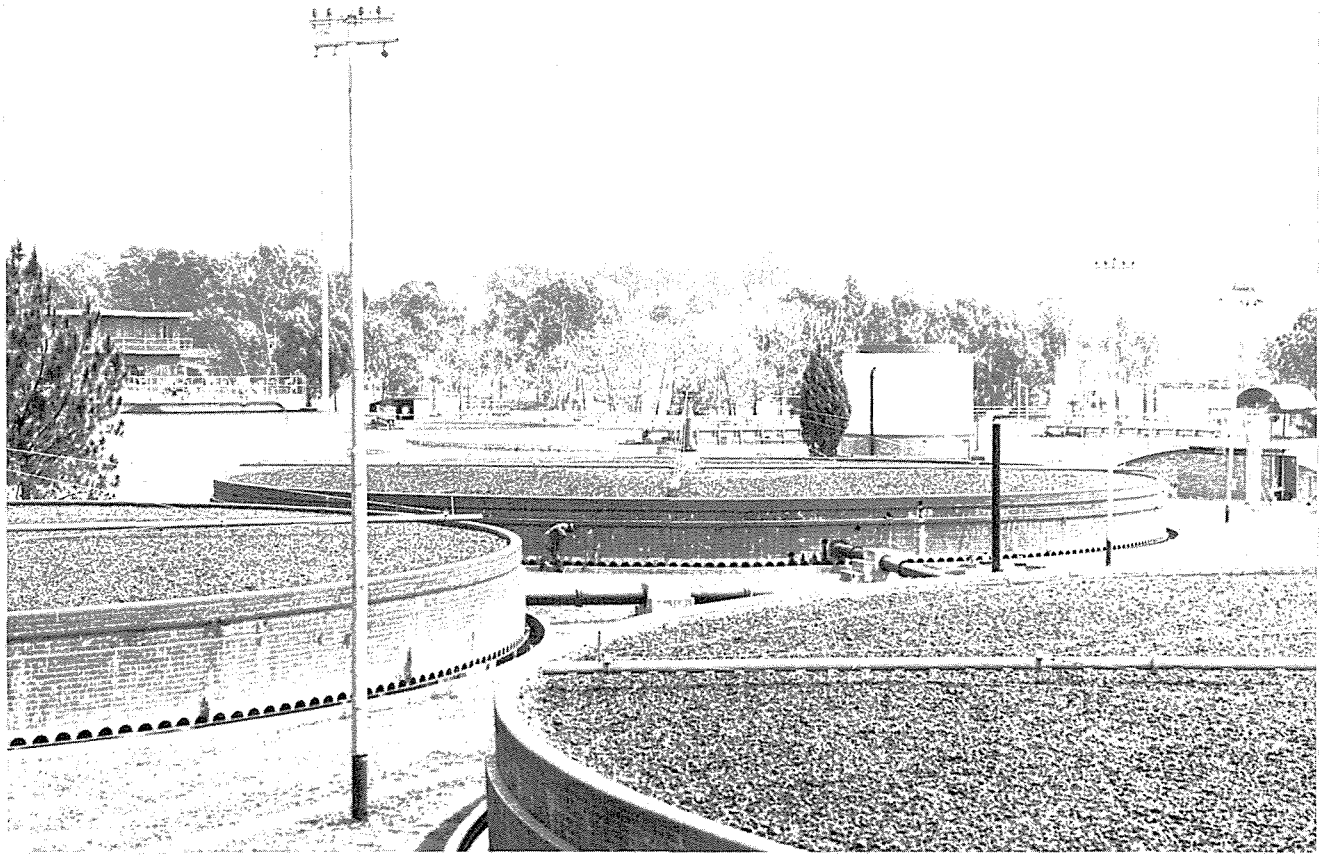
Nutrient removal in the activated sludge process

The research project on the optimisation of the modified activated sludge process for nutrient removal carried out by the Department of Civil Engineering of the University of Cape Town, terminated at the end of 1983. As discussed in Chapter 1, the results of this project together with those from previous Commission projects in this regard, have now been published in an extensive document entitled *Theory, design and operation of nutrient removal activated sludge processes.*

A new contract has been negotiated with the City Council of Johannesburg in terms of which research will be carried out on the enhancement of biological phosphate removal from sewage by altering process feed composition. The importance of the characteristics of feed sewage for biological phosphate removal became evident during a previous research project carried out at Johannesburg's Goudkoppies Sewage Works. A high quality effluent which conforms to the general and 1 mg/ℓ phosphate standard, is currently being produced.



Prof G van R Marais of the University of Cape Town in his laboratory where research is carried out on nutrient removal in the activated sludge process.



Biological filters at the Daspoort sewage works where research was conducted on chemical phosphate removal from effluents.

Nutrient removal from biological filter effluents

The research project with respect to the removal of plant nutrients from existing sewage works which comprise biological filters, was extended until April 1983 to allow for the evaluation of pre-filter nitrogen removal. Pilot tests at the Daspoort Sewage Works, Pretoria, showed that a final effluent with a total nitrogen content of about 10 mg/ℓ (as N) could be produced. When this technique of pre-filter nitrogen removal was combined with chemical phosphate removal, a high quality effluent (low in carbon, nitrogen and phosphorous), comparable to that of an effluent from a biological nutrient removal activated sludge plant, was produced.

Three organisations were involved in this project viz. the National Institute for Water Research, and the City Councils of Pretoria and Boksburg.

A guide for chemical phosphate removal from sewage effluents, mainly based on the results from this project, is being compiled. This guide will be aimed at local authorities and consulting engineering firms who require information on the design and operation of chemical phosphate removal processes.

Prof D Jenkins of the University of California, Berkeley, USA who was invited by the Commission to conduct courses on the control of sludge bulking.

Sludge bulking in the activated sludge process

The Commission entered into a two year contract with the University of Cape Town to carry out research on sludge bulking in the activated sludge process.

The phenomenon of bulking in the activated sludge process has long been recognised as an operational problem which occurs from time to time. It manifests as a sludge which has poor settling characteristics and generally results in solids which are carried over into the final effluent. This causes deterioration in the effluent quality and ultimately of pollution of the water environment.

The main objectives of the project are to determine the nature and extent of the sludge bulking problem in South Africa; to collect and synthesize all the literature on this topic and compile a guide aimed at user-organisations; and to identify research needs, if any.

Visiting scientist

In order to utilize overseas expertise on the control of sludge bulking and to assist the University of Cape Town in the execution of its project, the Commission brought Prof D Jenkins of the University of California, Berkeley, USA to South Africa. Prof Jenkins presented a series of one-day courses on sludge bulking in the activated process in Pretoria, Cape Town and Pinetown. As a result of this visit the sludge bulking project will be carried out on a cooperative basis with the Berkeley research group.

List of research projects on the treatment of municipal wastewater

- Research on the optimization of the modified activated sludge process for nutrient removal. (Contract with the University of Cape Town — Department of Civil Engineering).
- Research on biochemical processes which result in phosphate and nitrogen removal in the modified activated sludge process. (Contract with the University of Pretoria — Department of Biochemistry).
- Research on enhancement of biological phosphate removal from sewage by altering process feed composition. (Contract with the City Council of Johannesburg).
- Research on sludge bulking in the activated sludge process. (Contract with the University of Cape Town — Department of Civil Engineering).

9

Research on the treatment and disposal of sewage sludge

Throughout the world today considerable attention is being given to the treatment and disposal of sludge resulting from the purification of domestic wastewaters. In South Africa, there is no doubt that this has become one of the major problems facing local authorities.

Problems associated with sludge management have intensified in recent years due to, amongst others, restricted options for disposal. Before disposal, raw sludge must be treated in order to render it safe for such disposal. Although a variety of treatment processes are available to thicken and dewater sludges, to stabilise them and to disinfect them, most sludges are different and vary from sewage works to sewage works and within a particular works.

For land disposal of sludges in South Africa, stringent guidelines exist in order to ensure protection of the health of the public and animals. Sewage sludge which has undergone normal treatment contains a host of pathogenic micro-organisms and although quantification of the health risk associated with land disposal of the sludge is difficult, everything possible should be done to minimise that risk.

In order to assist local authorities in the effective management, treatment and disposal of sewage sludge and to develop national guidelines in this regard, the Commission embarked upon a national research programme and initiated several research projects in 1980. Two of these projects have reached finality and the final project reports have been received by the Commission. The first of these relates to sea disposal of sludge and the second to the stabilisation of sludge by means of photosynthetic bacteria.

Sludge disposal to sea

The project on sludge disposal to sea which was completed during the year, was carried out in terms of a contract with the City Council of Durban. The objectives of the research project were to address the effects of the discharge of sludge to sea at a selected site; to assess the implications of such disposal with respect to protection of the marine environment and the beaches (particularly with regard to bacteriological, virological, toxic and aesthetic considerations); and to derive a set of criteria for the discharge of sewage sludge to sea on a national basis. The monitoring programme was carried out by the National Institute for Water Research of the CSIR.

Settled sewage has been discharged to the sea by the City Council since 1968, but in terms of this contract, sludge, which was previously removed before discharge, was returned to the effluent stream for discharge to the sea through the sea outfalls. In effect, the discharge consisted of raw sewage from which detritus and floatable material had been removed.

The results of the study have shown that raw sludge can be discharged to sea under specific physical and oceanographic conditions with no deterioration or adverse trend in the quality of the surf of the beaches, the sea water, sea bed and marine organisms. The results have contributed substantially

Sampling by researchers in connection with the project on sludge disposal to sea.

towards a knowledge of the conditions and criteria under which sewage sludge could be discharged to sea in other localities along the coastline of South Africa. A national guide for such disposal is currently being prepared.

Stabilisation and disinfection of sludge

Research on the stabilisation of sludge by means of photosynthetic bacteria was carried out by the Institute for Environmental Sciences of the University of the Orange Free State. The ultimate finding of this completed project is that the use of the process for the stabilisation of sewage sludge is not recommended as an alternative treatment process, primarily because of an inexplicable failure of the cultures involved. Nevertheless, important findings with respect to the fermentation step in conventional anaerobic digestion and in the use of acid digested sludge for use in biological phosphate removal processes, have come to light.

