Water Research Commission

ANNUAL REPORT

1 January to 31 December 1981

WATER RESEARCH COMMISSION

Annual Report

1 January 1981 to 31 December 1981

Water Research Commission
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PRETORIA 0001

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THE OBJECTIVES OF THE WATER RESEARCH COMMISSION

In terms of section 2(3) of the Water Research Act (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 purposes of such application".

Printed in 1982 in
the Republic of South Africa
by
ABC Press Cape Town

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Water Research Commission
PO Box 824
PRETORIA
0001
20 April 1982

Dear Sir

We take pleasure in submitting to you, herewith, the report of the Water Research Commission. This report covers the period 1 January 1981 to 31 December 1981.

The balance sheet and statement of revenue and expenditure for the financial year 1 January 1981 to 31 December 1981, as certified by the Auditor-General, are furnished in Chapter 14 of this report.

Yours respectfully

MR Henzen
CHAIRMAN

J F Otto
VICE CHAIRMAN

Dr the Honourable CV van der Merwe, MP
Minister of Environment Affairs
PO Box 23
CAPE TOWN
8000

MEMBERS OF THE WATER RESEARCH COMMISSION

DR MR HENZEN
Chairman: Chief Executive Officer

DR CF GARBERS
President: Council for Scientific and Industrial Research

DR DW IMMELMAN
Director-General: Department of Agriculture and Fisheries

PROF DJ SCHOEMAN
Dean: Faculty of Engineering
University of Pretoria

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

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

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

DR JP KRIEL
Former Secretary for Water Affairs and now Consultant: Special Water Studies for the Directorate of Water Affairs

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

MR JG BRAND
City Engineer of Cape Town
(Co-opted member from 15 March 1981)

Chapter 1

The year in review

The Water Research Commission was established ten years ago. The Water Research Act, 1971 (Act No 34 of 1971) was promulgated on 19 May 1971 and the Commission commenced its activities formally on 1 September of that year. During this decade important principles were evolved and specific strategies and mechanisms developed which created the operational structure for the successful execution of its task. The Commission has identified and clearly defined its main task areas and criteria have been developed for consideration of financial support of specific research projects against the background of these main task areas and according to priorities decided on a national basis.

The Commission does not undertake research work itself, but negotiates with competent organizations to undertake work on a contractual basis. Since its inception 100 research projects have been initiated in terms of research agreements with organizations, 57 of which were completed by the end of 1981. The final dividend on its research investment is the practical application of research results derived from the projects and to achieve this, the partnership principle is incorporated in the contracts as far as possible, i.e. the potential user of the results is involved as a partner in the planning, formulation and execution of research. In this a number of operational organizations have been able to apply results in a meaningful way. Other methods (such as the publication of manuals and guidelines, organisation of symposia and demonstrations, etc) have also been used for the wider implementation of information.

From time to time Commission meetings are held in various centres where research projects of the Commission are in progress and visits to these projects are arranged to coincide with the meetings. In addition arrangements are made for Commission members to visit relevant research projects during the execution of research programmes. These arrangements are generally not only appreciated by the relevant research organizations and staff as well as the relevant end user, but also contribute significantly to the stimulation of research, the transfer of information, and the full-scale application of research results.

During the year under review, research progressed well and work in a number of new areas in the water field requiring urgent attention, has been initiated. Before reporting on progress and certain specific activities of the Commission, mention is made of publications of the Commission, new research projects and the appointment of a new Commission member.

1. Publications of the commission

Since the Commission's inception, a total of 205 publications have appeared in the form of scientific articles in journals such as *Water SA, Water Research* and others and/or papers at conferences, whilst 136 have been issued in the form of reports. The latter include final project reports; publications which have formed part of a series of publications at research institutes or university; and practically oriented documents, including manuals and guidelines published by the Commission on the basis of research results generated in a project. A list of all the publications based on research which has been financed, wholly or in part, by the Commission appears in the Annexure.

The Commission's publications are distributed widely and publications of practical value are announced in the Commission's *SA Waterbulletin.*

2. New research projects

During the year certain existing agreements were extended some with an increase in contract funds and others without. Eleven new agreements were also entered into in terms of which the following research projects are being undertaken:

- 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).
- 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).
- 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).
- 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).
- Eutrophication research in the Hartbeespoort Dam (Contract with the CSIR — National Institute for Water Research).
- Research on the technological development of continuous conter-current ion exchange for the reclamation of water of potable quality from secondary effluents (Contract with the University of Cape Town — Department of Chemical Engineering).
- Research on and development of polymeric membranes and supplemental coatings for reverse osmosis and ultrafiltration (Contract with the University of Stellenbosch — Institute for Polymer Sciences).
- Pilot plant studies in connection with the adsorption capacity of regenerated activated carbon (Contract with the CSIR — National Institute for Water Research).
- 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 drought occurrences (Contract with the University of Stellenbosch — Department of Civil Engineering).
- Water requirements of certain agronomic and vegetable crops (Contract with the University of Pretoria — Department of Plant Production).

3. New commission member

On the 15th March 1981 Mr JG Brand, city engineer of Cape Town, was co-opted as a member of the Commission.

Mr Brand's co-option is of special significance in view of his involvement over many years with research on water reclamation and the contributions that he is therefore able to make in this regard. As former city engineer of Windhoek, he was directly involved with research on water reclamation and which led to the use of reclaimed water in the water supply of the city.

4. Important developments

During the year certain developments and activities took place which deserve mention in this chapter. In addition to this, the various chapters contain brief reports on other activities and progress of research projects.

4.1 Establishment of master research plan for ground-water research

By the end of 1981 all ground-water research projects financed by the Commission had terminated and it is intended that new projects be initiated during 1982 and 1983. When projects are considered the research aims and requirements are assessed anew and for this reason a master plan was developed during the year.

It was decided to appoint a study group to compile the master plan. In compiling the master plan for research and development the study group, in close cooperation with the Geohydrology Division of the Directorate of Water Affairs, used various sources of information made available as the result of Commission activities in the past. These included, *inter alia,* the reports of Dr JF Enslin, a specialist consultant to the Commission, and a fact-finding mission abroad.

Geohydrological research is necessary for the efficient planning, management and utilisation of ground-water resources and is dealt with in detail in the master plan. For the sake of convenience, the broad research framework for the master plan has been divided into the following categories: Instrumentation — methods and techniques; process studies; location and development of ground-water resources; geohydrological studies and the modelling of specific ground-water systems; regional geohydrological studies; pollution aspects; the effects of mining, and artificial recharge.

Research fields covered in the master plan, and the priorities associated with them, will be revised on a regular basis.

4.2 Establishment of master research plan for the effect of rural land use and catchment management on water resources

During a workshop on the effect of rural land use and management on water resources held in 1980, gaps in the available knowledge on the subject and research requirements were identified, and a master plan for research was compiled by the Coordinating Committee for Research on the Hydrological Cycle (CCRHC).

The master plan, accepted in principle by the Commission comprises the following objectives:

- to increase the availability of beneficially usable water
- to optimise the beneficial use of water
- to minimise adverse effects on water resources.

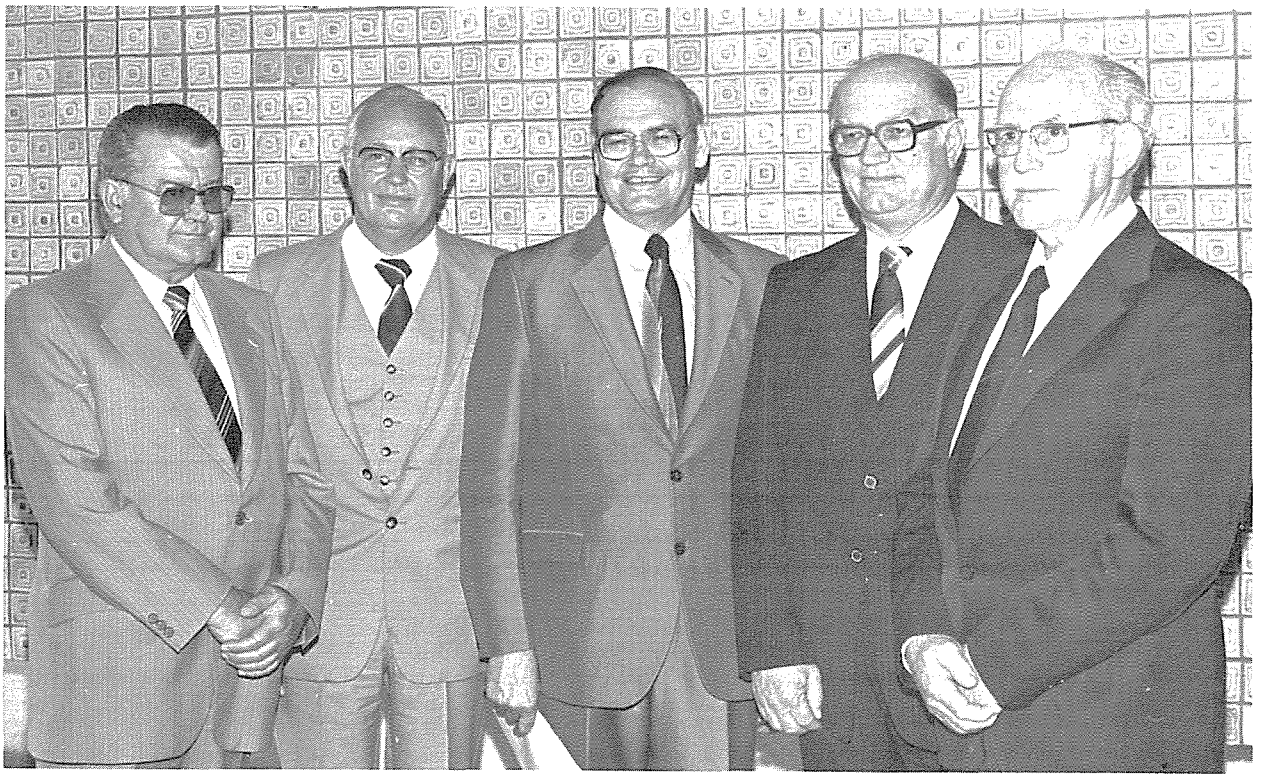
Copies of the relevant master plan have been made available to all universities and research organisations where projects in this regard are actively being undertaken in order to afford research scientists the opportunity of submitting specific research proposals to the CCRHC.

4.3 The development of a scientific methodology for the evaluation of flood damages

Research on flood damage which had been supported over the past six years by the Commission, was successfully completed during the year under review.

Floods which cause large-scale losses and disruption of agricultural development, communication and transport networks, urban areas and industries in flood plains, occur on average every second year in South Africa. Information on floods, flood damage and actual losses must be available before meaningful decisions on flood control measures can be taken and for this reason the Department of Water Affairs as it was then, requested that the Commission initiate research in this field. This led to research projects being undertaken by the Institute for Social and Economic Research (ISER) of the University of the Orange Free State and the Bureau for Economic Research (BER) of the University of Stellenbosch.

The objectives of the research were, briefly, to develop a methodology for the scientific evaluation of flood damage; to apply the methodology developed to certain river stretches; and to establish relationships between physical damage and flood conditions. The methodology which was developed, has been successfully applied to the river stretches in which the most important floods of 1974 and 1975 occurred. Further refining of the methodology will be done progressively as further investigations of flood damage are undertaken.



In November 1981 reports on flood damage research were presented to the Minister of Environment Affairs, Dr CV van der Merwe. Present at the ceremony were (f l t r): Prof DJG Smith (UOFS) who directed the research effort; Mr JG du Plessis, deputy director general of Environment Affairs and a member of the WRC; Prof W Mouton, principal of the UOFS; Dr CV van der Merwe, and Dr MR Henzen, chairman of the Water Research Commission.

The reports emanating from this research were presented to the Honourable the Minister of Environment Affairs on 26 November 1981.

4.4 Streamlining of coordination of research on water reclamation as a whole

During the year the Commission established two new coordinating research and development (CR&D) committees in connection with water reclamation. The aim is to improve coordination between the seven research projects currently being supported and to streamline the research programme. In this way members of the new CR&D committees are also afforded a broader insight into the research.

Apart from the normal functions of a CR&D committee, the CR&D committee for Technological Aspects of Water Reclamation also has the management function in respect of four of the projects involved with the technological aspects of water reclamation.

In the same way, the CR &D committee for Health Aspects of Water Reclamation has two functions to fulfil. It will, therefore, serve as steering committee for the two projects in connection with the microbiological and health aspects of reclaimed water, and the epidemiological studies regarding water reclamation.

This new arrangement, however, means that the CR&D committees will not be able to deal in detail with the technical minutiae of each project and the technical sub-committees have therefore been entrusted with the task of approving e.g. progress reports and research programmes within the framework of policy decisions taken by the CR&D committee.

4.5 Investigation into practical alternatives for limiting the progressive increase in the mineral content of the water supply system of the Vaal Barrage

The continuous increase in the dissolved mineral content of the water in the water supply system of the Vaal Barrage holds important cost implications for local authorities. A study undertaken by a

specialist consultant of the Commission, has revealed that the increase in the salt content of the water supplied to the Pretoria-Witwatersrand-Vaal triangle complex (PWV complex) can, by the end of the century, cause a financial burden of some R140 million annually on the community, should measures not be timeously implemented for systematically limiting mineralisation.

