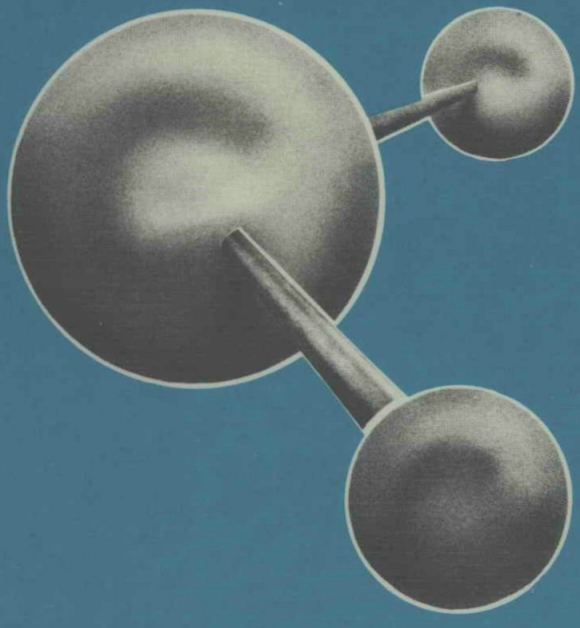


water research commission

ANNUAL REPORT

1 April 1973 to 31 March 1974

WATER RESEARCH COMMISSION

CONTENTS

WATER RESEARCH COMMISSION

P.O. Box 824,
Van der Stel Building,
Pretorius Street,
Pretoria.
0001

Telegraphic Address: WATERKOM

Printed in 1974 in the
REPUBLIC OF SOUTH AFRICA
by
Wallachs Printing Co. (Pty.) Ltd.,
Pretoria.

Water Research Commission,
P.O. Box 824,
Pretoria. 0001
April 1, 1974.

Dear Sir,

It is with pleasure that we submit to you, herewith, the report of the Water Research Commission. This report covers the period April 1, 1973 to March 31, 1974.

Balance Sheets and Statements of Revenue and Expenditure for the financial year April 1, 1973 to March 31, 1974, as certified by the Controller and Auditor-General, are furnished in Chapter 6 of this report.

Yours respectfully,

J.P. Kriel
CHAIRMAN

G.J. Stander
VICE CHAIRMAN

The Honourable S.P. Botha, M.P.,
Minister of Water Affairs,
P.O. Box 23,
CAPE TOWN,
8000.

Members of the Water Research Commission

MR. J.P. KRIEL
Pr. Eng., B.Sc. (Civ.Eng.)
Secretary for Water Affairs
Chairman

DR. G.J. STANDER
Pr. Eng., M.Sc., Ph.D., D.Sc.
Honorary Professor:
University of Pretoria
President of the "International Association on Water Pollution Research"
Vice Chairman: Chief Executive Officer

MR. V.N. BOLITHO
Pr.Eng., B.Sc. (Eng.), Dip (T.Pg.) (Rand)
Assistant City Engineer
Johannesburg Municipality

PROFESSOR B.J.V. BOTHA
B.Sc., M.Sc, D.Sc.
Head: Department of Geology,
University of the Orange Free State

MR. N.A. LEVER
B.Sc. (Eng.)
Assistant Technical Manager
AE & CI (Limited)

PROFESSOR S. MEIRING NAUDÉ
M.Sc., Ph.D., D.Sc. (h.c.), LL.D. (h.c.)
Scientific Adviser to the Prime Minister

PROFESSOR D.C. MIDGLEY
Pr.Eng., B.Sc. (Eng.), Ph.D.
Department of Civil Engineering
University of the Witwatersrand

DR. P.W. VORSTER
B.Sc., M.Sc., D.Sc. (Agriculture)
Retired Secretary of the Department of Agricultural
Technical Services.

Chapter 1

Review of the Year's Activities

The Water Research Commission met five times during the year under review. All the meetings were fully attended with one exception, when two members of the Commission were unavoidably absent on overseas visits.

Special attention was given to the compilation of a National Master Research Plan and the establishment of a National Information Centre on Water. It is on these two cornerstones that the Water Research Commission must structure the four main aspects of its work:

(i) The identification of constraints and problems in the water economy of the Republic requiring research priority.
(ii) The promotion and acceleration of priority research by activating research authorities on the one hand to adapt their internal research programmes accordingly, and secondly, by the judicious funding of water research projects. It should be emphasised in this connection that the Commission itself does not carry out research.
(iii) The co-ordination of water research in South Africa.
(iv) The furthering of communication, publication and application of information in the field of water conservation and water resources development.

A clear picture has unfolded of the Commission's organisational structure and the main scientific disciplines in which the Commission's professional staff should be proficient. Consequently, two senior appointments were made during the year: Dr. M.R. Henzen, Assistant Director of the National Institute for Water Research, was appointed Chief Adviser for Ground Water Resource Development in particular with the additional general responsibility of assisting the Vice Chairman and Chief Executive Officer where the latter is still professionally responsible for the water and effluent problems of industries, municipalities, mining and power generation. Professor P.J.C. Vorster, Head of the Department of Agricultural Engineering at the University of Natal, was appointed as Senior Adviser for Hydrology and the Agricultural Utilisation of Water.

Mr. P.E. Odendaal, Adviser (General) since the inception of the Commission, is now responsible for the extension of information and publication services as well as for liaison with countries abroad. He will also assist the Vice Chairman with the latter's responsibilities in promoting research management and co-ordination.

Centres of competence

In its survey of water research at universities, the Commission has identified specific centres of competence which can be utilised to carry out water research and development work. Consequently, the Commission has entered into a number of research agreements with universities in terms of which the Commission will finance projects which fall within its National Master Research Plan and are complementary to water research and development work carried out by Government authorities.

The Commission's survey of the water and effluent problems of industries, municipalities, mining and power generation has already yielded valuable information. It has shown that there is a real need for co-ordinated identification of problems on a national basis and the initiation of scheduled priority research and development programmes with responsibility allocated to those agencies best able to research the problems.

The Commission has recommended to the Honourable the Minister of Water Affairs that rates and charges should remain unchanged for the financial year 1973/1974. The surplus of R2 million from the previous financial year has been invested at an annual interest of 3½ per cent with the State Debt Commissioner. It will serve as a stabilisation fund to meet the necessary escalation of ground water and irrigation research during the next two years. According to expectations, the daily ratio of water usage for agriculture compared to urban and industrial use will diminish from the present 4:1 to 1:1 by the turn of the century. In view of the fact that agricultural production will have to satisfy the food requirements of a growing population, it is clear that the efficacy of water utilisation in agriculture will have to improve substantially. Crop production will have to increase fourfold with only a twofold increase in water consumption. Ground water is of cardinal importance if the livestock production potential of the Republic's arid and semi-arid areas is to be fully realised. It is also of considerable importance in supplementing water supplies in cities and towns with insufficient surface resources.

Experience with regard to support and co-operation during the first two and a half years of the Commission's existence has exceeded all expectations. The Commission has also exposed real deficiencies in the Water Research Act which will have to be put right. Certain amendments to the Act will be necessary to assist the Commission in progressively and rapidly overcoming the constraints which presently hamper the Republic's water economy.

Chapter 2

National Master Research Plan and National Priority Research Programme

One of the Commission's most important tasks is to set up a *National Master Research Plan* based on present and future constraints in the country's water economy. The plan will have to anticipate the research programme and will be amended from time to time as circumstances dictate.

Using the National Master Research Plan as a guide, a *National Priority Research Programme* will be drawn up to cover the following:

(i) Relevant on-going water research projects in the country (as evinced in the Commission's survey)
(ii) Projects the Commission finances itself or intends financing.

By way of general comment on the National Master Research Plan, it can be mentioned that for the efficient utilisation and management of the Republic's water sources, the collection and processing of reliable data with reference to the hydrological cycle, is of key importance. Although this function is already performed on a continuous basis by various Government Departments, for internal purposes, it is clear from the Commission's water research survey that a mass of potentially useful data lies stored away in records. If this information is processed into useful form, it can gainfully be incorporated into numerous important task areas of water research and development.

The Commission believes that this reservoir of accumulated information will provide answers to numerous research and development problems in addition to providing guidelines for new research.

The following is a tentative National Master Research Plan formulated in the context of the Commission's survey of water research in the country and of the Commission of Enquiry into Water Matters' recommendations in Report R.P. 34/1970 (pp 15 - 25).

Conservation and optimal utilisation of water by Municipalities, Mining and Industry

There is still considerable scope for developing and applying water conservation techniques in industry, mining and municipalities. In the case of industry, it will probably be possible to double industrial expansion without increasing the demand for water. The following aspects all deserve researching:

(i) Internal re-use of water in industry and mining.
(ii) Increased industrial output per unit of water use.
(iii) Cooling.
(iv) Water management in industry and mining.
(v) Industrial processes: modification and development.
(vi) Water saving techniques: domestic systems, elimination of leakage, metering techniques, regulation of water pressure, sizes or erven, horticulture, differential tariffs.

Municipal Water Supply

The efficacy of water purification and distribution systems influences cost structure, health aspects and the quality requirements of water supply. The water environment is continuously subjected to pollution and it is therefore essential to re-assess municipal water supply continuously, particularly with reference to the following:

(i) Purification processes, taking into account the quality of the raw water.
(ii) Monitoring systems.
(iii) Distribution systems.
(iv) Quality criteria.
(v) Health aspects.
(vi) Water management.

Irrigation

Irrigation presently constitutes about 80% of water usage in the Republic. It is thus obvious that an intensive research effort is required significantly to increase the efficiency of irrigation and agricultural output per unit of water use. Aspects worthy of research are:

(i) Planning, lay-out and management of schemes.

(ii) Identification of problems in existing schemes.

(iii) Soil surveys and classification of land use.

(iv) Water quality and its effect on soil and crops.

(v) Pollution and mineralisation of irrigation water.

(vi) Infiltration and soil compaction.

(vii) Mineralisation, prevention and reclamation of mineralised soils.

(viii) Waterlogging and drainage.

(ix) Drainage techniques and criteria.

(x) Irrigation techniques and systems.

(xi) Evaluation and standardisation of irrigation equipment.

(xii) Cultivation practices such as tillage, fertilisation, plant population, crop protection.

(xiii) Requirements of specific crops.

(xiv) Frequency and quantities.

(xv) Maximum yield per unit of water.

(xvi) Economic studies.

Water Reclamation

The substantial quantity of effluents discharged daily by our cities, towns and factories represents an invaluable source of water most of which has still to be reclaimed. It is obvious that pertinent attention must be paid to this issue. The specific research task areas are:

(i) Process development.

(ii) Quality criteria for human, animal, agricultural and industrial utilisation.

(iii) Health aspects.

(iv) Quality evaluation.

(v) Sub-surface storage of purified effluent.

(vi) Regional schemes.

Prevention of Pollution

There is hardly any need to expand on the decline in the usability of water sources for municipal, industrial, agricultural and leisure purposes as a consequence of pollution. Specific attention must be paid to the promotion of research in this field. Priority areas identified are:

(i) Domestic and sewage effluents.

(ii) Industrial effluents.

(iii) Mining effluents.

(iv) Agricultural effluents and run-off.

(v) Storm water and surface pollution.

(vi) Quality surveys of rivers, estuaries, dams, lakes and the sea.

(vii) Quality criteria for water environments.

(viii) Quality criteria for effluents.

(ix) Parameters of pollution.

(x) Mineralisation problems.

(xi) Utilisation of polluted effluents.

(xii) Measurement and evaluation of specific pollutants.

(xiii) Health aspects.

(xiv) Control systems.

(xv) Eutrophication.

(xvi) Solid waste.

(xvii) Influence of air pollution.

(xviii) Aspects occasioned by legal and administrative procedures.

Occurrence and Utilisation of Ground Water

It would appear that the present utilisation of ground water takes place mainly on an *ad hoc* basis due to the paucity of reliable information on the replenishment and delineation of aquifers and safe levels of extraction from aquifers. Ground water is a most important water source, the potential of which has not been fully evaluated or developed. It is therefore likely that there are several regions in the country where water is transported over long distances at great expense to serve the specific needs of mining, industry or other activities, whereas suitable underground water sources could probably be located if a thorough geohydrological investigation were conducted. The Republic's arid and semi-arid areas have tremendous development potential and the key to tapping this reserve is possibly to be found in the development of ground water resources. It is consequently essential that the Commission should concern itself with encouraging research in this field. Specific research task areas to which the Commission will devote its attention are:

(i) Occurrence and detection.

(ii) Quantitative and qualitative determination of ground water supplies and the establishment of a ground water map for the Republic and South West Africa.

(iii) Dolomitic water bearing formations.

(iv) Hydraulic properties of aquifers and safe yield.

