South African Marine Pollution Monitoring Programme 1979–1982

A report of the Committee for Marine Pollution
National Programme for Environmental Sciences

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ACRONYMS USED IN TEXT

NIWR National Institute for Water Research

NPRL National Physical Research Laboratory

NRIO National Research Institute for Oceanology

SFI Sea Fisheries Institute

UPE University of Port Elizabeth

ABSTRACT

A national marine pollution survey was initiated in 1974 to determine and assess the levels and effects of pollutant discharges to the marine environment of South Africa. During the period 1974-1979 impact area surveys, coastal and estuarine reference surveys as well as oceanic reference surveys were undertaken. From these, sites of major pollution concern were identified. A national marine pollution monitoring programme was then established to monitor these areas more closely for a period of three years (1979-1982). This report details the sites studied in the programme, together with the frequency of sampling and the parameters measured. After the termination of this programme at the end of 1982 the report will serve as a background reference for the programme and these areas.

SAMEVATTING

'n Nasionale seebesoedelingsopname is in 1974 begin om die vlakke en effekte van besoedelingsuitvloeisels in die mariene-omgewing van Suid-Afrika te bepaal en te ondersoek. Gedurende die tydperk 1974-1979 is opnames van trefgebied, kus- en riviermondingverwysingslyne, sowel as oseaanverwysingslyne onderneem. Hieruit is sekere punte van grootskaalse besoedeling geïdentifiseer. 'n Nasionale seebesoedelingsmoniteringprogram is daarna tot stand gebring om hierdie gebiede meer intensief vir 'n periode van drie jaar te moniteer (1979-1982). Hierdie verslag beskrywe die plekke wat in die program bestudeer word en sluit die frekwensie van monitering en die parameters wat gemeet word in. Na die beëindiging van die program aan die einde van 1982 sal die verslag as 'n agtergrondverwysing vir die program en hierdie gebiede dien.

INTRODUCTION

The National Marine Pollution Survey Programme which was initiated in 1974 had the following aims

- to discover and monitor sources of marine pollution
- to establish coastal monitoring stations
- to institute a national data centre where all the information which is being obtained from current studies can be collected and collated most effectively.

During the period up to March 1979, sites of pollutant input into the South African coastal environment were identified. On the basis of these findings a National Marine Pollution Monitoring Programme was established in April 1979 to monitor and assess changes in the pollution status of certain preselected impact sites, for a period extending till the end of 1982.

This document details the areas to be monitored, the types of pollutants to be investigated and the frequency of each investigation period. All the accumulated data will be stored in the National Marine Pollution Data Bank and will be available to scientists involved in the programme. After the termination of this programme at the end of 1982 the report will serve as a background reference for the programme and these areas.

1. SALDANHA BAY/LANGEBAAN LAGOON

1.1 Background

This area is probably the site of prime importance on the west coast. The semi-enclosed bay and lagoon are subject to various pollutant inputs, which include:

- fish factory effluents, from the processing plants in the vicinity of the town of Saldanha Bay. These inputs are generally seasonal.

- debris from the ore jetty. This material is primarily particulate, and consists mainly of iron oxides which in themselves are not acutely toxic. They do, however, change the sediment regime around the loading jetty, which has resulted in an alteration in the faunal community structure in this area. Since Saldanha Bay will be used as a port for shipping ores of copper, lead and various other metals in the near future, a build up of these elements in the sediments (and possibly in the biota) can be anticipated.

- oil pollution. The jetty will be used during oil off-loading procedures.

Apart from these three inputs, there is also localized disturbance caused by the dredging operations used to keep the channel clear. This causes redistribution of the sediments and has already led to changes in the faunal community structure in the area and a loss of diversity.

At present the "pollution" of the area has been confined to the bay. Should any incident arise that leads to pollution of the lagoon, the situation could be more serious, since the water exchange rate between the lagoon and the bay is relatively slow.

1.2 Sampling sites

Ten sampling stations (as previously established by the Sea Fisheries Institute) are recommended. The locations of these are shown in Figure 1.

1.3 Sampling parameters

Samples of water will be collected from the surface and bottom at the ten stations and analysed for temperature, salinity, dissolved oxygen, oxygen absorbed and the metals cadmium, chromium, copper, iron, mercury, manganese, nickel, lead and zinc. Surface water and sediment samples will also be collected at these stations and analysed for petroleum hydrocarbon content. Metals in the sediments will also be measured.

Biological samples of Pyura stolonifera, Choromytilus meridionalis, Aulacomya ater, Jasus lalandii, Mactra glabrata and Haliotis midae will

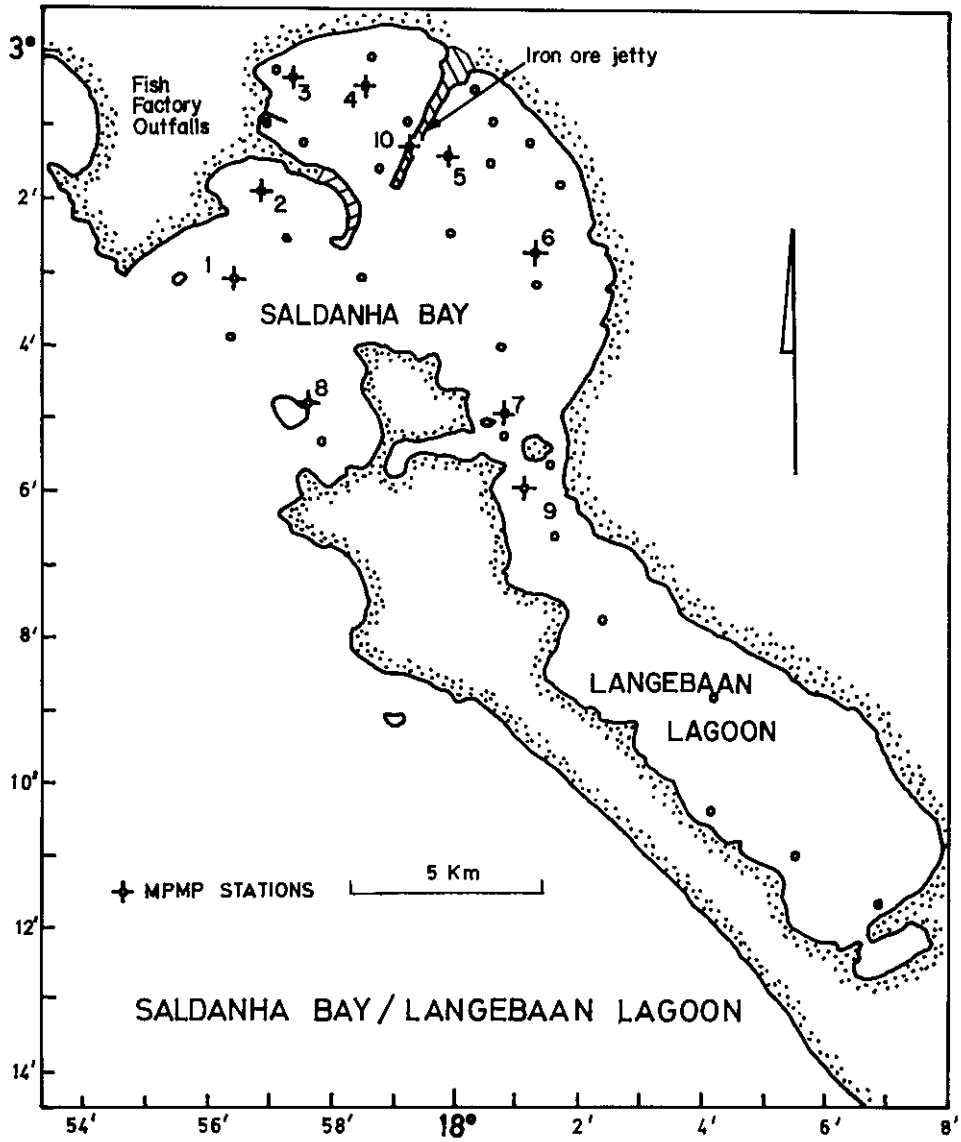

Figure 1. Sampling sites for the Saldanha Bay and Langebaan Lagoon monitoring programme

be collected from ten similar stations and analysed for the toxic metals and petroleum hydrocarbons.

Oysters (Crassostrea gigas) will be placed in artificial cages in the bay, from where they will be collected for the determination of the toxic metals and petroleum hydrocarbons.

1.4 Environmental parameters

State of tide, wind speed/direction, wave height/direction, season, general weather.

1.5 Frequency of sampling

Quarterly.

1.6 Responsible organization

Sea Fisheries Institute.

1.7 References

Christie N D and Moldan A 1976. Effects of fish factory effluent on the benthic macrofauna of Saldanha Bay. Marine Pollution Bulletin 8, 41-45.

Christie N D and Moldan A 1977. Distribution of benthic macrofauna in Langebaan Lagoon. Transactions of the Royal Society of South Africa 42, 273-284.

Fourie H O 1976. Metals in organisms from Saldanha Bay and Langebaan Lagoon prior to industrialisation. South African Journal of Science 72, 110-113.

Moldan A 1978. A study of the effects of dredging on the benthic macrofauna in Saldanha Bay. South African Journal of Science 74, 106-108.