Three other projects in connection with the stabilisation and disinfection of sludge are still in progress. These projects relate to pasteurization and thermophilic anaerobic digestion by the City Council of Cape Town; autothermic aerobic digestion by the City Council of Johannesburg; and forced aeration composting of sludge by the National Institute for Water Research. Forced aeration composting of sludge will be demonstrated in the near future and

The Commission supports research on forced aeration composting of sewage sludge.

tentative design criteria for the process will be presented. This process effectively combines the processes of stabilisation and disinfection into one and produces a relatively safe and valuable product for use in horticulture.

The two remaining projects concern sludge characterisation and mechanical dewatering of sludge and are being carried out by the National Institute for Water Research and the City Council of Port Elizabeth respectively.

List of research projects on the treatment and disposal of sewage sludge

- The stabilisation of sludge by means of photosynthetic bacteria. (Contract with the University of the Orange Free State — Institute for Environmental Sciences).
- Sludge dewatering and the treatment of sludge liquors. (Contract with the City Council of Port Elizabeth).
- Sludge disposal to sea. (Contract with the City Council of Durban).
- Autothermic aerobic digestion of sludge. (Contract with the City Council of Johannesburg).
- Pasteurization and thermophilic anaerobic digestion of sludge. (Contract with the City Council of Cape Town).
- Research into the characterisation of sludge. (Contract with the CSIR — National Institute for Water Research).
- Forced aeration composting of sewage sludge; prototype study. (Contract with the CSIR — National Institute for Water Research).

10

Research on the treatment of industrial effluents

The industrial sector is an important consumer of water — calculations are that 23% of the Rand Water Board's supply is supplied to industry (excluding mining). In order to maintain a healthy economic growth rate, this sector will steadily increase its demand on the available water supplies of the Republic. Furthermore the industrial sector has to deal with large volumes of effluents and the discharge of these could, to a greater or lesser degree, result in pollution of the water environment. It is therefore of great importance that a short, medium and long term strategy be developed to ensure that industry optimises water utilisation and that problems with respect to the treatment of effluents will be overcome. In this regard the Commission, during the past eight years, has financed twenty-one research projects at various organisations, some of which have been completed.

Special attention has been paid to the textile, fruit and vegetable processing, tannery, fish and meat industries. Research is aimed at developing and implementing the necessary expertise for sound water management and full-scale treatment of effluents, for which manuals will be compiled.

Treatment of effluents from the textile industry

In 1976 the Commission approved a master plan for research in the textile industry. The plan designated four categories of this industry for priority research, *viz* sizing and desizing, dyeing and printing, wool scouring, and washing and bleaching. The research projects in this regard are being undertaken by the Pollution Research Group, Chemical Engineering Department of the University of Natal, with financial assistance from the Commission.

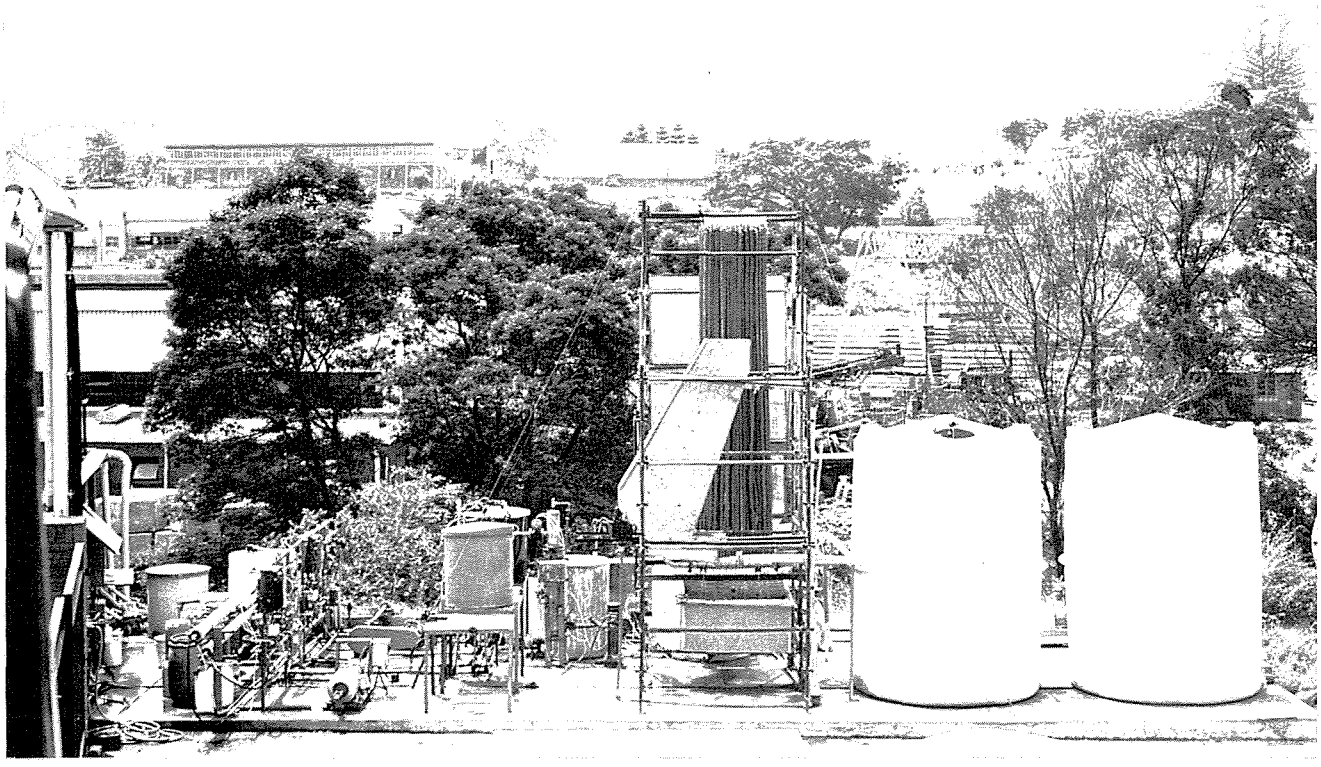
Research on sizing and desizing has successfully been completed and as mentioned in Chapter 1, the results have been published in the form of a guide. Research was done in cooperation with the firm of David Whitehead and Sons, who is currently considering the erection of a full-scale unit (based on he process developed) for the treatment of the effluent.

Research on the dyeing and printing effluents has also been successfully completed. In this regard the developed technology was demonstrated at a wool/synthetic fibre factory of Veldspun in Uitenhage and a cotton/synthetic fibre factory of Ninian and Lester in Pinetown. A full-scale unit based on the research results is being constructed at the factory in Uitenhage and this will soon be commissioned.

The research project on wool scouring effluent is being undertaken at the wool-scouring factory of Gubb and Inggs in Uitenhage. In this project a new technique was developed which altered the whole process of wool scouring and enabled reuse of the process water. The pilot plant performed successfully and a demonstration plant will be erected for demonstration to industry.

Treatment of effluents from the fish processing industry

During the year the project on shortcomings in the dry offloading systems for unloading of fish from



The unit used for the treatment of effluent from a cotton synthetic factory in Pinetown.

fishing vessels was completed, while the project on effluent treatment at fish processing factories was being continued.

A demonstration of practical techniques regarding water and effluent management problems was held on 12 April 1983 at a fishing factory belonging to Suid-Oranje Fisheries at St Helena Bay. On this occasion a report, *A Survey of Water and Effluent Management in the Fish Processing Industry in South Africa,* was presented to Mr JWE Wiley, Deputy Minister of Environment Affairs and Fisheries. This report was compiled by Binnie and Partners, the firm responsible for the investigations. An extensive manual for the treatment of effluents of the fishing industry is being prepared.

Treatment of effluents from the fruit and vegetable processing industry

Research in this regard was completed during the year and the Commission held an open day at Langeberg Cooperative's canning factory at Ashton in the Breede River Valley on 24 February 1983. On this occasion industrialists and other interested persons in the fruit and vegetable processing industry were informed of important findings regarding in-house and final effluent treatment. Pilot plants for dissolved air flotation, ultrafiltration and reverse osmosis were also demonstrated to visitors.

An operations manual on water consumption and effluent treatment in the fruit and vegetable industry is being prepared and will be published by the Water Research Commission.

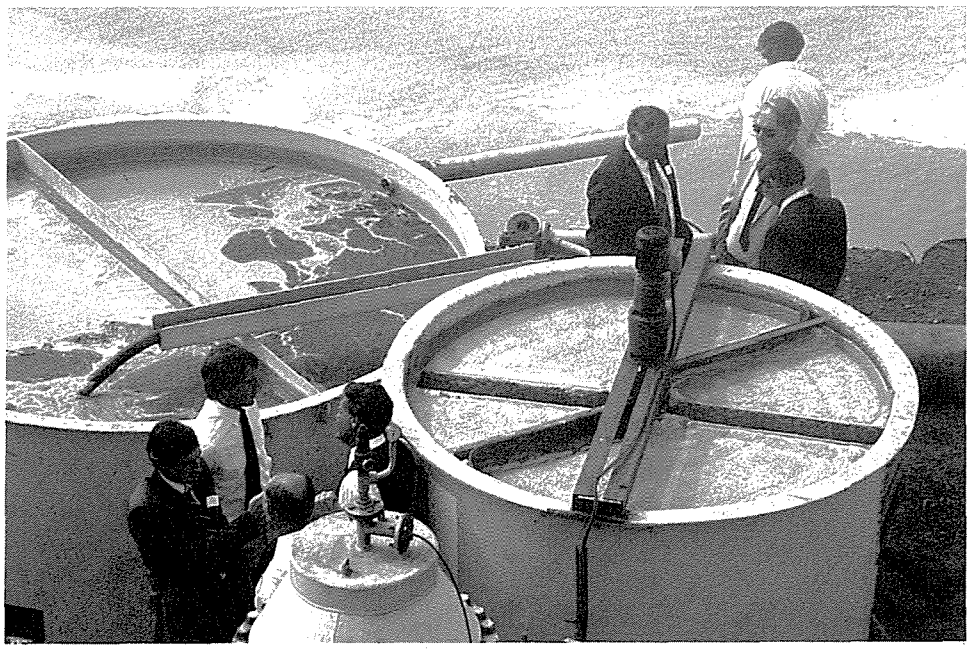
New projects concerning industrial effluents

Three new research projects commenced during the year.

