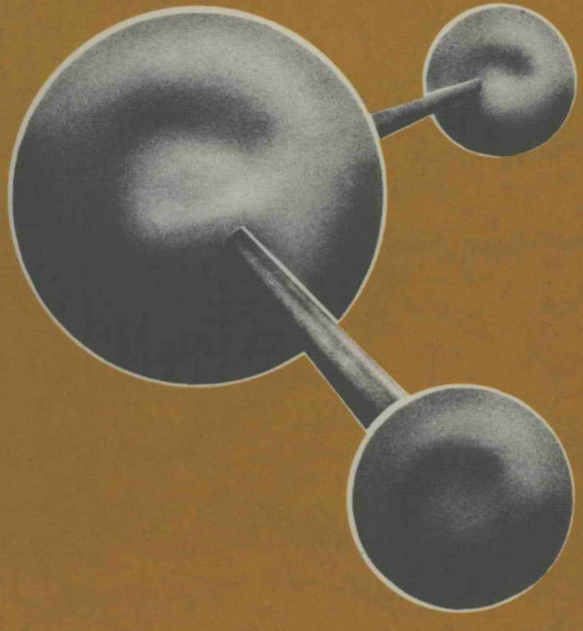

water research commission

ANNUAL REPORT

1 April 1974 to 31 December 1974

WATER RESEARCH COMMISSION

CONTENTS

WATER RESEARCH COMMISSION

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Telegraphic address: WATERKOM

Printed in 1975 in the
REPUBLIC OF SOUTH AFRICA
by Wallachs Printing Co (Pty) Ltd
Pretoria

Water Research Commission
P O Box 824
PRETORIA
0001
1st January, 1975

Dear Sir

We take pleasure in submitting to you, herewith, the Report of the Water Research Commission. This Report covers the period 1st April, 1974 to 31st December, 1974.

Balance Sheets and Statements of Revenue and Expenditure for the financial year 1st April, 1974 to 31st December, 1974, as certified by the Controller and Auditor-General, are furnished in Chapter 5 of this report.

Yours respectfully

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CHAIRMAN

J P Kriel
VICE CHAIRMAN

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Minister of Water Affairs
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Chapter 1

Review of the Year's Activities

Water Research Amendment Act, 1974 (Act No 16 of 1974)

The Water Research Amendment Act, 1974 (Act No 16 of 1974) was approved during the first session of Parliament and came into effect on 1st April, 1974. Amendments incorporated in the Act on the recommendation of the Commission, are directed mainly towards facilitating the effective implementation of the Commission's activities.

The most important amendment authorizes the Commission to recruit its own expert and specialized personnel with due regard to the necessary personal qualities. This amendment was essential in view of the complex and highly specialized nature of the activities of the Commission – the co-ordination and promotion of water research.

The constitution of the Commission was also amended in that the Minister of Water Affairs appoints one of the Commission members as Chairman, who also assumes office as Chief Executive Officer on a full-time basis. The Commission comprises the Secretary of Water Affairs and seven additional members appointed by the State President.

In view of the fact that the Commission is fully responsible for all expenditure from the Water Research Fund – subject to the approval of the Minister – a further amendment was incorporated whereby the administration of the Fund, previously the responsibility of the Department of Water Affairs, is transferred to the Commission. The Secretary for Water Affairs, however, retains responsibility for the collection of levies and taxes and the monthly transfer of funds to the Commission.

The fiscal year of the Commission has been changed to correspond with the calendar year, enabling the Minister of Water Affairs to table the Annual Report (including financial statements certified by the Controller and Auditor-General) during the following session of Parliament.

Meetings and constitution of the Commission for the second term

The Water Research Commission held four meetings during the period 1st April to 31st December, 1974. With the exception of two meetings when one member was overseas, all meetings were fully attended.

The seven members originally appointed to the Commission completed their three-year term of office on 31st July, 1974, and six have been re-appointed for a further period of three years. Dr C van der Merwe Brink, President of the Council for Scientific and Industrial Research, was appointed in the place of Mr N A Lever. Mr Lever contributed greatly towards establishing the Commission's activities and through this medium he is thanked for his valuable advice and services during the first three years of the Commission's existence.

Study Groups and Co-ordinating Research and Development Committees

Special attention was paid to the formulation of a National jpriority Research Programme, as expounded in Chapter 2 of the Commission's previous Annual Report. The Commission found that the establishment of Study Groups and Co-ordinating Research and Development Committees for specific problem areas constituted a practical and efficient procedure for determining research priorities and implementing research programmes. The key elements of co-ordination, *viz.* extension thereof to the level of the worker, the interaction between disciplines and organizations, and the development of collegial relationships, are implicit in the functioning of these Groups and Committees. Study Groups and Co-ordinating Research and Development Committees involving a number of selected problem areas have already been formed by the Commission. At this early stage, it is already evident that along these routes the Commission is establishing a common forum for scientists and engineers engaged in the same basic activity in various different sectors of governmental and statutory services and industry.

Problems in the Pretoria-Witwatersrand-Vereeniging-Sasolburg Complex

The Commission's survey of problems concerning the purification of industrial and sewage effluents and pollution control, indicated that the Pretoria-Witwatersrand-Vereeniging-Sasolburg complex is the most critically affected area in the country. As such, it will have to be subject to extensive research and development. Consequently, the Commission formed a Study Group for this complex, with representation from interested government departments, the Transvaal Provincial Administration, municipalities and research organizations effectively engaged in the planning and development of the area. The Study Group found that extensive research is essential for the protection and optimum utilization of the area's most important source of water supply, the Vaal River. This research will have to generate the knowledge required for future planning of pollution control, water reuse and regional systems for the reclamation of water and the purification of waste waters.

On the recommendation of the Study Group, the Commission established a Co-ordinating Research and Development Committee on which the Departments of Water Affairs, Health, Planning and the Environment, Agricultural-Technical Services and Bantu Administration and Development, the Provincial Administrations of the Transvaal and the Orange Free State, the S.A. Chamber of Mines and the Rand Water Board are represented. This Committee operates at high level, and is responsible for programming and co-ordinating all research done by collaborating institutions in the area. It will make recommendations concerning the financing of such work and will advise government departments, provincial administrations and relevant organizations of research findings and needs.

Irrigation research

To promote research on the agricultural utilization of water, the Commission, during the past year, established a Study Group for Irrigation Research consisting of two Commission members and representatives from the Departments of Water Affairs, Agricultural Technical Services and Agricultural Economics and Marketing and the South African Sugar Association's experimental station at Mount Edgecombe. The Study Group visited several irrigation schemes in the Republic to identify problems and acquaint itself with local conditions and existing research activities.

Professor P J C Vorster, Chief Adviser on Hydrology and the Agricultural Utilization of Water, made a study tour of the United States, Hawaii, Australia, France and Israel to gain insight into the co-ordination of agricultural research and the determination of research priorities in problem areas of irrigation farming. The Commission also took active steps to encourage research on irrigation by approving two research contracts which concern firstly, soil compaction under irrigation at the Vaalharts Irrigation Scheme, and, secondly, the effects of internal plant moisture stress on certain agronomic crops and the economic application of irrigation water in accordance with the moisture critical stages of crop production.

Reclamation of effluents and the prevention of water pollution

The Commission has made considerable investments in research and development on the prevention of water pollution, the reclamation of effluents, and water reuse. Particular attention is being paid to aspects affecting public health, especially in areas such as Windhoek, South West Africa, where effluents are reclaimed for domestic purposes, and in densely populated residential and industrial areas such as the Witwatersrand-Vereeniging-Sasolburg complex where fresh water supplies are exposed to increasing pollution by sewage and industrial effluents.

In view of the foregoing and owing to the fact that effluent reclamation and water reuse will, to an increasing extent, become an integral part of the Republic's water economy, the Commission instituted a Study Group for Health Aspects of Effluent Reclamation and Purification of Water derived from Polluted Sources. During the course of the year, this Study Group gave specific attention to: the current status of research into health aspects of water consumption in the Republic; the adequacy of this research for future protection of public health; the steps required to extend such research where necessary; the establishment of a Master Research Programme on a priority basis and its effective implementation.

On the recommendation of the Study Group, the Commission obtained the specialist services of Dr E Windle-Taylor, former Director of the London Metropolitan Water Board; to advise on health aspects of water pollution and water supply. Dr S H Jenkins of the consulting firm Bostock, Hill and Rigby, England, was commissioned to study problems related to the discharge of industrial effluents into sewerage networks in urban and industrial areas, and to make appropriate recommendations. The solution of these problems is of cardinal importance to the Republic in view of the detrimental effect of industrial effluents on effluent purification processes, on water reclamation and finally on rivers into which these effluents are discharged.

Ground water research

Ground water research also received special attention and three geohydrological projects were initiated by the Commission through contracts with the Council for Scientific and Industrial Research, the University of the Orange Free State and the University of the Witwatersrand. In addition, the Commission decided to establish a Study Group for Ground Water Research with representation from the Departments of Water Affairs, Mines (Geological Survey), Agricultural Technical Services, Forestry and Transport (Weather Bureau). The Group will commence its activities during the next fiscal year.

Dr M R Henzen, Chief Adviser of the Commission, attended an international conference in Vienna on the application of isotope techniques in geohydrology in order to acquaint himself with the most recent developments in this field.

Financing of research

During the first phase of the Commission's activities after its establishment towards the end of 1971, a considerable amount of preliminary, administrative and survey work had to be done to define the main functions of the Commission, to decide on the principal problem areas regarding water resource development and to develop a key research programme. Although the immensity of the research task soon became evident, the Commission encountered the problem that each of many possible projects had to be closely examined in scientific detail to ascertain whether the project warranted financial support. Next, a decision had to be taken on the priority the project had to be accorded. This made great demands on the technical staff of the Commission.

In spite of these difficulties, the Commission has already approved 28 projects. Funds allocated to these projects on contract periods varying from two to five years, amount in total to R8 625 400. The table below indicates the rapid increase in tempo of the Commission's financing programme since 1971.

EXPENDITURE ON CONTRACT RESEARCH, RESEARCH GRANTS AND CONSULTATION SERVICES

Year	1972/73	1973/74	1974*	1975**
Expenditure	R121 300	R591 700	R1 011 700	R2 454 000

*Reflects a period of 9 months only, as the fiscal year (previously 1st April to 31st March) was changed to coincide with the calendar year.
**Estimate.

One of the practical problems the Commission encounters in financing research is that it is difficult at this stage to estimate accurately for research as new fields are continually being entered.

The projects being financed are reported on in Chapter 4.

International activities of the Commission's personnel

The Chairman of the Commission was re-elected by secret ballot as President of the International Association on Water Pollution Research (IAWPR) for a fourth consecutive term of two years, and Mr P E Odendaal, Senior Adviser, has been reappointed Secretary-Treasurer for a third term. Dr M R Henzen, Chief Adviser, is one of three South African members of the Governing Board of IAWPR.

Chapter 2

Preview of Future Water Research Planning and Programming

Experience gained over the past three years in the performance of its functions (in terms of the Water Research Act) has enabled the Commission to present a rational outlook for the future planning and implementation of its work programme and the provision of the necessary funds.

From its experiences in initiating and managing research and development projects qualifying for financial support, the Commission has developed working procedures whereby the formulation and implementation of a National Priority Research Programme, within the framework of the tentative National Master Research Plan (as outlined in Chapter 2 of the Commission's Annual Report for1973/74), can be expedited.

The following is a preview of several important aspects of the Commission's future activities:

Formation of Co-ordinating Research and Development Committees and Study Groups

Certain basic principles will have to be observed to ensure effective national co-ordination, namely:

(i) the field of research, responsibility and specific task areas of each organization involved in research must be clearly defined. If zoning or grouping is necessary, the concurrence of these organizations must be secured;

(ii) teamwork is absolutely essential in cases of borderline or closely related research fields or projects. Consequently, every organization's contribution to the research programme and responsibility for submitting reports, should be defined and the principle of centralised leadership pursued. This applies especially to those main task areas of water research were interdisciplinary and interorganizational factors need to be emphasized;

(iii) in the case of multidisciplinary research projects or where a research organization lacks the required expertise, organizations having the specialized know-how could be involved (on a co-ordinated basis).

In maintaining these basic principles the Commission has been compelled to consider carefully the establishment of procedures which would promote an *esprit de corps* at worker level. This consideration forms the basis for the introduction of Study Groups and Co-ordinating Research and Development Committees (CRD Committees). The idea is that each Study Group or CRD Committee will cover a demarcated study area of related research and will consist of representatives from organizations with a continuous and active interest in the relevant research field.

The purpose of a *Study Group* is to study a problem area extensively in order to:

- identify problems and priorities;
- determine the task areas and disciplines involved;
- define priority research projects;
- make recommendations regarding the relevant responsibilities of collaborating organizations and for co-ordinating their respective research activities;
- indicate clearly the procedures for establishing a *CRD Committee,* where necessary.

A Study Group may, during the course of its working programme, submit interim recommendations to the Commission for the initiation of specific research projects on a priority basis. Should a relevant CRD Committee be formed at a later stage, such a project will fall under its auspices.

A *CRD Committee* is constituted of relatively high-level representation from collaborating organizations. *Work Groups* involving leaders of closely associated projects may be formed within the scope of a CRD Committee, thereby co-ordinating such projects.

The functions of a CRD Committee are to –

- co-ordinate the relevant research activities of collaborating organizations;
- plan and revise research programmes (including surveys and monitoring programmes);
- consider progress reports;
- initiate new projects in the light of progress made and proposals received from its Work Groups and make recommendations in regard to financing;
- make specific research proposals to the Commission in the light of the above;
- convey research findings to government departments and other organizations and advise them on matters relevant to the expertise of the Committee.

To date, the formation of Study Groups and CRD Committees has been handled with great circumspection. The Commission's approach is to utilise this procedure exclusively for priority task areas and projects (refer National Priority Research Programme, Chapter 2 of the Commission's Annual Report for 1973/74) and for work already being done effectively by research organizations. In this way, unhealthy multiplication of committees, vague definitions of research assignments, duplication and time wastage will be minimized. On this basis, the Commission will be able to carry through effectively the framing of a National Priority Research Programme for each main task area within the National Master Research Plan. Furthermore, this will lead to healthy co-ordination; mobilization of research facilities; activation of manpower; escalation of water research and the elimination of deficiencies. A further benefit will be the progressive generation of knowledge required for the short and long term planning of the country's water resources.