Sea Fisheries Branch, Department of Industries 1977. Marine Pollution. 1977 Annual Report to the National Programme for Environmental Sciences. Typescript.

Shannon L V and Stander G H 1977. Physical and chemical characteristics of water in Saldanha Bay and Langebaan Lagoon. Transactions of the Royal Society of South Africa 42, 442-459.

2. DUYNEFONTEIN

2.1 Background

This site, on the west coast, has been chosen for the construction of the Koeberg A and B Nuclear Power Stations. These are due to become operational in and after 1983 respectively. Although the most important pollutants, from a toxicological point of view, are liable to be fission products, there may also be some release of cobalt, chromium, iron, manganese, antimony and zinc caused by corrosion of the intake pipes.

The reactors will use about $100m^3$ cooling water per second, which will be returned to the sea approximately $10^{o}C$ above ambient, leading to a localized increase of $5-6^{o}C$. Therefore changes in water temperature will be monitored.

The most likely effect of the increase in water temperature will be changes in the structure of the local benthic community. Experimental work on the effects of increased temperatures on some of the locally dominant species has shown that changes in growth rate and reproductive capacity occurred in Jasus lalandii, Choromytilus meridionalis, Aulacomya ater, and Laminaria pallida. It is also quite possible that warm-water species from the south and east coasts could become established in the area. This will undoubtedly change the local ecology, and could mean large-scale mortalities should the heat supply be cut off, eg if the plant were closed down for maintenance.

The siting of the outfall will be of prime importance as regards the eventual dispersion of the heated effluent plume. The outfall will be sited directly inshore from the observation tower and discharge will be made in the surf zone. It is recommended that a large series of temperature measurements be made over an area approximately 5km by 3km around the outfall before the plant is commissioned, and that after commissioning the extent of the plume be initially monitored by airborne infra-red photography. Once the maximum extent of the plume has been determined under varying sea and weather conditions a series of vertical profiles should be taken around this area. Temperatures are at present being recorded on the observation tower at three different depths.

2.2 Sampling sites

To be determined. A map of the general area showing the position of the proposed outfall and observation tower is given in Figure 2.

2.3 Sampling parameters

Thermal pollution, nutrients, chlorophyll, elements resulting from corrosion of the intakes (cobalt, chromium, iron, manganese, antimony and zinc) and the fission products ^{90}Sr, ^{137}Cs, ^{106}Ru, ^{91}Y, ^{95}Zr, ^{141}Ce, ^{144}Ce, ^{95}Nb, ^{143}Pr, ^{147}Nd, ^{147}Pm, ^{239}Pu and tritium.

2.4 Environmental parameters

State of tide, wind speed/direction, wave height/direction, season, general weather.

2.5 Frequency of sampling

To be determined.

2.6 Responsible organizations

Radio-active pollution : Atomic Energy Board will undertake the first measurements when the first fuel element rods come on site in August 1981 and ESCOM will monitor the area thereafter.

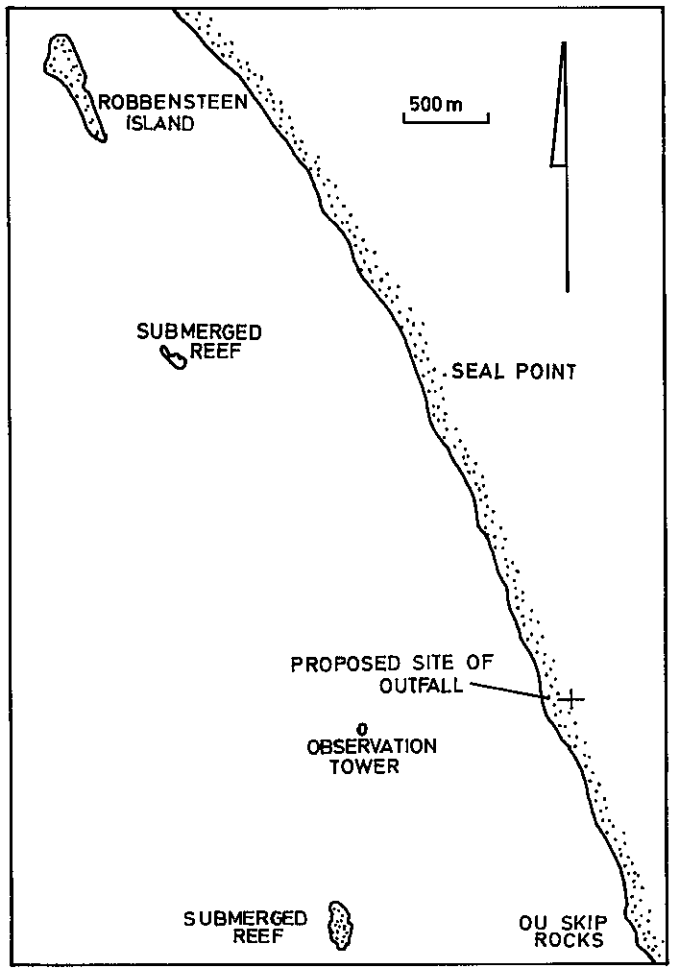

Figure 2. Map showing general area of Duynefontein outfall

Nutrients and chlorophyll : To be determined.
Thermal pollution : To be determined.

2.7 References

Cook P A 1978. A prediction of some possible effects of thermal pollution on marine organisms on the west coast of South Africa, with particular reference to the rock lobster Jasus lalandii. Transactions of the Royal Society of South Africa 43, 107-118.

Currie B and Cook P A 1975. A report on biological investigation for the proposed ESCOM nuclear power station at Duynefontein. Department of Zoology, University of Cape Town.

Van As D, Fourie H O and Vleggaar C M 1975. Trace element concentrations in marine organisms from the Cape west coast. South African Journal of Science 71, 151-154.

3. TABLE BAY AREA

3.1 Background

By virtue of the fact that the largest concentration of people and industry along the coast between Cape Recife and the Orange River occurs in Cape Town, it is evident that the most serious pollution along the coast will exist in Table Bay and the surrounding water. A large amount of industrial effluent is pumped into the Salt River system and there are a number of other discharges directly into the sea. Treated sewage also enters the Black River from the Athlone sewage works, while a large proportion of Cape Town sewage enters the sea via the Green Point sewage outfall (Orren et al 1979). Table Bay Harbour itself is another important source of pollution.

A preliminary survey of the Salt River mouth and adjacent beaches, carried out in 1975 by NRIO, indicated high concentrations of all pollutants measured in the outfall. In addition, total and faecal coliform counts were extremely high in the river mouth, although they fell off quite rapidly in the marine environment (Orren et al in press).

In view of the potential pollution threat from any large city, it is considered necessary to monitor the Table Bay area annually.

3.2 Sampling sites

The most dominant currents in Table Bay enter from the west, flow in an anti-clockwise direction and sweep out northwards along the west coast. In view of this the most important sampling area is the Salt River mouth and the beach north of this. Seven stations will be sampled at distances 0, 100, 500, 1 000, 2 000, 3 000 and 5 000 metres north of the mouth as shown in Figure 3.

3.3 Sampling parameters

Temperature, salinity, dissolved oxygen, oxygen absorbed, dissolved hydrocarbons, phosphate and total phosphorus, nitrate and bacterial composition will be determined on surface water samples (surf zone).

Dissolved oxygen, oxygen absorbed, phosphate, total phosphorus and nitrate will be determined on subsurface (300 mm depth) interstitial water samples.

Sediment cores at each station will be homogenized and meiofaunal distribution and particle size estimated. Oxygen absorbed and toxic metals (cadmium, copper, iron, lead, chromium, mercury, manganese, nickel and zinc) will be determined on three consecutive 100 mm lengths of core from each station.

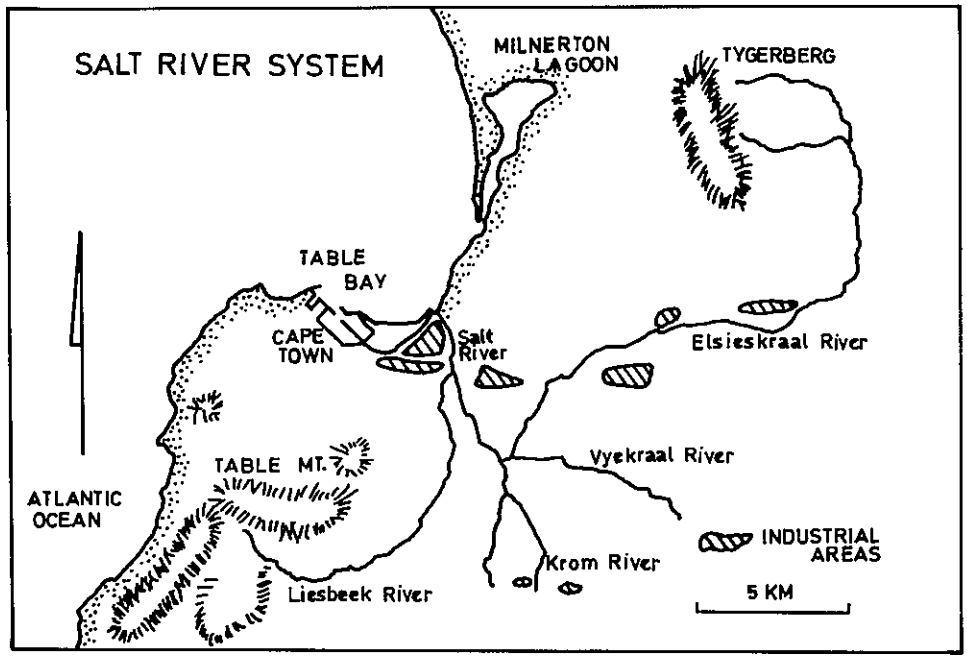

Figure 3. Sampling sites for Table Bay area monitoring programme

3.4 Environmental parameters

State of tide, wind speed/direction, wave height/direction, season, general weather.