This financial burden will be the result of the following joint factors:

- the detrimental effect of the high mineral content on domestic plumbing materials and hot water systems;
- an increase in soap consumption;
- municipal water reticulation systems are exposed to corrosion and water meters are affected by the precipitation of salts; and
- the reuse potential of the water is reduced considerably.

Investigations into possible alternative methods for combating this problem are currently being undertaken by the Department of Environment Affairs on the basis of further research sponsored by the Commission.

4.6 Combination of all projects on sewage purification in one coordinating research and development committee

During the year a CR&D committee for Sewage Purification was established. The committee will identify problems in connection with sewage purification on a continuous basis, compile master research plans and priority research programmes, coordinate research, evaluate progress and consider the publication and application of research results. The committee comprises representatives of the Department of Environment Affairs, the SABS, the Rand Water Board, several city councils, the CSIR, several universities and the WRC.

The CR&D committee will also act as steering committee for current research projects supported by the Commission namely those on activated sludge and biological filters. It is expected that these measures will promote better coordination between the various projects. Four of the current projects deal with the optimisation of the activated sludge process for the removal of plant nutrients from sewage effluents, whilst another project deals with the removal of nutrients from biological filter effluents. The removal of these substances can contribute greatly to the control of one of the best known symptoms of pollution of the water environment, namely eutrophication.

All research projects are in their final stages and at the first meeting of the new CR&D committee deliberations centred around the satisfactory completion of the current research programme. A subcommittee has also been appointed with the task of compiling a master research programme for future research.

The projects have shown extremely good progress and a manual on the planning, design and operation of activated sludge processes which remove plant nutrients, and a technical manual on the removal of plant nutrients from biological filters will be compiled.

4.7 Initiation of research on the management and control of water and effluents in the fruit, vegetable and fish processing industries

The Commission, for several years now, has been supporting research on water management and effluent problems in the industrial sector and during the year extended its research to two new industries. Current research projects cover effluents from the textile industry and the fellmongering and tanning industries whilst the latest investigations relate to the fruit and vegetable processing industry and the fishing industry.

The fruit and vegetable processing industry annually processes 870 000 t of fruit and vegetables. In the process more than 6 200 Ml of water is used annually and 300 000 t of solid waste generated. The effluent normally contains a very high organic load, a low pH and a large amount of suspended matter all of which present serious problems in the disposal thereof. The objective of this research is to reduce water consumption, promote recycling of water within the factories and develop economical methods for the treatment of effluents.

The nature of effluents from the fish canning and fish meal factories is such that they are unacceptable for discharge to

sewer and cause pollution when discharged to sea. For this reason the Commission has initiated research into decreasing water consumption in factories and developing methods for the effective treatment of effluents. Another investigation has also been initiated, namely that of shortcomings of dry offloading systems of offloading fish from fishing vessels. Although the industry has largely adopted dry offloading systems, water is still used in the process and the disposal of the bloodwaters causes serious pollution.

4.8 The compilation of a manual on the planning, design and operation of the handling of liquid and solid wastes at intensive animal feeding systems

The handling and disposal of liquid and solid wastes from intensive animal feeding systems and the potential pollution hazard it represents to the water environment has for a considerable period of time been a cause for concern to various organizations. Departments such as those of Agriculture and Fisheries, Health and Welfare, and Environment Affairs, as well as local authorities, agricultural organizations and managers and proprietors of intensive animal feeding systems, have all at some stage or other pointed out that a solution to these problems should be found.

In order to obtain answers to these problems it was necessary, first, to undertake a thorough investigation to the specific conditions locally, and to determine what was being done in this regard in other countries, and, secondly, that a manual for the treatment and disposal of liquid and solid wastes of intensive animal feeding systems be compiled. More attention was paid to the matter in that draft regulations for the registration of intensive animal feeding systems and for the control of pollution by these systems were jointly compiled by the abovementioned Departments. Against this background, and in view of the fact that the Department of Agriculture and Fisheries is chiefly responsible for extension services in this regard, the relevant Department and Vleissentraal jointly approached the Commission requesting an investigation of the matter with a view to the compilation of a practical manual which can be used under South African conditions.

The investigation was undertaken by the Commission and a detailed scientific report was compiled on the findings, based on complete literature surveys, discussions with all relevant parties, and visits, in cooperation with the Department of Agriculture and Fisheries, to several intensive animal feeding systems in all four provinces.

In consultation with the Department of Agriculture and Fisheries it had also been decided that it would be desirable to obtain the advice of an overseas specialist for an evaluation of the report of the Commission and in the eventual compilation of the manual. To this end the services of Professor Jackie Robbins of the College of Engineering, Louisiana Technical University, were secured by the Commission. Professor Robbins visited SA during July/August 1981 and after thorough discussion of the relevant report by Professor Robbins and all interested parties it was decided that the report would be accepted and a manual on the planning, design and operation of systems for the handling of wastes at intensive animal feeding systems would be compiled as speedily as possible. It was further decided that the Agricultural Engineering Division would in turn undertake an investigation into the performance of selected dam systems for the treatment of wastes of intensive animal feeding systems in order to test and refine the design and operational directives for such systems under South African conditions.

In time the manual will be made available by the Commission.

4.9 Overseas services of Waterlit extended

In 1980 an agreement was entered into with System Development Corporation (SDC) of California, USA, in terms of which services on *Waterlit* would be offered. During the year under review this became a reality and *Waterlit,* the computerised bibliographic data base developed by the South African Water Information Centre, has therefore become available on a worldwide basis.

However, this contract with SDC, one of the largest distributors of data bases in the world, provided only for retrospective searches. At the end of the year the contract was expanded to also include selective dissemination of information (SDI services). As a result users right around the

world can now obtain, on a regular basis, literature profiles on their fields of interest. This expansion of the contract proves the confidence placed in the quality of *Waterlit.* Owing to the coverage *Waterlit* enjoys, water research in South Africa will be publicised much more widely than before.

During the first month *Waterlit's* availability via the services of SDC, 55 retrospective searches were done for users from 12 countries. The Centre receives royalties for these services.

During the year 12 200 new items, selected from approximately 450 journals, reports and pamphlets, were added to *Waterlit.* The total number of items now contained in the data base amounts to 51 700.

Chapter 2

Research on water reclamation

The role of water reclamation in the improved utilization of available water resources and the way in which it can serve as a supplementary source of water has been proven locally and in certain countries abroad.

As a result the Commission since its inception has accorded high priority to the promotion of water reclamation. At present a total of seven research projects in various parts of the country are in progress. The main thrust of the investigations centres firstly around the technological aspects and secondly, around the water quality and health aspects relating to water reclamation and reuse.

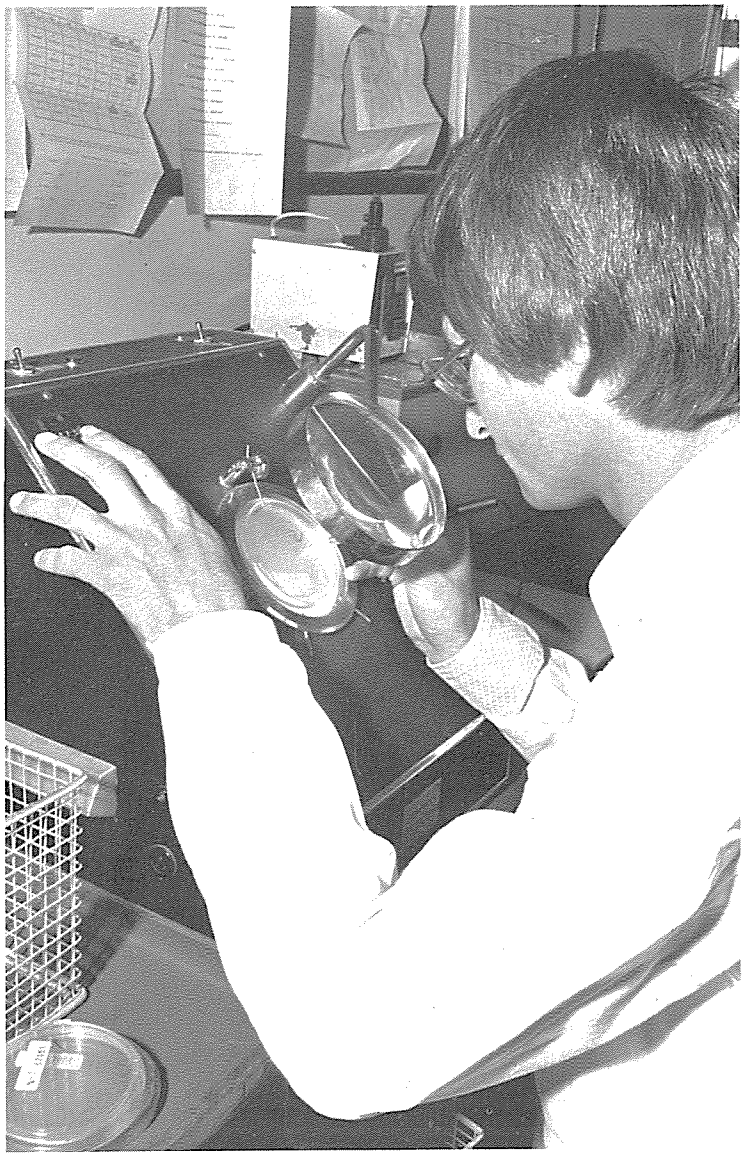
These projects were formally carried out under the guidance of separate steering committees. As the projects progressed to the stage where full-scale application of water reclamation became a reality, and in other cases where strong indications exist that it will have to be instituted as a supplementary source, an urgent need arose for all expertise in this field to be coordinated. Therefore two new CR and D committees were established.

1. Water reclamation in the Cape

During the year a shift in focus has occurred and attention has centred around water reclamation in the Cape Flats. It is envisaged that research activities in this regard will commence during 1982. The main objective with this research is to develop reclaimed water as a water source with a view to the possible augmentation of presently available fresh water supplies in Cape Town and environs.

Progress has also been made with the development of a background health data base before the possible introduction of reclaimed water as an additional water supply source in the Cape Town area. In this way any deviation which

Reclaimed water being evaluated microbiologically.



could possibly arise in the health pattern of the community, as a result of changes in the water supply source, could be observed.

2. Water reclamation in Windhoek

Modifications to the Windhoek water reclamation plant have improved considerably the operation of the plant.

For some time now Windhoek has been plagued by a serious drought and reclaimed water has been an indispensable source of water to meet the water demands of the city. During the year reclaimed water constituted 7,6% of the total water consumption.

Continuing research into the microbiological and health aspects of reclaimed water, once again showed that reclaimed water could meet all criteria for a potable water.

Epidemiological studies into the health pattern of the Windhoek community, which have been in progress for a number of years now, again indicated that reclaimed water did not detrimentally affect the health of the population.

3. International symposium on water reclamation

During the year an international symposium on the re-use of purified sewage of effluents was held in Washington D.C. by the Research Foundation of the American Water Works Assocation. This was the second event of its kind to be held in the USA and provided an excellent opportunity for South African research scientists, planners and design engineers in the field of water reclamation, to participate in this symposium. In this way insight into work being done in other parts of the world could be gained. At the symposium, South African delegates presented two papers and posters based on projects supported by the Commission.

4. List of research projects on water reclamation

- Technological development of water reclamation on the basis of the Windhoek plant. (Existing project: Contract with the Municipality of Windhoek and the CSIR — National Institute for Water Research).

- Research on water reclamation and pollution control: Operation of the 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. (Existing project: Contract with the City Council of Pretoria and the CSIR — National Institute for Water Research).

- Research on the microbiological quality and health aspects of water for reuse. (Existing project: 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 (Existing project: 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. (Existing project: 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. (Existing project: Contract with the University of Cape Town — Department of Civil Engineering).

- Pilot plant studies in connection with the adsorption capacity of regenerated activated carbon. (New project: Contract with the CSIR — National Institute for Water Research).

Chapter 3

Research on ground water

In European countries the contribution of ground-water to the total water supply is often as high as 80 percent but in South Africa the contribution is of the order of 10 percent. This is mainly because South Africa is poorly endowed with suitable aquifers and most boreholes are in fractured hard rock. Under these conditions, many boreholes are required to extract adequate volumes of water in a short period of time for urban, industrial or irrigation use. Consequently, the major thrust of ground-water programmes supported by the Commission in the past has been to improve techniques for determining the exploitation potential of ground-water in areas where surface supplies are limited.

All of these programmes, which involved the Universities of the Witwatersrand, Stellenbosch and Orange Free State, as well as the CSIR, had been concluded successfully by the end of 1981. The research priorities were carefully reviewed during 1981 and a master plan was formulated to guide future ground-water research programmes funded by the Commission. The master plan was developed by a study group appointed by the Commission in collaboration with the Division of Geohydrology of the Department of Environment Affairs. It is also envisaged that all future ground-water research and development projects to be sponsored by the Commission will be fully integrated with the needs of the geohydrological programmes of the Department of Environment Affairs.