The Pollution Research Group of the University of Natal commenced with a further project regarding water management and effluent treatment in the textile industry, *viz.* an investigation into the treatment of all types of washing and bleaching effluents.

A second investigation by the University relates to effluents with a high salinity as well as organic content. This type of effluent causes the most problems to local authorities who have to comply with the General Standard for the discharge of effluents. The application of advanced treatment techniques, such as membrane separation, is also being investigated.

The third project entails an investigation by a firm of consulting engineers, Binnie and Partners, into the use of physico-chemical techniques for water and wastewater management in the meat processing industry, i.e. both the red and white meat industry. The



A dissolved air flotation unit used for the treatment of fish processing effluent in St Helena Bay.

main aim is to compile a manual for the meat processing industry with a view to better water management which will lead to reduced water consumption. The manual will also contain guidelines for the planning, design and operation of full-scale plants for the treatment of effluents from this industry.

List of research projects on the treatment of industrial effluents

- Research on water management and effluent treatment in the textile industry: Wool scouring effluent treatment. (Contract with the University of Natal — Pollution Research Group, Department of Chemical Engineering).

- Research on the purification and reuse of effluents from the hides and skins curing, fellmongery and tanning industries. (Contract with the Leather Industries Research Institute).

- An investigation into the water and effluent management problems in the fishing industry: Effluent handling at fish processing factories. (Contract with a firm of consulting engineers, Binnie and Partners).

- An investigation into the water and effluent management problems in the fishing industry: Shortcomings in dry offloading systems for unloading fishing vessels. (Contract with a firm of consulting engineers, Binnie and Partners).

- An investigation into the water and effluent management problems in the fruit and vegetable processing industry: In-house optimisation of water use and effluent treatment in fruit and vegetable processing. (Contract with a firm of consulting engineers, Binnie and Partners).

- Investigations into the water management and effluent treatment in the processing of (i) pulp and paper; (ii) metals; (iii) fermentation products; and (iv) pharmaceutical products. (Contract with the University of Natal — Pollution Research Group, Department of Chemical Engineering).

- Water management and effluent treatment in the textile industry; scouring and bleaching effluents. (Contract with the University of Natal, Pollution Research Group, Department of Chemical Engineering).

- Research into the treatment of industrial effluents with high salinity and organic contents. (Contract with the University of Natal, Pollution Research Group, Department of Chemical Engineering).

- Research on and an investigation into the use of physical chemical techniques for water and wastewater management in the meat processing industry. (Contract with a firm of consulting engineers, Binnie and Partners).

11

Research on water reclamation and reuse

The reuse of water in the Republic of South Africa is of great importance since it can contribute significantly to the better utilisation of the available water resources. Reuse can be implemented in various ways, including recycling of water in industry, indirect reuse of purified effluents discharged to rivers and streams and direct reuse by means of the reclamation of water from effluents.

Indirect reuse of purified effluents is practised on a large scale in several inland areas, especially in the Pretoria-Witwatersrand-Vaal Triangle (PWV) area. In some industries, e.g. the paper and pulp industry, water reclamation and direct reuse are applied. The only place where reclaimed water is reused directly in the municipal supply, is Windhoek, South West Africa.

Since its inception the Commission has supported several research projects on different aspects of water reclamation and reuse. Attention is directed mainly at technological aspects, water quality and health aspects.

Reclaimed water as a supplementary water source

The water reclamation plant in Windhoek still serves as a supplementary source to the conventional water sources of the municipal supply. The Commission supports research done by the Windhoek Municipality and the National Institute for Water Research and which is aimed at supplying specialised services in respect of the technology of water reclamation and the quality of reclaimed water.

Demonstration of water reclamation

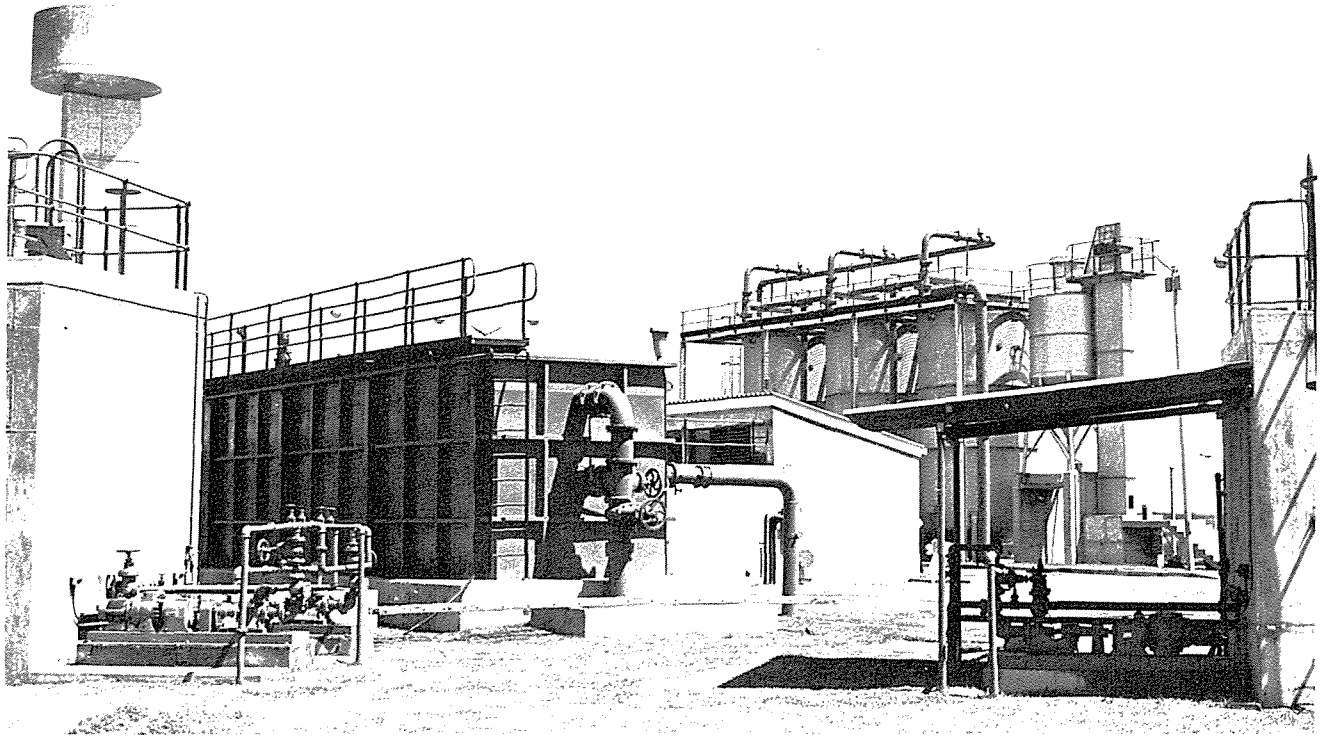
In collaboration with the City Council of Cape Town a prototype water reclamation plant for demonstration purposes was erected on the Cape Flats. It is expected that the plant will be fully optimised by April 1984 after which it will be operated as a demonstration plant with intensive water quality monitoring. The ultimate aim of this research is to develop information and expertise required for decisions on the possible application of full-scale reclamation in various areas of the country.

The use of reverse osmosis in water reclamation

Reverse osmosis is already being applied for the desalination of sea water and brackish water. However, it is also eminently suited to the reclamation of good quality water from purified sewage effluents since inorganic substances, salts and dissolved and colloidal organic material and other suspended substances are removed. Research on the application of reverse osmosis is being done by the National Institute for Water Research.

Publication on water stability

During the year, the Civil Engineering Department of the University of Cape Town, published a document entitled *Carbonate chemistry of high salinity waters.* This publication emanated from the research project on the development and application of aspects of equilibrium chemistry and precipitation kinetics on water stability problems experienced in water



The prototype water reclamation plant on the Cape Flats.

reclamation. It will contribute significantly to the technology for the desalination of brackish and sea water. For this purpose a method was developed for the correct chemical treatment for conditioning and stabilising these waters.

The removal of organic compounds from water

The Commission has initiated two research projects relating to the removal of organic compounds from water.

The removal of dissolved organic residues by means of activated carbon is one of the most important processes in water reclamation and the purification of potable water from polluted water sources. However, the mechanisms and efficiencies of activated carbon adsorption and reactivation still remain processes which cannot be fully quantified and their optimisation is therefore important. Research on various aspects of activated carbon is being done by several organisations and the Commission has coordinated the activities in one overall project. In this project the National Institute for Water Research is investigating carbon evaluation and reactivation, the Rand Water Board is doing research on pilot scale on the application of activated carbon in water purification and Klipfontein Organic Products will undertake basic and applied research especially with a view to the local manufacture of activated carbon.

The second project undertaken by the National Institute for Water Research deals with the effect of adsorption-oxidation process configurations on the quality of reclaimed water. The main objectives with this project are to investigate the removal of undesirable organic compounds, especially chlorinated compounds, and to prevent the formation of undesirable compounds by using alternative disinfectants.

Health aspects of reclaimed water

in Windhoek, where reclaimed water is used together with water from conventional sources in the municipal supply, the South African Institute for Medical Research is undertaking microbiological tests of drinking water with financial support from the Commission. Furthermore the Municipality of Windhoek, in collaboration with the National Institute for Water Research, is monitoring the water by taking samples on a regular basis for analysis. In this way the quality of the water is monitored daily to ensure compliance with the highest standards.

The project on epidemiological studies with respect to the reclamation and reuse of purified sewage effluents in the Cape Peninsula is nearing completion. Through these studies, undertaken by the Department of Public Health of the University of Cape

Town, a method for such investigations and a data base of the current disease patterns in the Cape population, have been developed. The possible effect of a change in the quality of water on the consumer can be studied by means of this method and data base. The method can be employed on a larger scale in other parts of the country since these studies are not confined to the area.

The limited number of virological analyses done on the reclaimed water from the experimental plant on the Cape Flats, confirmed earlier observations that the reclaimed water is free of viruses if properly disinfected.

On the whole it may be said that water is reclaimed successfully and on a continuous basis from purified sewage effluents and meets the highest quality requirements and does not pose any health hazards in terms of existing knowledge.