3.5 Frequency of sampling

Annually.

3.6 Responsible organization

NRIO.

3.7 References

Orren M J, Eagle G A, Fricke A H, Greenwood P J, Hennig H F-K O and Bartlett P D In press. Preliminary pollution surveys around the south western Cape coast. Part 4. Salt River mouth, Table Bay. South African Journal of Science.

Orren M J, Fricke A H, Eagle G A, Greenwood P J and Gledhill W J 1979. Preliminary pollution surveys around the south-western Cape coast. Part 2. Green Point sewage outfall. South African Journal of Science 75, 456-459.

4. CAMPS BAY

4.1 Background

A number of surveys have already been undertaken at Camps Bay to establish conditions on the beach prior to commencement of sewage disposal into the bay (Eagle et al 1977). These have shown the beach to be in a clean and unpolluted state in spite of the already existing sewage disposal pipeline in Balie Bay immediately to the south.

Discharge through the new system commenced in 1978. The effluent consists of domestic sewage and there is no industry in the area. Inspection of the point of discharge was made by NRIO divers and it was felt that the pipeline had been well sited.

In view of the increase of sewage discharge it is felt that monitoring is necessary, but only on an infrequent basis (once every three years) in order to ascertain long-term changes. If any changes are observed, sampling will become more frequent.

4.2 Sampling sites

At 100 metre intervals along the length of the beach as shown in Figure 4.

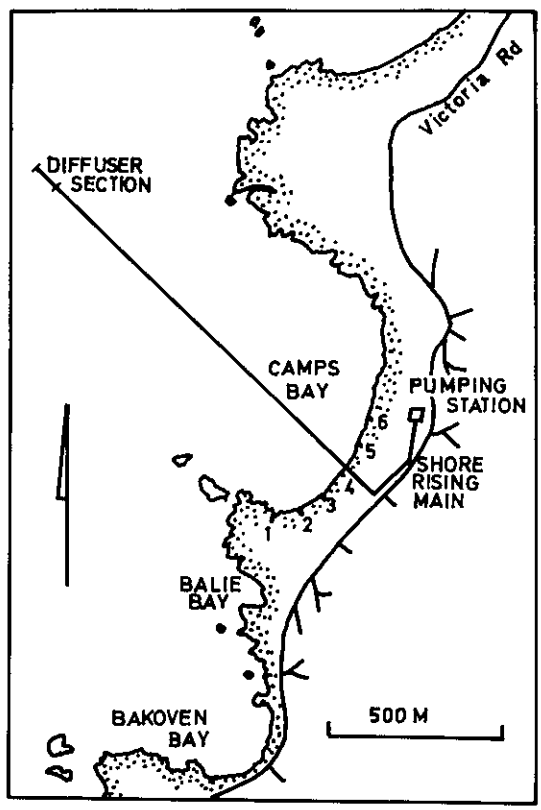

Figure 4. Sampling sites for Camps Bay area monitoring programme

4.3 Sampling parameters

Temperature, salinity, dissolved oxygen, oxygen absorbed, phosphate and total phosphorus, nitrate and bacterial composition will be determined on surface water samples (surf zone).

Dissolved oxygen, oxygen absorbed, phosphate, total phosphorus and nitrate will be determined on subsurface (300 mm depth) interstitial water samples.

Sediment cores at each station will be homogenized and meiofaunal distribution and particle size estimated. Oxygen absorbed and toxic metals (cadmium, copper, iron, lead, mercury, manganese, nickel and zinc) will be determined on three consecutive 100 mm lengths of core from each station.

4.4 Environmental parameters

State of tide, wind speed/direction, wave height/direction, season, general weather.

4.5 Frequency of sampling

Once every three years, both to detect any changes due to sewage and to act as a "control" west coast reference beach.

4.6 Responsible organization

NRIO.

4.7 References

Bartlett P D, Eagle G A, Fricke A H, Greenwood P J, Hennig H F-K O and Kenmuir R M 1981. Follow-up pollution survey of Camps Bay Beach. CSIR Report T/SEA 8103. Typescript, 13 pp.

Eagle G A, Fricke A H, Gledhill W J, Greenwood P J, Orren M J and Mazure H 1977. Camps Bay Beach - A pollution survey. South African Journal of Science 73, 342-345.

5. HOUT BAY

5.1 Background

Hout Bay is a rapidly expanding urban and industrial area. The bay itself is used extensively as a fishing harbour and a number of local fish processing factories discharge effluent directly into the harbour.

In addition a sewage outfall discharges into the bay just south of the harbour.

As a result of this, considerable organic pollution occurs in the bay. A previous survey undertaken by NRIO indicated very low (in some cases zero) oxygen content of the interstitial water along the beach. As a result numbers of meiofaunal animals were extremely low. In view of the popularity of the beach as a recreational area, the enclosed nature of the bay and the organic pollution already encountered, it is considered necessary to monitor the bay on an annual basis.

5.2 Sampling sites

The beach each side of the Palmiet River mouth will be sampled at 100 metre intervals to a distance of 500 metres. Additional samples will be taken from within the harbour itself and near the sewage outfall as shown in Figure 5.

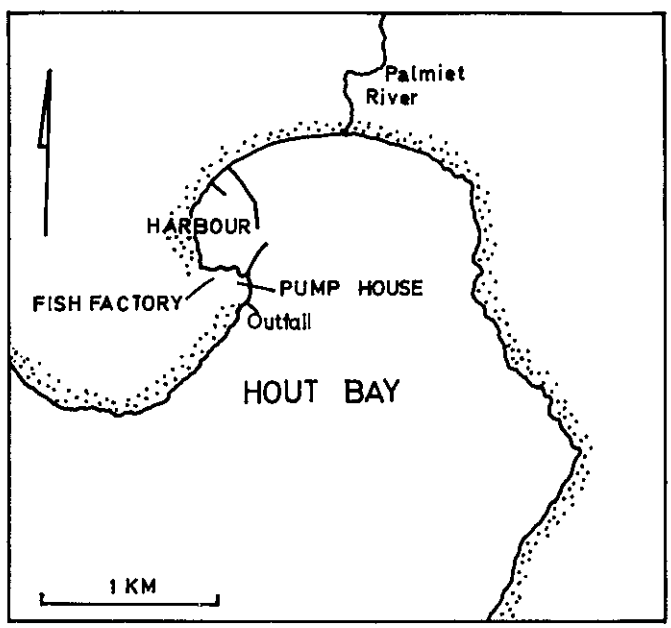

Figure 5. Sampling sites in the Hout Bay area monitoring programme

5.3 Sampling parameters

Temperature, salinity, dissolved oxygen, oxygen absorbed, phosphate and total phosphorus, nitrate and bacterial composition will be determined on surface water samples (surf zone).

Dissolved oxygen, oxygen absorbed, phosphate, total phosphorus and nitrate will be determined on subsurface (300 mm depth) interstitial water samples.

Sediment cores at each station will be homogenized and meiofaunal distribution and particle size estimated. Oxygen absorbed and toxic

metals (cadmium, copper, iron, lead, mercury, manganese, nickel and zinc) will be determined on three consecutive 100 mm lengths of core from each station.

5.4 Environmental parameters

State of tide, wind speed/direction, wave height/direction, season, general weather.

5.5 Frequency of sampling

Annually, towards the end of the fishing season.

5.6 Responsible organization

NRIO.

5.7 References

Eagle G A, Bartlett P D and Hennig H F-K O 1980. The second pollution monitoring survey of Hout Bay Beach. CSIR Report SEA 8008. Typescript, 14 pp.

Fricke A H, Eagle G A, Gledhill W J, Greenwood P J and Orren M J 1979. Preliminary pollution surveys around the south-western Cape coast. Part 3. Hout Bay. South African Journal of Science 75, 459-461.

6. STRAND AREA

6.1 Background

A large industrial factory complex is situated around the Strand area at the north-east corner of False Bay. Factories at present in the vicinity are AECI, Triomf Fertilisers, Somchem and Gants Food, all of which discharge effluent into the sea. A large new housing development is under construction in the Macassar Beach area and a new sewage plant discharges purified sewage into the bay at Macassar.

A limited survey of the AECI factory outfall was conducted in 1976. This indicated high nutrient concentrations and low oxygen values around the outfall, which caused a sharp drop in meiofauna numbers. The effect was confined to a fairly narrow margin on either side of the outfall (Eagle 1976).

Current measurements in False Bay (Harris 1978) indicate that a small vortex often exists in this corner of the bay. Because of this any material discharged into the bay in this area will have a relatively long

residence time. In the near future, a rapid growth rate and a large increase in sewage disposal into this portion of False Bay can be anticipated.

The nearby beach at Swartklip, which has been previously sampled, will be used as a reference against which any long-term or major pollution can be measured.