The research fields covered in the master plan, and the priorities associated with them, will be revised on a regular basis to ensure that the research and development programmes are progressively adjusted to meet the immediate needs.

1. Ground-water investigations in the Southern Free State and the Northern Cape

The project on the development and evaluation of techniques for determining the exploitation of ground-water resources in the Southern Free State and in the Northern Cape was completed during the year and it is expected that the final reports will be received and distributed by the Commission early on in 1982. During the project extensive research was done on a variety of aspects and large areas in the Southern Free State and the Northern Cape were surveyed by means of geohydrological mapping.

Regional investigations as well as detailed investigations were done in the Southern Free State at Phillippolis and the Northern Cape at Vryburg. It was found that with judicial placement of boreholes the ground water of the Southern Free State could be utilized effectively and water shortages could be alleviated.

During the course of this research a large number of computer simulation models were developed relating to ground-water movement and water quality changes in the ground-water system.

The grouping together of ground-water scientists at the Institute for Ground-water Studies can be regarded as one of the most important by-products resulting from the contract. It is, therefore, the policy of the Institute to make any knowledge acquired in this way available to organisations outside the University.

2. The applicability of ground-water models as an aid to the study of South African aquifers

The acquisition of sufficient data for adequate testing and development of mathematical ground-water models is an expensive procedure and therefore three areas in South Africa that have been well monitored in the past have been chosen for model testing in a new research programme being undertaken by the Institute for Ground-water Studies. The three areas chosen are listed below and each requires a different type of model:

- The Sishen Aquifer which is made up of a primary aquifer of Kalahari deposits above a secondary aquifer of hard fractured rock.
- The Crocodile River System which involves modelling the interaction between a river and an aquifer.
- The Atlantis Aquifer which is a coastal aquifer and involves modelling interaction with the sea.

The testing of the models in the various areas will not only aid the development of the models but will also provide information as to where additional data are required and the level of accuracy that should be met in the data collection processes for each variable.

3. List of research projects on ground-water

- The development and evaluation of techniques for determining the exploitation potential of ground-water resources in the Southern Free State and Northern Cape. (Existing project: Contract with the University of the Orange Free State — Institute for Ground-water Studies).
- 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 Ground-water Studies).

Chapter 4

Research on the water environment

The rapid growth of South Africa's population and the concomitant urban, industrial and agricultural development unavoidably result in the increase in the quantity and diversity of pollutants finding their way into the water environment and thereby adversely affecting the optimal utilization potential of the available water resources. Of these pollutants, those resulting in the increase in the mineralization and the eutrophication of the water are of the utmost importance in view of their debilitating effects on the water environment. The Commission, consequently, sponsors several projects dealing with various aspects related to the water environment and, in particular, those dealing with eutrophication, and mineralization, fish production in irrigation supply canals and with inland water ecosystems in general.

1. Eutrophication

Eutrophication is a natural process which may be greatly accelerated by the activities of man, such as by the use of excessive fertilizers for agriculture purposes (which may find their way into the water environment by stormwater wash-off or via the atmosphere), industrialization, urbanisation and the discharge of nutrient-rich effluents into these water systems.

Eutrophication is manifested by the growth of algae and water plants, which in turn may give rise to various secondary problems, such as —

- increased water treatment costs;
- taste and odours in drinking water;
- deoxygenation of bottom layers of dams;
- aesthetic problems;
- interference with recreational use of dams;
- skin irritation and gastro enteritis;
- loss of livestock; and
- interference with irrigation

The research sponsored by the Commission on eutrophication has recently entered a new phase as a result of the findings of an exploratory research investigation carried out by the CSIR on behalf of the Commission on the utilization of

eutrophied impoundments in South Africa. This short-term investigation was launched to define the research needs and to formulate an appropriate research and development programme of alternative management strategies which could effectively be applied to inhibit the adverse effects of eutrophication on the usefulness of the water environment. Based on the findings, a new long-term contract has been negotiated with the CSIR, in terms of which the NIWR will undertake further research on eutrophication in the Hartbeespoort Dam. In order to meet the above objective ten specific projects have been identified and included in an overall Hartbeespoort Dam study. This programme will be carried out by the NIWR in close collaboration with the Department of Environment Affairs, the Committee for Inland Water Ecosystems and the Commission.

It is envisaged that the programme will take at least three years, but possibly longer, to complete. Guidelines will be developed during the execution of the project by which it will be possible to effectively manage and control the problems associated with eutrophication.

2. Mineralization

The project on the mineralization and reclamation of effluents in the Pretoria-Witwatersrand-Vaal Triangle (PWV) complex has reached a stage where the necessary hydrological mathematical models have been developed for application and testing of the 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, consequently, now 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.

3. Fish production in irrigation supply canals

During the year the project aimed at establishing the technical and economic feasibility of utilizing the water flowing in existing irrigation canals of farmers for the additional purpose of the commercial production of fish, was terminated. From the results it was found that it was technically feasible, under certain specific hydraulic and water quality conditions, to produce marketable fish.

The final project report will be considered by the Commission in 1982.

4. Inland water ecosystems

The Commission indirectly supports research on the water environment by means of an annual block grant to the Committee for Inland Water Ecosystems (CIWE) of the National Programme for Environmental Sciences of the CSIR.

This Committee, in terms of a formal agreement between the Commission and the CSIR, acts as a Coordinating Research and Development Committee on behalf of the Commission in the field of inland water ecosystems. During 1981 the block grant was reviewed and it was decided that the current grant would be maintained up to and including 1982, whereafter it will be subject to annual review.

The Commission has also indicated that extension of research financing in the CIWE's field of interest will, in future, be effected by direct contract financing between the Commission and the relevant research organisations, by means of new projects, and on the recommendation of the CIWE.

5. List of research projects on the water environment

- Water pollution and reclamation of effluents in the Pretoria-Witwatersrand-Vaal Triangle complex (Existing project: Contract with a firm of consulting engineers in collaboration with various local bodies).
- Research on intensive freshwater fish production using the raceway system. (Existing project: Contract with the Transvaal Provincial Administration — Department of Nature Conservation).
- Eutrophication research in the Hartbeespoort Dam. (New project: Contract with the CSIR — National Institute for Water Research).

Chapter 5

Research on the treatment of municipal wastewater

Since its inception the Commission has been working in close collaboration with the local authority sector and supports various research projects relating to the treatment of municipal wastewater of importance to this sector and to the country as a whole. The role of local authorities in the optimisation of water utilization cannot be stressed sufficiently. They have an important responsibility regarding the prevention of pollution which results from the discharge of domestic sewage and industrial wastewater, as well as solid and toxic wastes and sludges.

The Commission has always received excellent cooperation from local authorities. The Research Review Committee for local authorities, which comprises the six largest cities in the Republic, has played a significant role in decisions relating to the identification of research fields and priorities. The Committee was formed in 1977 by the Commission. The involvement of the local authorities and their willingness to make inputs have resulted from the practice of undertaking research projects on a joint venture basis.

Commission research related to the local authority sector covers a broad spectrum of projects. This chapter will however, only deal with two research fields, i.e. research related to the treatment of sewage for the removal of pollutants, including plant nutrients which give rise to eutrophication, as well as research on the treatment and the disposal of sewage sludges.

1. The purification of sewage

The Commission is currently sponsoring four projects related to the optimisation of the activated sludge process for the removal of plant nutrients from sewage. Three of these projects are aimed at the development of criteria for the planning, design and operation of the activated sludge process and are being carried out by the City Council of Johannesburg, the NIWR of the CSIR and the University of Cape Town. The fourth project is a new one which commenced this year at the University of Pretoria. The Commission also sponsors a project on the removal of plant nutrients in biological filter sewage purification works which is being carried out by the City Councils of Pretoria and Boksburg and the NIWR.

2. The activated sludge process

The first three projects mentioned will all be concluded at the end of 1982. Excellent progress has been made with this research and as a result a start has already been made with the compilation of a manual for the planning, design and operation of activated sludge processes for optimal removal of plant nutrients. It is anticipated

that this manual will be of great value to the municipal and consulting engineer, as well as the management and operational staff of sewage purification works in their planning, design and operation of existing and /or new sewage works of this type and will contribute significantly to the prevention and control of the eutrophication.

3. Removal of plant nutrients from biological filter works effluents

Investigations into the removal of plant nutrients from effluents from existing sewage works which comprise biological filters have been supported by the Commission for more than two years. These investigations are of particular importance since about 65 percent (on a volume basis) of the sewage produced in critical river catchments in South Africa is purified in biological filter sewage purification works. Good progress has been made with the chemical removal of phosphates at the biological filter works at Daspoort and Vlakplaats in Pretoria and Boksburg, respectively. A start has already been made with the compilation of a technical guide for the practical application of these processes.

A Coordinating Research and Development Committee for Sewage Purification was formed during the year. It will also serve as a Steering Committee for the projects on activated sludge and biological filter effluent.

4. Determination of the mechanism of biological phosphate removal

The agreement with the University of Pretoria was concluded in order to get clarity on the mechanism of biological phosphate removal in activated sludge processes. Information on this mechanism and factors which control it, is judged to be of crucial importance in the refinement and application of existing design and operational criteria for the efficient removal of plant nutrients in biological sewage purification processes.

5. Eutrophication control by altering the chemical composition of synthetic detergents

Professor PH Jones, an expert in the field of sewage purification from the University of Toronto, Canada, visited South Africa at the invitation of the Commission in connection with projects on sewage purification and eutrophication. Very beneficial discussions were held with him concerning the relevant Commission projects and he also addressed a number of research groups. He is also assisting in the compilation of a memorandum on the possible replacement of phosphates in household synthetic detergents by other chemicals which do not contain phosphates. This eutrophication control strategy has been applied with great success in Canada and the USA. It is anticipated that further studies by the Commission in cooperation with detergent manufacturers will be undertaken on the statistics of detergent use and possible replacement of phosphates in synthetic detergents. The purpose of these studies will be to indicate whether a full-scale experiment to test the viability of such a strategy should be carried out in the Republic.

6. The treatment and disposal of sewage sludge

The treatment and disposal of sewage sludge resulting from the treatment of wastewater has long been a problem for local authorities both here and abroad. This problem is becoming more and more serious as the socio-economic development of the country progresses and the mass of sludge to be treated takes on greater and greater dimensions.

The Commission therefore initiated a research and development programme in this field aimed at the development of techniques that may separately or in combination with other processes, be properly aligned in order to provide a solution to the problems under a variety of geographical and other physical conditions. In order to achieve this goal, some seven research projects were initiated on a partnership basis with local authorities and research institutes with control of future planning and execution of the projects in the hands of the following two co-ordinating committees, *viz.*

- the Co-ordinating Research and Development Committee for Solid and Toxic wastes; and
- the Sludge Management Committee which is responsible for the co-ordinating and programming of all research activities with respect to the treatment and disposal of sewage sludge.

Instead of establishing a steering committee for each research project, only four were originally established, each with responsibility for two or more projects. Research on the treatment of sludge, for example, is under the guidance of one steering committee which is currently responsible for the research being undertaken by the Municipalities of Johannesburg and Cape Town.

Similarly, the sludge dewatering project (which is being undertaken by the City Council of Port Elizabeth) and the project on the characterisation of sludge (by the NIWR) have a common steering committee. The same principle applies to the composting project (by the NIWR) and the project on the stabilisation of sludge by means of photosynthetic bacteria (by the Institute for Environmental Sciences — University of the OFS). A fourth steering committee, which guides the research on the disposal of sludge to sea, is by very nature a specialised steering committee and has responsibility for this project only.

Detailed progress reports are considered on a regular basis by the responsible steering committee and the working programmes duly adjusted according to the ongoing findings. Steering committee meetings, in the case of the project on the disposal of sludge to sea, are held more frequently than other steering committee meetings. The reason for this being firstly, to ensure that immediate preventative steps can be implemented if it is found that in practise the disposal of sludge to sea has a detrimental effect on the marine environment and the health of the public, and secondly, that the research programme can be reviewed on a regular and progressive basis and adjusted if circumstances warrant it in the light of results obtained.

Progress reports and press releases on the progress of the project are submitted on a regular basis after each steering committee meeting to the Director General of Environmental Affairs for his consideration. Research to date has progressed well and results obtained have been satisfactory.

7. Attendance of international conference on the disposal of sludge to sea

Mr DC Mccleod, City Engineer of Durban and Dr GG Cillié, Director of the NIWR, attended a specialised international conference on the disposal of sludge to sea in London. The conference was organised by the International Association on Water Pollution Research. Mr Macleod presented a paper entitled *Sludge Disposal to Sea in South Africa* at the conference and at the request of the Commission, undertook a brief study tour of organisations involved in policy, control, operations and research in connection with the disposal of sludge to sea. The Commission paid the costs of the study tour and contributed towards the costs of attendance of the conference by the Director of the NIWR.

8. List of research projects on the treatment of municipal wastewater

- Research on the optimization of the modified activated sludge process for nutrient removal. (Existing project: Contract with the CSIR — National Institute for Water Research).

- Research on the optimization of the modified activated sludge process for nutrient removal. (Existing project: Contract with the City Council of Johannesburg).