The undermentioned Study Groups and CRD Committees created by the Commission have already made good progress and several of their recommendations have already been implemented by the Commission:

- Study Group on Irrigation Research;
- Study Group on Health Aspects of Effluent Reclamation and Purification of Water from Polluted Sources;
- Co-ordinating Research and Development Committee for the Pretoria-Witwatersrand-Vereeniging-Sasolburg complex.

In addition, the Commission has already recommended the establishment of Study Groups and CRD Committees for problem areas allocated high priorities, *inter alia* –

- The Mining Industry (CRD Committee)
- Ground Water Research (Study Group)
- Discharge of Industrial Effluents into Sewerage Networks (Study Group)
- Water and Effluent Problems of Industries, namely –
  Textile Industries (Study Group)
  Canning Industry for Vegetables and Fruit (Study Group)
  Abattoirs, Meat Processing, Feed Lots and Hides and Leather Industries (CRD Committee)
- Water Conservation in Urban Areas (CRD Committee)

The formation of the latter committee resulted from recommendations to the Commission by the Committee for the Conservation of Water in Urban Areas appointed by the Minister of Water Affairs.

In establishing the abovementioned CRD Committees and Study Groups and others which will arise from constraints and priorities in the country's water economy, the Commission will create productive reservoirs of information. As a result of the cumulative research action, future development could continue for many years beyond the turn of the century in spite of the country's limited water resources. Without this viable source of knowledge and its progressive and practical extension and maintenance, an irreversible problem situation could arise in the country's development as far as policy, planning and water management are concerned.

Water reclamation and prevention of pollution: Spotlight on the Pretoria-Witwatersrand-Vereeniging-Sasolburg complex

The complex and its problems

The Pretoria-Witwatersrand-Vereeniging-Sasolburg complex (PWVS complex) is the most densely populated and industrialised area in the Republic and is in fact the country's most important "economic power house".

It is estimated that the total population of the area will have doubled by the turn of the century – a factor which will obviously go hand-in-hand with an increasing demand for water. This, in turn, will generate larger volumes of sewage and industrial effluent which will have to be purified to prevent critical pollution of the strategic water resources of the area and secondly, will have to be reclaimed as far as possible to augment water supplies.

A problem already exists in that the Vaal River below the Vaal Dam is being mineralized by highly mineralized water from mining areas and by factory waste waters with high salinities. The adverse effect of mineralization on the utilization value of the water is presently being alleviated by the diluting effect of fresh river waters of the area and those of the Vaal Dam catchment. The benefit of this effect, however, will diminish rapidly as the water cycle of the Witwatersrand-Vereeniging-Sasolburg complex becomes a closed system and the necessity grows for keeping river water supplies fresh. In future, the control and reclamation of mineralized water will become vitally important.

From the foregoing it is obvious that pollution prevention, reuse of water and reclamation of effluents will form the crux of the planning and management of the water economy of this complex. It is timely, therefore, to review the Commission's working programme in the field of water reclamation and the prevention of pollution.

Projects of consequence to the PWVS complex and financed by the Commission

Three pilot scale water reclamation plants, each with a capacity of 4 500 m^3d are being financed by the Commission:

- at *Windhoek* domestic water supply is being studied, especially in so far as hygienic quality, epidemiological aspects and toxicological monitoring are concerned;
- at *Daspoort, Pretoria,* attention is being paid to the formulation of design and operational criteria for water reclamation plants which have to produce water in accordance with quality requirements for industrial purposes, domestic use and water pollution control;
- on the *Cape Flats,* aspects of reclamation, storage and extraction of purified sewage effluent in the Cape Peninsula, are being studied.

Apart from this development work, the Commission supports supplementary research in other task areas related to water reclamation and pollution control, namely:

(i) Eutrophication of rivers and dams
(ii) Denitrification and removal of phosphates
(iii) Research on the activated sludge process
(iv) Desalination of mineralized effluents
(v) Desalination of brackish and sea water
(vi) Discharge of industrial effluents in sewerage networks

The main deficiencies in available knowledge which have to be supplemented by this research and development work, relate to –

- health aspects of pollution, effluent reclamation and purification of polluted water supplies;
- the discharge of industrial effluents in sewerage networks;
- the discharge of purified effluents into rivers;
- the problems of undesirable plant and algal growth as a result of effluents, rich in nitrogen and phosphates, reaching the water environment;
- the purification and control of mineralized effluents.

Results obtained from the aforementioned research will be integrated directly into the working programme carried out under the aegis of the CRD Committee for the PWVS complex (see Chapter 1). Final practical implementation of the in-depth studies in the PWVS complex, however, will require that the Commission initiate, without delay and in collaboration with local and other authorities, full-scale production studies by establishing reclamation plants within the industrial areas of Vereeniging-Vanderbijl Park and Johannesburg-Germiston with capacities of the order of 45 000 m^3d and 23 000 m^3d respectively.

Applicability of research results in other industrial and urban areas

In initiating a comprehensive research and development programme on water reclamation and the prevention of pollution, the Commission has created a cumulative source of important information which will ensure that the abovementioned full scale studies in the PWVS complex are carried out successfully. The necessary sources of knowledge for the optimization of pollution control and water utilization will be established not only for this complex as a whole but also for other industrial and urban areas in the Republic. In fact, the Commission, in this context, is supporting a National Priority Research Programme in terms of the following main tasks of the National Master Research Plan as formulated in the Commission's Annual Report for 1973/74, namely:
(i) Municipal Water supply
(ii) Re-use of water
(iii) Prevention of pollution

Contractual recruitment of overseas researchers and expertise

It appears from the Commission's findings that the quality of leadership and expertise of the country's scientists, engineers and technicians involved in water research, compares favourably with that of the world's large industrialized countries. The Commission is, however, concerned about the shortage of manpower required to carry out the comprehensive water research necessary for the country's dynamic economic development.

Information at the Commission's disposal indicates that water research in government departments and statutory organizations is hampered by a shortage of manpower rather than a lack of funds or posts. The basic problem is that South African universities do not produce enough students trained in the required disciplines to meet the deficit. This is aggravated by the fact that too few of the available graduates have the necessary experience, expertise and specialized training to undertake independent and effective water research. The Commission has already found that its own contract projects are hampered by the manpower problem.

Although the basic shortage of trained scientists is a problem outside the Commission's terms of reference, it does have a direct effect on the task the Commission has to perform. Therefore, the Commission strongly recommends that bodies

with the necessary authority should give active attention to this problem. The Commission's own experience is that the escalation and promotion of its activities are adversely affected by the manpower problem.

In regard to the dearth of proficient scientists with specialized training, the Commission has thus far employed two methods of approach in an effort to alleviate the problem. On the one hand, the consultant services of overseas experts with practical experience of water problems currently arising in the Republic, have been obtained on a contract basis. With the necessary adaptation to local circumstances, the Commission may gain useful and valuable information in this manner. On the other hand, the Commission exploits the Republic's leading position in the world in respect of proficiency in certain fields, for example, water reclamation and pollution control, to establish closer contact with overseas experts.

Several scientists and engineers engaged in research on Commission contracts have visited overseas experts and attended international congresses, thereby opening up channels of information and communication on a collegial basis. This type of interaction is supplemented by subscribing to scientific magazines, exchanging publications or by correspondence, but these measures are insufficient on their own. The benefits to the Republic from such visits more than offset the costs and the Commission intends continuing extensively with this approach.

A further and probably more important method of overcoming the shortfall in expert manpower has recently been approved by the Commission. Overseas researchers or research teams will be contractually recruited to undertake or assist with projects of government departments or other research organizations (under the centralized leadership of the particular organization). The general procedure will be discussed with the organizations concerned during 1975.

The specific procedure envisaged will be to identify, in collaboration with relevant organizations, particular priority projects which, owing to manpower or other problems, cannot be commenced with or are not progressing satisfactorily. Such projects will be programmed jointly and the needs with respect to expertise, personnel and facilities required, determined. The necessary expertise and personnel will then be recruited contractually overseas.

Chapter 3

Communication and Information

In terms of Section 3(1)(f) of the Water Research Act, 1971 (Act No 34 of 1971) a function of the Commission is "to accumulate, to assimilate and to disseminate knowledge in regard to the results of . . . [water] research and the application thereof and to promote development work for the purposes of such application". The Commission will undertake this assignment along various routes and those that have already taken shape are discussed briefly below.

National Information Centre on Water

In terms of a contract entered into by the Commission and the Council for Scientific and Industrial Research, the Council's Information and Research Services Division will establish and operate a National Information Centre on Water. The main functions of the Centre will be to co-ordinate existing information and library services in the country, to extend computerized information services and to promote an efficient and rapid journal service. It could be mentioned that the Department of Water Affairs, which had been planning its own information service, has decided to relinquish this in favour of a collective scheme which will also serve its own needs. The establishment and functions of the Information Centre were fully reported on in the Commission's previous Annual Report.

Scientific Journal on Water – *Water S.A.*

The Commission's function of disseminating information is only partially covered by the abovementioned Information Centre. A medium has to be created for publicising the results of local water research nationally and internationally, and for this reason it has been decided to establish a South African scientific journal on water.

The journal will be entitled *Water S.A.* and will appear quarterly, with the first edition due for publication in April, 1975. Original research and review articles on all aspects of water science will be published as well as abstracts of articles published elsewhere by South African authors.

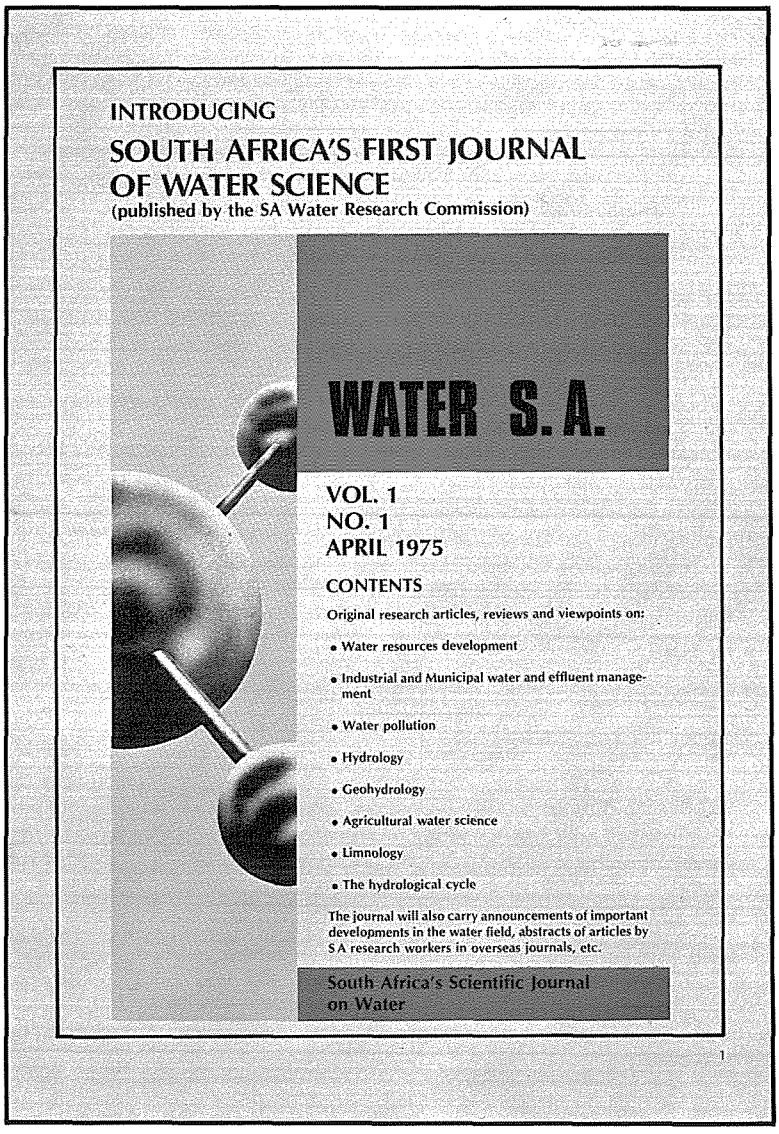
Besides the obvious aim of publicizing research results, other considerations led to the establishment of *Water S.A.:*

1. South African water scientists should not have to depend on overseas journals for the publication of research results. Certain types of research articles – although of great local import – simply do not have international impact and are therefore rejected by overseas journals. Overseas journals also tend to show a bias in favour of articles by authors resident in the country of publication.

   In South Africa, no existing journal caters exclusively or predominantly for Water Science. Articles on water are distributed over a wide range of journals and mostly consist of review articles – owing to the limited space provided for original research articles.

   One of the greatest sources of frustration to the research scientist is the lack of opportunity for communicating his work to interested parties, and for transferring the results of his research into practical application.

   This frustration does not only undermine the scientist's enthusiasm and the efficiency of his work, but it may even precipitate his resignation from the research profession. A South African scientific journal on water can fill the breach and offer scientists the assurance of a medium which will readily publish articles of the required standard.



The descriptive brochure used to introduce Water S.A.

2. Water science is a multi-disciplinary science, and a multi-disciplinary journal can contribute greatly towards broadening the insight of scientists and increasing their awareness of relevant research in other disciplines. Scientists and engineers show a general tendency to limit their reading to profession-orientated journals and the essential interaction with other disciplines is sometimes lacking.

   While at international level there is considerable specialization in professional journals on water owing to the extensive scale of water research and the large number of articles generated, the establishment of a multi-disciplinary journal is feasible in South Africa in view of the relatively limited extent of water research. At this stage, South Africa is possibly the only country where an organization has been created by legislation to co-ordinate and promote water research on a broad front, so that the multidisciplinary journal envisaged will probably also be unique.