6.2 Sampling sites

The beach each side of the outfalls will be sampled at 100 metre intervals to a distance of 500 metres as shown in Figure 6. The beach at Swartklip will be sampled for bacterial composition.

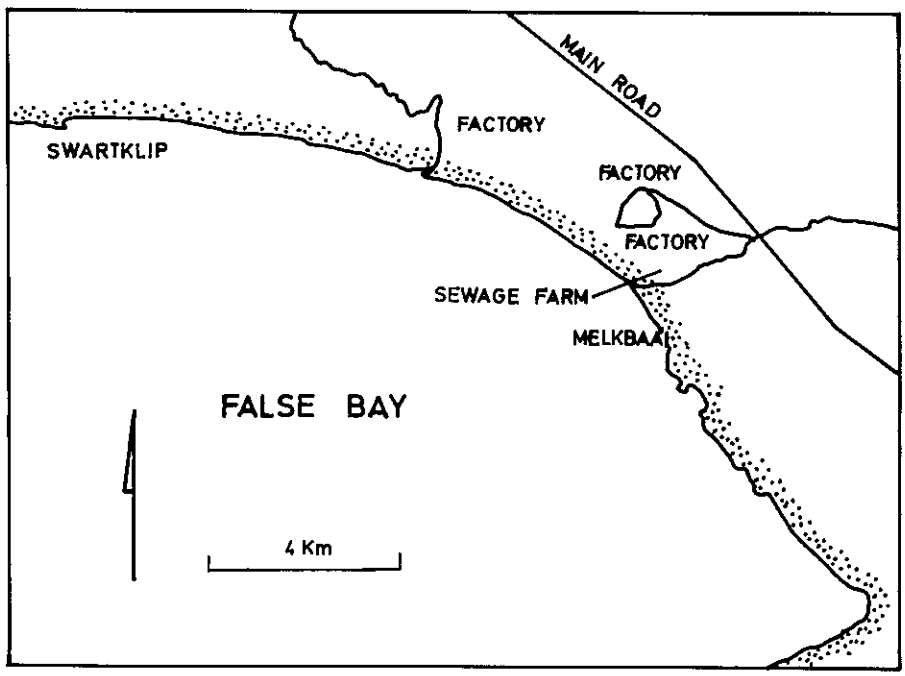

Figure 6. Sampling sites for the Strand area monitoring programme

6.3 Sampling parameters

Temperature, salinity, dissolved oxygen, oxygen absorbed, phosphate and total phosphorus, nitrate and bacterial composition will be determined on surface water samples (surf zone).

Dissolved oxygen, oxygen absorbed, phosphate, total phosphorus and nitrate will be determined on subsurface (300 mm depth) interstitial water samples.

Sediment cores at each station will be homogenized and meiofaunal distribution and particle size estimated. Oxygen absorbed and toxic

metals (cadmium, copper, iron, lead, mercury, manganese, nickel and zinc) will be determined on three consecutive 100 mm lengths of core from each station.

6.4 Environmental parameters

State of tide, wind speed/direction, wave height/direction, season, general weather.

6.5 Frequency of sampling

Annually.

6.6 Responsible organization

NRIO.

6.7 References

Bartlett P D 1980. Investigation of the beach around the AECI factory outfall, Somerset West on 6th November, 1979. CSIR Technical Report SEA 8013. Typescript, 24 pp.

Eagle G A 1976. Investigation of the beach around the AECI factory outfall, Somerset West on 1 April 1976. CSIR Research Report 354. CSIR, Stellenbosch. Typescript, 10 pp.

Harris T F W 1978. Review of coastal currents in Southern African waters. South African National Scientific Programmes Report 30. CSIR, Pretoria. 103 pp.

7. MOSSEL BAY

7.1 Background

Mossel Bay is the largest urban and industrial centre along the coast between Port Elizabeth and Cape Town and as such may be regarded as a potential impact area. Three important rivers enter the sea in the vicinity - Hartenbos, Little Brak and Great Brak. The town of Great Brak River is situated a few kilometers from the mouth of the Great Brak River and has a tannery and shoe factory.

A survey conducted by NRIO in July 1978 has revealed a certain amount of organic pollution from a pipeline which discharges effluent from factories in the Voorbaai area into the sea at Diaz Beach.

7.2 Sampling sites

Beach samples will be taken up to 500 metre distance on both sides of the Diaz Beach pipeline. Two reference stations will be established on Mossel Bay Beach and all three rivers will be sampled at the points shown in Figure 7. In addition water samples will be taken on Santos Beach and on the Mossel Bay sewer outfall adjacent to the harbour.

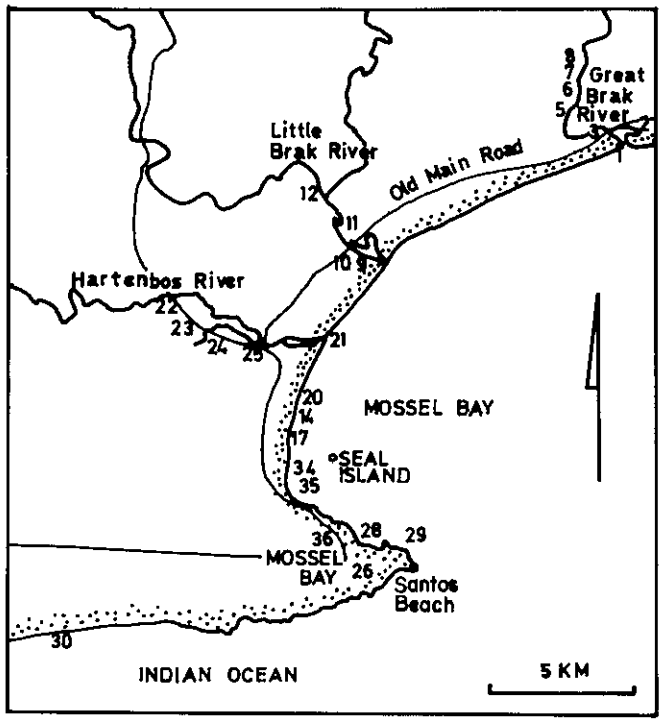

Figure 7. Sampling sites for Mossel Bay area monitoring programme

7.3 Sampling parameters

Temperature, salinity, dissolved oxygen, oxygen absorbed, phosphate and total phosphorus, nitrate and bacterial composition will be determined on surface water samples (surf zone).

Dissolved oxygen, oxygen absorbed, phosphate, total phosphorus and nitrate will be determined on subsurface (300 mm depth) interstitial water samples.

Sediment cores at each station will be homogenized and meiofaunal distribution and particle size estimated. Oxygen absorbed and toxic metals (cadmium, iron, lead, mercury, manganese, nickel and zinc) will be determined on three consecutive 100 mm lengths of core from each station.

Hydrocarbon content of sediments from the Great Brak and Little Brak Rivers will be determined.

7.4 Environmental parameters

State of tide, wind speed/direction, wave height/direction, season, general weather.

7.5 Frequency of sampling

Once every two years.

7.6 Responsible organizations

NRIO.
Department of Zoology, UPE (toxic metals).

7.7 References

Eagle G A, Greenwood P G, Hennig H F-K O and Orren M J 1979. Preliminary pollution surveys around the south-western Cape coast. Part I. Mossel Bay. South African Journal of Science 75, 453-456.

Fricke A H, Eagle G A, Bartlett P D and Hennig H F-K O 1981. Mossel Bay : a follow-up pollution survey. CSIR Report T/SEA 8101. Typescript, 15 pp.

Watling R J and Watling H R 1980. Trace element studies in South African estuaries. III. Great Brak, Little Brak and Hartenbos Rivers. NPRL Special Report FIS 205. CSIR, Pretoria. 44 pp.

8. KROMME RIVER ESTUARY

8.1 Background

The Kromme River estuary is not only one of the major estuaries in the south-eastern Cape, but it is also unpolluted by industry and could therefore serve as a "control" southern Cape estuary in the Marine Pollution Monitoring Programme. It is also the only estuary with an established marina. There are no extensive irrigation schemes on the banks of the river along its course and no marked nutrient enrichment or pesticide runoff are to be expected from this source. The estuary is also a major recreational area. Engineering projects which are affecting the estuary to various degrees are the Churchill Dam, the construction of a new dam, a new road bridge across the flood-plain and a marina.

Research on this estuary is limited to a two day survey by the Department of Zoology at UCT in 1951 (J H Day personal communication), a MSc thesis by T Hecht in 1973, a low intensity, SANCOR funded project by the Department of Zoology at UPE, which started in 1978 (Baird et al 1981) and a

trace element survey undertaken by the NPRL, CSIR, in 1978 (R J Watling personal communication). This available data is very limited and fauna-orientated, and little is known about the flora and physical and chemical components of the system.

The Kromme River has its origin in the Tsitsikama Mountains in the Blue-liliesbush Forest Reserve. The river is joined by the Dwars River above the Churchill Dam which is approximately 43 km from the mouth. About 14 km from the mouth the river descends in a series of rapids which mark the limit of sea water penetration.

The main tributary is the Geelhoutboom which flows into the estuary approximately 9 km from the mouth. Other tributaries include the Klein River (11 km from the mouth), the Boskloof River (5,2 km from the mouth), the Sand River (2 km from the mouth) and the Brakfontein River (1 km from the mouth).