List of research projects on water reclamation and reuse

- Technological development of water reclamation on the basis of the Windhoek plant. (Contract with the Municipality of Windhoek and the CSIR — National Institute for Water Research).
- Research on the microbiological quality and health aspects of water for reuse. (Contract with the South African Institute for Medical Research).
- Epidemiological studies pertaining to the reclamation and reuse of purified sewage effluent in the Cape Peninsula. (Contract with the University of Cape Town — Department of Community Health).
- The construction and operation of the Cape Flats prototype water reclamation plant and the surveillance of reclaimed water quality. (Contract with the City Council of Cape Town).
- Research on the development and application of aspects of equilibrium chemistry and precipitation kinetics to water stability problems encountered in water reclamation. (Contract with the University of Cape Town — Department of Civil Engineering).
- Surveillance of the virological quality of reclaimed water from the Cape Flats prototype water reclamation plant. (Contract with the University of Cape Town — Department of Bacteriology).
- Research on the reclamation of secondary sewage effluent by reverse osmosis. (Contract with the CSIR — National Institute for Water Research).
- Research on the characterisation, evaluation and regeneration of activated carbon for water reclamation and water purification. (Contract with the CSIR — National Institute for Water Research; the Rand Water Board; and Klipfontein Organic Products — a division of Sentrachem).
- Research on the effect of adsorption-oxidation process configurations on the quality of reclaimed water. (Contract with the CSIR — National Institute for Water Research).

12

Research on desalination

The crippling drought in South Africa has stimulated a new interest in desalination as a supplementary source of water. Although the technology for the desalination of sea and brackish water has been developed to a large extent and is being applied elsewhere in the world, the cost of desalinating sea water still remains relatively high when compared with water derived from conventional sources, *viz* R1,50 to R2,00/m^3 as against 30c to 40c/m^3. Desalination can therefore be used as an emergency measure during critical drought situations or, where necessary, as a standby supply source.

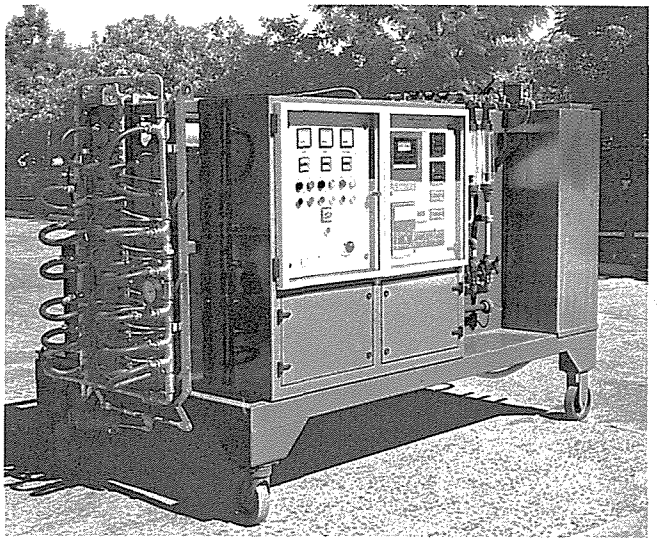
In the past the Commission has supported research projects on the desalination of sea and brackish water by means of reverse osmosis. Particular attention is currently focused on the following: desalination of mineralised effluents such as underground mine waters and cooling tower blow-down; water reclamation and desalination of purified sewage effluents (as reported in Chapter 11); and development of membranes and membrane support systems for reverse osmosis and ultrafiltration.

Desalination of underground mine water

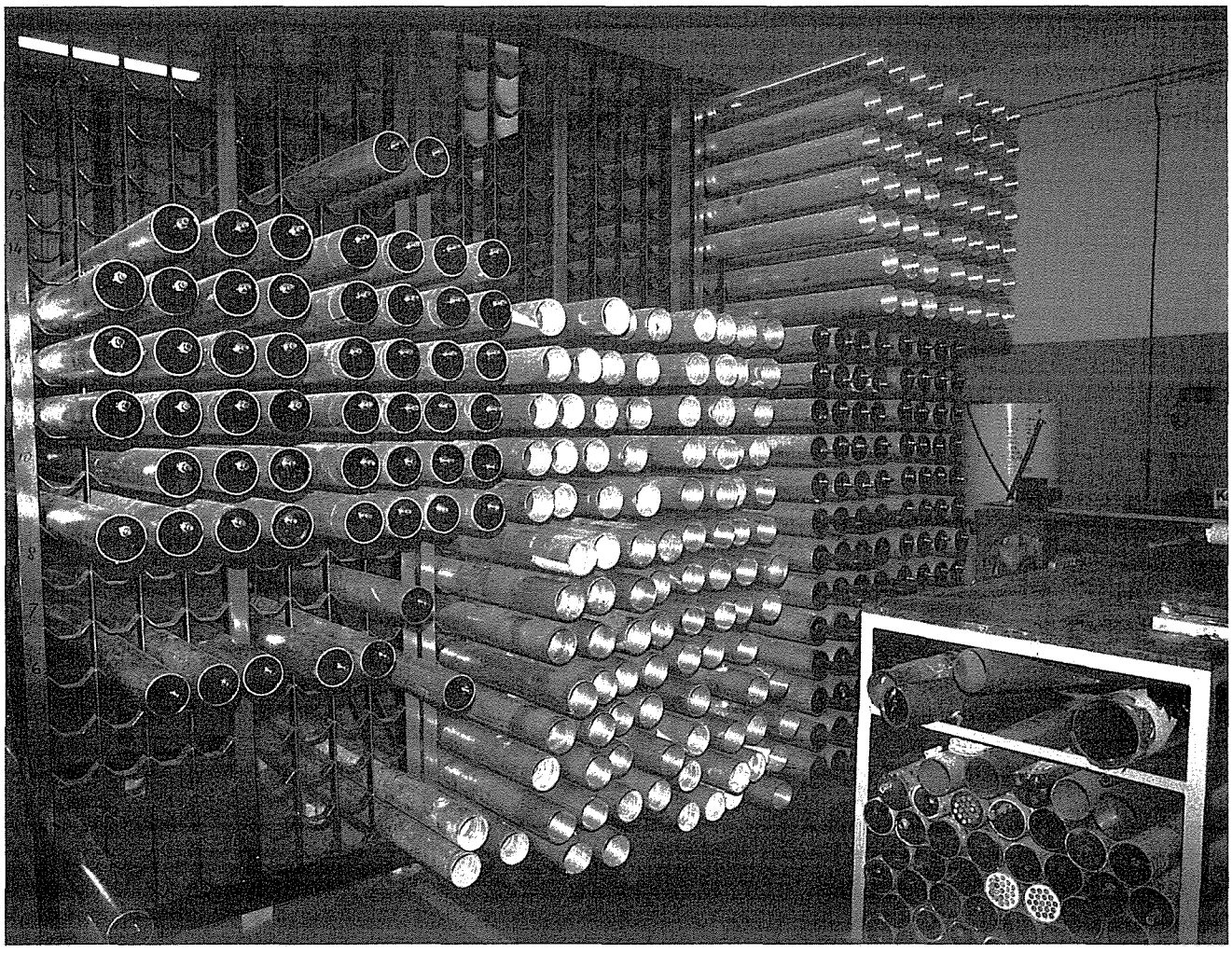
Underground mine water is a large point source that contributes to the salt load of the Vaal River system. As a result, and with a view to the reclamation and use of underground mine waters to enable mines to become more self-sufficient with respect to their water requirements, the Commission supports research by the Chamber of Mines on the desalination of underground mine water.

Desalination on cooling tower blow-down

Cooling tower blow-down is another point source of pollution that contributes significantly to increased concentration of dissolved salts of inland water resources. As mentioned in Chapter 1, the desalination of this water, by means of an electrodialysis reversal process is being researched by ESCOM in terms of an agreement with the Commission.



A locally produced reverse osmosis membrane unit. The Commission supports research on the application of reverse osmosis for the desalination of various types of effluents.



Locally produced modules used in reverse osmosis membrane units.

Development of membranes and membrane support systems for reverse osmosis and ultrafiltration

The Institute of Polymer Science at the University of Stellenbosch is currently engaged in two research projects in the above-mentioned regard, with financial support from the Commission. These membranes and support systems are being developed specifically for the desalination of effluents by means of reverse osmosis and ultrafiltration. The projects also aim to establish local expertise for the production of membranes and modules.

CRD committee for desalination

During a meeting on 26 October 1983 the Co-ordinating Research and Development Committee for Desalination updated the Master Plan for Desalination Research.

List of research projects on desalination

- Research on and development of polymeric membranes and supplemental coatings for reverse osmosis and ultrafiltration. (Contract with the University of Stellenbosch — Institute for Polymer Science).

- Research on and development of membrane support systems for reverse osmosis and ultrafiltration (Contract with the University of Stellenbosch — Institute for Polymer Science, and the CSIR — National Institute for Water Research).

- Research on the desalination of mine water. (Contract with the Chamber of Mines).

- Evaluation of electrodialysis reversal for the desalination of effluents and brackish water. (Contract with ESCOM).

13

Research on water economy in urban areas

Water consumption in urban areas, including both the domestic and industrial sectors, is continually rising and the economic use of water in these areas could result in considerable savings in the country's water balance as a whole. This fact was repeatedly stressed during the drought in 1983 and several actions were introduced by various authorities to save water. The need and potential of water economy in urban areas, was also early recognised by the Commission and since its inception various research activities were initiated in this regard. One of these was the establishment of a Co-ordinating Research and Development Committee to identify research priorities for water economy measures and to coordinate research and evaluate results. A master plan for research in this field was prepared, and subsequently research projects were formulated. These were done in view of the excessively high per capita water consumption in many instances and the extent of "unaccounted for" losses in many municipal distribution systems.

The first projects included investigations into water losses in distribution systems and into water consumption patterns, both in terms of contracts with the University of Pretoria. Based on these results a follow-on project was developed for research on water economy measures in urban areas as well as a project concerning leak detection in water supply distribution systems.

Water economy measures in urban areas

The research is carried out in terms of a tripartite agreement between the CSIR (through its National Building Research Institute — NBRI), the SABS and the Commission.

The objectives are to achieve a meaningful saving of water in urban areas through improvements in the design of water supply fittings; to reduce wastage of water through user education; and to draw up water regulations which will enable uniform control of urban water consumption. The SABS is developing National Water Supply Regulations and a Code of Practice for Plumbing and the NBRI is investigating all aspects of urban water use and is producing basic material for inclusion in the said Regulations and Code of Practice.