3. The journal should also be a valuable aid in executing the Commission's co-ordinating function. Not only will it inform individuals and organizations of the *nature* of research being done in the country, but also *where* and by *whom.*

   This should promote communication between scientists – an essential requirement for effective co-ordination.

   To perform this specific function effectively, the journal will cover the results of local research as fully as possible. For this reason it will include abstracts of articles published elsewhere by South African authors.

4. In terms of section 3(1)(g) of the Act, a function of the Commission is to "co-operate with institutions undertaking such research in other countries, with a view to the accumulation or dissemination of knowledge of such research and the results thereof". The Commission's liaison with over-

seas countries will benefit from the journal in that it will serve as a display window in order to negotiate the exchange of information and establish contacts.

An introductory brochure on *Water S.A.* (see illustration) has been compiled and distributed throughout the country.

Newsletter on water

The Water Year of 1970 gave impetus to a "water awareness" at all levels of the South African community, and since then the Department of Water Affairs has continued to stimulate public interest. The Commission deems it of the utmost importance to contribute actively to such a communication programme since it would induce an *esprit de corps* among those interested in water. In turn, this will stimulate serious thinking on water problems and will promote water research and the application of research results. The Commission will therefore launch a newsletter on water during 1975. It will regularly publish important research information of local and international content, as well as articles of general interest and more specifically on developments in the water field. Initially, the newsletter will be published bi-monthly.

Technology transfer

In promoting water research, the Commission also endeavours to effect the practical application of research results. After all, research investment pays dividends only when the results are applied in practice.

The problems of technology transfer are being realized internationally to an increasing extent and special organizations have already been established to promote technology transfer. In South Africa too, increasing attention is being paid to this problem, as illustrated e.g. at a special symposium on technology transfer held jointly by the CSIR and the Engineers' Association of South Africa, in Pretoria during November, 1974.

As mentioned previously in this chapter, the Commission has taken steps to effect the distribution of information and the results of research. However, the mere dissemination of information is insufficient to promote its application. For this reason the Commission will, during the next year, actively attend to this aspect and develop strategies for effecting technology transfer.

Chapter 4

Research and Development Projects

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 organizations. The committee also includes members chosen for their personal expertise. Steering committees have to consider and approve, *inter alia,* working programmes, progress reports and budgets.

Twelve new contracts were awarded during the year under review, bringing the total number of research contracts in which the Commission is involved, to twenty-eight. In addition, the Commission has approved a further three projects for the next financial year. Two of these involve the Commission in the very important field of irrigation research. The Commission intends further to extend the financing of research in this field during the coming year. Projects which the Commission finances at this stage, are the following:

WATER RECLAMATION

Reclamation of water at the Athlone Sewage Works

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

A pilot plant for reclaiming sewage effluent for various purposes is to be constructed at Athlone and operated by the Municipality of Cape Town. The main objectives of the investigation are the adaptation of research results generated by the CSIR, and the development of guidelines for continuous practical operation.

The process design for the plant was completed after conducting laboratory and biological treatment studies on site. It would appear that the effluent (which contains a high proportion of industrial waste water) could best be treated by purely physical-chemical means.

Detailed design specifications were completed by the Engineering Department of the Cape Town Municipality in collaboration with the National Institute for Water Research, and tenders have been invited for final construction.

It is estimated that the plant will reach completion at the beginning of 1976.

Adaptation of the Windhoek water reclamation plant to the latest research data and developments

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

An extensive programme to investigate the hygienic quality and epidemiological impact of reclaimed water in the Windhoek area is in progress. All sources of water supplied to the area are evaluated weekly for chemical, bacteriological and virological quality by the National Institute for Water Research. Parallel bacteriological testing on all samples is done by the Windhoek Municipality and the South African Institute for Medical Research (SAIMR). The Windhoek Municipality also duplicates most of the chemical analyses. At a later date virological testing will be duplicated by the SAIMR. The results of the bacteriological quality testing of water from the Von Bach Dam (one of the water supply sources of Windhoek) by the Department of Water Affairs, SWA, are also available. The SAIMR is responsible for the collection and interpretation of epidemiological data in the area.

A fully automatic electronic fish biomonitoring system has been established to monitor reclaimed water and other water resources at Windhoek. Constructed after intensive research into the effects of a number of toxicants on the breathing rate of largemouth bass, the system utilises a basic electrode chamber to provide information on any environmental toxic change affecting fish respiration. Breathing signals from the fish sensors are amplified and electronically counted. A preset alarm monitor, based on the maximum 99 per cent confidence limit of natural breathing rate for each fish sensor, is triggered whenever the breathing rate exceeds the defined limits. The total biomonitoring system consists of twelve units; each alarm, when triggered, remains in operation until reset. Should a median number of fish present an alarm condition, the water source may be redirected until such time as the toxic agent is located and any fault rectified. In this way the quality of the water under test is maintained. The biomonitoring system was the subject of a paper delivered at the Seventh International Conference of the International Association on Water Pollution Research held in Paris during September, 1974.

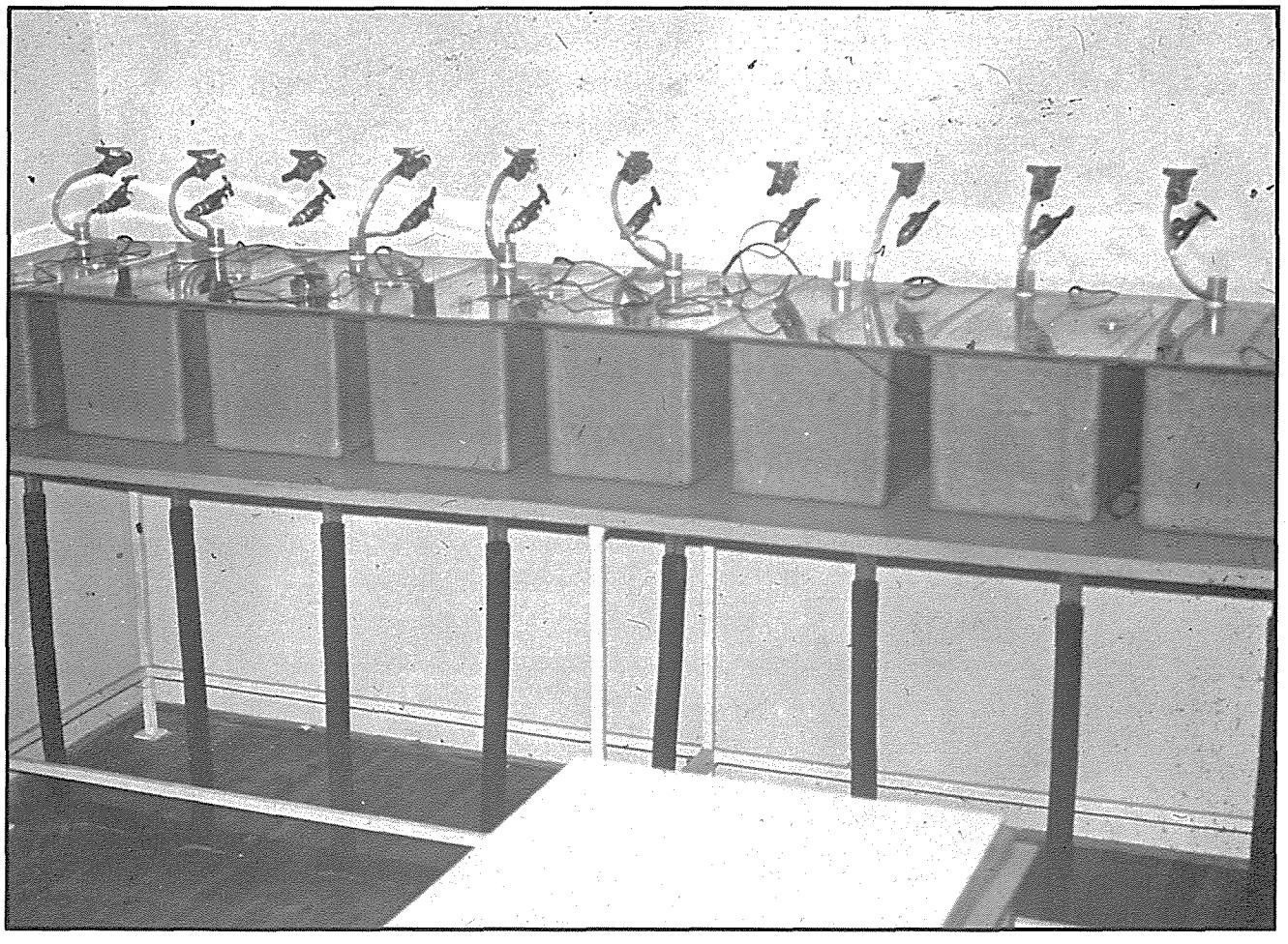
To date, reclaimed water is normally of a better quality than other supplies in the Windhoek area.

Technological development of water reclamation and pollution control

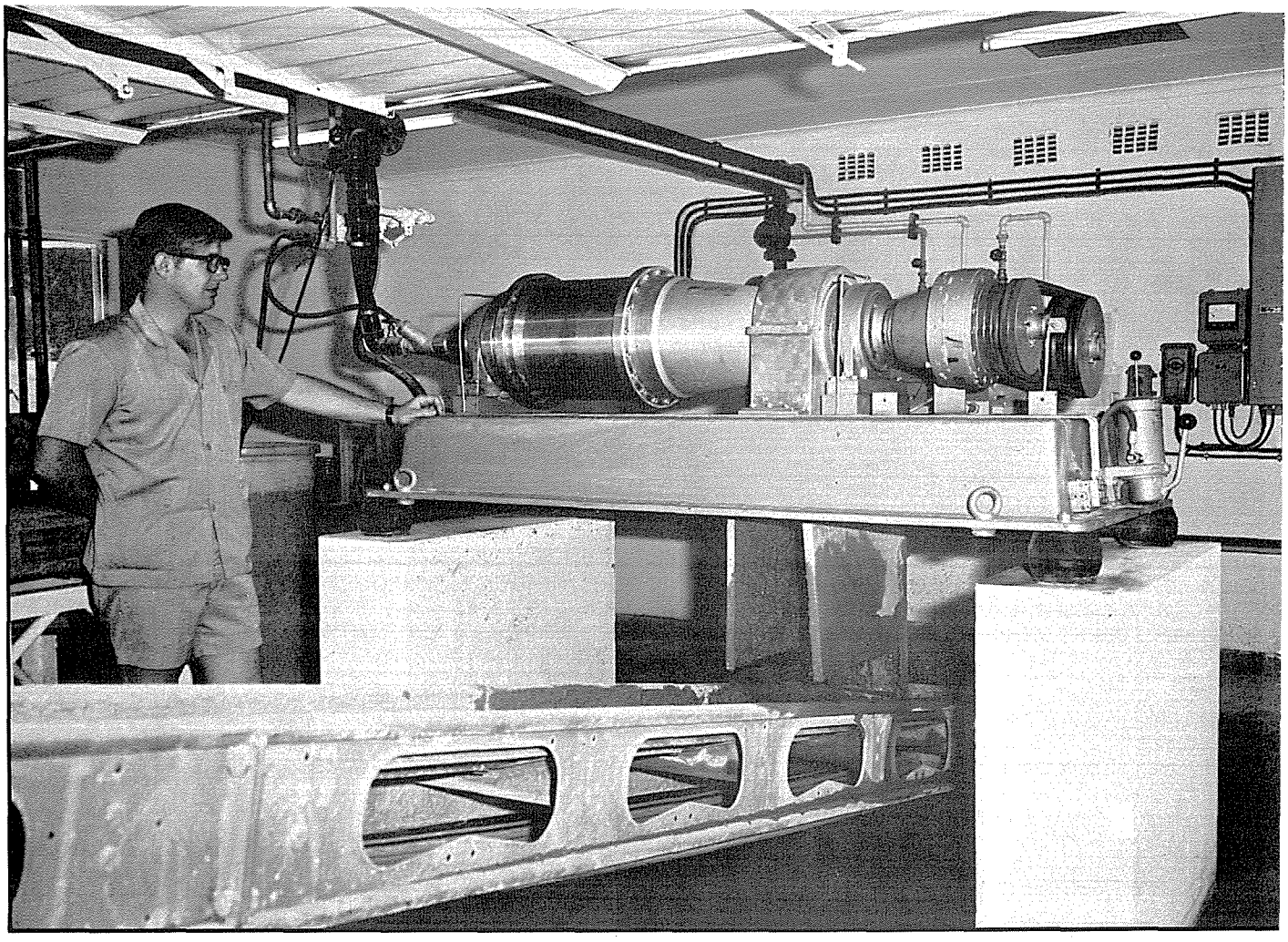
(Existing project: Contract with the CSIR – National Institute for Water Research)

The Daspoort Water Reclamation Plant was designed as a prototype for formulating design and operating criteria for water reclamation plants, and for the study of health aspects related to effluent reuse. These objectives have now been partially achieved. Very useful design information has been obtained regarding automatic lime dosing, settling velocities, ammonia stripping efficiencies, carbon dioxide dosing, breakpoint chlorination and dewatering of sludge. Operating criteria have also been derived and are at present being applied to achieve optimal performance of each unit process. Provisional cost and quality evaluation against seasonal variations in quality had been made earlier and can currently be assessed more accurately.

One of the major process adjustments made to facilitate fully continuous operation of the plant was an alternative



Fish tanks fitted with electronic apparatus to monitor the breathing rates of fish. Changes in the breathing rate indicate the presence of toxicants in the water. The monitoring units have been installed at the Windhoek water reclamation plant.



The centrifugal decanter being used at the experimental water reclamation plant, Daspoort, for the dewatering of sludge.

method for sludge dewatering. Up to November, 1973, sand drying beds were used to dewater gravity thickened sludges from the sedimentation tanks. However, this method was found to have serious disadvantages: The capacity of drying beds has to be inordinately large to handle full solids loads, especially during wet weather conditions; the removal of the solids cake proved to be a labour-intensive operation; and it would be difficult to reclaim lime economically from the dewatered sludges. Alternative means of dewatering the chemical sludge were investigated, therefore, leading to the purchase of a centrifugal decanter ($4m^3/h$). This apparatus has successfully dewatered the full solids load from the plant under conditions of continuous operation. Further trials are in progress to optimize performance.