(v) Origin, infiltration and natural replenishment.

(vi) Artificial replenishment.

(vii) Management and control of ground water resources.

(viii) Geohydrological techniques.

Desalination of Water

The Republic has substantial brackish underground water resources which can not be fully utilised. Some of these also contain harmful salts, e.g. fluorides and nitrates, toxic to both man and beast. Industrial and sewage effluents as well as drainage water from irrigation schemes, are also subject to salination. Large-scale reclamation of these effluents and the control of water resource mineralisation through effluent discharges, will require desalination.

The desalination of sea water is also important for strategic and regional reasons. The economics of the issue should be viewed in the light of cost-benefit rather than the absolute cost of sea water desalination.

Research into water desalination should be instituted with all speed as follows:

(i) Occurrence, utilisation, detection, and quantitative assessment of mineralised water along the Republic's coastline and in the interior.

(ii) Cost benefit studies of desalination in specific areas for
  (a) Sea water
  (b) Brackish water
  (c) Mineralised effluents

(iii) Evaluation and development of desalination processes.

Evaporation

In some dams almost as much water is lost to evaporation as is beneficially used. A further unfortunate side-effect of evaporation is the concentration of mineral salts in the water. Techniques developed thus far for the direct control of evaporation are practically and economically applicable only to relatively small water surfaces and in the light of present knowledge, it appears unlikely that the problem will ever be satisfactorily solved. Nevertheless, the amount of water lost through evaporation is so vast that attention must be given to research in this field. The pertinent research target areas are the following:

(i) Development and application of techniques to reduce evaporation from existing open reservoirs.

(ii) Water management techniques to reduce evaporation.

(iii) Effect of evaporation on water quality.

(iv) The possibility of underground storage.

(v) Selection of deeper dam basins.

(vi) The release of water from storage dams by means of variable draft systems.

Utilisation of Atmospheric Moisture

Only a small percentage of atmospheric moisture above the land appears to precipitate as rain and supplement water resources. Extraction of moisture from the air, whether by direct means or stimulation of rain, would therefore seem an attractive proposition. On the other hand, it must be realised that the air: moisture ratio is so large that massive quantities of air would have to be manipulated to show a significant gain in water, so that research expenditure in this direction could be substantial. Nevertheless, this is the type of research which should be launched immediately if future benefits are to be reaped. The research task areas are the following:

(i) Development and application of techniques for the stimulation of rainfall, with follow-up studies of the long-term effects.

(ii) Development of techniques for the extraction of water from atmospheric moisture and the interception of rainfall.

(iii) Studies in connection with the moisture content of air and the movement of moisture over the land.

(iv) Studies of specific weather conditions.

Factors influencing River Flow

It is an accepted fact that soil utilisation in catchment areas influences river flow, but there is a paucity of reliable statistics. For planning purposes and the effective management of catchments it is essential that data of this nature should be available. Priority should be given to the following research task areas:

(i) Management of catchments.

(ii) Conservation of catchments.

(iii) Determination of the effects of afforestation and farming practice on river flow.

(iv) Determination of the effects of natural vegetation on the surface runoff.

(v) Determination of the effects of burning on surface runoff.

(vi) Execution of specific hydrological studies, e.g. runoff/rainfall ratios and the incidence of drought in selected catchment areas.

(vii) Flood control.

Siltation of Dams

The real threat of siltation and its deleterious effects on the storage capacity of existing and future water supply dams, demands serious research especially with regard to the following:

(i) Effect of erosion and damage to sponges and catchments.

(ii) Extent of silt loads and the siltation of dams.

(iii) Effects of flood control and flood back water curves on the control of siltation.

(iv) Management of catchments.

(v) Development and application of hydraulic techniques for the control of siltation.

Weather forecasting

Short-term weather forecasting is the task of the Weather Bureau of the Department of Transport and is extremely useful for transport purposes. These short-term forecasts also have limited *ad hoc* value in agricultural planning and water management. Long-term weather forecasts could be of great value in the effective management of storage reservoirs and the forward planning of irrigation programmes. Research in this field must be intensified to make long-term weather forecasts – even up to a year or more – a reality.

Business economic aspects

Apart from scientific and technological knowledge generated by meaningful research, systematic development of the Republic's water resources will call for comprehensive economic and business economic research. Thorough cost-benefit analyses are indispensible to the establishment of a rational basis for choosing priorities and optimal development of water supply schemes. In other words, information should be accumulated to ensure that the right schemes are tackled at the right time. The Commission's Master Reasearch Plan will have to be incorporated into economic and business economic studies of this type. In broad terms, these studies should adhere to the following pivotal questions:

(i) Analyses of usage trends.
(ii) The value of water in various applications.
(iii) Socio-economic factors in the development and allocation of water sources to various regions.
(iv) Strategic water usage.
(v) Rationalisation of water development with general economic development.
(vi) Decentralisation of economic activities compatable with the requirements of efficient exploitation of water resources.
(vii) Damage and loss caused by varying flood strengths in specific river regimes.

Chapter 3

National Water Information Centre

The Commission of Enquiry into Water Matters states in its Report R.P. 34/1970 (page 161) with reference to water research:

"In the absence of the continous cultivation of new knowledge and the progressive refinement and practical extension of existing knowledge, it is possible that water policy, planning and management may be directed towards creating irreversible situations in the Republic's development." It is equally important that all authorities charged with the development and utilisation of the country's water resources should acquaint themselves with available knowledge and expertise which can be implemented immediately. They should also be conversant with the research and development work at the various research organisations and be prepared to apply it with the necessary foresight. The Commission has paid special attention to this important facet of water resource development.

Submissions considered by the Commission in its survey of water research in the Republic brought to light that the South African Council for Scientific and Industrial Research (CSIR) and the Department of Water Affairs maintain a sophisticated current information service for internal use in the specific fields of water management and research. It is adequately clear that this type of information service should take on national impetus. There is an urgent need for a centralised, co-ordinated service to serve all Government and other organisations directly concerned with water resources development, water utilisation and water research on the one hand, and on the other, organisations directly involved in the water environment through their normal functions involving for example recreation, nature reserves and environmental pollution.

The Commission has decided to set up a National Water Information Centre to specialise in the provision of information services linked to water and related fields. As the CSIR already has the necessary basic facilities and expertise, the Information Centre will be established there in terms of a formal agreement with the Commission. The work programme of the Centre will be carried out under the direction of a steering committee under chairmanship of the Commission.

Own identity

The Centre will have its own identity, act in its own name and serve as a central clearing house, for scientists, engineers and technologists in industry, research organisations, universities, government departments, provincial administrations, municipalities, consulting engineering firms, statutory bodies and other organisations wishing to avail themselves of the information and documentation service.

The Centre also invites interested parties to participate in its activities. The following important functions i.a. have been assigned to the Centre:

(i) Co-ordination of planned information services on water to ensure that optimal use is made of existing facilities, specialist knowledge and the information expertise available in various organisations.
(ii) Investigation of the information needs of scientists, engineers and technologists in the field of water and development of its information services accordingly.
(iii) The Centre must promote the use of its services by scientists, engineers and technologists through media such as lectures, publications and newsletters.
(iv) It must co-ordinate contributions of local publications to overseas information centres and act in turn as a national receiving centre for exchange services. The Centre should also liaise with similar organisations overseas when this of mutual benefit.
(v) The processing of magnetic tape data bases in the field of water, which can be hired or bought from overseas information centres. The Centre should also co-ordinate the computerised information services associated with magnetic tape data bases.
(vi) The purchase or hire of additional magnetic tape data bases must be coordinated with a view to making available comprehensive computerised information services to include related disciplines.

(vii) The Centre must investigate the possibility of expanding the use of magnetic tape data bases within the limitations set by the magnetic tape suppliers and economic/technological considerations. These services could, in the course of time, include retrospective literature searches and on-line computer searches.

(viii) The development of computer programmes for these additional services and the co-ordination of existing computerised services.

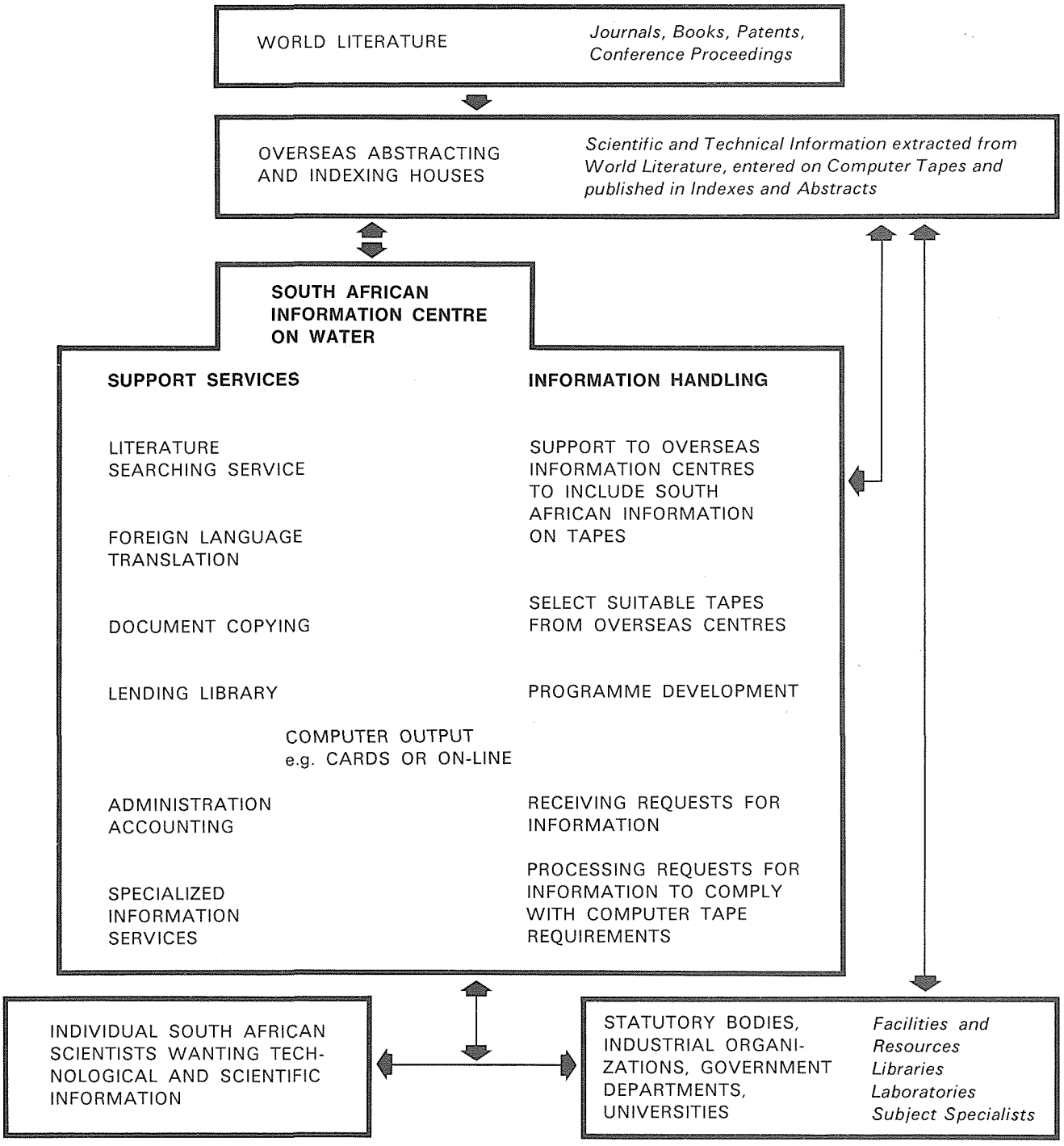
(ix) A survey of the periodical holdings of all interested organisations with the ultimate object of eliminating unnecessary duplication and providing a more efficient and rapid periodical service.

(x) Co-ordination of library services to library users. These services will include: inter-library loans, literature reference services, translations out of foreign languages and document copying services.

(xi) Liaison with the committees of the Prime Minister's Scientific Advisory Council and the National Library Advisory Council, which are presently investigating the problem of co-ordinating information services in South Africa.

(xii) The design of an administrative accounting systems with a view to compensating organisations for information services rendered to the Centre and also, with a view to assessing the information services supplied by the Centre to its users.

The functional structure of the Centre is given in the following diagram:



Chapter 4

Allocation to Research and Development Projects

The Water Research Commission has to date accepted the following two criteria as germane to its funding of research. First, a project must be directed at a priority area in the country's water economy. Secondly, the research should as far as possible have reached the development stage. As far as the latter is concerned, the Commission believes it should not involve itself in the early stages of its activities with the financing of basic and laboratory research, since this type of work is catered for by the State, State-supported research organisations and the universities. This does not exclude the possibility of stimulating basic research at some future date in the hope that it will ultimimately lead to development research.