Positive technology transfer has already been achieved by the NBRI in that manufacturers have incorporated several of the recommendations which emerged during the course of the project in the design of various water supply fittings. Based on the research findings to date, a variety of proposals have been formulated for inclusion in the National Water Supply Regulations and for updating SABS standard specifications for water supply fittings.

New research project on leak detection

Although the exact amount is not always known, there is agreement that vast volumes of water are lost through leakage from water distribution networks. As said in Chapter 1 the Commission initiated a project to be carried out by the National Building Research Institute of the CSIR into leak detection and repair in water supply distribution systems in South Africa. The aim is to prepare a manual on leak detection and repair programmes for local use.

Several demonstrations of leak detection in various parts of the country have been arranged by the Commission.

Demonstration of leak detection

The Commission arranged several demonstrations in various parts of the country to introduce the latest equipment for the detection of leakages in water pipes. As this equipment was not yet available in South Africa, the Commission collaborated with local companies to bring representatives of the manufacturers concerned together with their equipment to this country, in order to explain and demonstrate its operation. The equipment includes an electronic device known as a leak noise correlator which has recently become available overseas, but very little was known locally about its operation. This equipment is capable of pinpointing the location of underground leaks with a very high degree of accuracy and is unaffected by extraneous noises which have proved to be a limitation of acoustic devices used up till now.

List of research projects on water economy in urban areas

- Research on water economy measures for water distribution systems in urban areas. (Contract with the South African Bureau of Standards and the CSIR — National Building Research Institute).

- Research to investigate leak detection in water supply distribution systems. (Contract with the CSIR — National Building Research Institute).

14

Research on water economy at power generating stations

It is estimated that approximately two-thirds of the water used by industry in South Africa (excluding mining) is required for cooling purposes, especially at power generating stations. However, large volumes of water are lost during the wet cooling process. It is calculated that in a 3 600 MW wet cooled power station the volume of water lost through evaporation (together with relatively small volumes of water used for other purposes) amounts to 120 000 m^3 per day. If wet cooling could therefore be replaced by dry cooling, considerable water economies may result.

Dry cooling differs from wet cooling in that water flows through cooling elements and is therefore air-cooled wothout evaporation taking place. Although dry cooling effects considerable water savings, it suffers two disadvantages. Firstly, the capital cost for a dry cooling unit greatly exceeds that of wet cooling. Secondly, dry cooling is somewhat less efficient, necessitating the use of more coal for the same amount of energy generation than with wet cooling. Dry cooling systems therefore, should be made to operate as efficiently as possible.

The Commission currently supports three research projects in connection with dry cooling at power generating stations.

Optimisation of dry and dry-wet cooling

In terms of an agreement with ESCOM and the CSIR, research is directed at two aspects. First, the effect of atmospheric conditions such as wind and temperature inversions on the efficiency of cooling is being investigated. The second aspect being investigated is the effect of various environmental factors such as moisture content and pollution on the corrosion of various types of cooling elements.

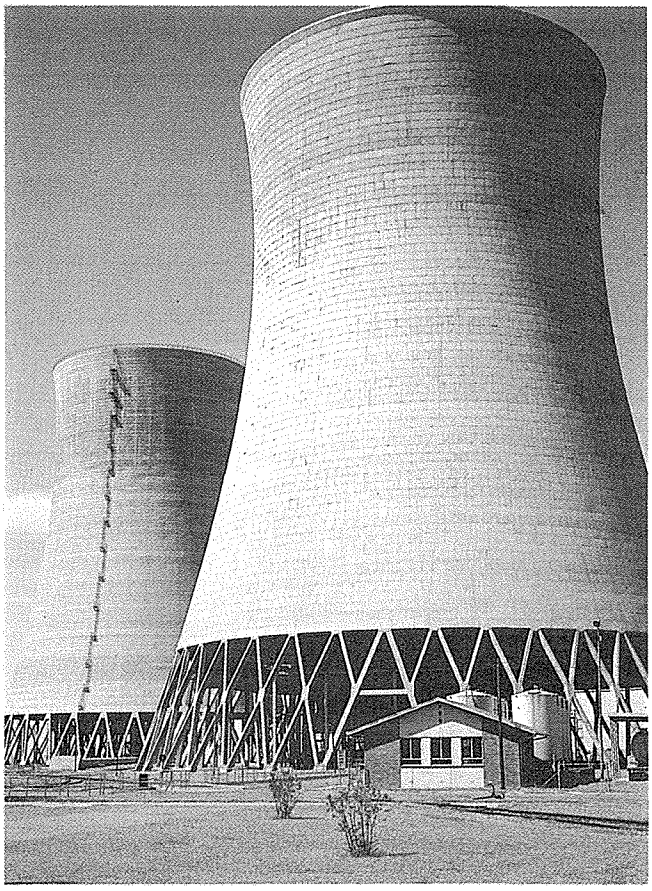
In terms of another agreement with ESCOM and the CSIR the optimal siting of dry cooling units is being investigated with a view to the prevention or suppression of warm air circulation which will result in more effective cooling. These investigations are being conducted in a wind tunnel at the CSIR.

Computer program for evaluating dry cooling systems

The cooling elements used for dry cooling play an important role in the process since they represent a considerable part of the capital cost involved and their characteristics affect cooling efficiency. In view of the fact that a variety of cooling systems and cooling elements are available, it is important that techniques be developed for the evaluation and possible optimisation of the efficiency of the various possible combinations of systems and elements. The only way in which all variables can be accommodated in such an evaluation technique is by means of a computer program and the aim of the work being undertaken by the University of Stellenbosch, is to develop such a program.

Visit to a dry cooling unit

During an open day at the Grootvlei power station on 23 March 1983 and on the invitation of ESCOM, members of the Commission together with represen-



Research on dry cooling is being undertaken at ESCOM's power station.

tatives of the Directorate of Water Affairs and other guests were afforded the opportunity of taking a closer look at dry cooling. In addition to the visit to a dry cooling tower, lectures on dry cooling were also given.

List of research projects on water economy at power generating stations

- Research on the optimisation of dry and dry-wet cooling systems at power stations in South Africa. (Contract with ESCOM and the CSIR — Atmospheric Sciences Division, and Corrosion Research Division).

- Wind tunnel studies on the effect of the orientation of cooling units on warm air recirculation and efficiency of air cooled systems. (Contract with ESCOM and the CSIR — National Mechanical Engineering Research Institute).

- The development of computer evaluation techniques for dry cooling systems. (Contract with ESCOM and the University of Stellenbosh — Bureau for Mechanical Engineering).

15

Research on analytical techniques regarding water quality

Before application water must conform to certain requirements and these requirements or quality norms are determined by the specific purpose for which the water is to be used. When quality norms are determined, it is important that reliable analytical techniques should be available in order to establish whether the water conforms to the requirements. Reliable analytical methods are also needed to obtain more information on the constituents present in the water. It is equally important that existing methods be revised and updated from time to time, and that new methods be developed in order to keep pace with changing circumstances and requirements, especially as far as new chemical compounds are concerned. Routine analytical laboratories may not always have the manpower and facilities available for the development of methods. Because of the importance of water quality the Commission established a CRD committee for Water Quality some years ago. This Committee concerns itself, inter alia, with analytical techniques for the chemical analysis of water. During the year the Commission also supported a research project at the University of Pretoria on analytical methods.

CRD Committee for Water Quality

The development and improvement of analytical techniques represent one facet only of water quality determination. There are other facets that are of importance, e.g. sampling at a particular point, the number of analyses required to obtain a measure of variability in quality, the interpretation and publication of the water quality of the country's supplies, etc. The CRD Committee for Water Quality which deals with all these aspects has gained new momentum and it is planned that it will feature prominently in respect of the determination, interpretation and publication of the country's water quality.

Determination of sulphate and alkalinity

In collaboration with various organisations responsible for water analyses, it has been established that determination of sulphate and alkalinity, in particular, creates problems and that these should therefore enjoy priority in any research programme involving auto-analyses of water. Sulphate and alkalinity are important to water quality and current methods for analysing these are subject to interference. Results vary in accuracy and are often not reproducible. As a result, analyses often have to be repeated.

In terms of an agreement with the University of Pretoria, the Chemistry Department of the University is undertaking research on the auto-analysis of sulphate and alkalinity by using the flow injection technique. Methods for these analyses will be developed for potable, surface, ground and wastewater.

Research project on analytical techniques regarding water quality

- Research on the auto-analysis of sulphate and alkalinity in water. (Contract with the University of Pretoria — Department of Chemistry).

16

The transfer of information and technology

In terms of the Water Research Act the Commission has a specific responsibility for the promotion of information and technology transfer, and in doing so, follows the following basic plan of action:

Partnership research

Partnership research is regarded as the most effective method for successful technology transfer. This partnership principle is incorporated, as far as possible, in research contracts, which means that the potential user of the results becomes involved in the planning, formulation and execution of research.

The South African Water Information Centre

The South African Water Information Centre was established in 1974 by the Water Research Commission after consultation with the CSIR and the then Department of Water Affairs. It is operated as an independent unit on behalf of the Commission, and under contract by the Centre for Scientific and Technical Information of the CSIR, and provides various information services in the water and related fields.