Another major process modification was the installation of a balancing pond for water quality smoothing. Additional benefits were derived in terms of ammonia stripping, bacterial and virus kill-off and further precipitation of calcium carbonate. The balancing pond proved effective in smoothing the ammonia concentration peaks in the effluent and facilitating eventual chlorination control.

Ammonia stripping has been improved by correcting unfavourable water and air distribution, and the installation of more efficient fans and the removal of scale deposits.

Since breakpoint chlorination of the water is regarded, from a health point of view, as of the utmost importance, an automatic closed-loop chlorination system has been installed at the works. The system is being evaluated and an optimal control strategy is being investigated.

Reclamation, underground storage and abstraction of purified sewage effluent in the Cape Peninsula

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

This project concerns the reclamation and storage of purified sewage in the sand beds of the Cape Flats.

During the course of 1974 the design of the 4 500 m^3d reclamation plant which will serve as a demonstration unit was completed and tenders were invited for construction. Excellent response was received from reputable firms and final assignment of the contract will be made early in 1975.

A dynamite explosion for generating shock waves during seismic surveys of the Cape Flats. This is one of the geophysical methods to be used in determining the thickness of sand deposits in the eastern part of the Cape Flats, as well as the suitability thereof for storing runoff from Eerste River.

The research activities associated with this project were directed mainly towards a quality survey of the underground waters in this area. The object was to establish a quality base line for future reference when underground storage of purified sewage comes into practice. These studies also include the influence of garbage dumping and seasonal changes on the quality of underground waters. An extensive survey has been conducted and is still under way with special reference to heavy metals and organic toxicants.

GROUND WATER RESEARCH

Utilization of water from Eerste River by means of storage in sand beds

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

Existing sources of water supply in the Cape Peninsula are sufficient to meet requirements during the next number of years and should, with the incorporation of water from the Theewaterskloof Dam, be adequate until about 1992. It is estimated that demand at that stage will equal the total assured supply and alternative sources of supply will have to be developed to meet requirements towards the turn of the century.

At present, the Peninsula imports approximately 95 per cent of its water supplies from adjacent areas. After having been used once only, the greater part of this water is discharged to sea as it is impractical to return it to the original catchments, and because reclamation is practised on a limited scale only.

Optimum utilization of all available sources is essential to ensure effective water usage and a sufficient and economic water supply to Cape Town and environs in the long term. This prompted an investigation a few years ago into the possible storage of reclaimed water in the sand beds of the area. It was established that the beds south of the N2 highway, between Strandfontein and Weltevreden Roads alone, had a storage capacity of 697 million m^3 – nine times the combined capacities of the Wemmershoek and Steenbras Dams.

The storage capacity of the sand beds between Weltevreden Road and Macassar, however, is largely undetermined. This area may be important in supplementing the water supplies of the Peninsula by means of:

- stormwater from the lower reaches of the Eerste River – the river has a mean annual runoff of 17,5 million m^3 after 30 million m^3/annum have been diverted to the Theewaterskloof Dam and 17,5 million m^3/annum withdrawn for existing requirements;
- reclaimed water from the Macassar sewage purification works which will eventually provide 127 000 m^3d.

Should the sand beds in this area be suitable for the storage of water, combined infiltration and withdrawal systems could be developed. The Commission, consequently, has entered into an agreement with the University of Stellenbosch in terms of which the University's Department of Civil Engineering will investigate the storage possibilities of the area.

Research will be aimed at determining:

- the physical, chemical and hydraulic characteristics of representative sand strata on laboratory-scale;
- particle size distribution and the nature of the sand beds in the area;
- the permeability, storage capacity and yield of the aquifer;
- the water balance of the area.

The project will also involve:

- investigation of the geological profiles, water levels and quality of water in existing boreholes;
- identification of zones along the coastline where fresh water enters the sea subterraneously;
- development of an optimal policy for withdrawal and supplementation by means of mathematical simulation studies.

The second phase will comprise:

- geological mapping of regional structures to select areas for the application and development of geophysical techniques;
- development of geohydrological techniques with special reference to dolerite structures;
- projection studies on similar areas, especially in the semi-arid Karoo regions;
- development of mathematical models to establish a withdrawal policy;
- testing, selection and development of the most suitable geohydrological techniques for determining borehole sites and establishing geohydrological constants;
- determination of geohydrological constants of the aquifer through the application of isotope techniques, and correlating these with results obtained by conventional geohydrological techniques.

Development and evaluation of techniques for determining the exploitation potential of ground water resources in the Southern Orange Free State and North Western Cape

(New project: Contract with the University of the Orange Free State – Department of Geohydrology)

With the exception of the dolomitic formations and sand beds along the coastline of the Republic, the greatest concentrations of ground water are to be found along faults, seams and dolerite intrusions. These zones derive water from the surrounding formations (with relatively low permeabilities) and the safe yield of these water resources is limited by the hydrological characteristics of the surrounding formations.

Surveys of these resources and research on the abovementioned aspects will have to be expanded and accelerated substantially to ensure that ground water exploitation keeps abreast of development in and the requirements of the country. The Commission has therefore commissioned the University of the Orange Free State's Department of Geohydrology to research the exploitation potential of ground water resources in the southern Orange Free State and the North Western Cape.

The research programme will consist of two phases. The first will comprise:

- collection and analysis of all geophysical data available on the area;
- collection of all data on boreholes and fountains;
- compilation of a geological aerial survey of the area to obtain a picture of the geological structures in the area as a whole;
- analysis of all available data which may relate to investigations during the second phase;
- studies of water levels, water quality and temperature, and borehole yields.

Development and evaluation of techniques for determining the exploitation potential of ground water resources along the Doornberg fault zone

(New project: Contract with the CSIR – National Physical Research Laboratory and the University of the Orange Free State – Department of Geology)

During construction of the Orange-Fish River tunnel, a fault zone with an abnormally large storage capacity and yield was discovered. Ground water initially flooded the tunnel at a rate of 3 090 m^3/h, which may be indicative of an important aquifer in an area where the agricultural potential is largely dependent on the availability of water for stock drinking.

The optimal exploitation of a ground water source requires a knowledge of –

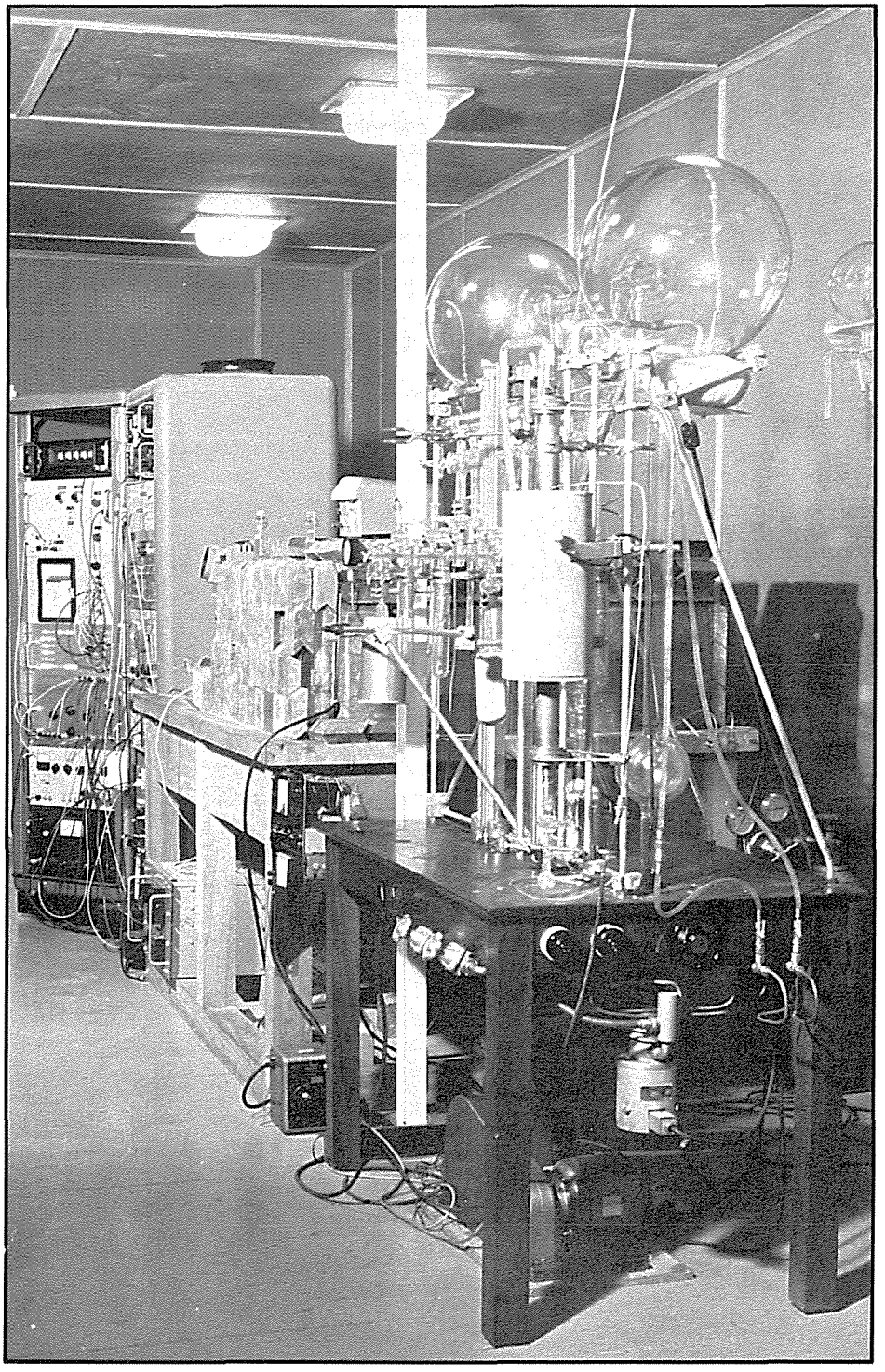
- the dimensions of the underground aquifer;
- the safe yield equal to natural replenishment;
- the quality of water and of remedial measures, if required;
- variations in permeability of the aquifer and the most suitable sites for and methods of withdrawal.

Existing techniques for locating waterbearing formations and determining the geohydrological constants from which the exploitation potential may be calculated, are ineffective. In an effort to solve this problem, the National Physical Research Laboratory of the CSIR and the Department of Geology of the University of the Orange Free State, under contract with the Commission, will undertake a research programme.

The first phase will comprise:

- collecting and analysing all geological and geophysical data on the area;

Equipment for the determination of Tritium, an environmental isotope. The equipment is being used by the Nuclear Physics Research Unit of the Witwatersrand University in geohydrological studies of groundwater.



- studying the existing boreholes and collecting data on fountains in the area (from Aliwal North to Upington);
- a structural study of ERTS satellite photographs and aerial photographs;
- evaluating data to determine whether the fault zone is an important regional aquifer and whether its approximate location can be established.

Should the first phase yield encouraging results, further research will be carried out mainly to formulate a policy for the withdrawal of ground water.

Geohydrological studies in the Gamagara catchment using environmental isotope and complementary techniques

(New project: Contract with the University of the Witwatersrand - Nuclear Physics Research Unit)

Ground water is a valuable resource in the Republic, especially in areas like the Kalahari with a low mean annual rainfall and no perennial rivers. Although often meagre, ground water

supplies are important in that they can be found at or near the site where they are required, e.g. in homelands development, cattle ranching and mining activities. However, a situation can arise such as at the Sishen mine where large volumes of ground water were encountered which might impede mining activities in an otherwise generally dry area. These apparently contradictory facts underline the need for a more scientifically-based understanding of ground waters in order better to control, develop and utilise this resource.

The value of geohydrological observations can be much enhanced by the measurement of certain environmental isotope concentrations in the water. Some of these isotopes are radioactive, such as tritium (hydrogen -3) and radiocarbon (carbon -14) which enables an "age" or time to be determined since infiltration. Others are stable, such as deuterium (hydrogen -2) and oxygen -18, and are indicative of the history of the water, its degree of evaporation and, therefore, its origin. These isotopes can be regarded as traces which nature has constantly introduced into the hydrological cycle. Their measurement can provide information often difficult or impossible to determine by means of "classical" methods.

A research contract aimed specifically at ground water investigations has been granted by the Commission to the University of the Witwatersrand's Nuclear Physics Research Unit, which for some years now has gained experience in the use of isotope techniques in the Kalahari. In a combined hydrological, hydrogeochemical and environmental isotope study, the catchment of the Gamagara river in the North Western Cape (in which the Sishen mine is situated) is to be studied.

Research will be concentrated on the Sishen mine and surroundings with its current surplus ground water features. This should develop into the more extensive study of the major flow in and drainage from the Gamagara catchment, thought to be underground in ancient channels cut into the bedrock by the river and since filled with more recent materials, known as the "Kalahari beds". The main aim of this study is to verify and quantify the flow in and drainage towards these channels and to study the infiltration of rain water through the Kalahari sands.

WATER SAVING MEASURES

Research on dry cooling

(Existing project: Contract with the CSIR – National Mechanical Engineering Research Institute)

The relatively high water consumption rates of power generating stations incorporating conventional wet cooling towers can be eliminated almost entirely by using the dry cooling principle. With this system no direct contact takes place between the water to be cooled and the air, thus preventing loss of water due to evaporation – as in wet cooling systems.

Dry cooling systems require extensive capital outlay in view of the high costs of heat exchangers – running expenses, however, are less than in the case of wet cooling as little or no water is consumed. Investigations carried out in terms of this contract are aimed at improving the heat exchanger design so that the capital cost of dry cooling systems can be reduced, thus making such systems more competitive with water-consuming wet systems.

The investigations are being carried out in two parts:

Part one involves a particular basic design of heat exchanger developed by a private company. After completion of laboratory tests on small heat exchanger elements, a 600 x 600 mm face area prototype unit is under construction. The object is to test the heat transfer and pressure drop performance of the prototype to assess the manufacturing techniques as well as to estimate the cost of manufacturing full size heat exchangers.