The Commission grants research appropriations on conditions laid down in Section 3(1)(c) of the Water Research Act, by way of formal contracts previously approved by the Honourable the Minister of Water Affairs. Each project is carried out under supervision of a steering committee representing the Commission and other interested organisations. The committee also includes members chosen for their personal expertise. Steering committees have to consider and approve i.a. work programmes, progress reports and budgets.

Ten new contracts were concluded during the year under review, bringing the total number of research contracts in which the Commission is involved to sixteen. In addition, the Commission has approved a further three projects for the coming financial year.

The Commission has not yet made appropriations for research into the important areas of irrigation and geohydrology. This is because the Commission has considered it advisable first to set up a rational and well motivated master research plan in consultation with all interested parties. In view of manpower and financial limitations the Commission can not afford to finance research in these key areas merely on an *ad hoc* basis.

Projects which the Commission finances at this stage, are the following:

Reclamation of Water at the Athlone Sewage Works

(New project: Contract with the Municipality of Cape Town and the CSIR – National Institute for Water Research)

A pilot plant to reclaim sewage effluent for various purposes is to be constructed and operated by the Cape Town Municipality, at Athlone. The National Institute for Water Research (NIWR) will advise on the planning of the plant and provide specialist services.

In view of the constraint imposed by potential water shortages and the escalating cost of developing new water sources, water reclamation constitutes an attractive prospect for supplementing the water resources of the Cape Peninsula. Even at this stage there should be a reasonable market for reclaimed water.

Before water reclamation can be commercially applied in the Cape Peninsula, it will be necessary to set up a pilot plant in the area and operate it on a continuous basis. This is essential in view of the ultimate aim of adapting the reclama-

tion process developed by NIWR, to local conditions. The NIWR has accumulated considerable know-how on the technology of water reclamation, first in its pioneering work at Windhoek and later at its experimental plant at Daspoort, Pretoria. Adaptation and further extension of this research in the Cape Peninsula is essential for the following reasons:

- Conditions at Windhoek are unique to that area, so that the design and operation criteria there can not be projected *per se* to cities in the Republic.

- Research in Pretoria is primarily aimed at optimisation of the technology of water reclamation, and as such the experimental plant is operated by technical personnel of the NIWR. An evaluation of the operation of a pilot plant by municipal operators is thus called for at this stage. The Cape Town Municipality is also in the privileged position of being able to use water produced to good advantage, so that a complete economic feasibility study can be carried out.

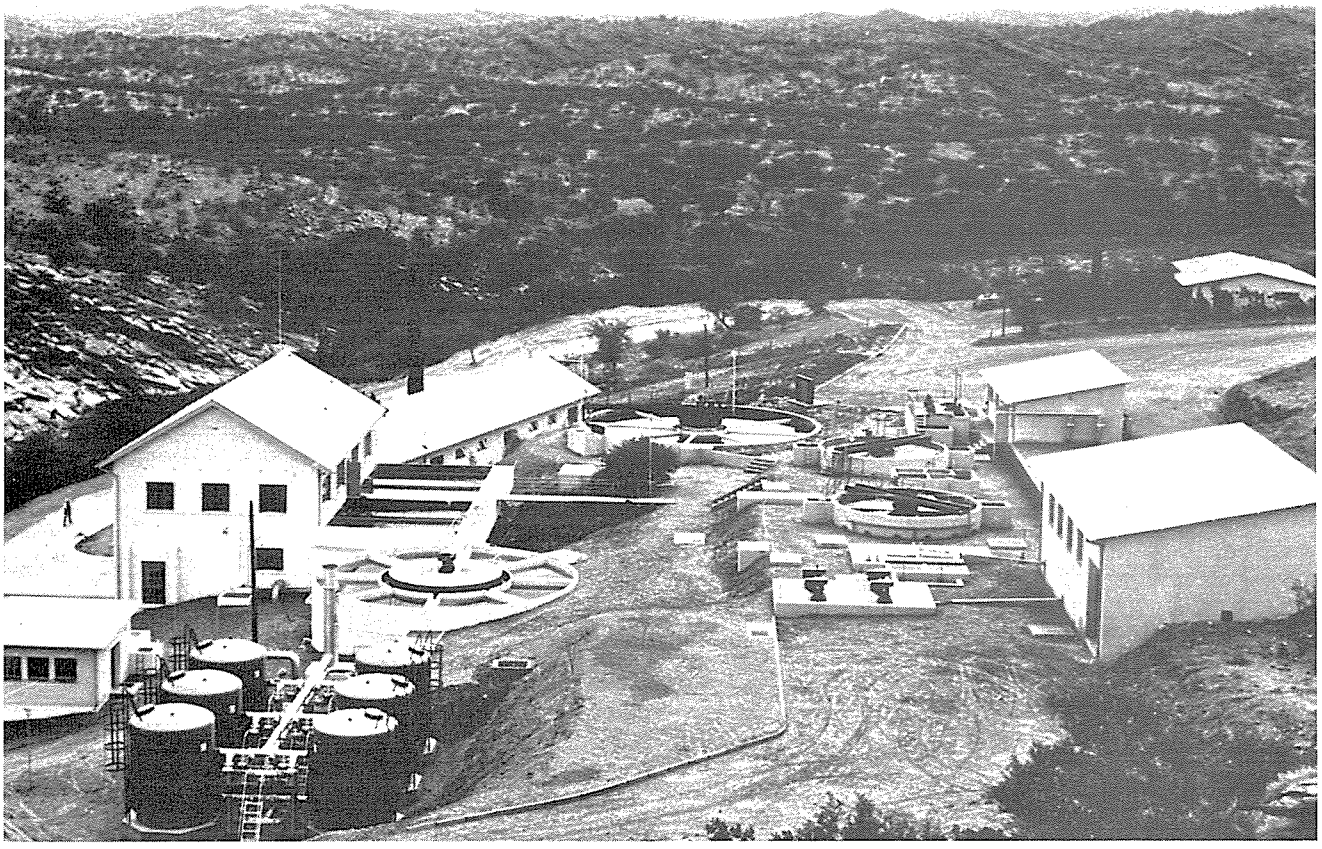
- The Cape Town Municipality, in parallel with technological investigations by the NIWR in Pretoria, can make an important contribution to the research and development phase of large-scale application of water reclamation.

Adaptation of the Windhoek Water Reclamation Plant to the latest Research Data and Technological Developments

(Existing Project: Contract with the Windhoek Municipality and the CSIR – National Institute for Water Research.)

In the wake of the successful contribution made by purified sewage effluent to the relief of a critical water shortage in Windhoek during 1969-71, and in view of the important rôle which water reclamation can play in the future of both Windhoek and other cities of the Republic, the Commission decided during the previous financial year to lend its full support to this undertaking by modernising the existing reclamation plant in accordance with the most recent data supplied by the National Institute for Water Research (NIWR). The Municipality of Windhoek will be responsible for the design, supervision and construction of the modified plant and will operate the plant at its own expense.

Design and planning of the modernised plant has been completed. Specifications have been issued and tenders called for both for detailed design and construction. While these changes are implemented, the project steering committee has initiated an extensive programme to investigate the hygienic quality and epidemiological status of reclaimed water, with



The Windhoek water reclamation plant.

particular reference to toxicological monitoring. The Commission has contracted with the South African Institute for Medical Research for specialized services in connection with studies of these aspects.

Technological Development of Water Reclamation and Pollution Control

(Existing project: Contract with the CSIR – National Institute for Water Research)

Research has adequately demonstrated the technological and economic feasibility of water reclamation not only as a method of purifying waste water for re-use, but also as a means of limiting effectively the increasing pollution of water sources. Important work has been carried out by the National Institute for Water Research, first in contributing to the erection of the Windhoek water reclamation plant and later the pilot scheme and large-scale experimental plant at Daspoort, Pretoria.

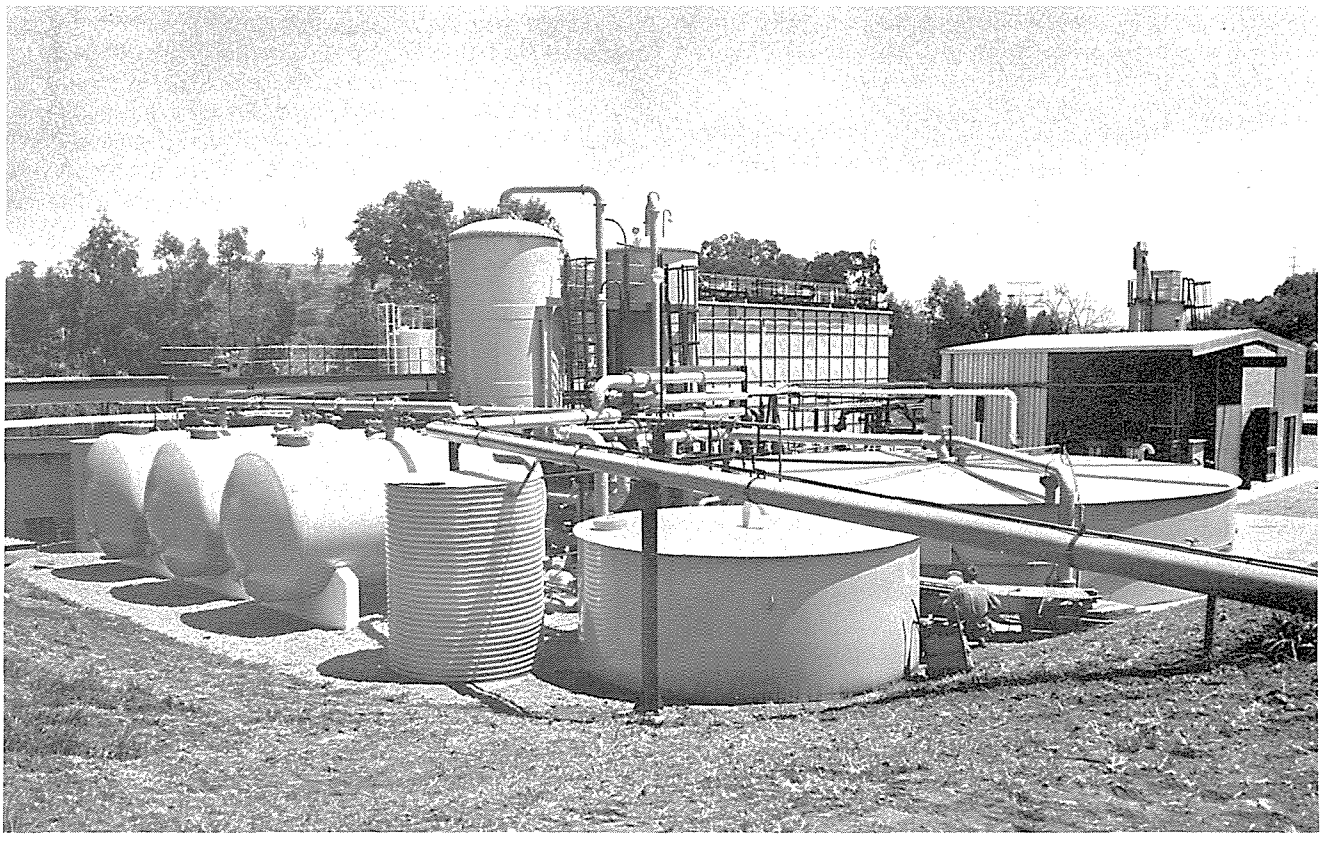
While the Institute's Windhoek investigations were directed at reclamation of maturation pond effluents using the aluminium sulphate flotation process, research in Pretoria concentrated on reclaiming humus tank effluent by utilising excess lime treatment and the stripping of ammonia nitrogen.

After the commissioning in November 1970 of the large-scale experimental plant at Daspoort (capacity 4,5 Ml/d) the plant was operated intermittently until December 1972. During this period, investigations were aimed at optimising the various process units and carrying out a provisional cost and quality evaluation against the background of seasonal variations.

With these criteria in mind, the plant operated for short continuous periods varying from a few days to several weeks. Various small-scale process adjustments were made. The results obtained were extremely gratifying and verified pilot-scale experimental findings, but it was evident that several large-scale process adjustments and modifications were necessary to ensure continuous production of reclaimed water. The Commission was approached and an agreement concluded whereby the Commission will financially support further development work.

The Daspoort water reclamation plant is an eminently suitable prototype for formulating design and operating criteria for water reclamation plants and in the study of health aspects related to effluent re-use. These, in effect, are the two main objectives of the research programme which makes provision for the monitoring of any industrial effluents incorporated into the reclamation system and the microbiological and chemical evaluation of the quality of reclaimed water.