- Research on the optimization of the modified activated sludge process for nutrient removal. (Existing project: Contract with the University of Cape Town — Department of Civil Engineering)

- The removal of nitrogen and phosphate from biological filter effluents. (Existing project: Contract with the CSIR — National Institute for Water Research, and the City Council of Pretoria).

- Research on biochemical processes which result in phosphate and nitrogen removal in the modified activated sludge process. (New project: Contract with the University of Pretoria — Department of Biochemistry).

- The stabilisation of sludge by means of photosynthetic bacteria. (Existing project: Contract with the Institute for Environmental Sciences, University of the Orange Free State).

- Sludge dewatering and the treatment of sludge liquors (Existing project: Contract with the City Council of Port Elizabeth).

- Sludge disposal to sea. (Existing project: Contract with the City Council of Durban).

- Pasteurization and thermophilic anaerobic digestion of sludge. (New project: Contract with the City Council of Cape Town).

- Autothermic aerobic digestion of sludge. (Existing project: Contract with the City Council of Johannesburg)

- Research into the composting of sludge by means of forced aeration. (Existing project: Contract with the CSIR — National Institute for Water Research)

- Research into the characterisation of sludge. (Existing project: Contract with the CSIR — National Institute for Water Research).

Chapter 6

Research on the treatment of industrial effluents

The discharge of industrial effluents into the natural drainage systems generally results in the organic and mineral pollution of the natural water sources to a greater or lesser degree. In a majority of cases the organic pollutants are adequately removed by either sewage works and/or the selfpurification processes in rivers. These processes are, however, not capable of reducing the mineral salt content of the water. The result is a progressive increase in the mineral content and plant nutrients such as soluble phosphate and nitrogenous compounds which in turn encourage the growth of algae and other undesirable aquatic plants. It can be expected that the intensity of this problem will increase with the increasing socio-economic development of the country and it is therefore imperative that research in this area be expanded and intensified. Due to the differing nature of the various industries, it is not always possible to directly apply available developed technology. It may be necessary in some instances to apply new techniques or a combination of existing and newly developed techniques to solve a particular problem. The Commission, therefore, sponsors various research and development projects on water management and effluent treatment in the industrial sector.

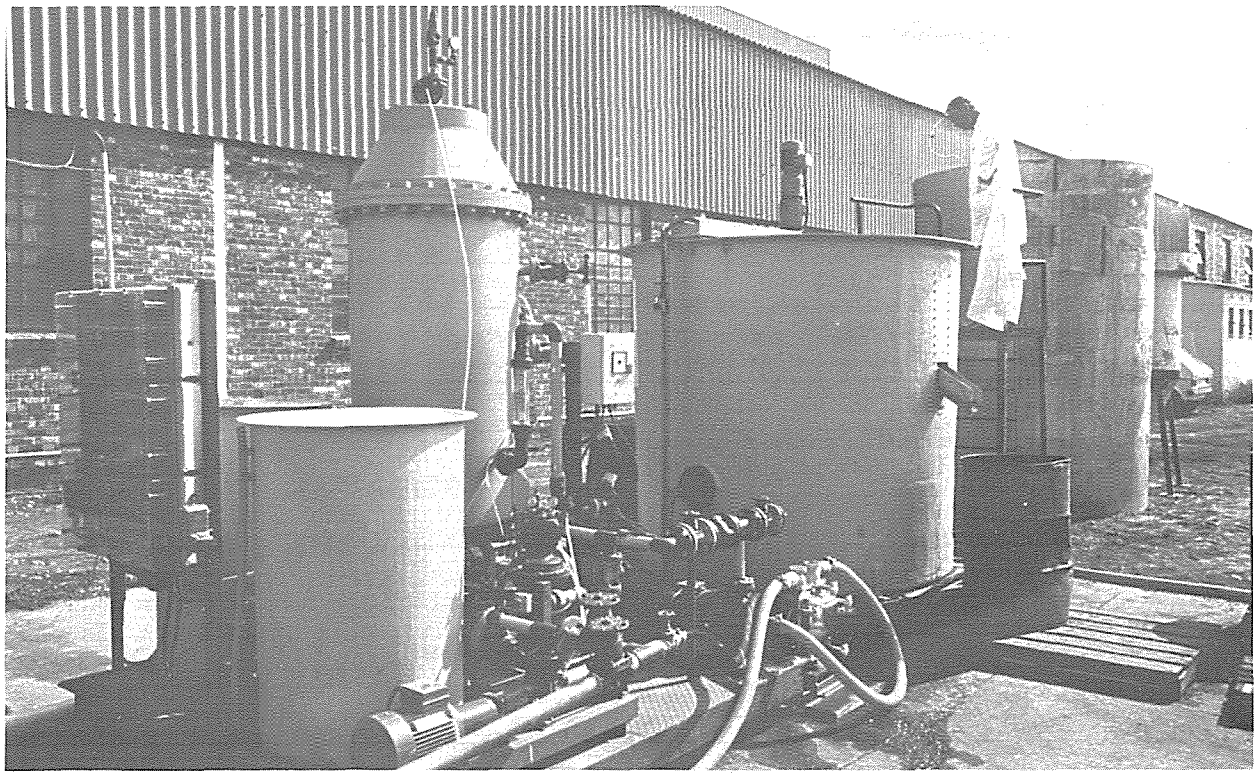
The Commission's premise in its support of this type of research is that it should benefit the country as a whole. Liaison with industry, therefore, takes place through the various national industrial associations which are also represented on several CR & D committees. Three of the seven projects concerning industrial effluents, currently supported by the Commission, are associated with textiles. Of the remaining four projects, one deals with the effluent problems of the fellmongery and tanning industry, and the other three are new agreements, entered into during the year, dealing with the fruit and vegetable processing industry and fish canning and fishmeal industries.

1. Treatment of industrial effluents from textiles

Regarding research in connection with textiles, two of the projects have already yielded such promising results that the firms involved, who are partners in the joint research, decided to erect full scale plants. One of these plants will treat effluent from the wool/synthetic fibre dyeing process, while the other will treat effluent from the sizing and desizing process.

Pilot scale studies in connection with dyehouse effluents at a cotton/synthetic textile mill, are continuing, as well as with respect to effluents from a wool scouring plant. Preliminary results of research on these effluents are promising and the possibility exists that these studies could also lead to the construction of full scale plants.

A typical scene at an intensive animal feeding unit. The treatment of effluents and solid waste of these feeding units is currently being studied. (Picture with permission of Kanhym, Middelburg, Tvl).



A pilot plant for research on effluents from the fruit and vegetable processing industries.

2. Treatment of effluents from the fellmongery and tanning industries

As a result of research supported by the Commission in respect of fellmongery and tanning industries, a full scale plant has already been commissioned at a tannery in Pretoria, with great success. The entire effluent from the plant is treated to a degree where it complies with the requirements of the Pretoria City Council for disposal to municipal sewer.

The various processes, biological as well as physical-chemical, which have been tested over a number of years, were further tested on pilot scale at another tannery during 1981.

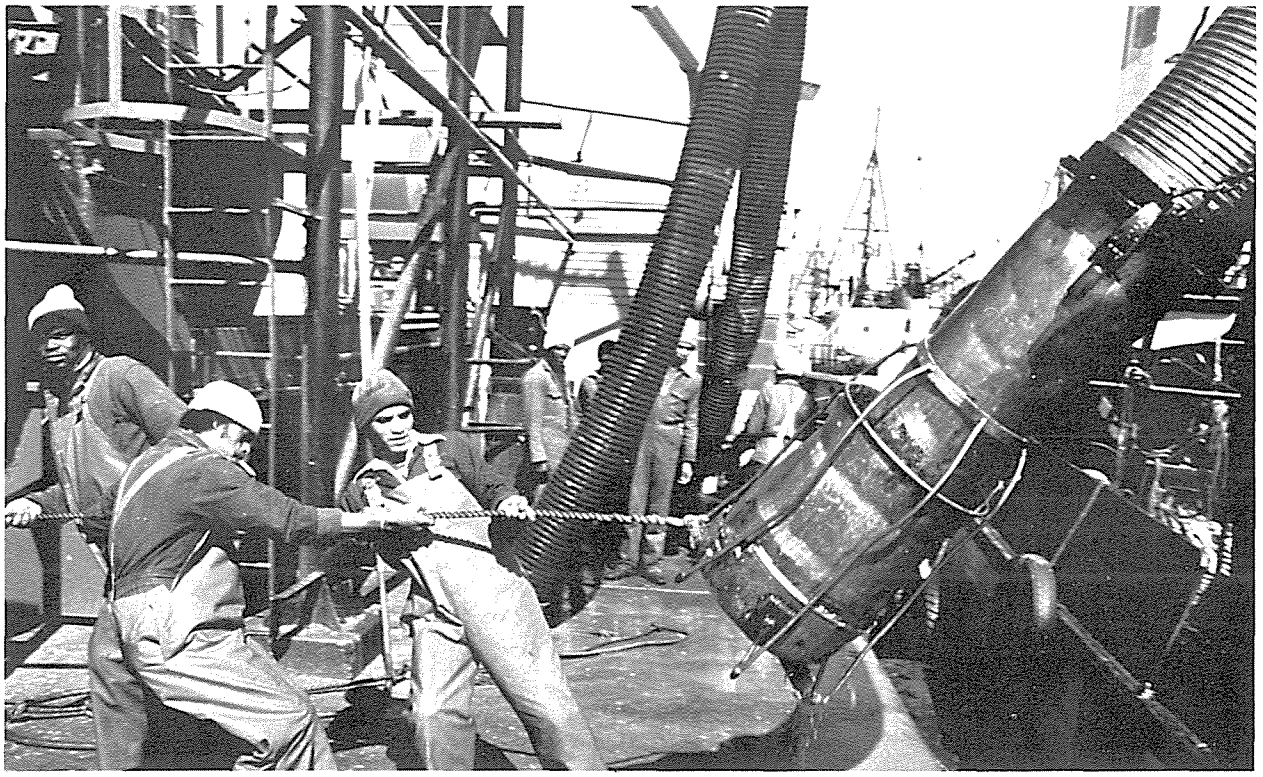
It was established that a combination of physical-chemical and biological processes gave excellent results and delivered an effluent with an organic content acceptable to a municipal sewerage system. The mineral salt content, however, is still very high — an aspect which will need attention in the future.

3. Treatment of effluents and solid waste at intensive animal feeding units

A survey concerning the handling and disposal of liquid and solid waste derived from intensive animal feeding units was completed during the year and a manual in this connection will be compiled with a view to a wider application of the information.

4. List of research projects on the treatment of industrial effluents

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



A suction pipe used in the offloading of fish. Water and effluent problems in the fishing industry are being investigated.

ject: Contract with the University of Natal — Pollution Research Group, Department of Chemical Engineering)

- Water management and effluent treatment in the textile industry: Pilot plant treatment of cotton/synthetic fibre dyehouse effluents with water reuse. (Existing project: 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. (Existing project: Contract with the Leather Industries Research Institute).

- An investigation into the water and effluent management problems in the fishing industry: Shortcomings in dry offloading systems for unloading fishing vessels. (New project: Contract with a firm of Consulting Engineers)

- 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. (New project: Contract with a firm of Consulting Engineers)

- An investigation into the water and effluent management problems in the fishing industry: Effluent handling at fish processing factories. (New project: Contract with a firm of Consulting Engineers).

Chapter 7

Research on desalination

The research on desalination supported by the Commission is aimed at procuring optimal use and reuse of saline waters and effluents. The desalination of effluents also has the effect of decreasing the pollution load on the water environment.

The Commission finances research on several aspects of desalination including desalination of sea water, brackish water and industrial effluents, as well as on the development of suitable desalination membranes, membrane and support systems for reverse osmosis and ultrafiltration units.