Part two covers a wide range of conventional air-cooled heat exchangers and includes both experimental work in the Institute's temperature and humidity controlled wind tunnel as well as analytical evaluation of data on various heat exchangers. A method of performance evaluation has been developed for this purpose.

As a result of the work up to date, a comprehensive list of various heat exchangers for possible dry-cooling application has been compiled. The list includes information on the performance indices, basic cost data and limitations in respect of each type of heat exchanger. Certain types have been selected for further investigation.

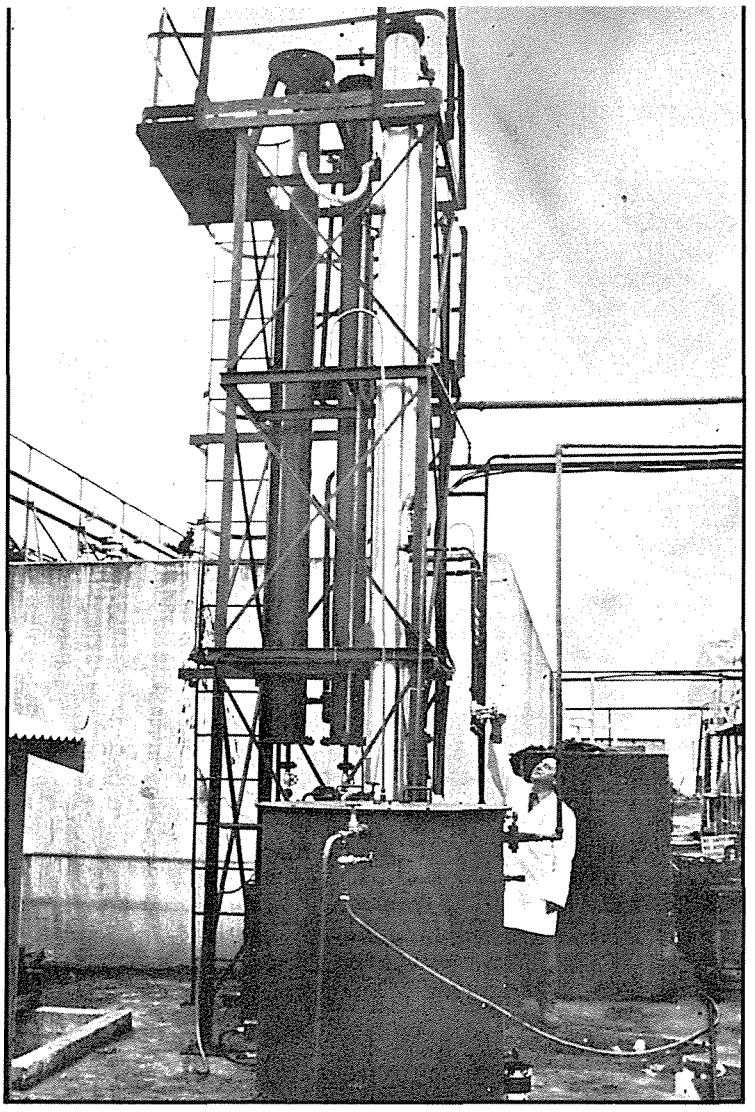
Water losses in pipe networks

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

Loss of water from pipe networks impedes the efficient utilization of a water supply scheme as a whole: storage capacities must be enlarged, larger quantities have to be purified than normally required, and the water network – including mains and reservoirs – has to be enlarged or supplemented.

Losses from pipe networks do not necessarily replenish ground water supplies, since they occur close to the surface where the water is lost through evaporation and transpiration. To acquire more information on this subject, the Department of Chemical Engineering of the University of Pretoria, under contract to the Commission, will undertake a study comprising:

- a study of water metering in pipe networks;
- a study of pipe materials and construction methods;
- selection of centres (Pretoria and Cape Town are indicated) for the determination of losses with due consideration to materials and construction methods;
- investigation of detection methods;



This film evaporator was erected at a wool washery for the pilot-scale removal of wool grease from the effluent. The investigation is being carried out by the S.A. Wool and Textile Research Institute.

- economic implications of the abovementioned studies;
- investigation of methods for prevention and control.

The project will run for three years and consist of two phases: Firstly, determining the extent of water losses in pipe networks and, secondly, preventing and controlling these losses.

EXPLOITATION OF ATMOSPHERIC MOISTURE

Production of water by abstracting moisture from the atmosphere by means of hygroscopic materials

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

Studies in connection with cooling towers for power stations led to the idea that moisture may possibly be abstracted and reclaimed economically from the atmosphere by means of chemical processes.

Tentative investigations have shown that Lithium chloride (LiCl) – already applied for a considerable period in demoisturizing plants (i.e. where the purification of air is the main objective) – may be a suitable hygroscopic material for the abstraction of moisture from the atmosphere. The Department of Chemical Engineering of the University of Pretoria, under contract to the Commission, will study this method of water production.

The project will consist of two phases. The first will comprise a strictly technical investigation of water absorption from the atmosphere and will include –

- selecting the most suitable hygroscopic material and determining its effective life span;
- determining the most suitable process, i.e. a wet process (in solution) or a dry process (from absorption);
- studying the mass transfer of the hygroscopic material to forecast operating procedures for the absorption unit;
- conditioning of the intake air in order to simulate a wide range of ambient conditions;
- preliminary calculations of absorption and reclamation costs for different reclamation processes.

Should the results of the first phase prove encouraging, the second will be planned involving *inter alia,* construction of a suitable pilot plant.

EFFLUENT TREATMENT

Treatment of waste water from wool textile industries

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

Effluents from wool scouring plants cause pollution problems in that they contain wool grease which forms a layer on the surface of effluent ponds, impeding efficient evaporation.

The South African Wool and Textile Research Institute of the CSIR has developed a technique for reclaiming high quality wool grease and simultaneously conserving water by recirculation. The process is being tested on a laboratory scale by the Institute, under contract to the Commission, and research is currently focussed on the rising-and-falling film evaporator used for reclaiming the wool grease solvent.

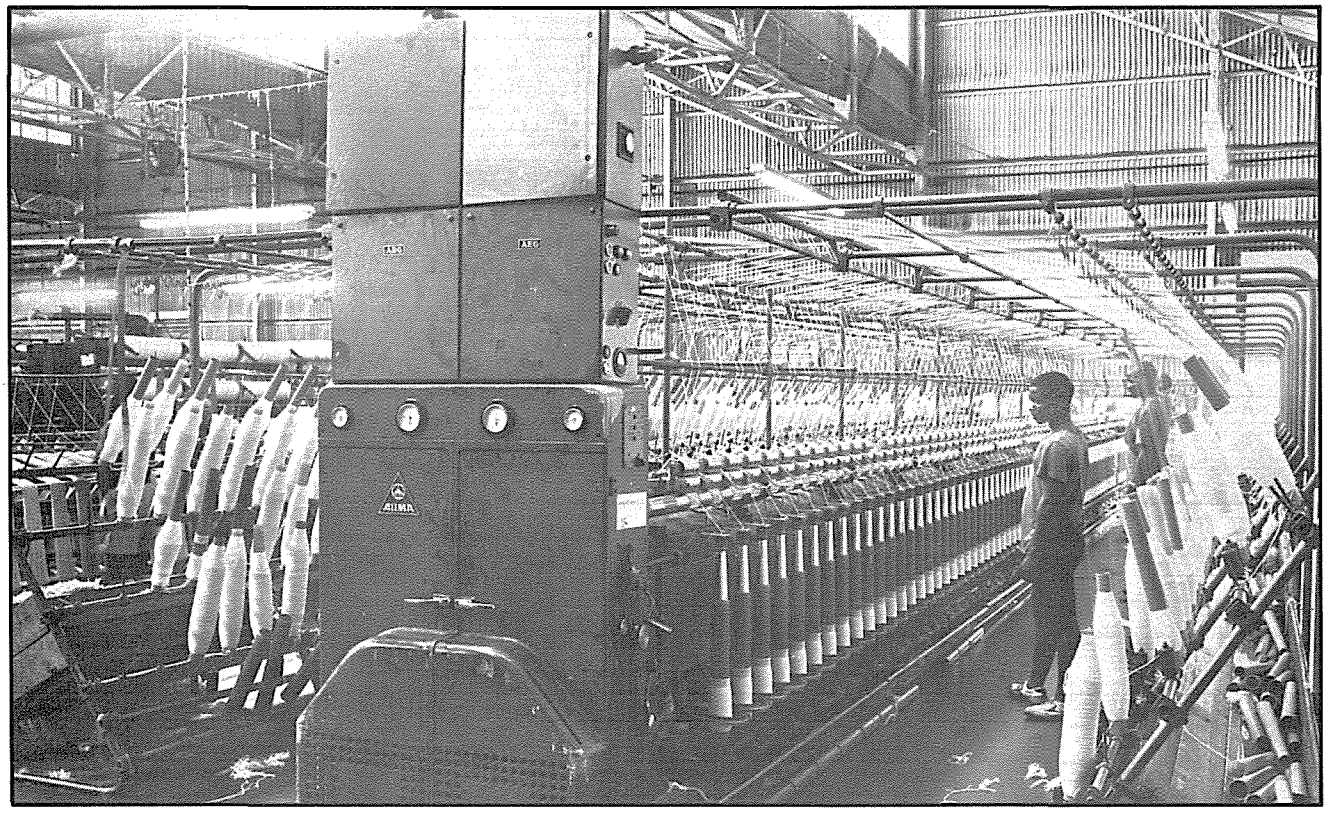
During the year under review, a commercial evaporator was installed at a large scouring plant to evaluate the results of laboratory experiments on pilot scale. Problems encountered with explosion hazards in the separators (the boiling point of the solvent – benzine – is only 70°C to 115°C) were successfully eliminated.

Recycling of water and recovery of chemicals in the textile industry

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

Textile factory effluents contain a variety of substances in the form of impurities from the basic fibres, as well as chemicals added during the manufacturing stages and removed during the wet finishing operations. Chemicals as diverse as sodium chloride, sodium carbonate, starch, synthetic detergents, dyes and bleaches find their way into these effluent streams.

In most cases the process water and chemicals are used once only and then discharged – a costly procedure. It is therefore highly desirable in many of the wet processing operations to "close the loop" and recycle the water and chemicals, not only to conserve water, but also substantially to reduce effluent discharges and obtain cost benefits by reclaimed reusable process chemicals. If the chemicals have to be recovered, it is generally not feasible to recycle the full volume of textile factory effluent because a multitude of chemicals are present, but it is practicable for a particular manufacturing operation.



A study of the recirculation of water and the reclamation of chemicals in the textile industry being made by the Department of Chemical Engineering of the University of Natal.

A research programme comprising *inter alia,* a survey of process operations, water and water quality requirements and effluent compositions at several textile sites, has been initiated by the Department of Chemical Engineering of the University of Natal, under contract to the Commission. High volume/high environmental impact waste streams will be identified. Furthermore, a material balance is being made on the manufacturing operations producing these effluents by means of an inventory of raw materials and additives and detailed chemical analysis of representative effluent samples collected by a proportional-flow sampling apparatus.

These studies will provide a detailed basis for assessing the applicability and economic feasibility of various treatment/separation/recycle configurations, which will be tested in the laboratory before undergoing pilot-scale trials at a factory site. The effluent streams selected for closed-loop operation are being scrutinized for possible intractable materials, which, if allowed to build up, may interfere with the manufacturing operation.

Treatment of waste water by ion-exchange

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

In the Report of the Commission of Enquiry into Water Matters, 1970 (Report R.P. 34/1970) it is reported that the reclamation of effluents for unrestricted reuse will be one of the essential measures to relieve future water shortages in South Africa. Another measure will be the desalination of sea water for water supply at coastal cities, as well as the desalination of brackish water. The multiple reuse of effluents, will also require desalination to control the accumulation of mineral salts after each cycle of use.

Apart from the ocean, there are three potential sources of supply in the vicinity of Cape Town. Their exploitation is being hampered by relatively high salinities or by the danger that the salt contents could rise to unacceptable limits. These are:

- sewage effluents
- the very large underground reservoir of the Cape Flats
- the Diep River.

All three sources of water are unsuitable for direct use because of their high salt content. In the case of sewage effluent the presence of organic pollutants is an additional problem. Sewage effluent is, however, the most readily available of the three and, to produce water of a quality which conforms to World Health Organization standards, the use of ion-exchange is being investigated on sewage discharge from Athlone and from Milnerton. This research is being carried out by the Chemical Engineering Department of the University of Cape Town under contract to the Commission.

The effectiveness of ion-exchange for water purification is being examined in two phases: ability to remove salt and, secondly, ability to remove organic pollutants.

The ability of ion-exchange resins to remove salt from water is well known and the investigation into salt removal is concerned with the best configuration for local conditions and, in particular, the lowest cost system. Costs are mainly dependent on the types of resin used, the contacting procedures and, more important, the resin regeneration technique. Progress has been made in finding a resin bed configuration which will operate at lower cost than those proposed overseas and present work is concentrated on reducing regeneration costs. In the latter case the emphasis is on a process which will produce a chemical usable as a synthetic fertiliser, so that much of the initial chemical regeneration cost can be recovered.

The additional ability of ion-exchange resins to remove organic pollutants allows the potential production of good quality water from sewage effluent in one process. Work done to date shows that anion resins are effective for organic removal and that very little permanent fouling of the resin takes place as a result of irreversible organic take-up.

Ion-exchange has other useful qualities as a method of water purification. Nitrates and phosphates which are major causes of river pollution are removed during ion-exchange and all hardness ions are also taken out of solution. Thus ion-exchange fulfils the requirements of being a complete tertiary treatment in its own right.

Research will continue in order to determine the most suitable resins for combined salt and organics removal, and to establish the most economical regeneration process. These experiments are being done on laboratory scale and once the variables are established, pilot scale equipment will be designed and built to determine operating conditions for a full-scale plant.

Research on the activated sludge process

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

Treatment of organically polluted effluents by means of the activated sludge process is being applied to an increasing extent in South Africa. It is therefore necessary to investigate the process thoroughly to develop design criteria which will lead to its optimum application.