From the upper limits to the confluence with the Klein River the estuary is bordered on either side by rocky cliffs. It widens downstream, particularly on the south bank of the estuary, into a broad flood plain. The north and south banks of the upper and part of the middle reaches are overgrown with dense bush. Salt marshes occur on the south bank of the middle reaches of the estuary, and on the north bank of the lower reaches.

The inflow of fresh water is regulated by the Churchill Dam. During the dry season (December to March) the sluices are kept closed with the result that little fresh water enters the estuary and a reversed salinity gradient occurs. This situation is reversed in the rainy season, from April to November.

Drift sand, consolidated sand and alluvium of the Late Tertiary extends to 3 km from the mouth. Quartzites, shales and sandstone persist near the mouth. These belong to the Bokkeveld Group of the Cape System.

The substrate at the mouth area varies between medium and coarse sand with some silt. In the lower and middle reaches mud and silt are encountered whereas the substrate of the upper reaches consists of a coarse silty sand.

The basic distributional pattern of the benthic communities in the Kromme River estuary, namely sand dwelling, mud dwelling and again sand dwelling, correlates well with the changes in substrate along the estuary.

There is not at present sufficient biological data available to be able to interpret the data from twice a year community surveys in terms of pollution trends.

8.2 Sampling sites

Seven stations between the mouth and freshwater in mid-estuary as shown in Figure 8.

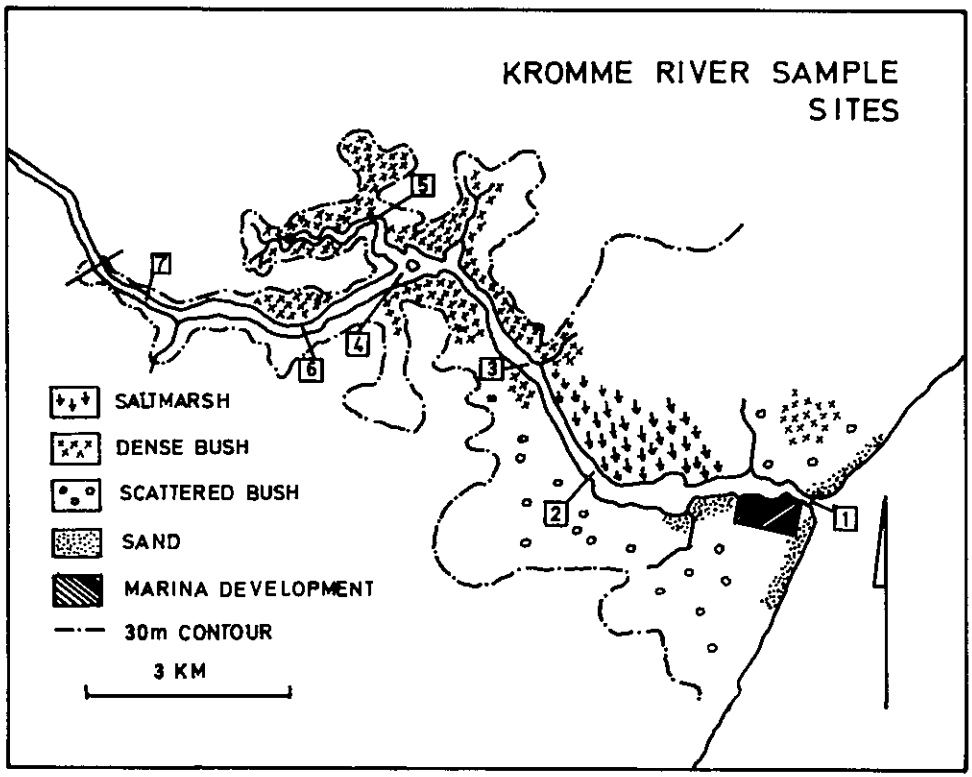

Figure 8. Sampling sites for Kromme River monitoring programme

8.3 Sampling parameters

Temperature, salinity, dissolved oxygen, oxygen absorbed, phosphate, total phosphorus, nitrate and toxic metals will be determined on surface and near bottom water samples. In addition Escherichia coli counts will also be made on each sample.

Sediment and faunal samples will be taken from the river bed using a core or dredge. Particle size, faunal composition and density, oxygen absorbed, toxic metals (cadmium, copper, iron, mercury, manganese, nickel, lead, zinc and chromium) and total oil will be determined in each sample.

Toxic metals will be determined in tissues from the following accumulator species :

Rocky shore - Perna perna and Crassostrea margaritacea
Sandy beach - Bullia rhodostoma and Donax serra
Estuary - Upogebia africana, Callianassa kraussi and Solen capensis

Chlorinated hydrocarbons will be determined in liver and flesh of Liza dumerili.

Siltation rate will be determined.

8.4 Environmental parameters

State of tide, wind speed/direction, wave height/direction, season, general weather. Rainfall figures for catchment area for preceding six months. Waterflow at Churchill Dam for preceding six months.

8.5 Frequency of sampling

Twice annually - dry season (February) and wet season (August) at low spring tide.

8.6 Responsible organizations

Chlorinated hydrocarbons: NIWR (Durban).
Siltation rate: Department of Geology, UPE.
Rest of parameters: Department of Zoology, UPE.

The Department of Zoology, UPE, will collaborate with the Department of Geology, UPE, for fieldwork as well as with NIWR (Natal Regional Laboratory) for nutrient and pesticide analysis.

8.7 References

Baird D, Marais J F K and Woolridge T 1981. The influence of a marina canal system on the ecology of the Kromme estuary, St Francis Bay. South African Journal of Zoology 16, Part 1, 21-34.

Hecht T 1973. The ecology of the Kromme estuary with special reference to Sesarme catenata. MSc thesis, University of Port Elizabeth.

9. ALGOA BAY

9.1 Background

Algoa Bay stretches from Cape Recife to Cape Pedrone and includes sandy beaches, rocky shores, estuarine areas and several small offshore islands. For the Swartkops and Sundays River estuaries, see Sections 10 and 11. This area is not only a recognized impact area, but from a pollution point of view it should be realised that Algoa Bay is the ultimate sink for the entire Port Elizabeth-Uitenhage-Despatch industrial and domestic effluent as well as possible agricultural pollutants via the Sundays and to a lesser extent the Swartkops Rivers. The pollutant contribution, especially oil from ship traffic, places additional environmental strain on this area. Algoa Bay on the other hand, forms the backbone of a sea-oriented holiday and recreational industry and also supports a small fishing industry.

From a conservational point of view, St Croix Island is the sole breeding ground for the threatened Jackass penguin (Spheniscus demersus) in the eastern Cape. It is also part of the transitional zone for marine animals between the warmer tropics and the colder temperate areas and several species are therefore endemic to this area. There are also substantial coastline areas that are still relatively unspoilt.

The present major marine pollution threats are limited to the area between the Cape Recife sewage outfall and the Fishwater Flats sewage outfall and include areas such as Port Elizabeth Harbour and the Papenkuils River. Oil pollution from accidental and intentional oil spills is a constant major threat to the bay.

Pollution background data is available from NIWR (Natal Regional Laboratory), the NPRL (trace elements) and the Port Elizabeth City Engineer (Chemistry Section).

Data on the marine animal and plant life are available from the University of Port Elizabeth. There is sufficient biological background data on this area, so that it should be possible to interpret data from community surveys, undertaken twice a year, as possible indications of marine pollution.

9.2 Sampling sites

Cape Recife sewage outfall, public convenience near Oceanarium, mouth of Papenkuils River, Fishwater Flats outfall, southern side of Swartkops River mouth, beach at Hougham Park opposite St Croix Island, beach at Maitland River mouth (reference site) and St Croix Island.

For locations see Figure 9.

9.3 Sampling parameters

Temperature, salinity, dissolved oxygen, oxygen absorbed, phosphate, total phosphorus, nitrate and toxic metals will be determined in surface water samples. E. coli counts will also be made on each sample.

Sediment samples will be taken from each site using a corer or dredge. Particle size, oxygen absorbed, toxic metals (cadmium, chromium, copper, iron, mercury, manganese, nickel, lead and zinc) and total hydrocarbons will be determined in each sample.

Toxic metals will be determined in tissues from the following accumulator species :

Rocky shore - Perna perna and Crassostrea margaritacea
Sandy beach - Bullia rhodostoma and Donax serra
Estuary - Upogebia africana, Callianassa kraussi, Solen capensis, Liza dumerili and Pomadasys commersonni.

Chlorinated hydrocarbons will be determined on the liver and flesh of Liza dumerili and in birds' eggs (Spheniscus demersus and gull species).