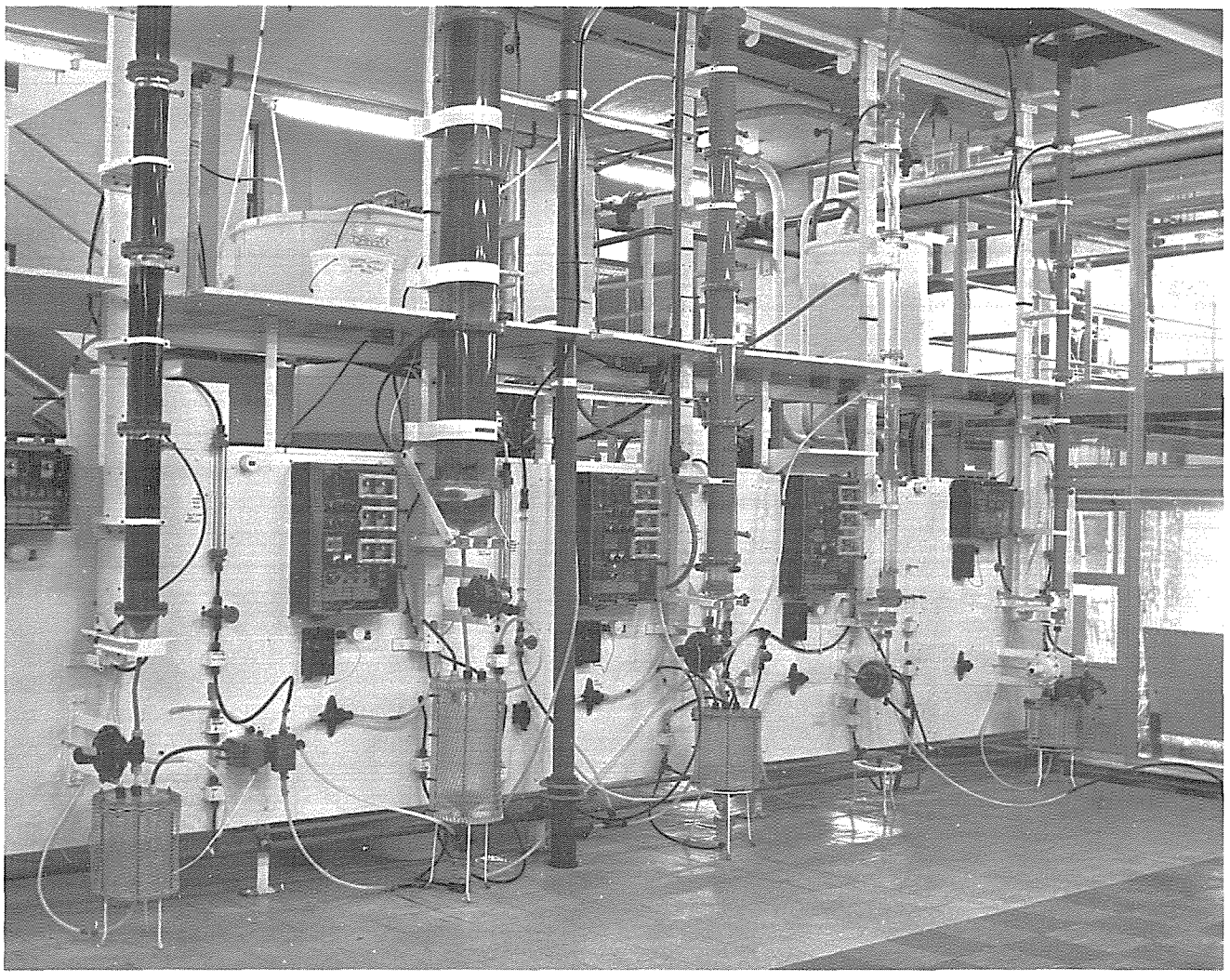
1. Desalination of sea water

Research on the desalination of sea water at Swakopmund has been completed and the final report on the project has been accepted by the Commission. This project was undertaken in cooperation with the Department of Water Affairs (SWA) and the NIWR of the CSIR. The project confirmed the technical feasibility of reverse osmosis for the desalination of sea water. However, various problems have been identified which will require in-depth investigations in future if reverse osmosis is to become a viable process for the desalination of sea water. These problems are related mainly to the pretreatment of the water and this will form the centre of attention of future research.

2. Development of desalination membranes and membrane support systems

The agreement, in terms of which membrane support systems for reverse osmosis were developed, terminated at the end of 1981. The development of local expertise in manufacturing tubular membranes has been especially successful. Good progress has also been made with the development of other types of support systems but further research is required. A follow-up agreement has therefore been entered into with the University of Stellenbosch to allow further development in this regard.

Research which is closely related to this aspect, namely that on the development of more effective reverse osmosis membranes, is also being undertaken at the University of Stellenbosch. The research agreement with the University commenced in 1980 and the development of composite membranes aimed specifically at local desalination problems has already shown good progress.



Ion exchange columns used in the project on the reclamation of water from secondary effluents.

3. Desalination by means of ion exchange

As far as the ion exchange project at the University of Cape Town is concerned, the previous agreement regarding the construction of a demonstration plant of 100 m^3/d was cancelled by mutual consent of the contracting parties. However, the Commission has decided to enter into a short-term agreement with the University of Cape Town in order to complete, at pilot scale, research on those aspects which would have been investigated on the demonstration plant. The primary objective of this project is to demonstrate, at pilot scale, the feasiblility of the

technique of counter-current ion exchange for the desalination and tertiary treatment of purified sewage effluents.

4. List of research projects on desalination

- Research on and development of desalination of sea water at reverse osmosis pilot plant, Swakopmund. (Existing project: Contract with the Department of Water Affairs (South West Africa) and the CSIR — National Institute for Water Research).
- Research on the development of membrane support systems and modules. (Existing project: Contract with the CSIR — National Institute for Water Research).
- Research on the technological development of continuous counter-current ion exchange for the reclamation of water of potable quality from secondary effluents. (New project: Contract with the University of Cape Town — Department of Chemical Engineering)
- Research on and development of polymeric membranes and supplemental coatings for reverse osmosis and ultrafiltration. (New project: Contract with the University of Stellenbosch — Institute for Polymer Sciences).

Chapter 8

Research on urban and industrial water consumption

Water economy and in particular the economic use of water in the domestic and industrial sectors can effect a considerable decrease in the water demand. As a result the Commission has for several years been supporting research on water economy in urban and industrial water consumption. Some projects have already been completed and two projects are currently being financed by the Commission relating to this subject, *viz* research on the optimization of systems for dry and dry-wet cooling at power stations in South Africa, and water economy measures for water distribution systems in urban areas.

1. Water economy at power generating stations

Large volumes of water go to waste in the process of wet cooling at power stations. It is estimated that the volume of water which is lost through evaporation in a 3 600 MW wet-cooled power station (together with relatively small volumes of water used for other purposes) amounts to some 150 000 m^3d^{-1}. This constitutes approximately 50 per cent of the total water supply of a city such as Pretoria. The importance of dry cooling as a water savings measure therefore becomes self-evident.

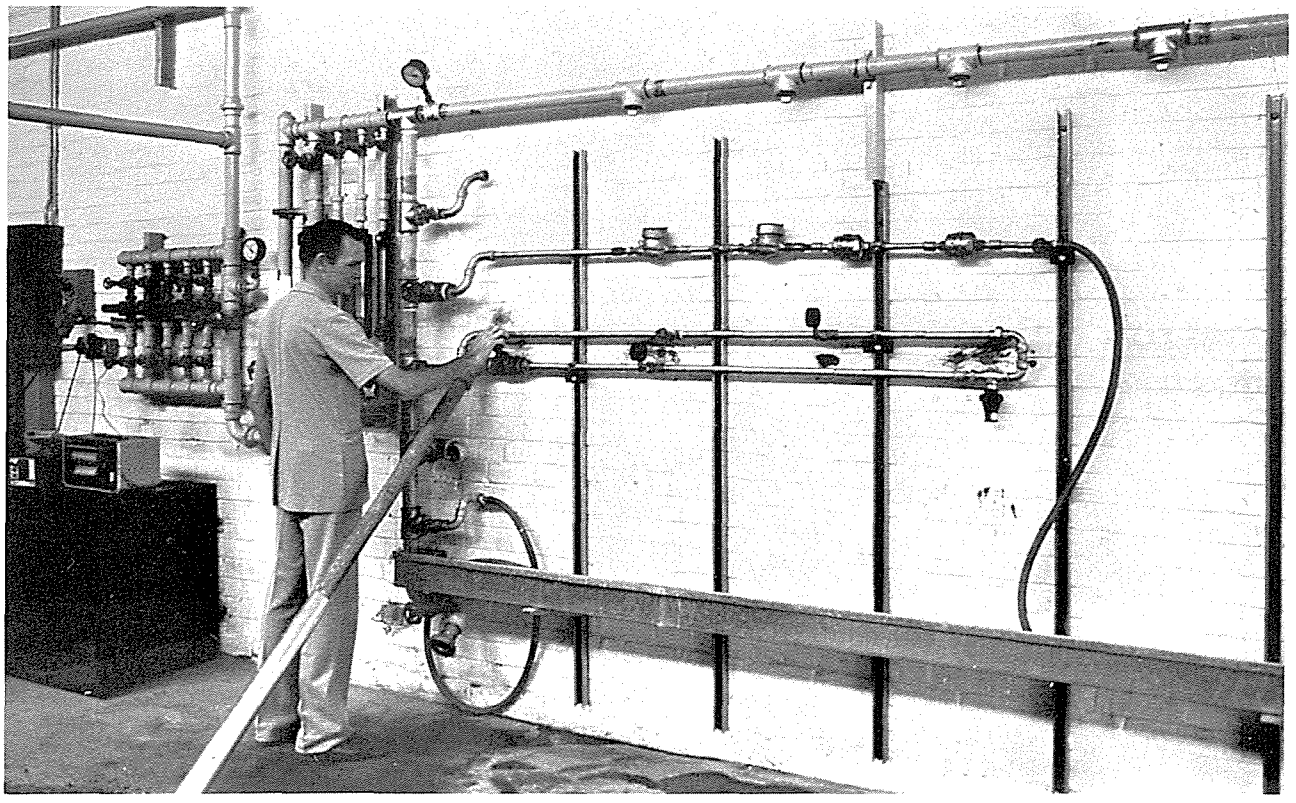
Dry cooling differs from wet cooling in that water flows through cooling elements and is cooled by air without evaporation taking place. The cooling elements can be placed in a cooling tower similar to that used in wet cooling, or in a structure containing fans which forces air over the elements.

Dry cooling, therefore, offers great advantages for water economy. Major disadvantages of this system are: Firstly, air cooling is less effective than cooling by evaporation, and consequently more coal (approximately 5 per cent on average) has to be burnt in order to generate the same amount of power as with wet cooling. Secondly, the capital outlay for a dry cooling unit is considerably higher than for a wet cooling unit since the water has to be cooled in expensive cooling elements.

In recent times research on dry cooling has attained a new significance with the announcement by ESCOM that the Matimba power station to be erected near Ellisras, the first unit of which will become operative in 1986, is to be fully dry-cooled. This power station will be the largest of its kind in the world by far, and it is therefore important that as much information as possible should be available on the performance of air-cooled units under local atmospheric conditions.

Current research centres around the effect of local atmospheric conditions on the performance of air-cooled units with a view to compensating for these conditions in the design and layout of a dry-cooled power station.

A further aspect being investigated deals with corrosion of the cooling units and measures which may be applied for preventing this.



Testing of water supply fittings in the NBRI's laboratories in Pretoria.

2. Water economy in urban areas

The project concerned with water economy measures in urban areas is being executed in terms of a tripartite agreement between the Commission, the CSIR and the SABS. The main objective of this project is to achieve a meaningful saving of water through the correct design and use of water supply fittings and to develop criteria for up-dating the relevant parts of the National Building Regulations.

Regular meetings were held during the year by the various committees established by the SABS. The aim of these meetings was, *inter alia,* to develop and publish design criteria for domestic water supply fittings and the relevant general national regulations in this regard.

Commission members visited the National Building Research Institute of the CSIR during the year in order to learn more about the project.

3. List of research projects on urban and industrial water consumption

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

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

Chapter 9

Research on irrigation

The agricultural sector is currently the largest water consumer in South Africa and expectations are that this will remain the case for several decades to come. However, this does not imply that efficiency of water use in agriculture need not be increased. In fact, with the increasing competitive water requirements of industries and urban development, it is of the essence that everything should be done to increase the efficient use of water in agriculture. This purposeful use of available water, however, will have to go hand in hand with the maintenance of and even an increase in the current yield per unit volume of water of crops being raised under irrigation.

Against this background several constraints in irrigation farming have been identified and in its support of irrigation research the Commission endeavours to alleviate these problems.

The Commission currently supports seven irrigation research projects. Scientific scheduling of irrigation plays the most important part in increasing water use efficiency in agriculture and thus in virtually each of these seven projects an aspect is studied which could make a contribution in this field. The projects are in various stages of completion.

1. Movement of water through the soil/plant/atmosphere system

One of the projects is being undertaken by the Soil and Irrigation Research Institute of the Department of Agriculture and Fisheries. In this instance the Commission's contribution involves the recruitment, employment and seconding of specialist research scientists to the Institute. In this way Dr WM Meyer, a plant physiologist of Australia, was involved with the project for a period of three years. He was succeeded by Dr DM Oosterhuis, a South African plant physiologist who was recruited in the USA, and Mr PR Berliner of Israel. The latter two scientists, together with other members of staff supplied by the Institute, currently constitute a research group studying the problem of soil moisture through the soil/plant/atmosphere system.

During the year under review two new research agreements have been negotiated. Both new projects will commence in 1982.

2. Continuation of research on the plant available water capacity of a soil profile

The project currently being undertaken by the Department of Soil Science of the University of Fort Hare will come to an end on 31 March 1982, and had as objective the development of a simple procedure for determining the profile available water capacity (PAWC) of a soil. A further agreement has now been negotiated with this University in terms of which the developed procedure will be applied to selected soil/crop combinations, and the modelling of PAWC's of soils will be investigated.