The Department of Civil Engineering of the University of Cape Town is currently studying the following aspects of the process:

Kinetics of denitrification

The removal of nitrogen from waste water is effected through denitrification, a process whereby nitrate nitrogen is biologically reduced to nitrogen gas which escapes to the atmosphere. The kinetics of the process has been studied, and as a result of progress made, a procedure developed for the design of full-scale activated sludge plants. Further research is being done in laboratory units to obtain more information on the effect of temperature and cyclic flows on the denitrification process.

Kinetics of the activated sludge process

The dynamic response of activated plants has not yet been thoroughly developed theoretically. A computer programme was developed, therefore, to simulate the dynamic response of an activated sludge plant to cyclic loading. The computer programme will be modified as experimental reaction data are generated.

Aerobic digestion of sludge

In order to optimise the aerobic digestion of sludge originating during the activated sludge process, a dependable method is required to determine the mass of the biologically active material as well as the time required for digestion. Such a method has been developed on the basis of experimental work.

Oxygen requirements

To determine the oxygen requirements of an activated sludge plant, knowledge of the oxygen equivalent of the sludge lost in the process is essential. Research has been done in this respect to corroborate, in practice, certain theoretical figures, and a high degree of correspondence was found.

Flotation characteristics of activated sludge

Effluent from activated sludge plants can be clarified by flotation or sedimentation. Flotation experiments have been commenced on the effluent of an operational plant in an effort to draw an economic comparison between the two methods.

Pilot plant

The design of a pilot plant to be situated at Strandfontein has been completed and construction will commence in the near future.

Removal of metal ions from dilute solutions in an electrolytic precipitator

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

In industrial areas, effluents may contain metals such as zinc, iron, copper, manganese, nickel, tin, lead and chromium. Should concentration levels exceed certain values, these metals can adversely affect the performance of sewage purification processes.

Research initiated by the Department of Chemical Engineering of the University of the Witwatersrand, under contract to the Commission, has been directed at the removal of metal ions from a solution without the addition of chemicals, and at the recovery of the metals in a re-usable form.

During the year under review, a laboratory-size packed bed cell was constructed to investigate the efficiency of copper removal from a dilute copper sulphate/sulphuric acid solution. The initial programme was aimed at determining the optimum current density and solution flowrate as well as testing and selecting suitable materials for the cathode bed, anode bed and partition membrane.

Results showed that at low current densities, efficiencies in excess of 60 per cent were obtained, apparently independent of flowrate. At higher current densities the effect of flowrate became more marked owing to the increased importance of mass transfer resistance.

It was established that when copper concentration is reduced to 10 ppm the current efficiency drops significantly. Indications are, however, that efficiencies as low as 5% would still make the packed bed cell attractive as a pollution control device.

Development of criteria for removal of nitrogen and phosphorus from sewage effluents by means of improved biological treatment processes

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

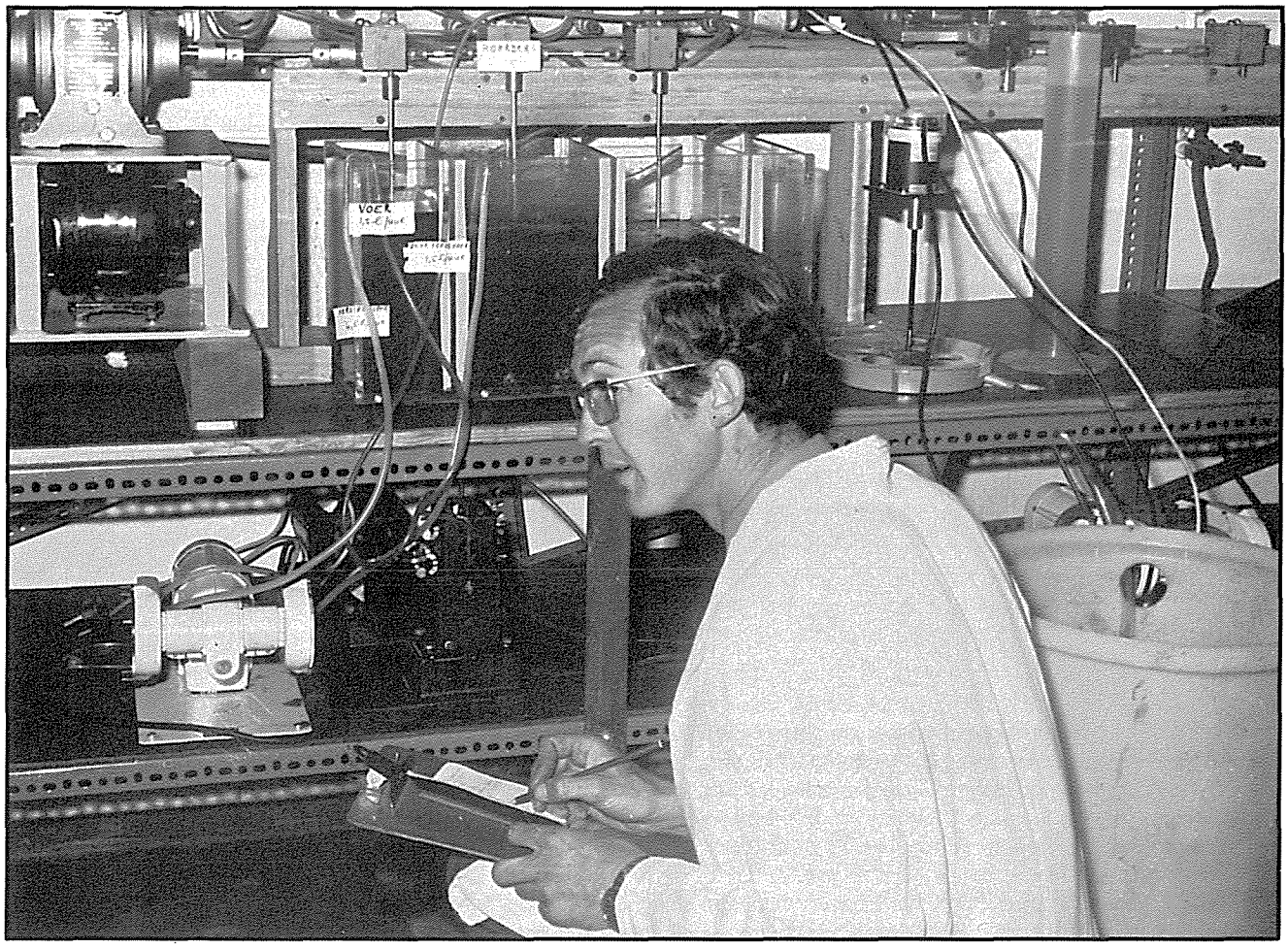
Conventional treatment systems do not remove the nitrogen and phosphorus from sewage effluents and researchers have been trying for many years to develop a successful biological method for eliminating these nutrients which cause eutrophication, i.e. undesirable algal growth in natural waters into which the effluent is discharged.

It has long been established that if the liquor, which has already been aerated and nitrified, is allowed to become anoxic (that is, instead of oxygen being added to the sewage it is merely stirred) certain bacteria will convert the nitrates to gaseous nitrogen – a process called denitrification. However, for this reaction to take place it is necessary to add carbonaceous substances such as methanol. Although incoming sewage will serve the same purpose inexpensively, this process has many limitations. For example, if sewage is added at this stage the nitrogen contained in the sewage itself escapes the full treatment and still appears in the effluent.

The CSIR's National Institute for Water Research (NIWR) has developed a process which can remove nitrates and phosphates from sewage without the addition of chemicals. In the NIWR system, known as the 'Bardenpho' activated sludge process, such difficulties are overcome by the unusual innovation of making the *first stage* in the treatment an anoxic one.

The system consists of four stages – the first and third are anoxic and the second and fourth are aerated. The NIWR researchers also found that if the mixed liquor, after being aerated, was allowed to become anoxic for a time in a second mixing basin to remove remaining nitrates, and was then sufficiently aerated in a final basin, the soluble phosphates present in the effluent would precipitate. These insoluble products would not be present in the final effluent.

Dr. G. G. Cillié, (left), Director of the National Institute for Water Research and Dr. G. J. Stander, Chairman of the Water Research Commission, at the informal opening of the pilot plant for evaluating the Bardenpho process for the removal of nitrogen and phosphorus from sewage effluent.



The Bardenpho process for the removal of nitrogen and phosphorus from sewage effluent is based on preceding laboratory experiments. This is some of the apparatus used in the experiments.

Laboratory and pilot plant studies carried out by the NIWR during the past three years have demonstrated the potential of the Bardenpho activated sludge process as a sewage treatment system for the removal of nitrogen and phosphorus compounds. With the knowledge the NIWR has gained, it is already possible to design a sewage treatment plant that will remove more than 90 per cent of the nitrates from sewage and substantially reduce the phosphates.

Development, therefore, has a three-fold value:

(i) It can lead to a substantial saving in expenditure on chemicals – this will become increasingly important if the cost of chemicals continues to rise.
(ii)It can reduce eutrophication of rivers and dams.
(iii) It can provide an effluent more suitable for subsequent reclamation and reuse.

Although some large-scale sewage treatment plants are already incorporating the Bardenpho principle of nitrification and denitrification, there are many factors influencing the process that still need elucidation and optimisation. In terms of the contract entered into between the NIWR and the Water Research Commission, funds have been made available for the construction of a new Bardenpho pilot plant at Daspoort. The new pilot plant (100 m^3/d) incorporates a number of design features making it ideally suitable to investigate the effect of variables on the process. Economic implications will be given particular attention.

SURFACE HYDROLOGY

Hydrological investigations of small catchments

It is estimated that the annual runoff of rivers in the Republic is in the region of 55 000 million m^3, i.e. approximately 8,5 per cent of the mean annual rainfall. Due to the fact that almost 90 per cent of the Republic's water consumption is derived from river flow, it is of the utmost importance to study the relationship between rainfall and runoff more intensively.

Data on precipitation/runoff relations for all catchments are continuously being collected by the Department of Water Affairs. The Department of Forestry has also collected data on a number of small catchments, notably at Jonkershoek and Cathedral Peak. Mathematical simulation models have been developed from available data to enable predictions of river flow in large catchments from meteorological information. These models have to be modified and refined through further studies, chiefly of small catchments where more complete observation by means of superior instrumentation is possible.

As stated in the previous Annual Report, the Department of Geography of Rhodes University, under contract to the Commission, had started with a hydrological study of catchments in the Grahamstown area in 1973. To enhance the reliability of deductions made from this study, the Commission has deemed it desirable to extend this research to other catchments where the mean rainfall, vegetation, soil utilization, soil types, topography and geology differ markedly. The Commission consequently decided to finance similar projects at the Universities of Natal and Zululand.

Investigation in the Grahamstown area

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

Research on five small catchments in the Grahamstown area comprises, *inter alia,* the collection of morphological, geomorphological and geohydrological data. During the year under review, a network of autographic rain gauges was installed and is considered adequate to reflect variations of rainfall duration and intensity across the catchment.

Two evaporation pans have been built and a preliminary morphometric analysis completed in respect of the composition of the drainage network. The research programme for 1975 involves:

- construction of weirs, flumes and recorder housings;
- selection of simulation models in consultation with the Hydrological Research Unit of the University of the Witwatersrand;
- collection and analysis of rainfall, runoff and evaporation data;
- a detailed morphometric analysis of drainage composition;
- mapping of soil depth and variation in vegetative cover in the catchments.

Investigations in the Natal Midlands

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

Since 1964, the Department of Agricultural Engineering at the University of Natal has conducted a programme of research on the hydrology of small catchments. In terms of the contract with the Commission, this programme is to be expanded.

Gauging weirs will be constructed at the Cedara Experimental Station and rainfall and runoff continuously recorded from the selected small catchments. This data, together with historic data recorded by the Departments of Water Affairs and Forestry will be used to test existing models for applicability to the Natal Midlands.

The proposed site of a gauging station below the Ngoya forest. It falls within the boundaries of one of the small catchments in the Natal coastal area where rainfall-runoff relations will be studied.

Investigations in the Natal coastal area

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

Nine small catchments, varying in area from 1 km² to 80 km², will be studied by the Department of Geography of the University of Zululand. For this study, the catchment of the Ntuze River, a tributary of the Umlalazi River in the Mtunzini District, has been selected because of its geological homogeneity, relatively high precipitation (1 100 to 1 500 mm per annum) and variations in land use patterns such as afforestation, natural forests, sugar cane farming and virgin grassland. Apart from the testing and refining of existing models, the investigations will also generate data on the influence on runoff of catchment management, conservation and farming practice, afforestation, and burning.

The geological survey of the area has been completed and the soil and vegetation surveys commenced. Sites for the construction of weirs have been surveyed and sites for installation of autographic rain gauges have been selected.

Financial support of hydrological research

(Existing contract: University of the Witwatersrand – Hydrological Research Unit)

The Hydrological Research Unit of the Witwatersrand University receives a block grant from the Commission on the basis that research done by the Unit continues to cover fields in which the Commission is obliged to interest itself in terms of the Water Research Act.

The staff of the Unit continue to assist the Water Research Commission in aspects of its work concerned with engineering hydrology.

All the major projects on which the Unit is presently engaged involve the development and application of mathematical models of hydrological processes:

Water Resource Model. The Unit has completed the development of a watershed model which makes it possible to generate monthly hydrographs of riverflow anywhere in South Africa from monthly catchment rainfall and evaporation data. This model has already been applied to a variety of problems. The development of a model based on daily data is now being investigated.

Flood hydrograph models. A method for rapid, direct estimation of design flood hydrographs has been devised, eliminating the tedious unitgraph processes.

Swamp, lake and estuary models. Reports have been published on research done at St. Lucia and a further three are being prepared. These deal with estuary and lake model simulations to test the effects of proposed remedial measures; lake model description and calibration.

The Pretoria-Witwatersrand-Vereeniging (PWV) project. The PWV project entails a study of the circulation of water and waste water in the Pretoria-Witwatersrand-Vereeniging area as regards quantity and quality.