For the purpose of complete and effective evaluation of the reclamation system, it is necessary to operate the plant unin-



The National Institute for Water Research's experimental water reclamation plant at Daspoort, Pretoria.

terruptedly over long periods as a fully-fledged production entity. Verification is necessary as to whether or not the plant is capable of producing water of the desired quality on a continuous basis. The production of reclaimed water is being investigated both for unrestricted re-use and for intermediary quality requirements.

Necessary large-scale process modifications have been completed and as a trial run, the plant has been operating continuously for a month.

The reclamation system comprises the following unit processes: excess lime treatment; quality smoothing; ammonia stripping; recarbonation; treatment with powdered carbon; stabilisation; secondary recarbonation; sand filtration, chlorination and carbon filtration.

No *E. coli* (an indicator of faecal pollution) were detected in the water after stabilisation. No viruses could be found after chlorination.

It was, however, established that the efficacy of the ammonia stripping tower left a lot to be desired, the reason being short-circuiting of the water across the wooden slats of the tower and poor distribution of air at the base of the towers. Ammonia should be removed as completely as possible since the residual ammonia concentration in the water relates directly to the amount of chlorine which has to be applied (an expensive item). Obviously, this could affect the whole cost structure of water reclamation. It has also been found that high dosages of chlorine lowered the pH and alkalinity of the water to levels where it became corrosive. Steps are being taken to increase the efficiency of ammonia stripping.

One of the most important modifications introduced into the plant was the construction of a balancing tank immediately after the lime treatment unit. The chief function of this unit is to smooth out the quality of the water.

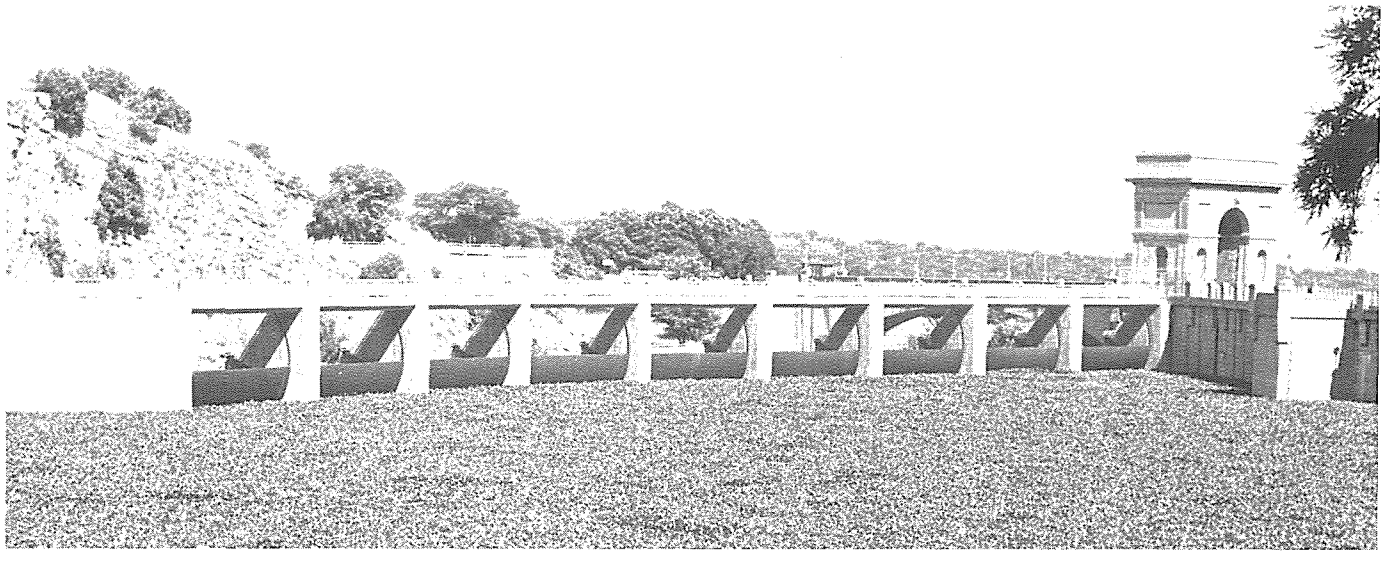
Eutrophication of Rivers and Dams

(Existing project: Contract with the CSIR – National Institute for Water Research.)

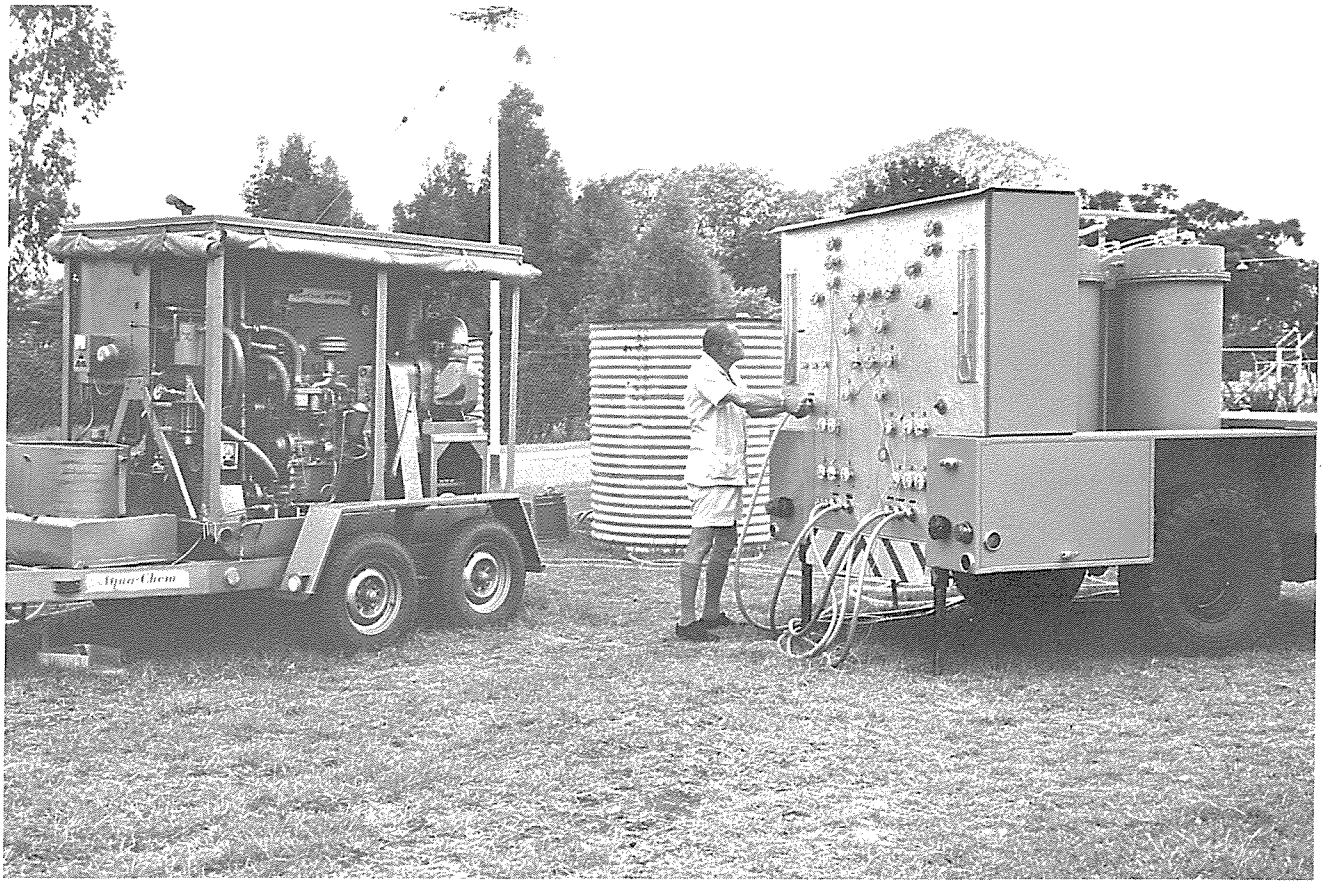
South Africa's growing population and overall expansion have resulted in increased quantities of treated municipal and industrial effluent flowing into rivers and dams. These effluents are rich in plant nutrients which, in turn, give rise to eutrophication – excessive growth of algae and aquatic plants. This brings concomitant problems of aesthetics, health, recreation and water treatment.

The National Institute for Water Research, with an appropriation from the Commission, is presently investigating eutrophication problems in the Republic. Four dams (Hartbeespoort; Roodeplaat; Rietvlei and Buffelspoort) are being intensively studied with respect to chemical water quality; plant nutrient loads and balances; concentration and type of algae and invertebrates, and the rôle of dam sediments in the balance of plant nutrition. The degree to which sewage effluents stimulate the growth of plants and algae is also being determined.

Findings thus far point to substantial enrichment of the Hartbeespoort, Roodeplaat and Rietvlei dams with plant nutrients. Periodic excessive outbreaks of algae in these dams can be attributed to treated sewage finding its way into the dams. Buffelspoort Dam, on the other hand, has no eutrophication problems and irrigation in its catchment area does not contribute sufficient plant nutrients to create problems.



Excessive growth of the water hyacinth, Eichhornia Crassipes, *on the water of the Hartbeespoort Dam. Excessive growth of aquatic plants can be a consequence of pollution.*



Experimental ion exchange and vapour compression installations for the desalination of brackish water, tested during field trials in the Beaufort West District.

Nitrogen and phosphorus are the most important plant nutrients in all four dams. Since certain types of algae are able to fix nitrogen from the atmosphere, the removal of phosphorus from sewage effluent is the best line of attack to counter eutrophication problems. Phosphorus reaches the Hartbeespoort, Roodeplaat and Rietvlei dams chiefly from sewage effluents discharged into the Jukskei, Pienaars and Hennops Rivers respectively.

Two tertiary sewage treatment processes i.e. activated sludge with increased denitrification and physical-chemical water reclamation, eliminate plant nutrients so efficiently that both can be used in preventing eutrophication problems. The technological know-how to remove phosphorus adequately already exists, although the economic implications in its practical application must still be assessed.

If phosphorus is eliminated at a sewage works, it remains to be established whether sediments from eutrophied dams will not still be able to release sufficient phosphorus to stimulate excessive growth of algae. It would appear from sediment studies at the Rietvlei Dam that the sediments do not release sufficient quantities of phosphorus to encourage excessive growth of algae.

Microcystis aeruginosa is the predominant algae type in the Hartbeespoort and Roodeplaat dams. It is a blue-green algae which under certain conditions produces a toxin. In 1973, twelve head of cattle died after ingesting the toxin at the Hartbeespoort Dam. A nitrogen-fixing blue-green algae is significant in the Rietvlei Dam in that it binds nitrogen from the atmosphere. When the algae dies off, nitrogen becomes available for *Microcystis*. The prevalence of potential toxin producers in high concentrations is cause for concern in these dams.