3. Development of equipment for ensuring efficient application of irrigation water

A new agreement has also been negotiated with the University of Stellenbosch. The aim of this research project, which will be undertaken by the Chair in Irrigation Engineering of the Department of Civil Engineering, is the development of the required apparatus for monitoring irrigation water applications and systems and programmes for the management of an irrigation set-up

4. Completed irrigation research projects

Two research projects which had been supported financially by the Commission were completed during the year under review. One project dealt with the effect of internal plant moisture stresses on the growth and production of agronomic crops and was undertaken by the Department of Agronomy/Horticulture at the University of the Orange Free State. The following two final reports on this project have been accepted by the Commission:

- *Die invloed van plantvogstremmings op die groei en produksie van sekere akkergewasse,* by JJ Human, LP de Bruyn and MJM Spamer. Results showed that, in the case of wheat, moisture stresses during the flowering stage had the most detrimental effect on the grain harvest, followed by moisture stresses in the piping stage and thereafter during the tillering stage. The decrease in yield could be attributed partly to the smaller number of grains produced per ear of wheat when moisture stresses occurred during the three stages mentioned above.

- *Die invloed van interne plantvogstremming op die groei en produksie van koring,* by MJM Spamer, JJ Human and LP de Bruyn.

  In order to determine the relative drought sensitivity in the basic growth stages of wheat, the mathematical model for determining internal plant moisture stresses in wheat (modified for specific soil and climatic conditions and cultivar characteristics) was used to determine moisture stress days during the growing season for the various treatments. The relative drought sensitivity of the various growth stages was determined quantitatively by calculating correlation co-efficients between the number of stress days and the yield data. Using these results a priority order has been established for the application of irrigation water in accordance with the moisture sensitive growth stages of wheat. This will lead to a decrease in applications thereby optimizing the yield per unit irrigation water applied.

The project on the water requirements of agronomic and vegetable crops undertaken by the Department of Plant Production of the University of Pretoria was also completed during the year and the following final report was accepted by the Commission:

- *Waterbehoeftes van akkerbou-en groentegewasse,* by PC Nel, MS Burgers and GR Naudé.

  This project was launched with a view to the planning and refining of irrigation programmes. The results show that irrigation programmes currently in use may be simplified considerably by adopting less differentiation between the various growth stages of the relevant crops. This will lead furthermore to altered irrigation applications which will lead to more efficient production under irrigation. A technique has also been developed by which thermal readings are used for determining plant moisture status. This represents a significant advance in the efforts to use the plant itself as an indicator for irrigation programmes.

In an effort to publicise these results as widely a possible and to have them applied in practice, the research reports have been sent to all relevant organisations and interested persons. It is hoped that this manner of distribution, supported furthermore by articles in popular agricultural magazines and the necessary personal contact, will assist in bridging the gap between research and application of the results.

5. Coordination of irrigation research

The Coordinating Committee for Irrigation Research (CCIR), led by the Department of Agriculture and Fisheries and functioning with representatives from the Department of Environment Affairs and the Commission, has as primary obligation the identification of gaps and priorities in irrigation research. In an effort to achieve this, the CCIR at its most recent meeting decided that a series of workshops will be arranged during the course of 1982 and 1983 during which, *inter alia,* progress in irrigation research since 1967 will be reviewed. The National Irrigation Symposium was held in 1967 and on that occasion not only were research results presented, but the focus also centred around irrigation research required and extension aspects which would promote the application of results in practice.

The specific aims of the workshops will be to identify gaps in the South African irrigation scene and to award priorities to these identified gaps so that research in those fields can be promoted.

This includes the necessary basic and applied research, as well as development research regarding instrumentation and measuring techniques.

In order to fully assess the situation, it has been decided that a total of five workshops will be held on the following facets of irrigation:

- Agronomic aspects of irrigation
- Soil aspects of irrigation
- Impact studies of irrigation development
- Agricultural economic and management aspects of irrigation
- Irrigation and drainage systems

6. List of research projects on irrigation

- Water requirements of certain agronomic and vegetable crops. (New project: 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. (Existing project: Contract with the University of the Orange Free State — Department of Agronomy/Horticulture)
- The efficiency of water extraction from fine sandy irrigation soils by different root systems. (Existing project: Contract with the University of the Orange Free State — Department of Soil Science)
- Research on the scheduling of irrigation of wheat in the irrigation areas of the Orange Free State. (Existing project: Contract with the University of the Orange Free State — Department of Agrometeorology).
- Development of effective irrigation methods for application to steep lands with special reference to micro-methods. (Existing project: Contract with the University of Stellenbosch — Department of Civil Engineering, Chair of Irrigation Engineering).
- Evapotranspiration and water use studies by means of weighing lysimeters: Evapotranspiration as a function of soil, plant and atmospheric factors. (Existing project: Contract with the Department of Agriculture and Fisheries — Soil and Irrigation Research Institute).
- Research on the soil factors affecting the optimal utilization of irrigation water in the National States. (Existing project: Contract with the University of Fort Hare — Department of Soil Science).

Chapter 10

Research on surface hydrology

Approximately 90% of the total water consumption in South Africa is derived from runoff reaching rivers and streams.

This runoff amounts to approximately 53 milliard m^3 per annum, which is almost 9 per cent of the estimated rainfall. However, less than 60 per cent of this runoff can be made available for use by means of storage facilities.

The major objective of the hydrological (and geohydrological) studies supported by the Commission, is to provide the information that constitutes the basis of water resource analysis, planning and management in South Africa. Information required for adequate control of water resources comprises data on —

- the volume of water available;
- the quality of the water;
- the distribution of both the quality and quantity in time and space; and
- the likely response of the various hydrological systems to change, i.e. the ability to predict changes in quality and quantity of runoff as a result of changes in land-use and management.

Estimates of water resources should be continuously updated to facilitate proper planning. Techniques such as rainfall/runoff models are required for estimation and planning and they must continuously be developed and refined as more data become available. There has been a notable change in hydrological concepts during the past 5 years in that hydrologists throughout the world now accept that estimates of overland-flow, interflow and baseflow are quantitatively very misleading when obtained from hydrograph separation. The storm runoff mechanisms that give rise to flood hydrographs are considerably more complex than those represented in most hydrological models. Recent research indicates that existing models are far less deterministic than was initially accepted and much research is required to improve the ability to predict the effects of change.

1. Development of Master Research Plan

A Master Plan for research on the effects of rural land-use and catchment management on water resources has therefore been developed by the Co-ordinating Committee for Research on the Hydrological Cycle and will be used for the purpose of allocation of priorities for proposed projects submitted to the Commission for consideration.

2. New contract on drought occurrences

During the year under review a new contract was entered into with the University of Stellenbosch in terms of which their Department of Civil Engineering will carry out research on a project

entitled "Research on drought occurrences". The main objectives of this project are to define droughts and their characteristics; to determine the frequency of occurrences of droughts; to develope prediction techniques for droughts; and to determine from historical data the areal extent and pattern of development of droughts in South Africa. Results will be important in the management of dams during water shortages and in the planning of agricultural activities.

3. Integration of current projects and establishment of national data bank on digitized rainfall records

The nine surface hydrology research projects currently financed by the Commission can be divided into three groups on the basis of the nature of the data that are used for research. Four of the nine projects derive their hydrological data from the national network of raingauges and streamflow stations and are consequently concerned with broad scale research covering the whole country. In contrast, three of the projects derive their data essentially from intensively instrumented research catchments and these data are used for the development and testing of techniques that can subsequently be used with data from the national network. The remaining two projects are engaged in the development of a single national data bank for fine time interval autographic rainfall data. The digitizing of the many rainfall records and the development of an efficient storage, retrieval and routine analysis system for the national data bank is a major undertaking. Good progress has been reported and users throughout the country will soon be able to request data from the national data bank in a variety of forms.

4. Completion of projects

The project "Research on Water Resources" of the University of the Witwatersrand and the project "An Agrohydrological Survey of Natal" of the University of Natal have recently terminated and the final reports will be considered by the Commission during 1982. It is expected that these two reports will be of great benefit to the practising hydrologists in South Africa.

5. List of research projects on surface hydrology

- Research on water resources. (Existing project: Contract with the University of the Witwatersrand — Hydrological Research Unit).
- Hydrological investigation of rural catchments in Natal with specific reference to flood events. (Existing project: Contract with the University of Natal — Department of Agricultural Engineering).
- An agrohydrological study of Natal. (Existing project: Contract with the University of Natal — Department of Agricultural Engineering).
- Hydrological research in Zululand. (Existing project: Contract with the University of Zululand — Department of Geography).
- Research on continuous streamflow modelling of South African rivers. (New project: Contract with the University of Natal — Department of Civil Engineering).
- The development of a data bank of autographic raingauge records in South Africa. (Existing project: Contract with the University of Natal — Department of Agricultural Engineering).
- Hydrological research in the Ecca and Wilderness catchments. (Existing project: Contract with the Rhodes University — Department of Geography).
- Digitizing of autographic rainfall data. (Existing project: Contract with the Department of Transport — Weather Bureau).
- Research on drought occurrences. (New project: Contract with the University of Stellenbosch — Department of Civil Engineering).

Chapter 11

Research on flood occurrences and flood damage

Floods are relatively common phenomena in South Africa and can cause considerable damage. This damage is not only restricted to farming communities, since urban areas, industries and communication and transport networks may also occur in the flood plains. As a result of the sharp increase in the value of residential areas, industries and irrigation property during the past decade direct damage as a result of floods is extremely costly. When indirect damage (e.g. loss of productive manpower and losses owing to delays and detours) is added, it becomes clear that flood control measures should be an integral part of any planning action regarding flood plains.

However, any future decisions on flood control measures will have to be based on economic considerations. This implies that the nature and extent of flood damage must be clearly defined and that the relationships between flood damage and physical flood conditions must be determined with a view to predicting the flood which will result from various floods.

Against this background, the then Department of Water Affairs requested the Commission to initiate research on flood occurrences and damage. This led to research projects by the Institute for Social and Economic Research (ISER) of the University of the Orange Free State and the Bureau for Economic Research (BER) of the University of Stellenbosch.

1. Predictability of flood occurrences

Quantitative predictions of the extent and duration of floods are required to enable managers of water source systems to effectively restrict flood damage to structures, urban environments and flood plains and yet ensure maximum supply from the system. Usually this control is effected by means of catchment management and by utilising flood gates in dams. Initially, however, quantitative information on floods is required for the design of water source structures, road bridges and culverts.

In an effort to attain this goal, the Hydrological Research Unit, in terms of an agreement between the University of the Witwatersrand and the Commission, has undertaken research which, firstly, will enable the prediction of floods at any point in a river system by means of mathematical models. Secondly, the research would enable optimal control of flood gates. The main objective of the project, therefore, is to establish facilities for routing excess precipitation in a catchment through the river system and impoundments and through the flood plain downstream, in such a way as to minimise flood damage.

The emphasis has been on floods in very small catchments and real time predictions of floods. A request was received to extend research to include the arid regions of the Republic and SWA/Namibia since very little attention was paid to these areas during previous research programmes.

This contract with the University of the Witwatersrand terminated at the end of the year. During the year three reports were published as part of the publication series of the Hydrological Research Unit.

One report describes modifications to the ILLUDAS model and its application to the design of efficient stormwater drainage systems in South Africa. This publication has been received favourably by consulting engineers involved in the design of urban stormwater drainage systems. The second report describes the kinematic wave theory i.e. the theory which determines the development and forward motion of a wave of water over the ground and which can be used for the calculation or prediction of flood behaviour. The third report deals with time distribution of surface runoff from different parts of the catchment, for estimating flood runoff.

2. New scientific methodology for determining flood damage

ISER and BER completed the research after a period of six years and on 26 November 1981 the following reports on the research were officially presented to the Honourable the Minister of Environment Affairs:

- *Vloedskade in sekere riviertrajekte van die RSA: 'n Metodologie vir vloedskadebepaling,* by PH Spies, MF Viljoen and DJG Smith.

- *Vloedskades in sekere riviertrajekte van die RSA: Bevindings rakende vloedskades in drie riviervalleie in die Noord-Westelike en Oostelike Kaapprovinsie,* by PH Spies.

- *Vloedskades in sekere riviertrajekte van die RSA: Bevindings rakende die 1974-vloedskades vir verskillende riviertrajekte van die Oranje-, Vaal-, Riet-, Seekoei- en Hartbeesrivier* (Vol. 1 and 2), by MF Viljoen, JA Vos and PJ Marais.

- *Vloedskades in sekere riviertrajekte van die RSA: 'n Evaluering van die problematiek rondom vloedskadebepaling in die RSA,* by MF Viljoen, DJG Smith and PH Spies.

- *Die 1975-vloedskades vir verskillende trajekte van die Vaalrivier,* (Vol 1 and 2), by M F. Viljoen, JA Vos, DJG Smith and JW Prinsloo.

During the presentation the Minister said that before purposeful flood control planning can commence, flood plains will have to be classified according to their regional or national importance. Flood control measures are not, however, the responsibility of the central government alone, but the community also has a role to play.

From the reports mentioned above it appears that the relevant research organisations succeeded in developing an acceptable methodology for determining flood damage. This methodology has also been successfully applied to those river stretches in which the most important floods of 1974 and 1975 occurred. Relationships between physical damage and flood conditions have been developed, but since at this stage these are based only on the results of a few flood occurrences, they are currently regarded as 'informal' relationships and will eventually have to be refined.