An exploratory study has commenced and data are being collected in respect of the physical, hydrological and water quality regime within the study area, *viz.* the catchment from Vaal Dam to the Barrage. The object is to develop a mathematical model to permit simulation of the circulation and quality of water within the system and to provide a basis for optimising the system.

Development of the concept of the runhydrograph in the analysis of flood hydrographs

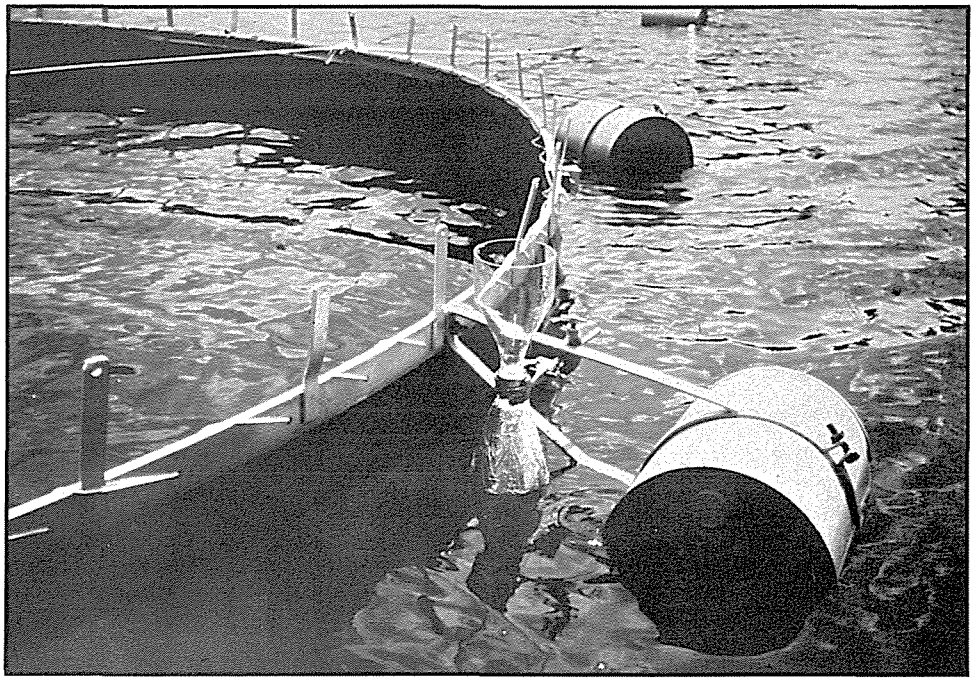
(New project: Contract with the University of Natal – Department of Civil Engineering)

A hydrograph is a curve which graphically depicts flow rate against time. For each watershed there exists a family of hydrographs for the same return period. (The return period indicates the probable regularity of similar floods). Normally, the civil engineer focusses his attention on the hydrograph with the highest instantaneous discharge in designing structures for water conservation or flood control purposes.

In many practical applications other hydrographs may be of greater value to the engineer. A hydrograph may have a lower instantaneous discharge rate, but may reflect a larger total volume of runoff and floods of longer duration. Extraction of such hydrographs from the flow record of a river will allow the engineer to select those of most value for a particular purpose. It will allow optimization of solutions to flood problems with regard to the whole family of hydrographs with the desired return period.

Preliminary work done by the Department of Civil Engineering of the University of Natal on the flow records of the Vaal River at Standerton has yielded interesting results. From this work the theory for the "runhydrograph" has been developed, a concept based on the mathematical and statistical processing of existing hydrographs. In order to make runhydrographs available for particular catchments, it is necessary to extract continuous hydrographs over as long a period as possible. From such hydrographs it may be possible to identify important parameters in the runhydrographs for gauged catchments, and to develop synthetic runhydrographs for ungauged catchments.

The Commission has commissioned the University of Natal's Department of Civil Engineering to continue the development of the runhydrograph concept. River flow data from approximately 120 gauging stations and extending over more than 40 years will be processed and the corresponding runhydrographs compiled. The objective will be to develop runhydrographs for the various river systems in the Republic which could be of great value to engineers in designing water schemes and flood control works.



An isolation column being used for studying eutrophication in the Rietvlei Dam. The column isolates 120 m³ water from external sources of plant nutrients. With the aid of the column it is possible to follow biological and chemical changes in the water, as well as the effects of nutrients on the bottom deposits of the dam.

WATER POLLUTION

Eutrophication of rivers and dams

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

Enrichment of surface waters with plant nutrients (eutrophication) is potentially a major water quality problem of South African impoundments because of the excessive growth of algae and water weeds that may result. The effect of industrial and domestic effluents, drainage from urban and agricultural developments and processes such as soil erosion on the aquatic environment must therefore be evaluated in order to develop criteria for the control of eutrophication and the sound management of South African water resources.

An algal bioassay survey of 98 major South African impoundments was undertaken to determine the extent of eutrophication on a national basis. Almost half were found to have low plant nutrient contents whereas six impoundments, *viz.* Hartbeespoort, Rietvlei, Roodeplaat, Shongweni and Johan Neser Dams and the Vaal Barrage, were severely eutrophied. The remainder could be classified between these two groups, indicating they receive moderate plant nutrient loads.

The National Institute for Water Research of the CSIR (under contract to the Commission) initiated intensive studies of four dams, *viz.* Hartbeespoort, Rietvlei, Roodeplaat and Buffelspoort, in 1973. The former three dams are eutrophied and the extensive algal growth gives rise to a number of water quality problems; the latter dam is not eutrophied. The most prominent nutrients which regulate algal growth in these dams are nitrogen and phosphorus.

The sources of the plant nutrients are significant: The Crocodile River, which receives secondary treated sewage and industrial effluents, supplied 99 per cent of the nitrogen and phosporus loads to the severely eutrophied Hartbeespoort Dam. The inflow of purified sewage effluent is an important source of nitrogen and phosphorus in respect of Rietvlei Dam. The Pienaars River, which receives secondary treated sewage effluents, contributed 94 per cent of the nitrogen and 98 per cent of the phosphorus loads to Roodeplaat Dam. In contrast, Buffelspoort Dam with no urban/industrial development (except two small holiday resorts) does not receive significant nutrient loads, despite agricultural activities in its catchment. Indications are that soil erosion, especially in the important dry land farming areas, may result in moderate nutrient loads in some impoundments.

The prominence of nitrogen and phosphorus indicates that eutrophication can be controlled by limiting the access of these nutrients to the aquatic environment. However, results obtained from Rietvlei Dam indicate that nitrogen removal is of little value in this respect because nitrogen-fixing algae can meet their nitrogen requirements from the atmosphere. The control of phosphorus enrichment is, therefore, the only long-term solution of eutrophication problems.

In order to develop criteria for the quantities of phosphorus admissable to a dam without inducing water quality problems, attention was given to a mathematical eutrophication model. This model relates the eutrophication status of a lake to the dangerous phosphorus loading rate which, when exceeded, could lead to excessive algal growth and water quality problems. The loading rates of the four dams comprising the intensive study are compared in Table 1. Buffelspoort Dam receives less than its dangerous loading level, but Hartbeespoort, Roodeplaat and Rietvlei Dams receive, respectively, 46, 53 and 40 times their dangerous loading levels.

TABLE 1: THE LOADING RATES FOR PHOSPHORUS OF FOUR TRANSVAAL DAMS

Dams	Estimated loading rate g P m^{-2} y^{-1}	Dangerous loading rate* g P m^{-2} y^{-1}
Hartbeespoort	21,55	0,47
Roodeplaat	22,39	0,42
Rietvlei	25,89	0,65
Buffelspoort	0,64	0,80

*From eutrophication model.

The long-term solution to the eutrophication problems of these dams must, therefore, be sought in limiting the access of phosphorus to the dams in order to attain the limits depicted in Table 1. Phosphorus loads may be reduced by diverting effluents from the catchments, but this would merely transfer the problem elsewhere. The solution would be to implement existing technology for the removal of phosphorus at point sources, such as sewage treatment plants.

In eutrophied dams phosphorus accumulates in the sediments; when oxygen is depleted in the bottom waters, phosphorus is released from the sediments into the water. The water of eutrophied dams could, therefore, be aerated in order to prevent phosphorus release. This procedure may be valuable in managing impoundments.

All processes that result in diminishing the phosphorus contents of a dam are potentially important. Fish have a fairly high phosphorus retention and are of economic importance as sources of protein. Their exploitation (even on a commercial basis) as a means of reducing phosphorus loads in impoundments, should be investigated. The results of this project during 1975 will enable a further refinement of essential safety limits on phosphorus loading rates for South African impoundments.

The rôle of aquatic plants in maintaining trophic conditions at Swartvlei, Wilderness

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

The ecosystem of Swartvlei – one of the six Wilderness lakes – presents an exceptional opportunity for investigating the rôle of aquatic weeds in the maintenance of trophic conditions in shallow water masses.

The Institute for Fresh Water Studies of Rhodes University has initiated a research project (in terms of a contract with the Commission) to determine the precise contribution of these weeds in purifying estuarine water, since the results may have an important bearing on maintaining trophic conditions in other lakes and natural purification systems. A special research field station is being erected on a suitable site for this purpose.

A number of important physico-chemical changes have been followed while the mouth of the lake was closed as well as open, and these confirmed earlier results. It was also conclusively established that the ecology of the estuary could not be effectively modelled in a laboratory.

The Institute is already engaged in collecting information on the possible land reclamation effect of the existing railway and road bridge levels, and in studying temperature, dissolved oxygen changes and water current regimes.

DESALINATION

Desalination of brackish water

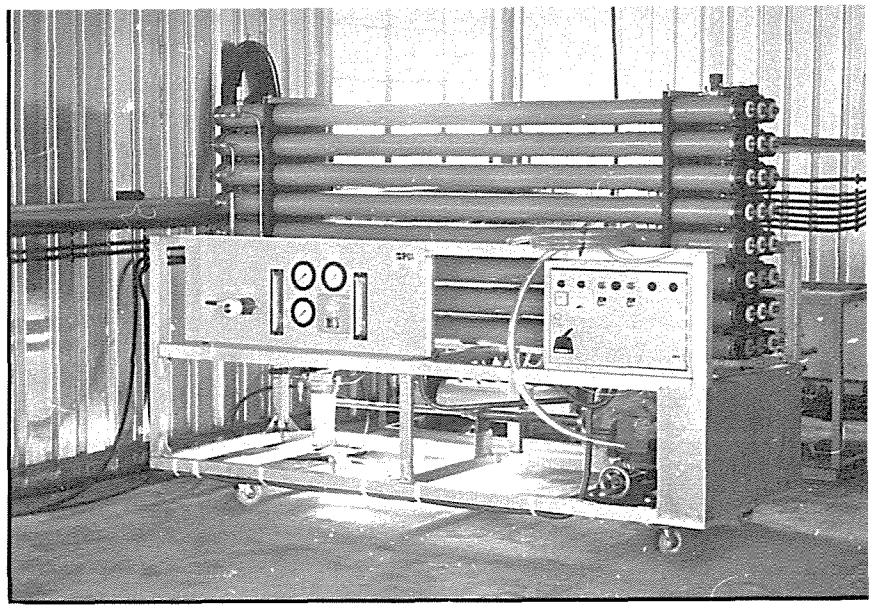
(Existing project: Contract with the CSIR – National Institute for Water Research)

The considerable sources of brackish water and mineralised industrial and sewage effluents in the Republic can be fully utilized only after desalination to a greater or lesser extent.

As mentioned in the previous annual report, the National Institute for Water Research of the CSIR, under contract to the Commission, has already initiated an intensive study of commercial desalination equipment and its large-scale application for the desalination of brackish water.

Tests with a vapour recompression unit have been completed and research currently focusses on the process of reverse osmosis. An experimental plant with a total capacity of 73 m^3 d was set in operation during November, 1974 in the Beaufort West district. The plant produces fresh water with a salt content of approximately 500 mg/l from a particularly strong source of brackish water (borehole with a yield of 3 275 m^3d) containing 4 000 mg/l dissolved salts. The intention is to test the units over a period of at least twelve months to determine the practicability of the process.

At the same time the availability and quality of underground water resources in the Republic are being investigated in conjunction with the Department of Water Affairs. The desalination investigation will be related to this study.



Reverse osmosis equipment being used to study the demineralization of brackish water. The unit has been erected in the Beaufort West district where it is being used in field trials.

The WAT-process for the desalination of sea-water

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

The WAT-process was devised to reduce the cost of water produced from the desalination of sea-water by means of special ion-exchange techniques whereby certain salts are reclaimed. The feasibility of the process is being studied by the National Institute for Water Research (NIWR) of the CSIR under contract to the Commission.

Kinetic and equilibrium studies of the various ion-exchange reactions on which the process is based have been completed. Results obtained by means of the microcycle apparatus have shown the resin to have a minimum life of three years under practical conditions. This figure can confidently be extrapolated to 5 years.

A laboratory-scale continuous ion-exchange plant for studying loading, regeneration, carbonation and wash cycles has been operated successfully and a sodium bicarbonate product stream in excess of 98 per cent purity has been consistently obtained. The ion-exchange section of the process has been shown to be technically feasible.

A techno-economic feasibility study of the process has been completed. This study was conducted jointly by the NIWR and the Industrial Development Corporation and has shown that while the process is technically feasible, it is not a sound economic proposition under present conditions.

Current laboratory investigations are to be completed and a detailed report on the state of the project prepared. This will incorporate design details for a pilot plant, should implementation at a later date be economically warranted.

Efforts will now focus on an assessment of some of the other methods used for sea-water conversion. This will be followed by an intensive investigation of the most promising methods applicable to South African conditions.