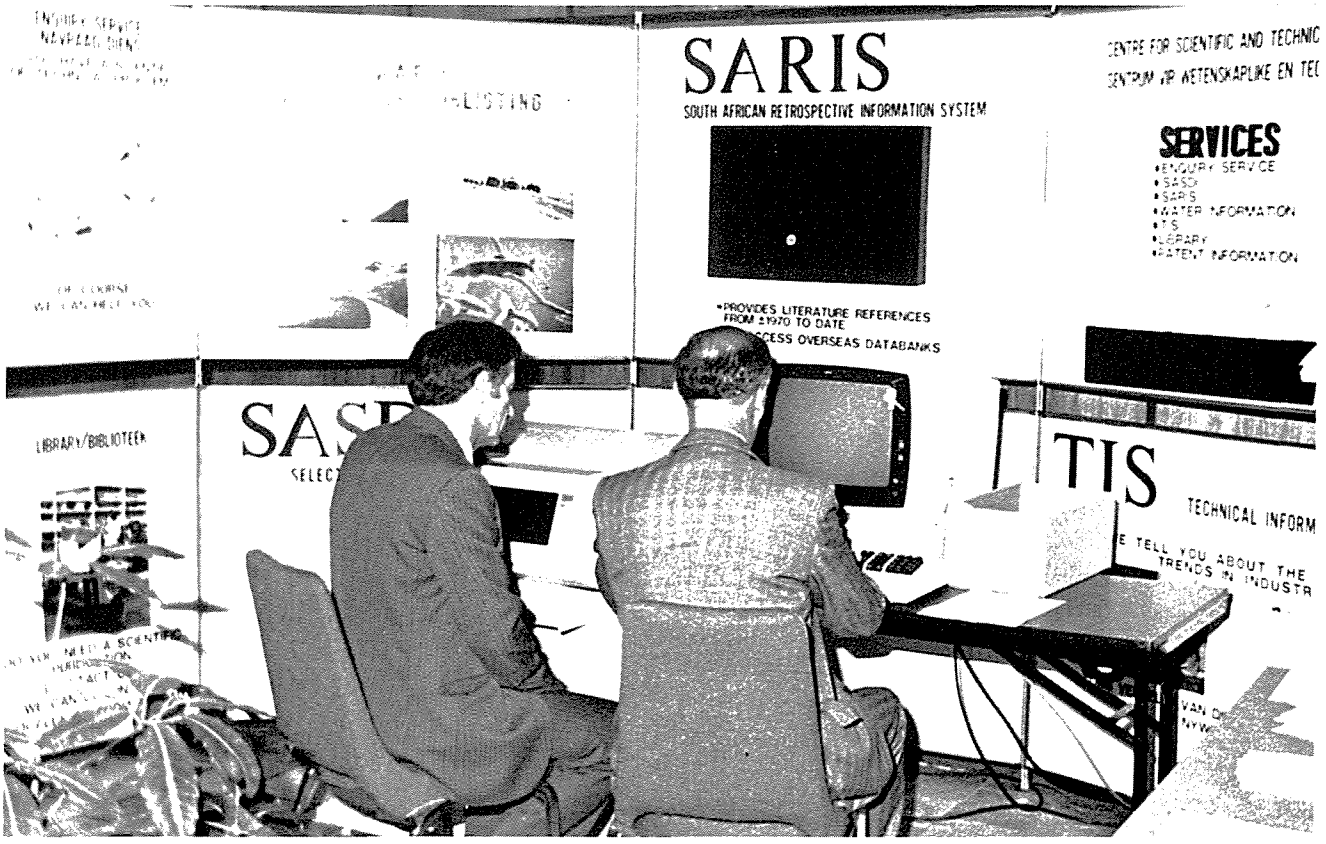
The Centre is an important component in water research and in the activities of the water community of South Africa. It has a national character with its own identity and operates under its own name, thereby providing a centralised point of access for all persons and organisations using information sources and services in connection with water.

The Centre has developed a computerised bibliographic data base *Waterlit* and during the year approximately 550 scientific and technical journals were selected by a team of graduate indexers for articles on water to be included in the data base. In addition to these articles, reports, theses, book patents and conference proceedings are also indexed. The data base already contains some 80 000 items and approximately 1 300 new items are added monthly. Since May 1983 American reports on water, supplied by the American National Technical Information Service, are also being included in *Waterlit*. These reports are derived from the Government Report Announcements (GRA) data base.

During the year the Centre operated approximately 225 SDI (selective dissemination of information) profiles, and approximately 800 retrospective information searches are done annually on the *Waterlit* data base, the majority by the Centre. However, searches are also done on *Waterlit* by other organisations such as the Centre for Scientific and Technical Information's regional offices in Durban and Port Elizabeth, the library of the Department of Environment Affairs and at some of the Universities' libraries.

Universities still remain the largest users of the Centre's services, followed by the CSIR, the Department of Environment Affairs, industries, consulting engineers and municipalities.

Since September 1981 *Waterlit,* in terms of an agreement with System Development Corporation (SDC) in the USA, has been made available on a world-wide basis through SDC's on-line information retrieval ser-



The South African Water Information Centre which is financed by the Water Research Commission, arranges regular demonstrations during conferences.

vice. An additional contract has also been negotiated for the rendering of SDI services on *Waterlit.*

During the year the Centre also compiled a hydrological register containing information on hydrological data in South Africa. The register contains, inter alia, a list of names of organisations in possession of such data together with details about the data.

The Centre also provides a current awareness service and the periodical *Selected Journals on Water* is distributed monthly to 120 subscribers.

Mass media

In this regard the accent falls on information transfer and press releases, radio and television are used to this end.

Publications

The Commission's publications provide for three levels, *viz* pure scientific, popular scientific and practical scientific levels.

Water SA

Water SA is the Commission's scientific journal which contains original research articles and review articles on all aspects of water science, technology and engineering. The first edition was launched in 1975 and the journal appears quarterly. All articles submitted for publication in *Water SA* are referred first to referees and thereafter a decision is taken on publication.

There are approximately 2 900 subscribers of whom some 900 reside abroad. It enjoys world-wide coverage and is included in the following abstracting services: Chemical Abstracts; Biological Abstracts; Engineering Index; Pollution Abstracts; Oceanic Abstracts; Current Contents Science Citation Index; Water Resources Abstracts (American Water Resources Association); Hydata; Selected Water Resources Abstracts; Desalination Abstracts; Waterlit; Water Research Centre Information; Aqualine; Abstracts Journal (Institute of Scientific Information of the USSR Academy of Science); Soils and Fertilizers (including Irrigation and Drainage Abstracts); Information Eaux; ISP Index and Abstracts; Cambridge Scientific Abstracts; Dokumentation Wasser; and Institute for Scientific Information.

SA Waterbulletin

This bilingual newsletter which was launched in August 1975 by the Commission and which appears quarterly, contains articles, news snippets and items of interest on local as well as overseas aspects of water. Activities of various institutions in the water field in the Republic are highlighted in the Bulletin.

During the year under review the bulletin's firmly established columns such as "technology transfer" and "new equipment and processes" again received an excellent response and many enquiries were dealt with.

Special editions of *SA Waterbulletin* appear from time to time and deal with a specific subject or aspect of the Commission's activities, and are aimed at the transfer of information to groups with special interests. During the year under review an issue was devoted to the WRC's involvement in effluents of the textile industry, and more than 7 000 copies were distributed.

Publication on research projects

During the year a new publication entitled *Research projects for 1982* was published. The publications deal only with projects current during 1982 and of which a few have since been completed. After the objective of the project has been discussed a concise report of each project is presented together with publications emanating from it.

Manuals and reports

At the conclusion of a project, and also whilst research is still under way, results are evaluated in respect of possible application and depending on the nature of the results a decision is taken on its publication, dissemination and application.

More information on these publications appears in the relevant chapters and in the Appendix.

List of publications of the Commission

The Appendix to this Annual Report contains a list of publications (articles, papers and published reports) which appeared during 1983 and which emanated from research supported wholly or in part by the Commission.

Column in IMIESA

Since January 1979 a column on the Water Research Commission has been appearing monthly in *IMIESA,* the official organ of the Institution of Municipal Engineers of South Africa. Since its inception in 1971 the Commission has developed a wide range of activities which are of direct importance to local authorities. The column endeavours to provide a continuous feedback of information to local authorities in an effort to inform them regularly of the activities and research being done in their interest.

Conferences, seminars, workshops and demonstrations

From time to time the Commission, on its own or in cooperation with other organisations, arranges such meetings. These afford ideal opportunities for promoting personal contact between research scientists, or between research scientists and the users of research results. In this way the transfer of information and technology is greatly enhanced.

More information on meetings held during the year is contained in the individual chapters.

Utilisation of overseas expertise

It is in the national interest that overseas expertise and knowledge be used where these are not available locally and the Commission has developed various methods to achieve this. Overseas specialists, for example, are used as consultants and the Commission from time to time sends study groups overseas in order to obtain information on a specific problem area. More information in this regard appears in the individual chapters.

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Financial statements

The Statement of Income and Expenditure and the Balance Sheet have been drawn up in terms of section 14(2) of the Water Research Act, 1971, (Act no. 34 of 1971), as amended and certified by the Auditor-General and cover the period 1 January to 31 December 1983.

The Commission derives its income from rates and charges on water usage and on scheduled irrigation land. The tariffs for the 1983 financial year were 0,35 c/m^3 for water supplied for urban, industrial or domestic use, and 60 c/ha of land scheduled for irrigation.

WATER RESEARCH COMMISSION

STATEMENT 1

Balance Sheet as at 31 December 1983

1982	Liabilities	1983	
R		R	R
	Sundry creditors —		
63 453	Revenue paid in advance		109 652,10
	Fund account —		
7 364 903	Balance at 31/12/82	7 364 903,31	
	Plus: Excess of income over expenditure, 1983	1 322 270,88	
			8 687 174,19
R7 428 356			R8 796 826,29

1982	Assets		1983	
R		R	R	R
	*Capital assets —			
5 000	Land (Cost)		5 000,00	
	Motor vehicles	14 873,05		
	Less: Depreciation	3 257,33		
5 810			11 615,72	
	Office Equipment	102 607,59		
	Less: Depreciation	4 556,37		
77 469			98 051,22	
	Office Furniture	31 543,25		
	Less: Depreciation	1 486,43		
29 156			30 056,82	144 723,76
	Loan			1 944 406,50
	Investments		4 122 320,18	
	Plus: Accrued interest, 1/10/83 to 31/12/83		137 072,52	
5 055 318				4 259 392,70
	Current assets —			
	Sundry Debtors —			
	Outstanding revenue:			
	Prior to 1983	61 903,47		
	1983	732 014,89		
843 088			793 918,36	
1 227 304	Project advances (Statement 3)	1 424 057,88		
19 107	Subsistence and transport advances	3 263,90		
81 211	Motor financing	43 996,24		
200	Deposits	200,00		
			1 471 518,02	
150	Cash on hand		150,00	
84 543	Cash in bank		182 716,95	
				2 448 303,33
R7 428 356				R8 796 826,29

*Capital assets purchased by organisations by means of research grants are not included.

Pretoria, 30 March 1984

(Sgd.) M.R. HENZEN
Chairman

The above Balance Sheet has been audited in accordance with the provisions of section 42(4) of the Exchequer and Audit Act, No. 66 of 1975, read with section 14(1) of the Water Research Act, No. 34 of 1971, and in my opinion it has been drawn up as to reflect a true and fair view of the financial affairs of the Water Research Commission.