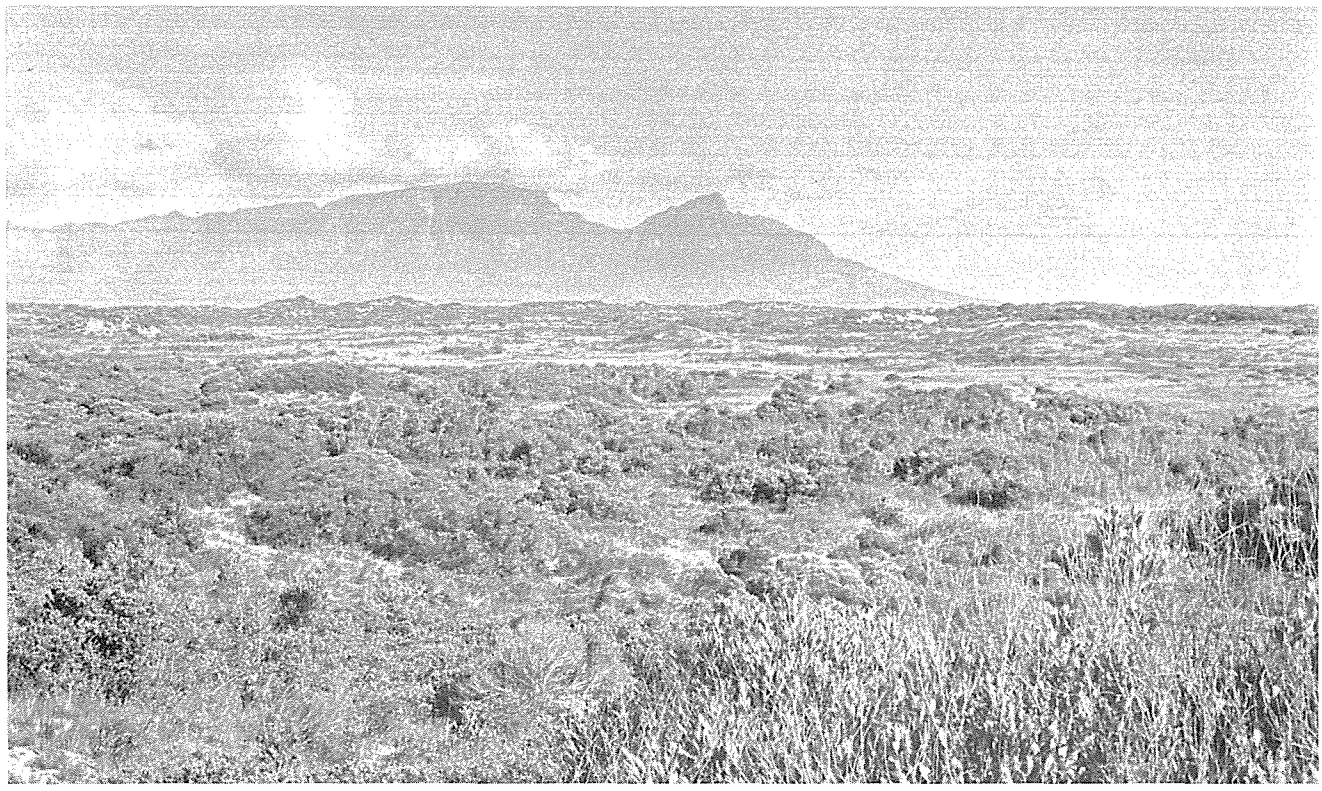
In summary, early observations indicate that the discharge of nutrient-bearing effluents into the catchment of a dam can cause eutrophication problems. The elimination of sufficient quantities of phosphorus from these effluents would prevent eutrophication without reducing the flow of water into the dam. Although the technical know-how for eliminating phosphorus already exists, economic evaluation and process development have still to be carried out.

The project is being continued with a view to developing a simulation model to predict the reaction of dams to enrichment. A further requirement is the setting up of national criteria for the prevention of eutrophication and for the rehabilitation of eutrophied dams.

Desalination of Brackish Water

(Existing project: Contract with the CSIR – National Institute for Water Research)

The Republic possesses considerable sources of brackish ground water which, to a large extent, can not be fully utilized. Some of these sources also contain noxious salts inimical to man and beast (e.g. fluorides and nitrates). Moreover, industrial and sewage effluents are also subject to mineralisation and the large-scale reclamation and re-use of such effluents necessitates a degree of desalination.



A general view of the Cape Flats. It has been found that the sand deposits, which reach depths of 40 metres, are suitable reservoirs for purified sewage effluent and possibly storm water as well.

It has therefore become necessary to launch a programme of comprehensive research and development into desalination techniques and their general application. Criteria must be arrived at for the design, construction and operation of desalination plants suited to local conditions and specific requirements. This work is now being performed by the National Institute for Water Research under contract to the Commission. The Institute has undertaken to compile a desalination manual for general use and to describe and classify the various types of brack water found in the Republic.

A collaborative effort has been initiated with the Hydrological Research Institute of the Department of Water Affairs to collect and process data on the occurrence of brackish ground water throughout the Republic and to characterise and classify the various types of water found.

A survey of groundwater types found in the Beaufort West area has been carried out and water sources suitable for the investigation of various desalination techniques have been identified. Ion exchange and vapour recompression distillation equipment were assembled, transported to Beaufort West and continuous field trials conducted on a highly saline water (8 000 ppm of total dissolved solids). Ninety Kl of borehole water from two sources near Beaufort West were transported to the Institute's regional laboratory in Bellville and pilot and laboratory scale reverse osmosis and electrodialysis trials were carried out successfully. It is anticipated that long-term field trials will be carried out at Beaufort West later.

Preliminary indications are that desalination of brack water on a comparatively small scale by evaporative processes is likely to be very much more expensive than by either electrodialysis or reverse osmosis.

Contact has been established with various suppliers of desalination plant to solicit their support in setting up a test programme for selected equipment. Plans for this programme are progressing well.

Reclamation, Storage and Extraction of Purified Sewage Effluent in the Cape Peninsula

(Existing project: Contract with the CSIR – National Institute for Water Research)

Investigations carried out by the National Institute for Water Research and the Cape Town Municipality and financially supported by the Cape Provincial Administration, have proved that the reclamation and re-use of purified sewage effluent in the Cape Peninsula can make a noteworthy contribution to relieving water supply problems in the area.

The results of the basic investigation bear out the contention that progressive incorporation of reclaimed water into existing water supply systems will increase the amount of water that can practicably be reclaimed from about 50 Ml/d (in 1978) to 425 Ml/d by the year 2 000. This is equivalent to nearly one and a half times the present fresh water demand in the Peninsula.

Investigations aimed at examining the possibility of storing reclaimed water in the sand deposits of the Cape Flats – and in so doing, providing the requisite buffering capacity in times of peak demand – have not only confirmed the practicability of the scheme but revealed that there are about 1,5 million Ml of natural water stored in the sand. This is equavalent to twice the combined storage capacity of the Wemmershoek, Steenbras, Voëlvlei and Theewaters Kloof dams. Natural replenishment of this source is estimated at about 36 000 Ml a day and about 28 000 Ml of this water flows underground to the sea daily along the False Bay Coast, where the sand reaches depths of 40 metres below sea level.

Based on the findings in this investigation, design criteria have been drawn up for a module reclamation unit with a capacity of 4,5 Ml/d. In terms of the contract between the Commission and the National Institute for Water Research, the unit will be erected and operated on the Cape Flats. One reason is to establish pre-treatment and post-treatment criteria for the sewage effluent before it is allowed to seep into the underlying sand beds and after extraction for general re-use. Suitable techniques of infiltrating and extracting the water into and out of the sand beds must also be developed and tested, while the influence of storage on the chemical, bacteriological and virological quality of the water must also be ascertained.

The module reclamation plant will provide for, firstly, the complete treatment and reclamation of the water for direct and unrestricted re-use. Secondly, it will provide for the partial treatment of the water for infiltration and storage in the sand, from which it can be extracted when needed and integrated into the distribution system for direct re-use after further treatment.

The experimental plant will probably be completed by July, 1975.

Water is pumped out of a test borehole in the sand beds of the Cape Flats at a rate of 4,5 Ml a day, evidence that it is possible to store a considerable volume of water in the sand and extract it as required.

Treatment of Waste Water from Wool Textile Industries

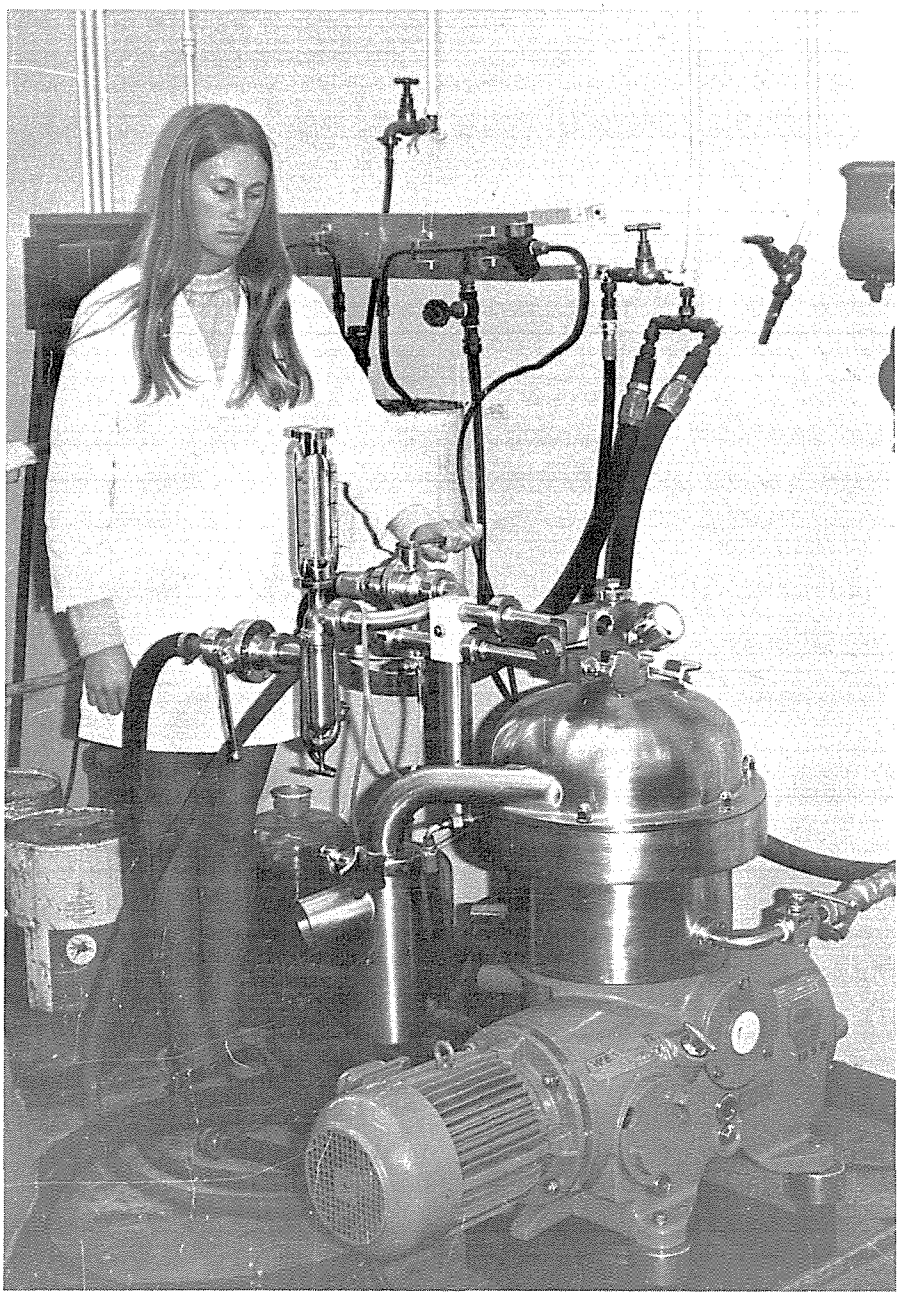
(New project: Contract with the CSIR – South African Wool and Textile Research Institute)

Possible pollution caused by the effluents of wool scouring plants is a considerable source of concern in the Republic. One of the most troublesome components of wool-washing effluent is the 3 – 4 per cent wool fats. This effluent is usually pumped into open dams without pre-treatment. Since the wool fat forms a thin, protective layer on the surface of the water, evaporation is minimal.