WATER CONSUMPTION PATTERNS

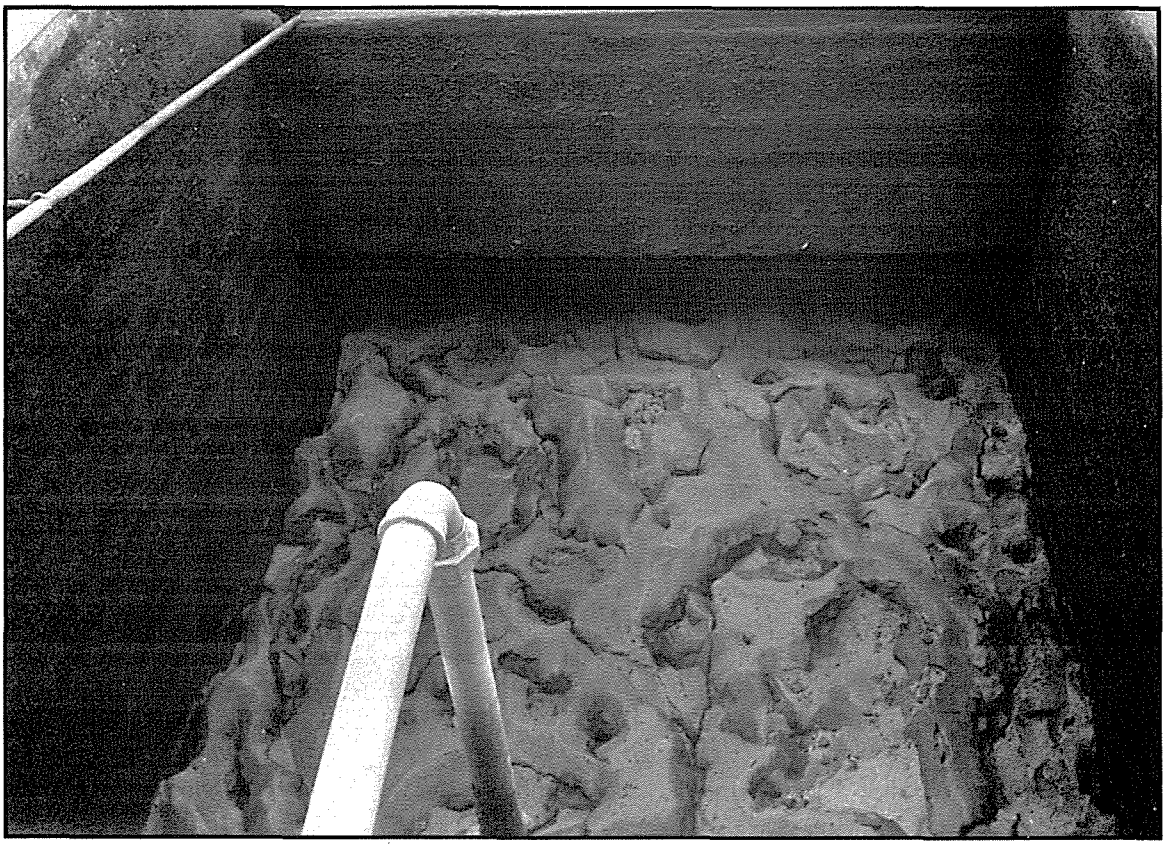
Research on water consumption patterns in urban areas

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

There is a dearth of information on water consumption patterns in the urban areas of South Africa, and to enable efficient utilization of water resources it is important to be able accurately to determine the proportion of water used for domestic and for industrial purposes. In order to obtain more information on this aspect of water utilization, the Commission has commissioned the University of Pretoria's Department of Chemical Engineering to investigate –

- water consumption patterns in the domestic and industrial sectors, in Bantu Townships and those of local and other authorities;
- water consumption, *per capita,* for occupiers of erven of varying sizes and for the various income groups;
- the influence of private boreholes in urban areas on water consumption patterns;
- the effect of water tariffs on consumption patterns;
- water requirements for sewage in sewerage systems;
- the use of sea and brackish water in sewerage systems and for fire-fighting;
- water conservation methods in urban areas.

During the investigation, climatic differences and the extent of industrialization will be taken into consideration. Studies are planned for Pretoria, Cape Town, Windhoek, Randburg, Alberton and Ga-Rankuwa.



Sludge originating from the water purification process. Disposal of the sludge creates problems and is now being investigated.

SOLID WASTES

Removal of sludge and wash water at water purification installations

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

The high turbidity of South African surface waters necessitates the addition of high coagulant dosages during water purification processes. The production of sludge per unit volume of water purified is consequently extremely high. Surface waters in the Republic afford little dilution but are, nevertheless, used for sludge disposal.

Little is known about the pollution potential of sludge from water purification plants and there is a need in South Africa for research on the subject and on the development of applicable techniques and criteria for the economic treatment and disposal of this sludge.

Such research will be undertaken by the Department of Chemical Engineering of the University of Pretoria, under contract to the Commission, and will comprise the following:

- determination of the pollution potential of water works sludge, and the biological, ecological and economic implications;
- identification of sludge volumes and characteristics according to simple parameters and as a function of raw water quality and purification methods for South African surface waters;
- identification of significant relationships between sludge volumes and sludge concentrations in sludges produced by means of different methods of purification;
- development of hydraulic criteria for sludges of varying concentrations transported by means of canals or pipelines;
- study of the kinetics of sludge settling in thickeners or sludge lagunes;
- development of design criteria for the treatment or disposal of sludge by means of sludge lagunes, and development of lagune designs for accelerating sludge dewatering;
- utilization of sludge residues;
- development of economic methods for the reclamation of alum from sludge with elimination of high concentrations of iron;
- a study of possible process modifications in water purification plants to reduce sludge volumes.

Chapter 5

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) and certified by the Controller and Auditor-General and cover the period 1st April, 1974 to 31st December, 1974.

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 728 of 26 April 1974:

(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 No 54 of 1956), to be irrigated at any time during the period 1 April, 1974 to 31 December, 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 aforementioned Water Act, to be irrigated at any time during the 1974/75 or, as the case may be, the 1974 financial year or 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, 1974 to 31 December, 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 56(3) or section 66 of the aforementioned 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 January, 1974 to 31 December, 1974 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 aforementioned 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 abovementioned public supplier during the said period the quantity of water supplied or made available from the 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, 0001, as follows:

(a) in respect of the period 1 January, 1974 to 30 June, 1974, not later than 30 September, 1974; and
(b) in respect of the period 1 July, 1974 to 31 December, 1974, not later than 31 March, 1975".

WATER RESEARCH COMMISSION

STATEMENT NO 1

BUDGET 1975

INCOME:		
Estimated revenue from rates and charges in terms of Section 11 of the Water Research Act		2 196 500
Estimated interest on investments		140 300
		2 336 800
Estimated appropriation from accumulated funds		504 500
		2 841 300
ESTIMATED EXPENDITURE:		
Administrative expenses:		
Salaries	213 900	
Subsistence and travelling expenses	76 600	
Postal, telegraph and telephone services	4 800	
Printing stationery, advertisements and publications	45 800	
General Expenditure	46 200	
Specialist and consultation services	90 000	
		477 300
Research Projects:		
4/1 Development of research on the reclamation of water at the Athlone Sewage Works, Cape Town	180 000	
5/1 Technological development of water reclamation on the basis of the Windhoek plant	250 000	
6/1 Eutrophication of rivers and dams	49 000	
7/1 Technological development of water reclamation and pollution control – Daspoort	175 000	
8/1 Research on the desalination of brackish water	70 000	
9/1 Reclamation, storage and extraction of purified sewage effluent in the Cape Peninsula	352 000	
11/1 Natural draught dry cooling heat exchangers	1 000	
12/1 Financial support of the Hydrological Research Unit of the University of the Witwatersrand	42 000	
14/1 Research on recycling of water and recovery of chemicals in the textile industry	22 500	
15/1 Research on the treatment of wastewater by ion exchange	60 000	
16/1 Research on the activated sludge process	35 000	
17/1 The removal of metal ions from dilute solutions in an electrolytic precipitator	20 700	
18/1 The rôle of aquatic macrophytes in maintaining trophic conditions in Swartvlei, Wilderness	21 400	
19/1 Hydrological investigation of small catchments in the Grahamstown area	51 000	
20/1 Hydrological investigation of small rural catchments with specific reference to flood occurrences	41 700	
21/1 Hydrological investigation of small catchments in the Mtunzini district	50 000	
22/1 Biological denitrification and phosphate removal	40 000	
23/1 An investigation of the optimal utilization of water from the Eerste River by storage in sand beds or other methods	60 000	
24/1 Development of the WAT-process for the desalination of sea water	60 000	
25/1 South African Information Centre on Water and related disciplines	22 000	
26/1 Research on the production of water by the abstraction of water vapour from the atmosphere by means of hygroscopic materials	44 000	
27/1 The development and evaluation of techniques for determining the exploitation potentials of underground water sources in the Southern Free State and North Western Cape	120 000	
28/1 The development and evaluation of techniques for determining the exploitation potential of underground water sources along the Doornberg fault zone and in the Kalahari	64 000	
29/1 Research on water consumption patterns in urban areas	26 000	
30/1 Research on the removal of sludge and washwater at water purification installations	17 000	
31/1 Research on water losses from pipe networks	14 700	
32/1 Geohydrological studies in the Gamagara catchment by utilizing environmental isotopes and supplementary techniques	70 000	
		1 959 000
Other possible projects		390 000
Research and other grants		15 000
TOTAL ESTIMATED EXPENDITURE		2 841 300

WATER RESEARCH COMMISSION

STATEMENT NO. 2

INCOME AND EXPENDITURE ACCOUNT FOR THE PERIOD 1 APRIL, 1974 TO 31 DECEMBER, 1974

1973-74	EXPENDITURE		1974
R			R
70 435	Salaries and Allowances		93 237,75
3 459	Subsistence		3 412,20
2 518	Motor Transport		1 944,06
7 422	General Transport		22 823,26
447	Postal Services		384,62
86	Telegraph services		77,55
2 327	Telephone services		2 695,77
2 086	Printing		2 346,55
4 090	Stationery		1 499,21
1 293	Advertisements		3 070,20
187	Publications		6 486,23
1 692	Lease and maintenance of office equipment		1 073,85
413	Entertainment		1 374,35
9 447	Office rental		6 783,76
5 070	Maintenance of and alterations of offices		2 719,64
—	Electricity		203,70
—	Maintenance of and lease of furniture		2,75
2 360	Depreciation		2 084,59
358	Typing Services		194,00
—	Insurance and Licences		826,12
—	Collection fees		15 651,15
—	Audit fees		250,00
1 330	Miscellaneous petty expenses		1 970,54
1 095	Expected new projects		—
	Research Projects:		
5 037	Technological development of water reclamation on basis of the Windhoek plant	16 366,36	
—	Development of the WAT-process for the desalination of sea-water	48 493,15	
18 160	Reclamation, storage and abstraction of purified sewage water in the Cape Peninsula	145 520,60	
32	Technological Development of water reclamation and pollution control – Daspoort	329 253,22	
4 664	Research on desalination of brackish water	90 031,75	
7 433	Eutrophication of rivers and dams	84 789,34	
10 750	Development of mathematical models for the optimisation of systems for the development of water resources	25 110,00	
—	Natural draught dry cooling heat exchangers	13 975,85	
—	Research on the treatment of effluent of the textile industries	23 000,00	
—	Development of research on the reclamation of water at the Athlone sewage works, Cape Town	3 041,56	
—	Research into the treatment of waste water by ion exchange	6 836,53	
—	Research on the activated sludge process	35 826,54	
—	The removal of metal ions from dilute solutions in an electrolytic precipitator	6 940,57	
—	South African Information Centre on water and related fields	4 185,15	
—	Biological denitrification and the removal of phosphate	62 571,12	
—	The development and evaluation of techniques for the determination of the exploitation potential of ground water resources in the Southern Free State and North Cape	30 520,40	926 462,14
6 500	Research and other grants		4 195,00
13 001	Specialist, consultation and legal services		62 056,38
2 076 039	Excess of revenue over expenditure		588 111,60
R2 257 731			R1 751 936,97

1973-74	REVENUE		1974
R		R	R
	Rates: Government irrigation schemes with canal systems:		
	Received	14 930,77	
76 374	Outstanding 1974	63 222,57	78 153,34
	Rates: Government irrigation schemes without canal systems		
	Received	2 163,05	
3 414	Outstanding 1974	2 789,15	4 952,20
	Rates: Irrigation board schemes:		
	Received	13 587,10	
28 816	Outstanding 1974	2 723,30	16 310,40
	Charges: Metered water from Government schemes:		
	Received	832 855,10	
1 487 408	Outstanding 1974	318 044,36	1 150 899,46
	Charges: Municipalities:		
	Received	390 014,44	
605 581	Outstanding 1974	2 375,08	392 389,52
56 018	Interest on investments		109 145,53
120	Sundry Revenue		86,52
R2 257 731			R1 751 936,97

WATER RESEARCH COMMISSION

STATEMENT NO. 3

BALANCE SHEET AS AT 31 DECEMBER 1974

1973-74	LIABILITIES		1974	1973-74	ASSETS			1974
R		R	R	R		R	R	R
	Sundry Creditors —							
28	Revenue paid in Advance		7 833,19		Capital assets —			
	Fund Account —				Motor vehicles	6 362,20		
4 163 443	Balance at 31.3.74	4 163 443,30		2 327	Less depreciation	1 168,29	5 193,91	
	Add Excess of Income							
	over expenditure, 1974	588 111,60	4 751 554,90		Office Equipment	10 526,22		
				9 850	Less depreciation	394,73	10 131,49	
					Office furniture	15 238,21		
				12 002	Less depreciation	521,57	14 716,64	30 042,04
					Current Assets —			
				2 056 018	Investment		2 912 813,08	
				233	Advance payments		396,04	
					Sundry Debtors —			
					Outstanding Revenue:			
					Prior to 1974	19 630,87		
					1974	389 154,46		
				402 969		408 785,33		
				617 034	Project advances	706 013,64*		
					S & T advances	835,00	1 115 633,97	
				50	Cash on hand		50,00	
				1 062 988	Cash in Bank		700 452,96	4 729 346,05
R4 163 471			R4 759 388,09	R4 163 471				R4 759 388,09

*Vide annexure

Pretoria, 27.3.1975

(Sgd.) G. J. Stander
Chairman (Chief Executive Officer)

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 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.

(Sgd.) F. G. Barrie
Controller and Auditor-General

Department of the Controller and Auditor-General

Cape Town 14.4.1975