Office of the Auditor-General,

Cape Town, 1 May 1984

(Sgd.) A.P. ELLIS
Auditor-General.

WATER RESEARCH COMMISSION

STATEMENT 2

Income and Expenditure Account for the year ended 31 December 1983

1982	Expenditure		1983
R		R	R
1 063 345	Salaries and allowances		1 224 659,86
35 863	Subsistence		37 338,44
4 484	Motor transport		3 764,81
135 853	General transport		146 397,86
3 200	Commission members' allowances		1 850,00
10 727	Postal and telegraph services		8 889,85
16 197	Telephone services		22 557,10
19 301	Printing and stationery		15 085,23
3 293	Advertisements		5 274,18
92 036	Publications and Information		117 231,59
12 836	Technology and information transfer		27 346,98
11 142	Lease and maintenance of office equipment		12 520,33
19 941	Entertainment		9 964,23
35 873	Office rental		41 420,10
3 739	Maintenance of and alterations to offices		2 697,12
3 785	Electricity		4 701,48
38	Maintenance and lease of furniture		—
400	Typing services		821,91
4 461	Insurance and licenses		4 685,32
58 674	Collection fees		70 279,60
1 131	Audit fees		1 065,00
1 937	Legal costs		12 740,00
14 125	Registrations and subscriptions		13 303,43
5 610	Miscellaneous petty expenses		7 472,41
6 613	Depreciation		9 300,13
4 053 242	Research projects (Statement 3)		3 488 848,53
	Contracting of researchers and expertise:		
195 908	Weather modification at Bethlehem	181 610,20	
55 782	Evapotranspiration and water use studies by means of weighing lysimeters	70 971,37	
75 281	Digitizing of autographic raingauge data	2 538,04	
—	Establishment of Hydrological data banks	16 001,40	
			271 121,01
162 400	Research and other grants		214 338,77
191 743	Specialist and consultation services		307 405,53
199 151	Excess of income over expenditure		1 322 270,88

1982	Income			1983
R		R	R	R
	Rates:			
	Government irrigation schemes with canal systems:			
	Received		38 295,37	
	Plus: Outstanding 1983		89 512,48	
86 615				127 807,85
	Irrigation Board Schemes:			
	Received	71 672,24		
	Less: Adjustment in respect of previous years	1 779,74		
			69 892,50	
	Plus: Outstanding 1983		1 487,64	
72 729				71 380,14
	Changes:			
	Metered water from Government schemes			
	Received	4 564 570,34		
	Less: Adjustment in respect of previous years	2 422,50		
			4 562 147,84	
	Plus: Outstanding 1983		641 014,77	
4 243 183				5 203 162,61
	Municipalities:			
	Received		1 479 250,74	
	Plus: Adjustment in respect of previous years		4 919,02	
1 313 332				1 484 169,76

STATEMENT 2 *(continued)*

1982	Expenditure *(continued)*	1983
R6 498 111		R7 405 351,68

1982	Income *(continued)*	1983		
R		R	R	R
	SWA:			
65 651	Received			47,55
92 186	Unallocated rates and charges			31 263,63
1 630	Interest on rates and charges in arrear			3 817,52
	Interest on investments:			
	Received		317 002,53	
	Accrued		137 072,52	
610 847				454 075,05
5 000	Research contributions			15 750,00
6 938	Sundry income			13 877,57
R6 498 111				R7 405 351,68

WATER RESEARCH COMMISSION

STATEMENT 3

Statement of Project Expenditure and Advances for the year 1983

Project	Expenditure		Total advances outstanding as at 31/12/83
	1982	1983	
	R	R	R
Technological development of water reclamation on the basis of the Windhoek plant	23 904	2 000,00	—
Reclamation, storage and abstraction of purified sewage effluent in the Cape Peninsula	11 302	—	—
An investigation on the optimal utilization of water in the Eerste River in sandbeds or by other means	x(690)	—	—
South African Water Information Centre	189 700	225 499,25	*(62 099,40)
The development and evaluation of techniques for the determination of the exploitation potential of ground water resources in the Southern Free State and Northern Cape	11 792	—	—
Research on the microbiological quality and health aspects of water for reuse	173 097	34 232,84	2 075,16
Research on the soil factors effecting the optimal utilization of irrigation water in National States	8 551	9 229,03	
Research on water requirements of certain agronomic and vegetable crops	3 200	—	—
Research on the purification and reuse of effluents from the hides and skins curing, fellmongery and tanning industries	54 865	676,64	41,00
Research on the development of membrane support systems and modules	802	x(3 167,46)	—
Water management and effluent treatment in the Textile Industry	84 014	—	—
Research on the development of effective irrigation methods for application on steep lands, with special reference to micro-methods	54 482	500,00	2 798,75
Research on flood occurrences	21 680	—	—
Research on water resources	130 279	—	—
Water pollution and effluent reclamation in the Pretoria-Witwatersrand-Vereeniging-Sasolburg Complex	3 201	8 688,19	731,31
Research on the scheduling of irrigation of wheat in the irrigation area of the Orange Free State	—	15 206,47	—
Research on the development and application of aspects of equilibrium chemistry and precipitation kinetics to water stability problems encountered in water reclamation	8 573	9 270,05	7 269,01
The removal of nitrogen and phosphate from biofilter effluents	43 484	—	—
Hidrological research in the Ecca and Wilderness catchments	64 032	73 437,53	2 562,47
Research on the optimization of dry and dry-wet cooling systems at power stations in South Africa	100 043	146 627,00	*(32 027,00)
Research on the optimization of the modified activated sludge process for nutrient removal (Johannesburg City Council)	8 396	33 568,59	6 099,08
Research on the optimization of the modified activated sludge process for nutrient removal (NIWR)	19 868	—	—
Hidrological investigation of rural catchments in Natal with specific reference to flood events	59 887	76 682,17	93 200,00
An Agro-hydrological study of Natal	7 346	—	—
The development of a data bank of autographic raingauge records in South Africa	26 375	14 224,00	—
Hydrological research in Zululand	32 032	23 780,48	17 906,52
The efficiency of water extraction from fine sandy irrigation soils by different root systems	15 572	4 628,27	—
Research on economy measures for water distribution systems in urban areas	157 672	134 566,47	433,53
Research on water reclamation and pollution control: Operation of Stander Water Reclamation Plant by the City Council of Pretoria, the implementation of surveillance programmes relevant to health aspects and the application of catchment quality control	85 189	—	—
Epidemiological studies pertaining to the reclamation and reuse of purified sewage effluent in the Cape Peninsula	80 522	78 962,56	69 799,14
The construction and operation of the Cape Flats prototype water reclamation plant and the surveillance of reclaimed water qualtiy	248 055	203 186,52	109 805,88

Optimization of the modified activated sludge process for nutrient removal (University of Cape Town)	105 865	105 678,70	75 476,65
Water management and effluent treatment in the textile industry: Pilot plant treatment of cotton/synthetic fibre dyehouse effluents with water reuse	94 811	96 600,00	—
Research on water management and effluent treatment in the textile industry: Wool scouring effluent treatment	80 627	103 240,11	78 259,89
Research on continuous streamflow modelling of South African rivers	23 447	22 647,28	13 210,97
The treatment and disposal of sewage sludge: The stabilisation of sludge by means of photosynthetic bacteria	16 844	6 787,50	812,50
The treatment and disposal of municipal sludges: Sludge dewatering and the treatment of sludge liquors	5 385	267,00	7 835,00
The treatment and disposal of municipal sludges: Sludge disposal to sea	24 200	32 800,00	—
Research on the water requirements of certain agronomic and vegetable crops	62 290	39 186,53	64 300,00
Research on the influence of different times and intensities of internal plant moisture stress on photsynthesis, respiration and water use efficiency of certain agronomic crops	114 686	92 344,85	1 890,87
The treatment and disposal of municipal sludges: Pasteurisation and thermophilic anaerobic digestion of sludge	8 610	3 109,17	2 780,90
The treatment and disposal of municipal sludges: Autothermic aerobic digestion of sludge	—	25 723,66	19 436,09
The treatment and disposal of municipal sludges: characterisation of sludge	19 227	24 255,00	*(382,00)
Research on biochemical processes which result in phosphate and nitrogent removal in the modified activated sludge process	12 026	23 641,68	3 655,38
Research on drought occurrence	79 435	37 500,90	*(1 136,12)
Research on the technological development of continuous counter current ion exchange for the the reclamation of water of potable quality from secondary effluents	85 268	33 206,98	—
A investigation into the water and effluent management problems in the fishing industry: Shortcomings in dry offloading systems for unloading fishing vessels	7 818	—	—
Research on and development of polymeric membranes and supplemental coatings for reverse osmosis and ultra filtration	—	220 475,36	5 024,64
An investigation into the water and effluent management problems in the fruit and vegetable processing industry: In-house optimisation of water use and effluent treatment in fruit and vegetable processing	60 293	34 040,52	—
An investigation into the water and effluent management problems in the fishing industry: Effluent handling at fish processing factories	64 525	39 611,88	—
Research on the profile available water capacities of soils	—	75 551,65	68 000,00
Eutrophication research on the Hartebeespoort Dam	58 795	76 472,00	4 433,00
Research on integrated studies of the generation of runoff, solutes and sediment in tributary catchments of the Great Fish River	101 775	65 512,13	13 912,99
The treatment and disposal of municipal sludges: Forced aeration composting of sewage sludge, prototype study	24 511	38 214,06	*(11,00)
Development of the required apparatus and programmes for the monitoring and management of irrigation systems	94 013	81 797,62	38 119,61
Investigations into the use of physical-chemical techniques for treatment and management of industrial effluents with high organic content. Preliminary investigation to define problem areas	45 169	10 831,33	—
Investigation into the water management and effluent treatment in the processing of (i) pulp and paper (ii) metals (iii) fermentation products (iv) pharmaceutical products	—	54 000,00	—
Research on and development of membrane support systems for reverse osmosis and ultra filtration	40 451	1 973,00	93 627,00
Surveillance of the virological quality of reclaimed water from the Cape Flats prototype water reclamation plant	—	17 364,16	18 523,66
Research on the revision of the temporal and spatial distribution of precipitation statistics in Southern Africa	—	22 835,97	47 264,03
Research on weather modification (C.I.C.)	769 049	—	—
Research on weather modification at Nelspruit (S.W.A.)	21	99 920,56	479,44