This research will be completed with the following report which will be released during 1982: *Guidelines for assessing flood damage in South Africa,* by DJG Smith, MF Viljoen and PH Spies, as well as with the release of the English translation of the fourth report mentioned earlier. In these reports the application of the methodology developed will be expounded and as such it will serve as a manual for future determination of flood damage. It is hoped that this will assist in standardizing the determination of flood damage to enable comparisons on various bases (e.g. flood occurrence and river stretches) to be drawn.

For the time being the Commission's involvement in flood damage research will terminate when the latter report is completed. Refinement of the 'informal' relationships referred to earlier does entail a research component and when such a stage is reached, the Commission will consider further support. The whole subject of prevention of flood damage is currently being studied by the Department of Environment Affairs and the possibility that the Commission will be approached to support further research is not excluded.

3. List of research projects on flood occurrences and damage

- Research on flood damage. (Existing project: Contract with the University of the Orange Free State — Institute for Social and Economical Research).
- Research on flood occurrences. (Existing project: Contract with the University of the Witwatersrand — Hydrological Research Unit)

Chapter 12

Research on rainfall stimulation

A serious water shortage is predicted for South Africa soon after the turn of the century and therefore it is essential that all possible alternative sources of water are investigated timeously. As a result of research carried out on weather modification in other parts of the world, it is apparent that it may be possible to increase rainfall by cloud seeding to an extent that an increase of runoff would occur and that this method of obtaining additional water may be one of the most economical alternatives.

In view of the possibilities offered by rainfall stimulation, the Commission considers it advisable to obtain the necessary background information about the physical characteristics of the clouds in the various parts of South Africa and to assess the local potential for weather modification activities. It is also necessary to develop adequate expertise in this complex field of research and to this end the Commission supports two separate projects.

1. The Bethlehem Project

The Commission makes a contribution to the rainfall stimulation research project being conducted at Bethlehem by the Weather Bureau of the Department of Transport. The objective of the project is to investigate the feasibility of increasing the rainfall by cloud seeding. In conjunction with this project, the Directorate of Water Affairs of the Department of Environment Affairs have a research programme in the same area that is aimed at determining the effects of changes in rainfall on stream runoff. The planning for the runoff project has reached an advanced stage and the data control systems are now fully operational. A start has been made on the assessment of the mathematical models of the rainfall/runoff process that will be utilized for the assessment of the effects of rainfall changes on runoff.

2. The Nelspruit Project

The second project was carried out near Nelspruit and was aimed at obtaining as much data as possible on the microphysics of the clouds and to determine whether or not there had been a change in rainfall during the period in which the Laeveldse Koöperasie Beperk (LKB) carried out an operational hail suppression programme. The research project constituted a minor adjunct to the extensive hail suppression programme of LKB but this approach permitted the collection of valuable additional basic information to that being collected at Bethlehem by the aforementioned project and at a relatively low cost. The data collected in this way was progressively evaluated by a group of specialist consultants from the USA (Simpson Weather Associates) and their final report for the project has been submitted to the Commission. On account of the possible impact that the results may have on future weather modification programmes in South Africa, it was decided to submit the report to two alternative consultants for a further independent scientific evaluation and to obtain recommendations as to the feasibility and desirability of conducting a fully randomised weather modification research programme at Nelspruit, that will investigate both rainfall stimulation and hail suppression aspects.

3. List of research projects on rainfall stimulation

- Research on the artificial stimulation of rainfall at Bethlehem. (Existing project: Contract with the Department of Transport — Weather Bureau).
- Research on the stimulation of rainfall at Nelspruit. (Existing project: Contract with the Laeveldse Koöperasie Beperk).

Chapter 13

Transfer of information and technology

Promotion of the transfer of information and technology is regarded, together with co-ordination, initiation and financing of water research as one of the four cornerstones of the Commission's objectives. In order to promote the transfer of information and technology a number of activities have been developed. Some of these are aimed mainly at information transfer (IT), whilst others centre around technology transfer (TT), i.e. the application of research results.

Certain basic requirements are of cardinal importance to a successful programme of information and technology transfer, *viz*:

- Correct information — it must be available or must be developed.
- Properly directed transfer — the transfer must be directed towards a target audience.
- Correct packaging — information transferred to the user is often too complex and sometimes written in too sophisticated a language to be readily accepted. Simplicity should be the norm and the information should be presented in such a way as to make it attractive and agreeable to the user.
- TT Specialist — successful TT does not entail only one action, it involves various stages and different people. In this regard the head of an organization will have an important role to play, and it is obvious that the researcher will be of the essence to the process. TT specialists, however, are also required and must take a leading role. Such a person will act in the dual capacity of strategist and catalyst and should wear the hat of both research scientist and that of user.
- Personal contact — this is essential for a viable programme of information and technology transfer and can be seen as the mortar which binds all the different techniques into one solid structure.

In the programme of information and technology transfer the Commission primarily uses the following methods:

1. Partnership research

This is regarded as the most effective method for successful transfer of information and technology. The involvement of the user as a partner in the research programme promotes the acceptance and application of the results to a very large extent.

2. Mass media

In this regard the accent is placed on information transfer and for this purpose press releases, radio and television are usually used.

3. Publications

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

3.1 *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 April 1975 and the journal appears quarterly. There are approximately 1 600 subscribers of whom approximately 600 reside abroad.

Water SA enjoys world-wide coverage and is included in 16 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); and Soils and Fertilizers (including Irrigation and Drainage Abstracts).

3.2 *SA Waterbulletin*

This bilingual newsletter which was launched in August 1975 by the Commission 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. Good cooperation has been built up with producers and distributors of new equipment and processes associated with the promotion of water matters, and information on equipment and processes appears regularly in the section on equipment.

A column on technology transfer appears regularly in the bulletin and deals with technology developed by Commission sponsored research and that developed by other organizations.

3.3 *Manuals and reports*

At the conclusion of a project, and in some cases whilst research is still underway, results are evaluated in respect of possible application and depending on the nature of the results a decision is taken on the publication, dissemination and application thereof. It may be that the final report has been compiled in such a way that it may selectively be distributed in that format. A decision may also be taken to package the results in the form of a manual in order to enhance the application possibilities. Interim reports and results are handled in the same way.

The titles of all these publications, as well as articles published and papers presented at meetings, based on research sponsored wholly or in part by the Commission, appear as Appendix I.

3.4 *State of the art reports and proceedings*

In planning for water research in new fields, it is often necessary to prepare state of the art reports. This is sometimes done by specialist consultants, or the responsibility is delegated to a study group. The nature of the report will determine whether it will be published or not.

From time to time the Commission arranges symposia, the proceedings of which may be published.

3.5 *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 Southern Africa. Since its inception in 1971, the Commission has developed a wide range of activities which are of direct importance to local authorities. For a considerable period of time there has been a need for regular feedback of information to local authorities and this column is aimed at keeping local authorities abreast of activities and research being done on their behalf.

4. Conferences, seminars, work sessions and demonstrations

From time to time the Commission, on its own or in cooperation with other organizations, 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.

During the year the Commission organized a successful work session in Durban which afforded research scientists working on various Commission projects the opportunity to exchange information and solve common problems. This work session related to physical-chemical processes in respect of water and effluent treatment, water recycling and the reclamation of chemicals and by-products.

5. The South African Water Information Centre

The South African Water Information Centre is operated on behalf of the Commission and under contract, by the CSIR as an independent unit and provides various information services in the water and related fields.

During the year approximately 12 200 items, selected from approximately 450 periodicals and various reports and pamphlets, were added to the computerized data base *Waterlit.* This means that the rate of addition has exceeded 1 000 items per month for the first time and which brings the total number of items contained in *Waterlit* to 51 700. A total of 466 retrospective searches were done and the number of selective dissemination of information (SDI) profiles increased during the year to 200. The documentation service provided about 3 500 articles to users, an increase on the previous year of approximately 60 per cent.

During September 1981 *Waterlit,* in terms of an agreement with System Development Corporation (SDC) in the USA, was for the first time made available on a world-wide basis through SDC's coupled information retrieval service. The Centre received royalties for the use of *Waterlit* via SDC services. An additional contract has been entered into with SDC during the year for the rendering of SDI services. This is further proof of the high regard for *Waterlit* and in this way water research in South Africa is being publicised throughout the world.

Since the *Water Patent Bulletin* was poorly utilised, publication has been terminated. South African patents which may be of importance to persons working in the field of water are now entered in *Waterlit.* The remaining current awareness services of the Centre are still well supported and *Selected Journals on Water* and *SA Waterabstracts* are currently mailed to 150 and 375 users respectively.

6. The utilization of overseas expertise

The Commission is of the opinion that the utilization of overseas expertise and knowledge, where such knowledge is locally unavailable, will benefit the country as a whole, and various methods have been developed to achieve this. Overseas specialists are used as consultants in cooperation with local specialists and consultants to view specific problems and make recommendations for research and the application of existing knowledge.

The Commission has already sent a few study groups overseas in order to obtain knowledge in a specific problem area. This is seen as an important strategy for transferring proven overseas technology and practice to South Africa and preventing duplication of work locally.

In general the Commission endeavours to strengthen and expand overseas contacts by entering into agreements for the exchange of information, by taking up membership of appropriate overseas and international organizations by subscribing to services and media which concentrate on the publication of important developments in research and technology.

Chapter 14

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 1981 to 31 December 1981.

The Commission derives its income from rates and charges on water usage and on scheduled irrigation land. Up to 30 June 1981, the tariffs for the 1981 financial year were 0,2 c/m^3 for water supplied for urban, industrial or domestic use, and an amount varying between 20 c and 40 c/ha of land scheduled for irrigation.

On 1 July 1981 the tariffs were fixed at 0,25 c/m^3 for water supplied for urban, industrial or domestic use and 40 c/ha for all land scheduled for irrigation.

WATER RESEARCH COMMISSION
STATEMENT 1
BALANCE SHEET AS AT 31 DECEMBER 1981

1980	Liabilities		1981	1980	Assets		1981	
R		R	R	R		R	R	R
	Sundry creditors —				*Capital assets —			
85 862	Revenue paid in advance		37 195,84	5 000	Land (Cost)		5 000,00	
	Fund account —				Motor vehicles	10 071,03		
6 245 920	Balance at 31/12/80	6 245 920,31			*Less:* Depreciation	2 342,11		
	Plus: Excess of income over expenditure, 1981	919 832,40		10 071			7 728,92	
			7 165 752,71		Office equipment	58 541,27		
					Less: Depreciation	2 759,67		
				53 728			55 781,60	
					Office furniture	30 119,87		
					Less: Depreciation	1 431,43		
				28 073			28 688,44	
								97 198,96
					Investments		4 550 431,59	
					Plus: Accrued interest, 1/10/81 to 31/12/81		144 038,76	
				4 943 493				4 694 470,35
					Current assets —			
					Sundry debtors —			
					Outstanding revenue:			
					Prior to 1981	15 581,27		
					1981	700 447,45		
				475 219			716 028,72	
				741 891	Project advances (Statement 3)	1 440 563,13		
				240	Subsistence and transport advances	2 580,00		
				—	Motor financing	62 669,11		
				300	Deposits	200,00		
							1 506 012,24	
				150	Cash on hand		150	
				73 617	Cash in bank		189 088,28	
								2 411 279,24
R6 331 782			R7 202 948,55	R6 331 782				R7 202 948,55

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

Pretoria, 25 March 1982

(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 so as to reflect a true and fair view of the financial affairs of the Water Research Commission.

Office of the Auditor-General,

Pretoria 19 April 1982

(sgd.) W.G. Schickerling
Auditor-General.