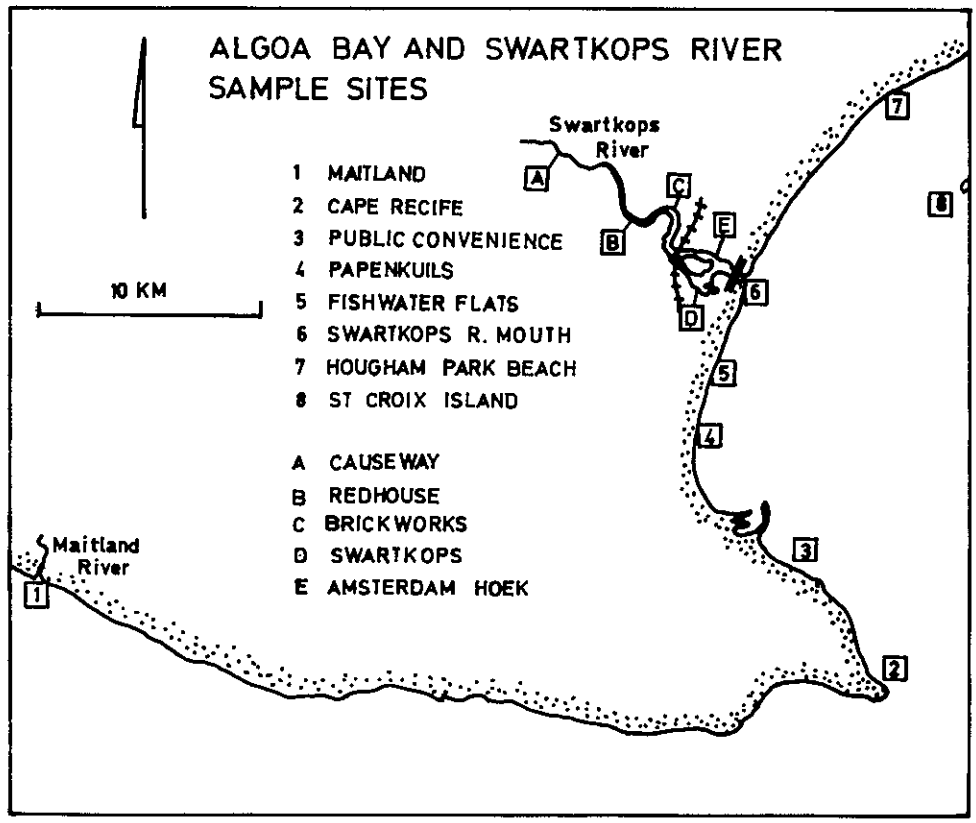

Figure 9. Sampling sites for Algoa Bay monitoring programme

Community analyses will be undertaken on macro- and meiofauna and flora (species composition, dry mass, density and diversity). At effluent outfall pipelines, quantitative horizontal transects will also be undertaken at midwater tide level at both sides of pipeline for at least 50 metres either side.

9.4 Environmental parameters

State of tide, wind speed/direction, wave height/direction, season, general weather.

9.5 Frequency of sampling

Twice annually - dry season (February) and wet season (August) at low spring tide.

9.6 Responsible organizations

Chlorinated hydrocarbons: NIWR (Durban).
Rest of parameters: Department of Zoology, UPE.

10. SWARTKOPS RIVER ESTUARY

10.1 Background

The lower portion of the Swartkops River valley lies 10 km to the north of the city of Port Elizabeth and covers some 100 km^2 in area within the authority of the Port Elizabeth Municipality. The valley is fringed by development of every description which has occurred largely without reference to any overall plan other than the piece-meal planning of individual projects. Consequently the environment has been abused by industrial and residential development. Estuarine waters have been contaminated especially by industrial pollutants released upstream, the effluents from tanning and motor industries and the construction of salt pans. The salt marshes are also threatened by landfill projects. The estuary receives all the effluent from Uitenhage and Despatch as well as the Markman Township storm-water. Some of its water is also used for cooling purposes at a local power station.

Due to the intrusion of industry into the valley and encroachments on the flood-plain the need for rational planning has become obvious. The municipality therefore commissioned a detailed environmental study to form the basis for future planning. Various experts on hydrology, botany, geology, marine biology, meteorology and other sciences have contributed to this study. This work has resulted in the publication of seven volumes of the Swartkops River basin environmental study prepared by Hill et al (1974). It is on the basis of this report that future planning proposals will be made. More research is however necessary to update, augment and refine their findings, especially into the inter-relationships between the biota and the environment.

A qualitative study of the intertidal plants and animals of the Swartkops River estuary was conducted between 1950-1954 by Macnae (1957), whilst Gilcrist (1918), Marais (1976) and van der Horst (1976) reported on aspects of the biology and ecology of fish in the estuary. Quantitative assessments of the faunal communities commenced in 1972 by staff and students of the Department of Zoology of the University of Port Elizabeth, the ultimate aim of this programme being a mathematical model that can be used as a management tool.

A detailed description of the estuary is given by Macnae (1957). The general topography has changed little since then, although the extent of residential areas, industrial development and communications have increased during the intervening period (McLachlan and Grindley 1974).

Several further schemes that may affect the estuary are at present being either undertaken (railway road depot) or are under consideration (roads). There is therefore an urgent need to monitor this estuary to establish long-term trends.

10.2 Sampling sites

Five sites between the mouth and the highest penetration of sea-water, in mid-estuary, as shown in Figure 9.

10.3 Sampling parameters

Temperature, salinity, dissolved oxygen, oxygen absorbed, phosphate, total phosphorus, nitrate and toxic metals will be determined in surface and near bottom water samples. *E. coli* counts will also be made on each sample.

Sediment samples will be taken from each site using a corer or dredge. Particle size, oxygen absorbed, toxic metals (cadmium, chromium, copper, iron, mercury, manganese, nickel, lead and zinc) and total hydrocarbons will be determined in each sample.

Toxic metals will be determined in tissues from the following accumulator species :

Rocky shore - *Perna perna* and *Crassostrea margaritacea*
Sandy beach - *Bullia rhodostoma* and *Donax serra*
Estuary - *Upogebia africana*, *Callianassa kraussi* and *Solen capensis*, *Liza dumerili* and *Pomadasys commersonni* (when available).

Chlorinated hydrocarbons will be determined on the liver and flesh of *Liza dumerili*.

Community analyses will be undertaken (where applicable) on macro- and meiofauna and flora (species composition, dry mass, density and diversity).

Siltation rate will be determined.

10.4 Environmental parameters

State of tide, wind speed/direction, wave height/direction, season, general weather. Rainfall figures for preceding six months. Waterflow at Groendal Dam for preceding six months.

10.5 Frequency of sampling

Twice annually - dry season (February) and wet season (August) at low spring tide.

10.6 Responsible organizations

Chlorinated hydrocarbons: NIWR (Durban).
Siltation rate: Department of Geology, UPE.
Rest of parameters: Department of Zoology, UPE.

10.7 References

Gilchrist J D F 1918. Report on nettings in the Swartkops River. Marine Biology, Report 4, 54-72.

Hill, Kaplan, Scott and Partners 1974. Environmental study of the Swartkops River basin, Vol 1-9. City Engineers Department, Port Elizabeth.

Macnae W 1957. The ecology of plants and animals in the intertidal regions of the Swartkops estuary near Port Elizabeth, South Africa. Journal of Ecology 45, Part I, 113-131, Part II, 361-387.

Marais J F K 1976. Comparative studies of the nutritional ecology of mullet in the Swartkops estuary. Unpublished PhD thesis, University of Port Elizabeth.

McLachlan A and Grindley J R 1974. Distribution of macrobenthic fauna of the soft substrata in the Swartkops estuary. Zoologica Africana 9, 211-233.

Van der Horst G 1976. Aspects of the reproductive biology of Liza dumerili (Steindachner, 1869) (Teltosti : Mugilidae) with special reference to sperm. Unpublished PhD thesis, University of Port Elizabeth.

Watling R J and H R Watling 1979. Metal surveys in South African estuaries. I. Swartkops Estuary. NPRL Special Report 183. CSIR, Pretoria. 79pp.

11. SUNDAYS RIVER ESTUARY

11.1 Background

The Sundays River enters Algoa Bay approximately 40 km east of Port Elizabeth. The river originates in the Karoo, near Nieu Bethesda, and flows over typical Karoo deposits, namely Beaufort, Ecca, Table Mountain and Witteberg geological groups. From Kirkwood onwards the Bokkeveld Group of cretaceous origin is the main geological unit. In the upper and middle reaches of the estuary the river flows over the Sundays River Formation. The eastern bank and escarpment is part of the Alexandria Formation of the Tertiary whereas the sand dunes on the western bank are of the Late Pleistocene. East of the escarpment the contour flattens out into a broad flood-plain. The conspicuous clay deposits along the river originated from the Beaufort and Ecca Groups whilst the sand is of Table Mountain Sandstone and Witteberg origin.

The river is dammed by the Mentz Dam near Jansenville, from where a steady flow of freshwater is released. The river drains the highly cultivated Sundays River valley but otherwise flows through undeveloped areas. In contrast with the Swartkops River estuary, the Sundays River does not have any salt marshes or extensive mud flats. The estuary system is, during its entire course, channel-like with a narrow intertidal zone. Due to this characteristic, flushing of the estuary during floods is virtually complete.

The estuary is approximately 2,5 metres deep near the mouth, but it increases gradually to a maximum of 5 metres on the first bend of the lower reaches. It then becomes gradually shallower to 2,5 metres at the limit of the tidal influence, which is approximately 20 km from the mouth. At its widest point near the mouth the estuary is approximately 200 metres wide, from where it becomes progressively narrower to approximately 20 metres wide at the head of the estuary.