Research on the applicability of groundwater models as an aid to the study and evaluation of South African aquifers	96 348	102 463,38	*(37 651,28)
Research on sludge bulking in the activated sludge process	—	—	6 179,23
Research on urban hydrology and drainage	—	126 529,12	*(6 529,12)
Research on the development of procedures for the selection of appropriate irrigation methods and for the design of irrigation systems	58 003	151 577,80	1 369,55
Research on an irrigation scheduling service for the Free State region	4 750	32 083,65	15 711,21
'A detailed regional soil moisture deficit analysis for irrigation planning in Southern Africa	—	2 396,16	14 103,84
Research on the characterization, evaluation and regeneration of activated carbon for water reclamation and water purification	150 319	17 636,00	964,00
Research on detailed geohydrological investigations in the Poesjenels River catchment in the Breede River valley, with special reference to mineralization	4 036	59 459,37	31 377,79
Research on the auto-analyses of sulphate and alkalinity in water	—	5 836,11	4 163,89
Water management and effluent treatment in the textile industry: Treatment of scouring and bleaching effluent	—	—	184 300,00
Research into the treatment of industrial effluents with high salinity and organic contents	—	—	146 500,00
Research on the desalination of minewater (RCC)	—	20 000,00	—
Research on the desalination of minewaters (Process Systems (Pty) Ltd)	—	53 309,88	—
Research on the reclamation of secondary sewage effluent by reverse osmosis	13 420	40 539,00	9 061,00
Research on an investigation into the use of physical/chemical techniques for water and wastewater management in the meat processing industry	—	—	109 875,00
Evaluation of electrodialysis reversal for the desalination of effluents and brakish water	—	139 077,32	—
Evaluation of the impact of phosphate limitation on the trophic status of South African impoundments	—	12 127,19	*(471,19)
Research on the effect of adsorption-oxidation process configuration on the quality of reclaimed water	—	34 214,00	186,00
Research on the inhibition of bacterial oxidation of pyrite and the concomitant acid mine drainage	—	10,830,47	*(10 830,47)
Construction of a dissolved air flotation pilot-scale unit for application for research on industrial effluents	—	35 920,58	—
An investigation into the condition of soils irrigated over a protracted period and an evaluation of applicable selection criteria, and reclamation and control measures	—	8 262,54	12 237,46
Research on the contribution of mine dumps to mineral pollution in the Vaal Barrage	—	20 777,82	*(3 742,82)
Research on enhancement of biological phosphate removal from sewage by altering process feed composition	—	2 564,78	46 000,00
Hydrological research in catchments of the Eastern and Southern Cape	—	—	67 230,00
Research on an evaluation of hydrological flood estimation techniques for small ungauged catchments	—	35 855,16	1 844,84
Research to investigate leak detection in water supply distribution systems	—	—	39 000,00
The development of computer evaluation techniques for dry cooling systems	—	—	19 070,00
	R4 053 242	R3 488 848,53	R1 424 057,88

*Excess expenditure over advances for projects.

[x]Amendment to expenditure of previous years.

STATEMENT 4
BUDGET 1984

	R	R
ESTIMATED INCOME		
Rates and charges in terms of Section 11 of the Water Research Act		9 195 000
Interest on investment		100 000
		9 295 000
Appropriation from accumulated funds		2 260 000
TOTAL ESTIMATED INCOME		11 555 000
ESTIMATED EXPENDITURE		
Administration expenses:		
Salaries and allowances	1 322 000	
Subsistence and travelling expenses	203 000	
Postal, telegraph and telephone	34 000	
Printing, stationery, advertisements and publications	233 000	
General expenditure	248 000	
		2 040 000
RESEARCH PROJECTS		
Approved Projects		
Technological development of water reclamation on the basis of the Windhoek plant	12 000	
South African Water Information Centre	276 600	
Research on the microbiological quality and health aspects of water for reuse	18 800	
Research on the development and application of aspects of equilibrium chemistry and precipitation kinetics to water stability problems encountered in water reclamation	4 800	
Research on the optimization of dry and dry-wet cooling systems at power stations in South Africa	44 000	
Hydrological investigation of rural catchments in Natal with specific reference to flood events	46 900	
Hydrological research in Zululand	26 300	
Wind tunnel studies on the effect of the orientation of cooling units on hot air recirculation and efficiency of air cooled systems	5 000	
Research on economy measures for water distribution systems in urban areas	4 000	
Epidemiological studies pertaining to the reclamation and reuse of purified sewage effluent in the Cape Peninsula	43 000	
The construction and operation of the Cape Flats prototype water reclamation plant and the surveillance of reclaimed water quality	150 000	
Research on water management and effluent treatment in the textile industry: Wool scouring effluent treatment	192 620	
The treatment and disposal of municipal sludges: Sludge dewatering and the treatment of sludge liquors	350	
Research on the water requirements of certain agronomic and vegetable crops	55 500	
Research on the influence of different times and intensities of internal plant moisture stress on photosynthesis, respiration and water use efficiency of certain agronomic crops	24 000	
The treatment and disposal of municipal sludges: Pasteurisation and thermophilic anaerobic digestion of sludge	20 000	
The treatment and disposal of municipal sludges: Autothermic digestion of sludge	9 400	
The treatment and disposal of municipal sludges: The characterization of sludge	6 000	
Research on biochemical processes which result in phosphate and nitrogen removal in the modified activated sludge process	2 600	
Research on drought occurrences	42 000	
Research on and development of polymeric membranes and supplemental coatings for reverse osmosis and ultrafiltration	86 000	
An investigation into the water and effluent management problems in the fishing industry: Effluent handling at fish processing factories	70 000	
Research on the profile available water capacities of soils	61 000	
Eutrophication research in the Hartebeespoort Dam	99 000	
Research on integrated studies of the generation of runoff solutes and sediment in tributary catchments of the Great Fish River	73 200	
The treatment and disposal of municipal sludges: Forced aeration composting of sewage sludge, prototype study	37 400	
Development of the required apparatus and programmes for the monitoring and management of irrigation systems	98 200	
Research on and development of membrane support systems for reverse osmosis and ultra filtration	216 000	
Surveillance of the virological quality of reclaimed water from the Cape Flats prototype water reclamation plant	26 200	

	R	R
Research on the revision of the temporal and spatial distribution of precipitation statistics in Southern Africa	53 200	
Research on the applicability of groundwater models as an aid to the study and evaluation of South African aquifers	134 600	
Research on sludge bulking in the activated sludge process	37 400	
Research on urban hydrology and drainage	90 000	
Research on the development of procedures for the selection of appropriate irrigation methods and for the design of irrigation systems	148 200	
Research on an irrigation scheduling service for wheat in the Free State region	32 200	
A detailed regional soil moisture deficit analysis for irrigation planning in Southern Africa	12 300	
Research on the characterization, evaluation and regeneration of activated carbon for water reclamation and water purification	1 081	
Research on detailed geohydrological investigations in the Poesjenels River catchment in the Breede River valley, with special reference to mineralization	55 000	
Research on the autoanalysis of sulphate and alkalinity in water	1 049	
Water management and effluent treatment in the textile industry: Scouring and bleaching effluents	182 100	
Research into the treatment of industrial effluents with high salinity and organic contents	144 200	
Research on the desalination of mine waters (Process Systems (Pty) Ltd)	5 000	
Research on the reclamation of secondary sewage effluent by reverse osmosis	16 500	
Research on an investigation into the use of physical/chemical techniques for water and waste-water management in the meat processing industry	155 000	
Research on the desalination of mine waters (U.C.T.)	2 000	
Evaluation of electrodialysis reversal for the desalination of effluents and brackish water	10 000	
Evaluation of the impact of phosphate limitation on the trophic status of South African impoundments	7 000	
Research on the effect of adsorption-oxidation process configuration on the quality of reclaimed water	5 600	
Research on the inhibition of bacterial oxidation of pyrite and the concomitant acid mine drainage	42 900	
CRAWS	1 541 200	
An investigation into the condition of soils irrigated over a protracted period and an evaluation of applicable selection criteria, and reclamation and control measures	18 100	
Research on the contribution of mine dumps to mineral pollution in the Vaal Barrage	48 000	
Research on enhancement of biological phosphate removal from sewage by altering process feed composition	112 000	
Hydrological research in catchments of the Eastern and Southern Cape	150 000	
Research on an evaluation of hydrological flood estimation techniques for small ungauged catchments	78 800	
Research to investigate leak detection in water supply distribution systems	25 500	
The development of computer evaluation techniques for dry cooling systems	112 000	
	4 971 800	
Possible projects	3 643 200	
		8 615 000
Contracting of researchers and expertise		370 000
Research and other grants		240 000
Specialist and Consultation Services		290 000
TOTAL ESTIMATED EXPENDITURE		R11 555 000

APPENDIX

Publications emanating from research financed wholly or partially by the Commission.

This Appendix contains a list of publications released in 1983. Requests for publications should be directed, as far as possible, to the authors themselves.

Publications for 1983

Articles and Papers

ADAMSON, P.T., ZUCCHINI, W. and ALLEN, J. (1983) On the application of a property of the gamma model to the analysis of drought sequences of increasing duration. Proc. National Hydrological Symposium. Pretoria, Sept. 8-9, 1983.

ASHTON, P. (1983) Nitrogen cycling in Hartbeespoort Dam. Paper presented at Limnological Society of Southern Africa Conference, Durban 4-7 July.

BENNIE, A.T.P. and BOTHA, F.J.P. (1983) Water uptake by maize and wheat: II Critical evaluation of soil-root contact resistance. Paper presented at the 11th Congress of the Soil Science Society of S.A., Stellenbosch.

BOTHA F.J.P. and BENNIE, A.T.P. (1983) Water uptake by maize and wheat: I Relative importance of hydraulic resistances in the soil-plant transpiration pathway. Paper presented at the 11th Congress of the Soil Science Society of S.A., Stellenbosch.

BRODISCH, K.E.U., GERBER, A. and SCHEEPERS, J.A. (1983) Denitrification of trickling filter effluents using external carbon sources. Paper presented at the IWPC Biennial Conference, East London, 16-19 May 1983.

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