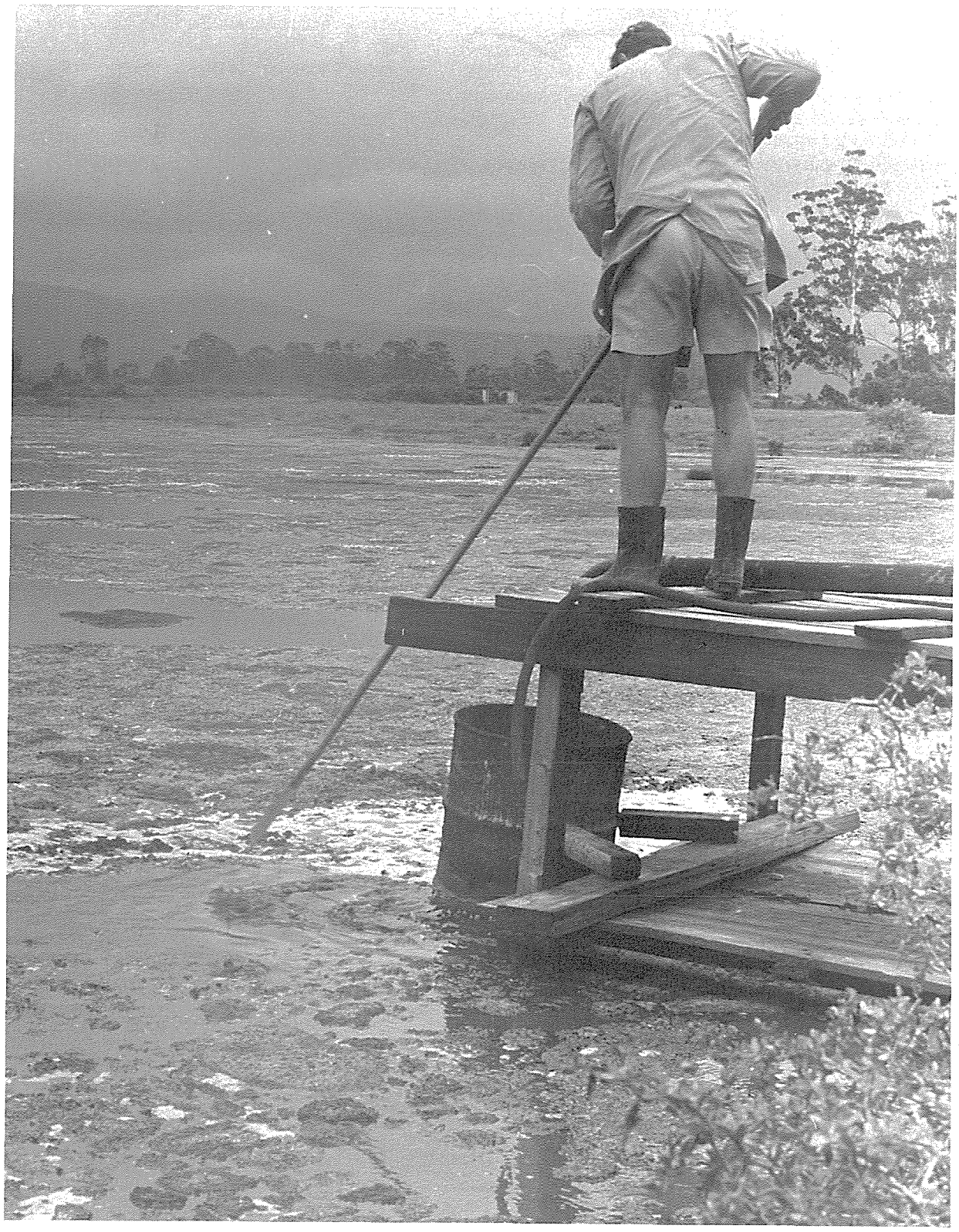
The South African Wool and Textile Research Institute (SAWTRI) of CSIR has, however, succeeded in developing a technique for removing wool fat from the effluent to a large extent. The defatted effluent can consequently be re-used in the first stage of the washing plant. This, in turn, realises a considerable water saving since the water can be recirculated. The process is being tested on pilot-plant scale under contract to the Commission. SAWTRI's technique is two-phased:

One per cent (per volume) of an organic solvent (benzine) is added to the effluent and pumped to a disc centrifuge. The fat is extracted by the solvent and the second phase begins – reclamation of the solvent. This takes place in a rising-and-falling film evaporator. About 98 per cent of the solvent can be reclaimed for re-use while the reclaimed wool fat is of a high quality and enjoys a considerable demand at the moment. The regained wool fat contains less than 0,5 per cent of the benzine solvent.

A commercial rising-and-falling film evaporator is presently being manufactured by a commercial firm. The apparatus will hopefully be installed at one of South Africa's largest wool refineries.



The disc centrifuge for the extraction of wool fat from wool scouring effluent.



Wool fat in the effluent of a wool scouring plant forms a thin protective layer on the surface of water in evaporation dams, hindering effective evaporation.

Research into Dry-cooling

(New project: Contract with the CSIR – National Mechanical Engineering Research Institute and a commercial firm)

The water consumption rate of power generating stations incorporating the conventional wet-cooling towers can be considerable. For example, if wet-cooling systems were to be generally applied to power generating stations, the overall water consumption rate would exceed 2 000 Ml a day by the year 2 000, based on an estimated overall installed capacity of 68 000 MW and a load factor of 55 per cent.

These relatively high water consumption rates can be largely eliminated by using dry-cooling. However, the cost of a dry-cooling tower, presently estimated at R1,5 million for a 200 MW power generating set, is 50 per cent higher compared with a wet-cooling tower.

In the wet-cooling system the water to be cooled is sprayed into the air stream within the cooling tower, the air stream being induced by the chimney effect of the tower. With this system the cooling is principally by evaporation of water into the air. The evaporated water is discharged into the atmosphere and is never recovered.

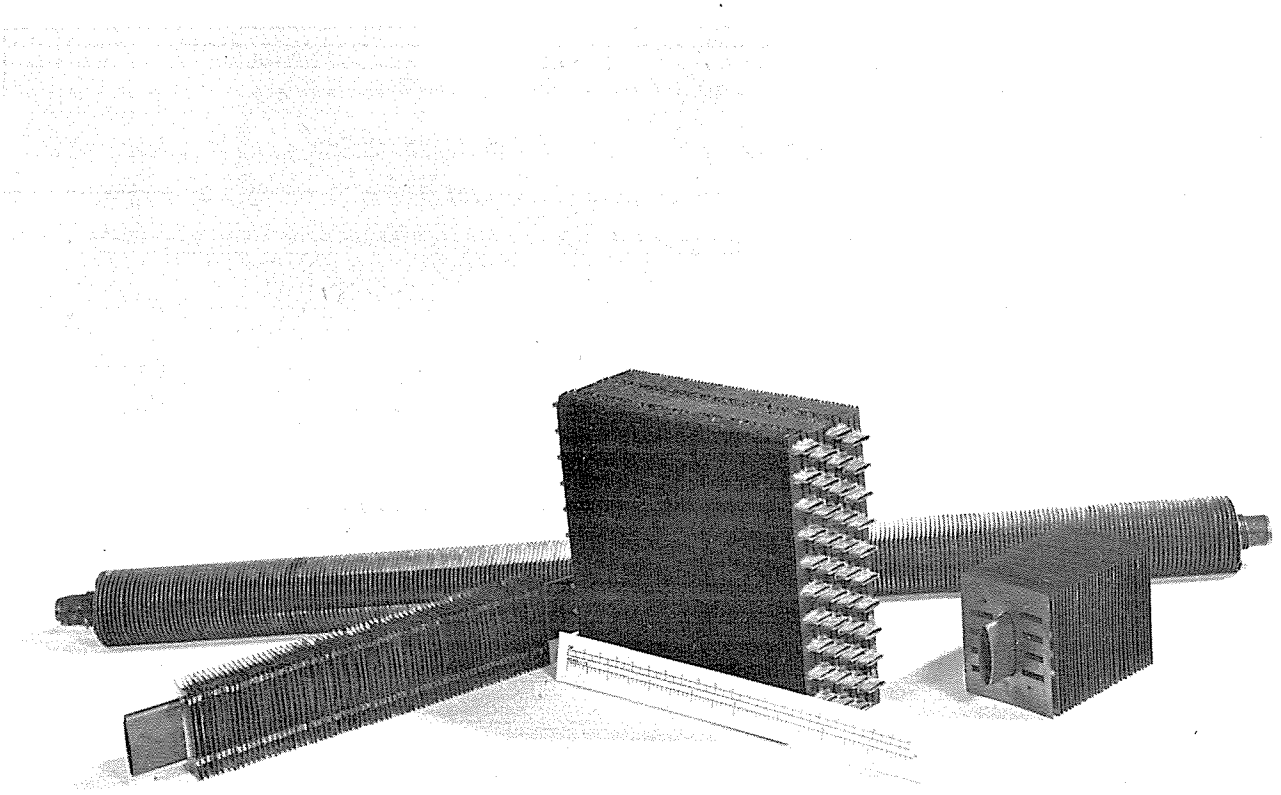
In the dry-cooling system, on the other hand, water to be cooled flows through the tubes of a heat exchanger positioned at the air inlet to the cooling tower. Therefore, no direct contact takes place between the water to be cooled and the air, thus preventing the loss of water due to evaporation.

The National Mechanical Engineering Research Institute is investigating, on behalf of the Commission, the optimisation of heat-exchangers for dry-cooling systems. The factors which led to the investigation are the following:

- Unlike the wet-cooling systems, where about 2,2 litres of water are evaporated to atmosphere for each unit of electricity produced, the dry-cooling system does not consume any water during normal operation.
- Dry-cooling systems when compared to wet-cooling systems, are expensive in capital outlay (high cost of the heat-exchanger) but cheap to run (water savings). Depending on the price of water on the one hand and the initial costs of heat-exchanger equipment on the other, dry-cooling can be competitive with wet-cooling.
- The price of water is expected to increase in future, making dry-cooling more competitive.
- It is believed that the capital cost of dry-cooling systems can be reduced by optimising the design of the heat-exchanger and the associated cooling tower, thereby saving on initial capital outlay.

In order to optimise the design of heat-exchangers for dry-cooling applications, the performance of different heat-exchanger designs is being evaluated by the Institute.

Depending on the outcome of the present series of tests, a decision will be taken whether or not to carry the study to the test plant stage.



Models of heat-exchangers for dry-cooling.

Recycling of Water and Recovery of Chemicals in the Textile Industry

(New project: Contract with the University of Natal – Department of Chemical Engineering)

The most common attitude to waste water treatment processes is often that they should render the effluent "fit" for discharge into streams or sewers. With stricter legislation and as requirements for quality of waste water discharges approach requirements for process water, the need to consider renovation and re-use within industry is being realised.

Where our supplies of water are limited, or likely to become so with industrial and population growth, it is desirable to limit, and as a goal, to eliminate effluents – both with regard to quality and quantity. In operations involving the use of water, the desirability of 'closing the loop' is clear. But it can only be achieved if the necessary research is carried out timeously.

The research must be directed at:

- Investigations into removal of inert nonbiodegradable synthetics in closed loop operation
- removal of inorganics
- development of effective and economical methods for the ultimate disposal of concentrated material removed from waste waters, especially by recovery and re-use.

Such research will bring closer the feasibility of operations under the closed loop scheme. This scheme is likely to offer not only the greatest savings in water but, with the right technology available, it is also likely to help recoup some of the costs of systems which rely on discharge to sewers.

The textile industry is of growing importance to the Republic, but it has to contend with exceptionally difficult waste water problems. For this reason, the Commission has selected the textile industry to initiate studies on closed loop operation in factory processes. The University of Natal's Department of Chemical Engineering, which has already accumulated extensive expertise in dealing with effluent problems in industry, has been contracted to carry out this research.

Treatment of Wastewater by Ion Exchange

(New project: Contract with the University of Cape Town – Department of Chemical Engineering)

The reclamation of water for potable and industrial use, involves the removal of organic and mineral substances in suspension and in solution and the inactivation of parasites, bacteria and viruses. A wide variety of unit processes are available for this purpose and current research on the reclamation of water involves the evaluation of unit processes to produce water of a desired quality.

In the other water reclamation projects supported by the Commission, attention is not paid to reducing the dissolved solids concentration. The fractional desalination i.e. reducing the dissolved solids concentration of the product water to the original level of the freshwater supply, constitutes a major problem in areas where the mineral salt increment in the water usage cycle is excessivley high. It is important that this facet of water reclamation should enjoy prompt attention.

Conventional ion exchange processes used for desalination suffer from the disadvantage of needing considerable excess regenerant over the requirements of the normal chemical reactions involved. This makes the process expensive and increases the load of solids for final disposal. In order to overcome this disadvantage, several specialized ion exchange processes have been developed. One of the most promising of these processes has been shown to perform a double function in that it can remove organic substances from waste waters and at the same time achieve desalination.

If this process could be developed for practical application as a water reclamation system in its own right, the number of unit processes used in current systems under investigation could be reduced with considerable techno-economic benefits. This process has been under investigation for some time in the Department of Chemical Engineering of the University of Cape Town and in view of its potential merits the Water Research Commission provides the financial support for the escalation of the research and development work.

Research on the Activated Sludge Process

(New project: Contract with the University of Cape Town – Department of Civil Engineering)

In South Africa to date the trickling filter has been the main process for waste water treatment. The process as operated does not remove phosphates and only partially removes the nitrogen. As future criteria for effluent quality are likely to demand a high percentage removal of these substances it is necessary to investigate processes which do remove them. Here the activated sludge process seems the most practical and economical.

The activated sludge process is likely to become the major process for waste water treatment in the future. Properly designed and controlled (compared to the trickling filter) it delivers an effluent of superior quality, is less demanding in space and is adaptable to both large and small flows.

Activated sludge plants can be designed to achieve different degrees of purification:

- Removal of organic carbon, discharging ammonia and phosphates
- Removal of organic carbon, discharging nitrates and phosphates
- Removal of organic carbon, nitrates and phosphates.

Criteria for the design of activated sludge processes have been derived essentially from overseas experience and from observations on existing plants. There are virtually no data from pilot scale plants in South Africa. Whereas the technology exists for the design of these plants, the design criteria do

Swartvlei, one of the Wilderness lakes. Data on the rôle of aquatic weeds at Swartvlei can be important to other vleis and dams as well.

not necessarily lead to optimum design solutions. Considerable investigation is still required, particularly in the denitrification and phosphorus removal aspects.