Little research has been carried out on the ecology of this estuary and no data exist on the occurrence, abundance and distribution of its faunal communities. However, the Department of Zoology of the University of Port Elizabeth recently initiated a research programme in the estuary on aspects of the ecology, including the physical and chemical characteristics, quantitative surveys of plankton, nekton, macro- and meiobenthos.

Although the estuary is industrially unpolluted it does flow through an intensive farming area (oranges) and can be expected to be polluted from this source. It can therefore serve as a control estuary to assess the pollution impact of agricultural activities on a river and on an estuary.

At present there is insufficient background information available on the biotic communities to be able to interpret the bi-annual surveys in terms of pollution effects.

11.2 Sampling sites

Seven stations between the mouth and freshwater in mid-estuary, as shown in Figure 10.

11.3 Sampling parameters

Temperature, salinity, dissolved oxygen, oxygen absorbed, and toxic metals (cadmium, copper, iron, mercury, manganese, nickel, lead and zinc) will be determined in surface and near bottom water samples. *E. coli* counts will also be made on each sample.

Sediment samples will be taken from each site using a corer or dredge. Particle size, oxygen absorbed, toxic metals (cadmium, cobalt, chromium, copper, iron, mercury, manganese, nickel, lead and zinc) and total hydrocarbons will be determined in each sample.

Toxic metals will be determined in tissues from the following accumulator species :

Rocky shore - *Perna perna* and *Crassostrea margaritacea*
Sandy beach - *Bullia rhodostoma* and *Donax serra*
Estuary - *Upogebia africana*, *Callianassa kraussi* and *Solen capensis*, and *Liza dumerili* and *Pomadasys commersonni* (where available).

Chlorinated hydrocarbons will be determined on the liver and flesh of *Liza dumerili*.

Siltation rate will be determined.

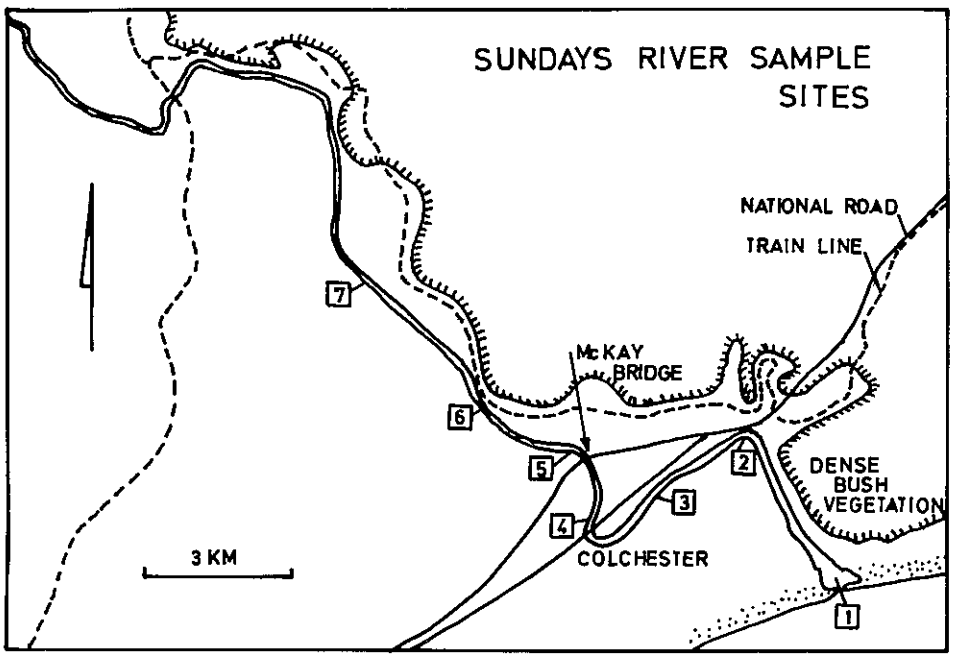

Figure 10. Sampling sites for Sundays River monitoring programme

11.4 Environmental parameters

State of tide, wind speed/direction, wave height/direction, season, general weather. Rainfall in catchment and waterflow at Mentz Dam for preceding six months.

11.5 Frequency of sampling

Twice annually - dry season (February) and wet season (August) at spring low tide.

11.6 Responsible organizations

Chlorinated hydrocarbons: NIWR (Durban).
Siltation rate: Department of Geology, UPE.
Rest of parameters: Department of Zoology, UPE.

12. GREAT FISH RIVER ESTUARY

12.1 Background

No existing data on the estuary is available. A preliminary visit indicated that siltation may be a major problem. The estuary will receive water from the Orange River Scheme and this may change the

quality and quantity of inflow. The catchment area houses an extensive irrigation scheme with intensive farming activities.

12.2 Sampling sites

Six stations between the mouth and freshwater in mid-estuary as shown in Figure 11.

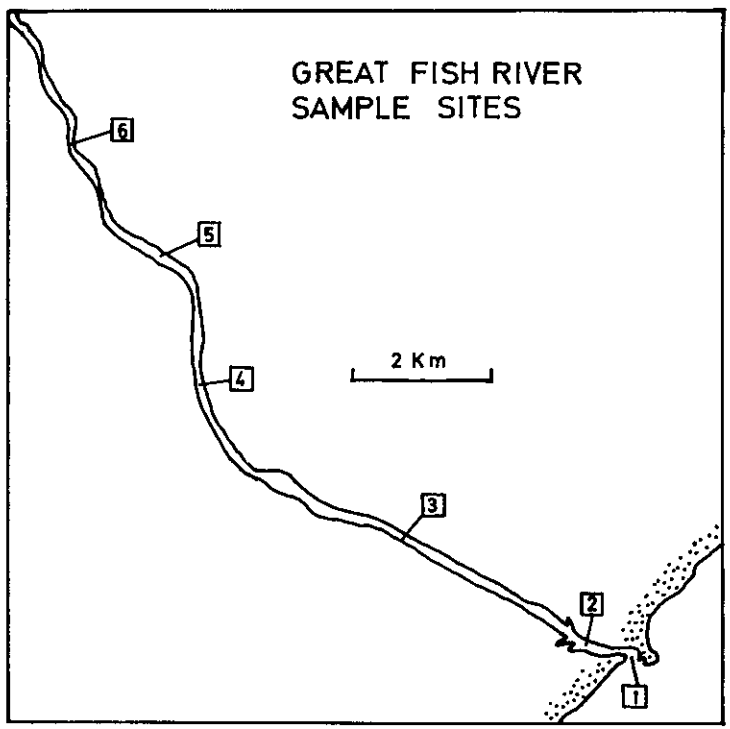

Figure 11. Sample sites for Great Fish River monitoring programme

12.3 Sampling parameters

Temperature, salinity, dissolved oxygen, oxygen absorbed, phosphate, total phosphorus, nitrate and trace elements (cadmium, copper, iron, mercury, manganese, lead and zinc) will be determined in surface and near bottom water samples. E. coli counts will also be made on each sample.

Sediment samples will be taken from each site using a corer or dredge. Particle size, oxygen absorbed, toxic metals (cadmium, chromium, copper, iron, mercury, manganese, nickel, lead and zinc) and total oil will be determined in each sample.

Toxic metals will be determined in tissues from the following accumulator species :

Rocky shore - Perna perna and Crassostrea margaritacea
Sandy beach - Bullia rhodostoma and Donax serra
Estuary - Upogebia africana, Callianassa kraussi and Solen capensis.

Chlorinated hydrocarbons will be determined on the liver and flesh of Liza dumerili.

Siltation rate will be determined.

12.4 Environmental parameters

State of tide, wind speed/direction, wave height/direction, season, general weather.

12.5 Frequency of sampling

Twice annually.

12.6 Responsible organizations

Chlorinated hydrocarbons: NIWR (Durban).
Siltation rate: Department of Geology, UPE.
Rest of parameters: Department of Zoology, UPE.

13. BUFFALO RIVER ESTUARY

13.1 Background

The river drains a largely agricultural catchment and enters the sea through the harbour. Upstream from the harbour it receives treated sewage and surface drainage from a local township. There is also a discharge of sewage into the upper part of the harbour.

13.2 Sampling sites

Seven stations between the harbour and freshwater in mid-estuary are shown in Figure 12.

13.3 Sampling parameters

Salinity, temperature, dissolved oxygen, oxygen absorbed, nutrients (nitrate, phosphate and total phosphorus), bacteria and toxic metals (cadmium, copper, iron, mercury, nickel, lead and zinc) will be determined in surface and near bottom water samples.

Particle size, oxygen absorbed, faunal composition and density, toxic metals (as above), chlorinated pesticides and oil will be determined on sediment and faunal samples.

Chlorinated pesticides and toxic metals will be determined in the accumulator species Mugilid spp, Pomadasys commersonni, and Elops machnata.