WATER RESEARCH COMMISSION

STATEMENT 2

INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR 1 JANUARY 1981 TO 31 DECEMBER 1981

1980	Expenditure		1981
R			R
610 240	Salaries and allowances		760 552,83
22 141	Subsistence		20 850,05
5 352	Motor transport		6 435,36
83 906	General transport		89 068,75
350	Commission members' allowances		1 950,00
3 971	Postal and telegraph services		6 597-82
11 512	Telephone services		10 112,48
8 151	Printing and stationery		9 828,59
—	Advertisements		1 372,40
27 669	Publications and Information		52 589,19
5 254	Lease and maintenance of office equipment		7 504,28
6 744	Entertainment		7 354,85
27 183	Office rental		29 159,12
1 088	Maintenance of and alterations to office		236,54
2 812	Electricity		3 287,45
222	Maintenance and lease of furniture		319,28
22	Typing services		500,00
3 364	Insurance and licenses		2 924,25
38 966	Collection fees		43 030,00
876	Audit fees		1 209,00
210	Legal costs		121,00
7 636	Registrations and subscriptions		15 152,35
2 359	Miscellaneous petty expenses		2 835,76
7 392	Depreciation		6 533,21
2 190 273	Research projects (Statement 3)		2 453 498,11
	Contracting of researchers and expertise:		
		R	
121 733	Weather modification at Bethlehem	140 218,78	
20 629	Evapotranspiration and water use studies by means of weighing lysimeters	51 458,68	
55 801	Digitizing of autographic raingauge data	53 525,83	
			245 203,29
185 698	Research and other grants		152 500,00
204 531	Specialist and consultation services		217 512,40
—	Repayment of interest on rates and charges in arrear		1 452,28
665 319	Excess of income over expenditure		919 832,40

1980	Income			1981	
R		R	R		R
	Rates:				
	Government irrigation schemes with canal systems:				
	Received	43 949,58			
	Plus: Adjustment in respect of previous years	283,24			
			44 232,82		
	Plus: Outstanding 1981		38 054,32		
71 165					82 287,14
	Government irrigation schemes without canal systems:				
	Received		1 651,86		
	Plus: Outstanding 1981		5 187,03		
4 660					6 838,89
	Irrigation Board Schemes:				
	Received	26 925,10			
	Less: Adjustment in respect of previous years	963,67			
			25 961,43		
	Plus: Outstanding 1981		560,34		
28 845					26 521,77
	Charges:				
	Metered water from Government schemes:				
	Received	2 690 722,59			
	Less: Adjustment in respect of previous years	5 516 33			
			2 685 206,26		
	Plus: Outstanding 1981		602 327,43		
2 931 831					3 287 533,69
	Municipalities:				
	Received		938 911,38		
	Plus: Outstanding 1981		11 007,31		
981 690					949 918,69

1980	Expenditure *(continued)*	1981	1980	Income *(continued)*		1980	
R		R	R		R	R	R
				S.W.A.:			
				Received		33 631,27	
				Plus: Outstanding 1981		43 311,02	
			86 686				76 942,29
			1 706	Unallocated rates and charges			181 088,11
			2 352	Interest on rates and charges in arrears			1 197,95
				Interest on investments:			
				Received		307 428,74	
				Accrued		144 038,76	
			212 035				451 467,50
			434	Sundry income			5 727,01
R4 321 404		R5 069 523,04	R4 321 404				R5 069 523,04

WATER RESEARCH COMMISSION

STATEMENT 3

STATEMENT OF PROJECT EXPENDITURE AND ADVANCES FOR THE YEAR 1981

Project	Expenditure		Total advances outstanding as at 31/12/81
	1980	1981	
	R	R	R
Development of research on the reclamation of water at the Athlone Sewage Works, Cape Town	31 314	3 480,17	29 615,35
Technological development of water reclamation on the basis of the Windhoek plant	21 482	21 463,54	21 188,43
Reclamation, storage and abstraction of purified sewage effluent in the Cape Peninsula	64 296	22 557,30	12 224,17
Research on the activated sludge process	54 128	—	—
Hydrological investigation of small catchments in the Mtunzini district	—	18 822,07	—
An investigation on the optimal utilization of water in the Eerste River in sandbeds or by other means	—	14 179,23	3 053,82
South African Water Information Centre	136 495	151 864,40	*(34 532,01)
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	188 553	189 558,21	11 791,79
The development and evaluation of techniques for the determination of the exploitation potential of ground water resources along the Doornberg fault zone and in the Kalahari	35 233	—	3 270,03
An investigation into the influence of internal plant moisture stress on the growth and production of certain agronomic crops	1 529	—	10,10
Research on flood damage — Institute for Social and Economic Research	20 999	1 526,49	2 474,03
Research on the microbiological quality and health aspects of water for reuse	84 904	264 161,16	*(78 569,95)
Research on the soil factors effecting the optimal utilization of irrigation water in National States	32 572	—	15 257,85
Research on water requirements of certain agronomic and vegetable crops	57 628	—	3 200,00
Research on the purification and reuse of effluents from the hides and skins curing, fellmongery and tanning industries	127 759	125 752,00	35 738,70
Research on and development of desalination of sea water by reverse osmosis on the pilot plant at Swakopmund	40 837	4 059,00	504,00
Research on desalination of treated sewage	7 064	—	—
Research on the development of membrane support systems and modules	32 669	51 519,00	2 748,00
Water management and effluent treatment in the Textile Industry	—	58 914,72	81 785,28
Research on the development of effective irrigation methods for application on steep lands, with special reference to micro-methods	63 153	—	57 780,91
Research on flood occurrences	27 193	—	21 680,53
Research on water resources	56 176	—	130 279,49
Water pollution and effluent reclamation in Pretoria-Witwatersrand-Vereeniging-Sasolburg Complex	129 675	46 770,25	20 413,31
Research on the scheduling of irrigation of wheat in the irrigation area of the Orange Free State	16 884	23 474,00	3 779,45
Research on rainfall stimulation at Nelspruit	134 443	43 281,15	*(2 121,15)
Research related to the purification and reuse of tannery effluent	287	—	—
Research on the development and application of aspects of equilibrium chemistry and precipitation kinetics to water stability problems encountered in water reclamation	—	16 087,97	8 021,98
Evaluation of the performance of a horizontal decanter centrifuge on the removal of sludge from liquid scouring wastes	11 000	—	—
The removal of nitrogen and phosphate from biofilter effluents	34 171	38 140,00	4 961,71
Hydrological research in the Ecca and Wilderness catchments	61 711	55 614,14	887,79
Research on the optimization of dry and dry-wet cooling systems at power stations in South Africa	109 472	163 942,00	*(40 244,49)

Research on the optimization of the modified activated sludge process for nutrient removal (Johannesburg City Council)	8 236	12 359,72	4 909,12
Research on the optimization of the modified activated sludge process for nutrient removal (NIWR)	100 420	108 712,00	1 277,00
Hydrological investigation of rural catchments in Natal with specific reference to flood events	—	53 401,92	60 788,18
An Agro-hydrological study of Natal	—	4 171,68	7 131,20
The development of a data bank of autographic raingauge records in South Africa	—	18 627,85	30 499,27
Hydrological research in Zululand	—	60 028,13	2 392,40
The efficiency of water extraction from fine sandy irrigation soils by different root systems	21 004	33 256,87	*(100,43)
Technological development of ion exchange for the desalination and tertiary treatment of effluents: Planning, design, construction and operation of a 100 kl/day pilot plant and evaluation of its performance	—	144 522,27	—
Research on economy measures for water distribution systems in urban areas	110 074	136 382,30	*(5 834,35)
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	155 337	—	32 616,00
Research on eutrophication in the Hartbeespoortdam	54 500	—	—
Epidemiological studies pertaining to the reclamation and reuse of purified sewage effluent in the Cape Peninsula	36 512	—	62 973,34
The construction and operation of the Cape Flats prototype water reclamation plant and the surveillance of reclaimed water quality	—	136 065,88	296 934,12
Optimization of the modified activated sludge process for nutrient removal (Univ. of Cape Town)	96 494	—	82 381,01
Water management and effluent treatment in the textile industry: Pilot plant treatment of cotton/synthetic fibre dyehouse effluents with water reuse	—	99 293,49	95 836,51
Research on water management and effluent treatment in the textile industry: Wool scouring effluent treatment	—	114 398,03	79 551,97
Research on continuous streamflow modelling of South African rivers	—	16 444,64	23 535,36
The treatment and disposal of sewage sludge: The stabilisation of sludge by means of photosynthetic bacteria	10 235	12 734,46	7 030,71
The treatment and disposal of municipal sludges: Sludge dewatering and the treatment of sludge liquors	119	—	6 746,40
The treatment and disposal of municipal sludges: Sludge disposal to sea	—	30 000,00	*(15 000,00)
Research on the water requirements of certain agronomic and vegetable crops	—	—	50 700,00
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	1 715	14 483,92	115 977,10
The treatment and disposal of municipal sludges: Pasteurisation and thermophilic anaerobic digestion of sludge	—	—	11 500,00
The treatment and disposal of municipal sludges: Autothermic aerobic digestion of sludges	—	5 278,25	15 459,75
The treatment and disposal of municipal sludges: Composting of sludge by forced aeration	8 000	—	—
The treatment and disposal of municipal sludges: The characterisation of sludge	6 000	15 500,00	2 300,00
Research on biochemical processes which result in phosphate and nitrogen removal in the modified activated sludge process	—	—	14 000,00
Research on drought occurrences	—	—	36 200,00
Pilot plant studies in connection with the adsorption capacity of regenerated activated carbon	—	12 499,00	—
Research on the technological development of continuous counter current ion exchange for the reclamation of water of potable quality from secondary effluents	—	—	60 559,35
An investigation into the water and effluent management problems in the fishing industry: Shortcomings in dry offloading systems for unloading fishing vessels	—	40 117,65	—
Research on and development of polymeric membranes and supplemental coatings for reverse osmosis and ultra filtration	—	—	45 000,00

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	—	48 680,34	—
An investigation into the water and effluent management problems in the fishing industry: Effluent handling at fish processing factories	—	21 372,91	—
	R2 190 273	R2 453 498,11	R1 440 563,13

*Excess expenditure over advances for projects.

WATER RESEARCH COMMISSION
STATEMENT 4

BUDGET 1982

	R	R
ESTIMATED INCOME		
Rates and charges in terms of Section 11 of the Water Research Act		5 052 000
Interest on investment		180 000
		5 232 000
Appropriation from accumulated funds		1 987 700
TOTAL ESTIMATED INCOME		7 219 700
ESTIMATED EXPENDITURE		
Administrative expenses:		
Salaries and allowances	901 000	
Subsistence and travelling expenses	141 800	
Postal, telegraph and telephone	21 000	
Printing, stationery, advertisements and publications	74 000	
General expenditure	158 900	
		1 296 700
Research Projects		
Approved projects		
Technological development of water reclamation on the basis of the Windhoek plant	7 500	
South African Water Information Centre	191 900	
Research on the microbiological quality and health aspects of water for reuse	189 400	
Research on the soil factors affecting the optimal utilization of irrigation water in National States	3 500	
Research on the purification and reuse of effluents from the hides and skins curing, fellmongery and tanning industries	63 200	
Research on the development of effective irrigation methods for application on steep lands, with special reference to micro-methods	3 500	
Research on the scheduling of irrigation of wheat in the irrigation area of the Orange Free State	10 000	
Research on the development and application of aspects of equilibrium chemistry and precipitation kinetics to water stability problems encountered in water reclamation	11 100	
The removal of nitrogen and phosphate from biofilter effluents	29 000	
Hydrological research in the Ecca and Wilderness catchments	58 200	
Research on the optimization of dry and dry-wet cooling systems at power stations in South Africa	133 300	
Research on the optimization of the modified activated sludge process for nutrient removal (Johannesburg City Council)	31 700	
Research on the optimization of the modified activated sludge process for nutrient removal (NIWR)	40 000	
Hydrological investigation of rural catchments in Natal with specific reference to flood events	74 000	
An agro-hydrological study of Natal	2 000	
The development of a data bank of autographic raingauge records in South Africa	14 600	
Hydrological research in Zululand	31 400	
The efficiency of water extraction from fine sandy irrigation soils by different root systems	20 500	
Research on economy measures for water distribution systems in urban areas	170 000	
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	61 200	
Epidemiological studies pertaining to the reclamation and reuse of purified sewage effluent in Cape Peninsula	69 000	
The construction and operation of the Cape Flats prototype water reclamation plant and the surveillance of reclaimed water quality	175 000	
The optimization and evaluation of the full scale treatment of spent wine residue	25 000	
Optimization of the modified activated sludge process for nutrient removal (University of Cape Town)	108 000	
Water management and effluent treatment in the textile industry: Pilot plant treatment of cotton/synthetic fibre dyehouse effluents with water reuse	96 700	
Research on water management and effluent treatment in the textile industry: Wool scouring effluent treatment	100 600	
Research on continuous streamflow modelling of South African rivers	26 500	
The treatment and disposal of municipal sludges: The stabilisation of sludge by means of photosynthetic bacteria	20 000	
The treatment and disposal of municipal sludges: sludge dewatering and the treatment of sludge liquors	6 950	
The treatment and disposal of municipal sludges: sludge disposal to sea	15 000	
Research on the water requirements of certain agronomic and vegetable crops	65 700	
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	49 900	
The treatment and disposal of municipal sludges: Pasteurisation and thermophilic anaerobic digestion of sludge	20 500	
The treatment and disposal of municipal sludges: Autothermic aerobic digestion of sludge	20 000	

The treatment and disposal of municipal sludges: The characterisation of sludge	19 300	
Research on biochemical processes which result in phosphate and nitrogen removal in the modified activated sludge process	14 000	
Research on drought occurrences	49 000	
Research on the technological development of continuous counter current ion exchange for the reclamation of water of potable quality from secondary effluents	29 900	
Research on and development of polymeric membranes and supplemental coatings for reverse osmosis and ultra filtration	92 000	
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	56 700	
An investigation into the water and effluent management problems in the fishing industry: Effluent handling at fish processing factories	44 850	
Research on the profile available water capacities of soils	79 000	
Eutrophication research in the Hartbeespoort Dam	80 000	
Intregated studies of the generation of runoff solutes and sediment in tributary catchments of the Great Fish River	154 100	
Forced aeration composting of sludge: Prototype study	40 000	
	2 602 800	
Possible projects		
Proposed	1 902 200	
Tentative	560 000	
		5 065 000
Contracting of researchers and expertise		388 000
Researching and other grants		200 000
Specialist and Consultation Services		270 000
TOTAL ESTIMATED EXPENDITURE		R7 219 700

ANNEXURE

Publications based on research which has been financed, wholly or in part, by the Commission.

Part 1: Articles and papers

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