There is likewise no information on the effect of different types of water on the kinetic behaviour of the process. For example, will a plant in Cape Town show the same denitrification and phosphate removal characteristics as on the Rand, when there is such a significant difference in calcium, magnesium and alkalinity concentrations? A comparison between the results from laboratory scale plants indicates that the inorganic content of the active sludge is significantly different, so that it is very likely that precipitation or adsorption of phosphates will be similarly affected.

The waters of the Rand and Cape Town are widely divergent with regard to chemical water quality. Duplication of the activated sludge process is necessary at both centres so that reasonable interpolations can be made for the waters of intermediate chemical quality.

Extensive studies on the activated sludge process have been carried out in the Civil Engineering Department of the University of Cape Town and because of the significance of the progress made, the Water Research Commission has contracted to support this research project in Cape Town.

Removal of Metal Ions from Dilute Solutions in an Electrolytic Precipitator

(New project: Contract with the University of the Witwatersrand – Department of Chemical Engineering)

In an industrial area such as the Witwatersrand, effluents from electroplating, pickling and other metallurgical operations flow into municipal sewerage systems. Metals, such as zinc, iron, copper, manganese, nickel, tin, lead and chromium could be present in these effluents. In general, it can be stated that all the metals mentioned above can adversely effect performance of sewage purification processes if their concentration levels are allowed to rise above certain values.

At present ion exchange columns are used on some plants to remove metal ions from effluent solutions. They have, however, the following limitations;

- A low metal absorption capacity results in frequent backwashing
- Chemicals (generally an acid or alkali) have to be added to the backwash solution.
- Further addition of chemicals to the backwash product is necessary to precipitate insoluble salts of the metals which are then generally dumped as solid waste.

The aim of this project is to attempt to remove metal ions from solution without addition of chemicals and to recover the metals in a re-usable form. Research and development work on this project is carried out in the Department of Chemical Engineering of the University of the Witwatersrand under contract to the Water Research Commission.

The rôle of Aquatic plants in maintaining Trophic Conditions at Swartvlei, Wilderness

(New project: Contract with Rhodes University – Institute for Fresh Water Studies)

The Water Research Commission has entered into a contract with Rhodes University in terms of which the University's Institute for Fresh Water Studies will carry out a hydrobiological investigation of Swartvlei – one of the six Wilderness lakes. The Swartvlei ecosystem presents a unique opportunity for investigating the rôle of aquatic weeds in the maintenance of trophic conditions in shallow water masses – in other words, the degree to which aquatic weeds will remove plant nutrients.

Swartvlei is ringed with aquatic weeds flourishing in the shallow water and it has been claimed that deterioration in the Swartvlei system is directly attributable to these weeds. Research carried out by the Institute for Fresh Water Studies has suggested, however, that this may not be the case and that weeds fulfil a useful purification function when there is a strong inflow of river water into the upper reaches of the vlei.

An in-depth study of the precise rôle of the weeds should provide basic data of immediate significance to natural purification systems like e.g. Olifantsvlei, the important vlei system south of Johannesburg. The investigation should also yield information with a direct bearing on the preservation of the Swartvlei ecosystem and the other Wilderness lakes – constituting one of the most popular coastal regions in the country and as yet still relatively inviolate.

Hydrological Investigations of Small Catchments in the Grahamstown area

(New project: Contract with Rhodes University – Department of Geography)

Not enough is known about the relationship between rainfall and runoff in South Africa. Information about this relationship in respect of all catchment areas is continuously being gathered by the Department of Water Affairs and processed by the Department and other agencies. As far as small catchments are concerned, intensive studies which can lead to considerable refinement of the methods of analysis, can be effectively carried out by smaller groups at universities.

Using the available manpower, research into large catchments (within the broad framework of climatic regions) has resulted in the development of mathematical catchment models which are useful in predicting runoff. However, the amount of variation from predicted runoff that can be expected when the models are applied to small catchments, is not fully known. The dearth of information has precluded the testing of catchment models with regard to their applicability to small catchments of, for example, 100 km^2 or less.

The Department of Geography of Rhodes University, under contract to the Water Research Commission, has launched an investigation into the hydrology of small catchments near Grahamstown. The project embraces four or five small catchments and the collection of morphological, geomorphological and geohydrological data through field work and the analysis of aerial photographs. The amount and intensity of precipitation as well as continuous streamflow data will be graphically recorded using specially installed automatic recorders.

The data collected will be used to test existing mathematical models of catchments and could lead to modifications of these models for application to small catchments.

Development work on the WAT-process for the Desalination of Sea Water

(Existing project: Contract with the CSIR – National Institute for Water Research)

The WAT-process for the desalination of sea water was developed and patented by the National Institute for Water Research and is based on the reclamation of certain salts, thereby recouping to a degree the cost of desalination. Before the process can be practically and economically applied, however, further refinement and development work is necessary. This is now carried out by the Institute under contract to the Water Research Commission.

Acting on a proposal by the Industrial Development Corporation, a theoretical feasibility study of the process was carried out and a full report submitted to an overseas firm of consulting chemical engineers. Their comment, in essence, was that the process is based on sound chemical principles and unit processes. They nevertheless reserved their judgement on the commercial viability of the process pending a further in-depth study of specific facets of the process. These basically concern the regeneration and life of the ion-exchange resin for the reclamation of salts.

In conjunction with the National Institute for Metallurgy, columns have been developed for the continuous operation of the ion-exchange and regeneration processes. This method has distinct advantages over the conventional fixed-bed design used in the feasibility study and these columns are now being evaluated.

Extremely encouraging results have been obtained with regard to the capacity of the resin used. Samples of the resin have been subjected to 12 000 cycles and have shown a diminution in capacity of only 7% after 7 000 cycles, with virtually no further changes thereafter. In the light of these findings, the life of the resin can already be extrapolated to five years. The longer the resin lasts, the greater the likely economic success of the WAT-process.

A further finding is that it is not necessary to apply carbon dioxide gas at a pressure of 50 – 75 psig for regeneration of the resin, as recommended by resin manufacturers. Efficient results have been obtained using enriched flue gases with 40% carbon dioxide.

In view of the promising results obtained, the Commission has decided to finance further pilot scale research.

Financial Support of Hydrological Research.

(New contract with the University of the Witwatersrand)

The Hydrological Research Unit of the University of the Witwatersrand has acquired a reputation for outstanding research with expertise in the development and application of mathematical models in hydrological research. In the past, the Unit has been fully financed by the CSIR and the University, but the Commission would like to see the Unit's activities expand even further. This would increase the Unit's capacity to undertake independent hydrological research projects and also allow the Unit to be gainfully used by the Commission, which already finances several projects – and plans to support more – ultimately requiring the development of mathematical models. The Commission is consequently making additional funds available to the Unit under contract with the University.

Chapter 5

Water and Effluent Problems of Local Authorities and Industries

Water supply and wastewater control are among the most important functions of a local authority, closely allied to the vital issue of public health. The problems in this field have been aggravated to an ever-increasing degree by the discharge of industrial effluents into sewerage systems. Many of the larger municipalities have carried out useful research in these fields, but there has been little co-ordination of this work, much of which could be of importance both nationally and to other institutions. Smaller local authorities have been unable to cope with these problems at all, and have found it difficult to get adequate assistance from other quarters.

In the industrial field itself there are instances where kindred undertakings have set up a research institute to deal with their own peculiar problems – in this respect, notably the leather, paint and sugar industries – but here again, much valuable technical information, which could be of use in other activities in the water and effluent field, is not freely available. This is not essentially because of reluctance on the part of any particular industry to help others, but because in many instances there are no channels of communication for the dissemination of this knowledge.

The Commission consequently took an early decision that guidance and assistance are urgently needed in these fields; this is more than justified when it is appreciated that the greater part of the Commission's revenue is derived from levies on the water consumption of local authorities and industries. It was thus planned that the first step towards helping these wide and divergent interests was to build up a complete and comprehensive background of the existing problems; to record the research work which had been, or was being done, and the techniques which had been adopted successfully in solving water and effluent problems. Also, to establish the magnitude and priorities of the tasks which have to be faced. In view of the possible conflict of interests between local authorities and industries, it was decided to deal with these in two distinct groups.

Local Authorities

The initial approach to this group was made through the United Municipal Executive, the body dealing (through the several provincial municipal associations) with all the local authorities throughout South Africa and South West Africa. In this way, all local government bodies were made aware of the intentions of the Commission to assist in this matter. A comprehensive questionnaire, covering all aspects of water supply and sewerage services, was then distributed to 385 local authorities and water supply corporations in the Republic and South West Africa.

Meetings were also arranged at Cape Town, Johannesburg and Durban, at which municipal engineers of those areas were addressed by the Vice Chairman of the Commission, Dr. G.J. Stander. In his address, Dr. Stander explained the aims and objects of the Commission and stressed the need for co-operation for the mutual benefit of all. In other areas where it was not practical to call engineers together, individual visits were made (such as in Port Elizabeth, East London, Bloemfontein, Kimberley and Uitenhage). The Vice Chairman also addressed the Annual Conference of Municipal Engineers of Southern Africa and other associations on this theme. Considerable interest in and appreciation of the intentions of the Commission has been expressed, indicating that the need for this work is long overdue.

The scope of the questionnaire was deliberately made very wide, so that a complete record can be built up of the present status of all water supply and sewerage services throughout the country – the problem of keeping these records updated thereafter will not be difficult once comprehensive background data have been established.

From the returns received to date, it is clear that the problems of local authorities and similar bodies dealing with all phases of water supply have a lot in common. Many of the problems highlighted have existed for years and the fact that there are still no clearly established solutions to most of them emphasises the need for the work the Commission now proposes to undertake. Some of the more common problems are:

Water Conservation: Stratification in dams; eutrophication of impounded waters, particularly with macrophytic growths due to increased nutrients and pollutants in the catchment; high turbidity waters; evaporation losses; losses in river conveyance of water; desalination of brackish waters (and for coastal communities, of sea water); pollution from agricultural sources.

Water Purification: Colour, taste and odour; improvements in the various treatment processes, including recovery and re-use of chemicals and reduction of high water losses in desludging and backwashing processes.

Water Distribution: Reduction of the uniformly high losses of water in supply systems; corrosion through aggressive waters; improved metering; multiple systems (potable water, purified effluents, brackish water, sea water) and their respective usage for industrial purposes, fire fighting, sewer flushing, irrigation and conveyance of sewage and wastes.

Sewerage: Reclamation and re-use of effluent for various purposes; improvements to purification processes (biofiltration, activated sludge, sedimentation, electrolytic treatment); sludge treatment (digestion, thermal, drying, composting); special problems (synthetic detergents, abattoir wastes, industrial effluents, use of garbage grinders, denitrification and reduction of phosphates, sulphates, chlorides and total dissolved solids).

Several research projects which cover items listed above have already been put in hand, and are described in Chapter 4 of this report.

To maintain adequate liaison with all local authorities once the background information now being built up has been completed, and to plan and direct future research projects in these fields, it is proposed to set up a Co-ordinating Research and Development Committee for the water and effluent problems of local authorities, on which representatives of local authorities will serve. This Committee, under the aegis of the Water Research Commission, will identify the water and effluent problems of local authorities, initiate new research projects where necessary, and co-ordinate all relevant research activities of local authorities, universities and research organisations.

In this way duplication of research and insularity of efforts amongst local authority groups will be avoided.

Industries

Control of industrial effluents is a significant factor in water conservation in this country. It represents a serious problem to all local authorities, since once an industry is established within a municipal area and its effluent is accepted by the local authority, the responsibility in terms of the Water Act (Act No. 54 of 1956) for the control and proper disposal of that effluent, passes to the local authority. It will be readily appreciated, therefore, that the standards for industrial effluents laid down by the local authority are often high to ensure that purification processes at the sewage works are not adversely affected and to ensure compliance with the requirements of the Department of Water Affairs.

In view of the importance of this problem to the national economy, it was clear that an early task of the Commission would have to be the building up of proper and comprehensive background data relating to industrial effluents. This would be the essential preliminary approach to the problem.

The first contact made was with the national body – the South African Federated Chamber of Industries – and thereafter, with the several provincial constituent bodies. Meetings were arranged with the following Chambers of Industry:

- Cape Chamber of Industries (Cape Town)
- Midland Chamber of Industries (Port Elizabeth)
- Border Chamber of Industries (East London)
- Natal Chamber of Industries (Durban)
- Pietermaritzburg Chamber of Industries (Pietermaritzburg)
- Transvaal Chamber of Industries (Johannesburg)
- Northern Transvaal Chamber of Industries (Pretoria)
- O.F.S. Chamber of Industries (Bloemfontein)

Meetings were also arranged with the South African Sugar Association in Durban, and the Steel and Engineering Industries Federation of South Africa (SEIFSA) in Johannesburg. At all these meetings Dr. G.J. Stander addressed members, and explained the necessity for the proper control of industrial effluents and the important part which the re-use of purified effluents must play in the future water resources of South Africa. At all these meetings, the Commission was assured of the support of the several Chambers of Industries and other bodies in its efforts.

Contact was also made with several group associations which have been formed between manufacturers of allied products, such as breweries; bricks; cement; lumber milling; soaps; detergents and candles; tyres; tanneries; textiles; batteries and the like. These associations are considered useful channels of communication for particular types of investigations.

A questionnaire was distributed to all members of the various Chambers and Associations. This document covered the range of information required by the Commission to build up the essential basic data on the present knowledge of industrial effluents and their proper and efficient purification and disposal.

From the 700 completed questionnaires received to date, it is abundantly clear that there are many problems still to be solved in dealing with industrial effluents. Where some form of solution satisfactory to the Local Authority and to the Department of Water Affairs has been found, the industrialist often complains about the high cost involved. Where no solution has been found to satisfy the authorities and they will not accept the effluent into the municipal sewerage system, expensive methods of dumping have to be adopted. Some of the problems to be investigated are quoted below as examples of the difficulties that confront industry in meeting effluent standards:

(a) Almost all industries have difficulty in complying with the limitations of total dissolved solids (T.D.S.), chemical ox-

ygen demand (C.O.D.), and oxygen absorbed (O.A.) – particularly the T.D.S. – and while certain general lines of research are common, each industry will have to be examined in the light of its own peculiarities.

(b) The textile industry has several problems – high sulphates and chlorides and low acidities. The persistence of colour in the effluent makes re-use a matter of difficulty in many cases.

(c) Oil refineries and oil processing firms have difficulty in reducing the oil content of the effluent, while sulphides and O.A. are high.

(d) The paper industry – a large user of water with 11 factories – uses some 6 000 Ml per day and employs nearly 11 000 people. It is gratifying to note that four of these factories use a total of 34 Ml per day of purified sewage effluent in the processes, and this will be increased as more effluent of an acceptable standard becomes available. One problem is the total removal of all colour, as it affects the quality of the white papers. Other problems of this industry are fibre content, high chlorides and O.A. of the effluent. It is of interest to note that the oxygen bleaching process which eliminates up to 80% of the pollution load from a conventional pulp bleaching operation, was first applied in this country (by SAPPI) and is likely to be adopted by the paper industry throughout the world.

(e) The leather industries (with which should be associated abattoirs, hides and skins curing, fellmongering and tanneries) have many problems peculiar to these industries. The Leather Industry's Research Institute is kept busy on these, but more research is required. High neutral salt concentrates, up to 20% to 30% of the weight of hides and skins, for example, prevent re-use of the tannery wastes; high T.D.S., C.O.D. and sulphides are further problems.

Similarly there are problems which require research in all of the industrial groups. The proposed organisation to deal with the industrial effluent problem will follow the general lines as outlined for local authorities. Where necessary, the Commission will create Co-ordinating, Research and Development Committees for the water and effluent problems of kindred industrial groups with a view to problem identification, the initiation of new projects and the co-ordination of research.

Chapter 6

Financial Statements

The statements which follow cover the period 1 April 1973 to 31 March 1974. 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 (Act 34 of 1971) and certified by the Controller and Auditor-General.

The Commission derives its income from rates and charges on water usage. The Minister of Water Affairs has, in terms of section 11 of the Water Research Act, announced the following rates and charges in Government Notice No. 529 of 5 April, 1973:

(1) "Forty (40) cents in respect of each hectare of land scheduled in terms of section 63 (7) or, where applicable, section 88 of the Water Act, 1956 (Act 54 of 1956), to be irrigated at any time during the period 1 April 1973 to 31 March 1974 with water supplied or made available from a Government dam and distributed by means of a canal, irrespective of whether or not such canal belongs to or is controlled by the Government, an irrigation board or other statutory body. This rate shall be recovered by or on the instruction of the Secretary for Water Affairs simultaneously with any rate which the Minister may levy in respect of the land concerned during the said period in terms of section 66 or section 56 (3) of the said Water Act, or, if no such rate is levied, the rate levied hereby shall be payable to the Secretary for Water Affairs upon demand."

(2) "Twenty (20) cents in respect of each hectare of land scheduled as in paragraph (1) but where the water supplied or made available is not distributed by means of a canal. This rate shall be recovered in the manner described in paragraph (1)."

(3) "Twenty (20) cents in respect of each hectare of land scheduled in terms of section 88 of the afore-mentioned Water Act, to be irrigated at any time during the 1973/74 or, as the case may be, the 1973 financial year of any irrigation board or other statutory body with water supplied or made available from a waterwork belonging to such irrigation board or other statutory body. This rate shall be recovered by the irrigation board or other statutory body concerned and shall be remitted to the Secretary for Water Affairs within thirty (30) days of the close of the financial year of the said irrigation board or other body."

(4) "Two tenths of a cent (0,2c) per cubic metre in respect of metered water supplied or made available during the period 1 April 1973 to 31 March 1974 from a Government waterwork for purposes other than the irrigation of land. This charge shall be recovered by the Secretary for Water Affairs simultaneously with any charge the Minister may levy in terms of section 66 or section 56 (3) of the afore-mentioned Water Act in respect of the supply of such water during the said period."

(5) "Two tenths of a cent (0,2c) per cubic metre in respect of the quantity of water used, supplied or made available for use for urban, industrial or domestic purposes during the period 1 April 1973 to 31 December 1973 by the Rand Water Board, by any regional water supply corporation established in terms of the Water Supply Ordinance, 1945 (Ordinance 21 of 1945), of Natal, by the Western Transvaal Regional Water Company (Pty) Ltd, by any water board or irrigation board established in terms of the afore-mentioned Water Act and by any local authority serving a White population in excess of 2 000 according to Report 02-05-01 published by the Secretary for Statistics: Provided that there shall be deducted from the total quantity of water used, supplied or made available by an above-mentioned public supplier during the said period the quantity of water supplied or made available from a Government waterwork in terms of paragraph (4) or the quantity obtained from any other such public supplier during that period. The total amount payable in terms of this paragraph in respect of water used, supplied or made available shall be remitted by the supplier concerned to the Secretary for Water Affairs, Private Bag X313, Pretoria, as follows:

(a) In respect of the period 1 April 1973 to 30 June 1973, not later than 30 September 1973; and
(b) in respect of the period 1 July 1973 to 31 December 1973, not later than 31 March 1974."

WATER RESEARCH COMMISSION

BUDGET 1973/74

STATEMENT NO. 1

INCOME:		
Expected revenue from rates and charges in terms of clause 11 of the Water Research Act		R2 335 500
Expected interest on investments		53 684
		R2 389 184
EXPENDITURE:		
Administrative expenses		
Salaries	R65 000	
Subsistence and travel expenses	14 000	
Postal, telegraph and telephone services	3 500	
Printing, stationery, advertisements and publications	27 400	
General expenditure	33 000	
Specialist and consultation services	50 000	192 900
Research Projects		
4/1 Development of research on the reclamation of water at the Athlone sewage works, Cape Town	7 500	
5/1 Technological development of water reclamation on basis of the Windhoek plant	91 000	
6/1 Eutrophication of rivers and dams	50 000	
7/1 Technological development of water reclamation and pollution control – Daspoort	149 300	
8/1 Research on the desalination of brackish water	56 000	
9/1 Reclamation, storage and extraction of purified sewage effluent in the Cape Peninsula and other areas in the country	87 000	
10/1 Research on the treatment of effluent from textile industries	23 000	
11/1 Natural draught dry cooling heat exchangers	10 000	
14/1 Research into recycling of water and recovery of chemicals in the textile industry	23 000	
15/1 Research into the treatment of waste water by ion exchange	46 000	
16/1 Research on the activated sludge process	42 000	
17/1 The removal of metal ions from dilute solutions in an electrolytic precipitator	13 000	
18/1 Research on the role of aquatic macrophytes in maintaining trophic conditions in Swartvlei, Wilderness	23 000	
19/1 Hydrological investigation of small catchments in the Grahamstown area	18 000	
24/1 Development of the WAT-process for the desalination of sea water	25 500	664 300
Possible other projects		125 500
Support of water research at universities		105 000
Research and other grants		20 000
TOTAL EXPECTED EXPENDITURE		1 107 700
Expected investment balance		1 281 484
		R2 389 184

WATER RESEARCH COMMISSION

STATEMENT NO. 2

INCOME AND EXPENDITURE ACCOUNT FOR THE PERIOD 1 APRIL 1973 TO 31 MARCH 1974

1972/73	EXPENDITURE	1973/74
R		R
35 716	Salaries and allowances	70 434,71
6 379	Subsistence	3 458,71
1 005	Motor Transport	2 518,23
2 375	General Transport	7 422,24
182	Postal Services	447,48
129	Telegraph Services	85,61
873	Telephone Services	2 327,28
724	Printing	2 086,40
1 903	Stationery	4 090,30
5 420	Advertisements	1 293,37
44	Publications	186,84
780	Hire and maintenance of office equipment	1 691,56
499	Entertainment	413,19
4 782	Hire of offices	9 447,07
408	Maintenance of and alterations to offices	5 070,06
119	Maintenance of and hire of furniture	—
1 202	Depreciation	2 360,24
1 042	Miscellaneous petty expenses	1 329,94
237	Typing Services	357,50
—	Expected new projects	1 094,99
—	Adaptation of the Windhoek water reclamation plant to the latest research data and technological development work	5 037,43
1 498	Abstraction of moisture from the atmosphere by means of the L-L-Process	—
28 309	Development work on the WAT-process for the desalination of sea water	—
—	Reclamation, storage and abstraction of purified sewage water in the Cape Peninsula and other areas in the country	18 159,81
—	Technological development of water reclamation and pollution control – Daspoort	32,28
—	Desalination of brackish water	4 663,52
—	Prevention of eutrophication of rivers and dams	7 432,86
—	Development of mathematical models for the optimisation of systems for the development of water resources	10 750,00
—	Research and other grants	6 500,00
3 789	Specialist, consultation and legal services	13 000,84
2 107 220	Excess of revenue over expenditure	2 076 038,89
R2 204 635		R2 257 731,35

1972/73	REVENUE		1973/74
R		R	R
	Rates: Government Irrigation Schemes with Canal Systems:		
	Received	61 798,26	
54 921	Outstanding 1973/74	14 575,52	76 373,78
	Rates: Government Irrigation Schemes without Canal Systems:		
	Received	2 417,38	
2 178	Outstanding 1973/74	997,04	3 414,42
	Rates: Irrigation Board Schemes:		
	Received	20 381,35	
33 061	Outstanding 1973/74	8 434,57	28 815,92
	Charges: Metered water from Government Schemes:		
	Received	1 237 729,84	
295 209	Outstanding 1973/74	249 677,88	1 487 407,72
	Charges: Municipalities:		
	Received	499 386,41	
1 819 146	Outstanding 1973/74	106 195,10	605 581,51
120	Contribution in respect of motor transport		120,00
	Interest on investments		56 018,00
R2 204 635			R2 257 731,35

WATER RESEARCH COMMISSION

STATEMENT NO. 3

BALANCE SHEET AS AT 31 MARCH 1974

1972/73	LIABILITIES	1973/74
R		R
	Sundry creditors:	
5 275	Revenue paid in advance	27,94
	Fund Account	
2 087 404	Excess of income over expenditure, 1973/74	4 163 443,30
R2 092 679		R4 163 471,24

1972/73	ASSETS			1973/74
R		R	R	R
	Capital assets:			
	Motor vehicle	3 713,16		
3 713	Less depreciation	1 385,96	2 327,20	
	Office equipment	10 255,38		
6 376	Less depreciation	405,45	9 849,93	
	Office furniture	12 570,79		
10 394	Less depreciation	568,83	12 001,96	24 179,09
	Current assets			
152	Expenditure paid in advance		233,60	
	Sundry debtors:			
	Outstanding revenue			
	1972/73 23 088,71			
505 949	1973/74 379 880,11	402 968,82		
92 700	Advances to C.S.I.R. and other instances	617 034,10	1 020 002,92	
—	Amount invested with the Public Debt Commissioners		2 056 018,00	
50	Cash on hand		50,00	
1 473 345	Cash in Bank		1 062 987,63	4 139 292,15
R2 092 679				R4 163 471,24

J.P. KRIEL
Chairman (Secretary for Water Affairs)

G.J. STANDER
Vice-Chairman (Chief Executive Officer)

PRETORIA

The above Balance Sheet has been audited in accordance with the provisions of Section 56 of the Exchequer and Audit Act, No. 23 of 1956, as amended, as 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.

Department of the Controller and Auditor-General.

F.G. BARRIE
Controller and Auditor-General.

PRETORIA