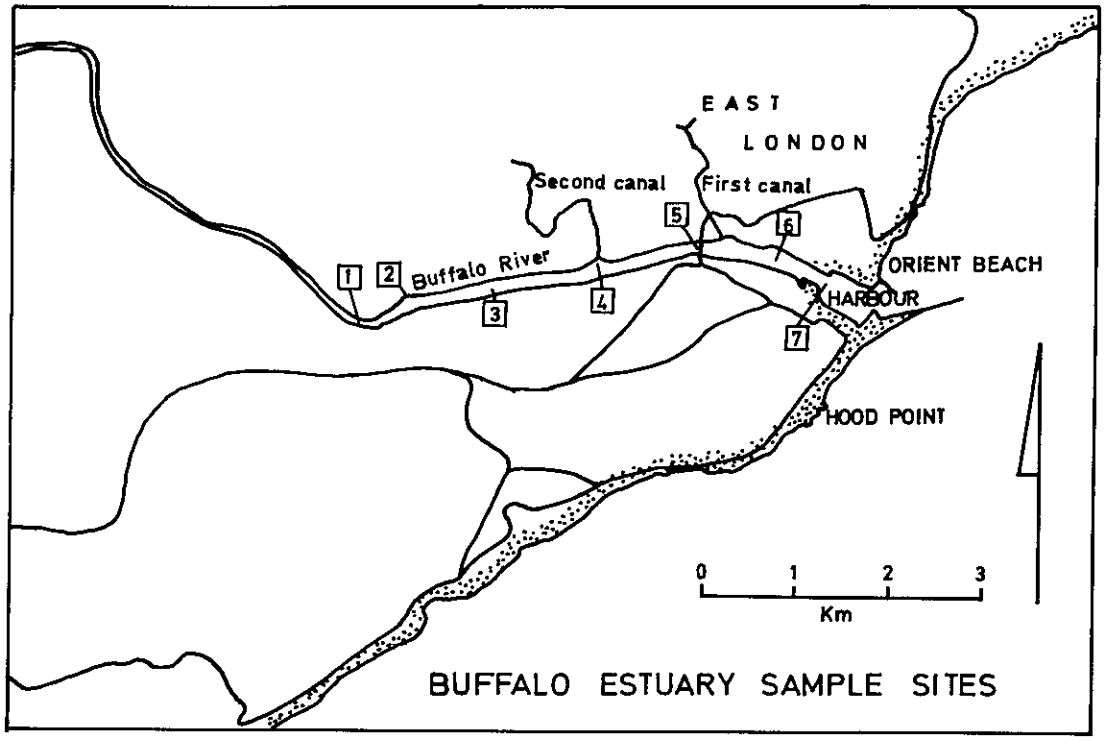

Figure 12. Sampling sites for Buffalo River estuary monitoring programme

Plankton samples will be collected using a D net and their composition and density determined.

13.4 Environmental parameters

State of tide, wind speed/direction, wave height/direction, season, general weather.

13.5 Frequency of sampling

Once every three years.

13.6 Responsible organization

NIWR (Durban).

13.7 References

National Institute for Water Research 1978. Marine disposal of effluents. Progress report no 35 presented at the thirty-sixth Steering Committee Meeting, 12 April 1978. Part III, Section 1, p 23. NIWR, Durban.

14. NAHOON POINT

14.1 Background

Nahoon Point is a favoured surfing area and the beach is both accessible and scenically attractive. At present macerated untreated sewage and industrial waste are discharged on the beach, which is bacteriologically unacceptable and probably will deteriorate as the volume of waste increases with time.

14.2 Sampling sites

Beach transects 100 metres north and south of the outfall, will consist of three stations down the swash zone between low water springs and high water springs as shown in Figure 13.

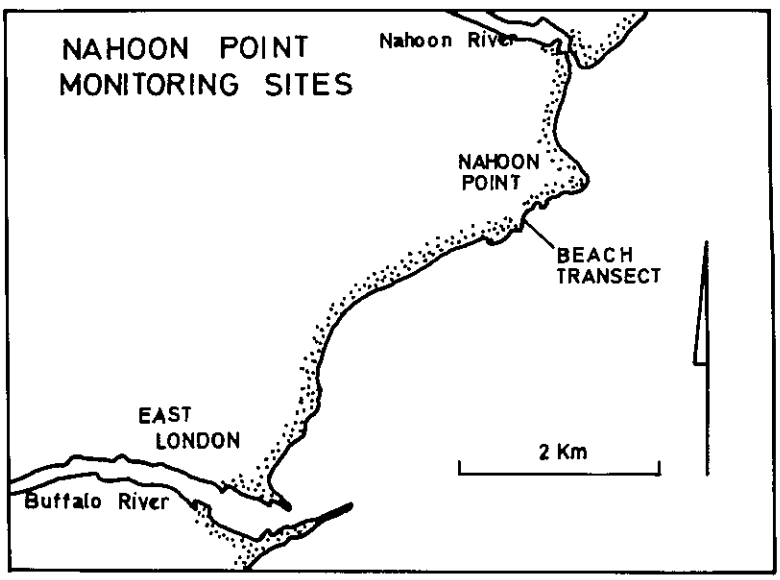

Figure 13. Sampling sites for Nahoon Point monitoring programme

14.3 Sampling parameters

Temperature, salinity, dissolved oxygen, oxygen absorbed, phosphate, total phosphorus, nitrate ammonia and bacterial composition will be determined on surface water samples (surf zone).

Sediment chemistry analyses : oxygen absorbed, particle size. Meiofaunal analyses will be undertaken on sediment cores from 0-100 mm and 100-200 mm in depth.

Interstitial water (samples taken at the water table) : dissolved oxygen, oxygen absorbed, salinity, temperature, bacteria, nutrients and toxic metals (cadmium, chromium, copper, mercury, nickel, lead and zinc).

Toxic metals will be determined in the rocky shore accumulator species Crassostrea margaritacea or Crassostrea cucullata and Perna perna.

14.4 Environmental parameters

State of tide, wind speed/direction, wave height/direction, season, general weather.

14.5 Frequency of sampling

Once every three years.

14.6 Responsible organization

NIWR (Durban).

14.7 References

National Institute for Water Research 1978. Marine disposal of effluents. Progress report no 35 presented at the thirty-sixth Steering Committee Meeting, 12 April 1978. Part III, Section 1, p 23. NIWR, Durban.

15. UMBOGINTWINI

15.1 Background

The beach at Umbogintwini, about 2 km north of Inyoni Rocks is an impact area. Waste from a large industrial complex is discharged by pipe just below low water spring tide. The waste contains various compounds (the major one being ammonia), and the pH is consequently high. The beach is composed of fairly coarse sand and a considerable amount of movement is experienced.

15.2 Sampling sites

Beach transects 30 metres north and south of discharge point. The transects to consist of three stations down the swash zone between low water springs and mean sea level is shown in Figure 14.

15.3 Sampling parameters

Salinity, dissolved oxygen, oxygen absorbed, phosphate, total phosphorus, nitrate, nitrite and fluoride will be determined on surface water samples (surf zone).

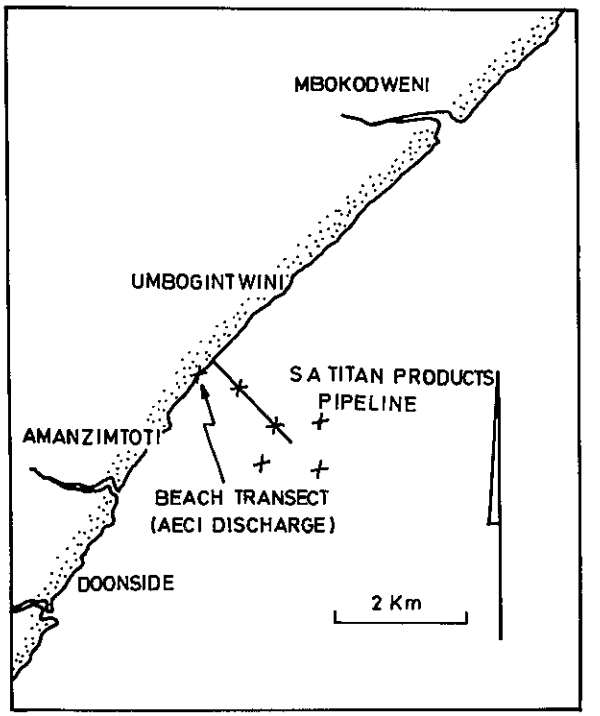

Figure 14. Sampling sites for Umbogintwini area monitoring programme

Sediment chemistry analyses : oxygen absorbed, particle size. Meiofaunal analyses will be undertaken on sediment cores from 0-100 mm and 100-200 mm in depth.

Interstitial water (samples taken at the water table) : dissolved oxygen, oxygen absorbed, salinity, temperature, bacteria, nutrients and toxic metals (cadmium, chromium, copper, arsenic, mercury, nickel, lead and zinc).

Toxic metals will be determined in the rocky shore accumulator species Crassostrea margaritacea or Crassostrea cucullata and Perna perna.

15.4 Environmental parameters

State of tide, wind speed/direction, wave height/direction, season, general weather.

15.5 Frequency of sampling

Once every three years.

15.6 Responsible organization

NIWR (Durban).

15.7 References

National Institute for Water Research 1969. Final report on conditions at Umbogintwini, November, 1969. CSIR Contract Report C Wat 22. NIWR, Durban.

16. TONGAAT RIVER MOUTH

16.1 Background

The Tongaat River carries secondary sewage effluent from the local works and also drains local cane lands. A pipe, containing industrial waste from a textile factory in the town, discharges into the sea on the beach near the mouth. The river mouth tends to move north or south on occasions and the beach is composed of coarse to medium sand.

16.2 Sampling sites

Beach transects 50 metres north and south of the mouth. The transects will consist of three stations down the swash zone between low water springs and mean sea level and are shown in Figure 15.

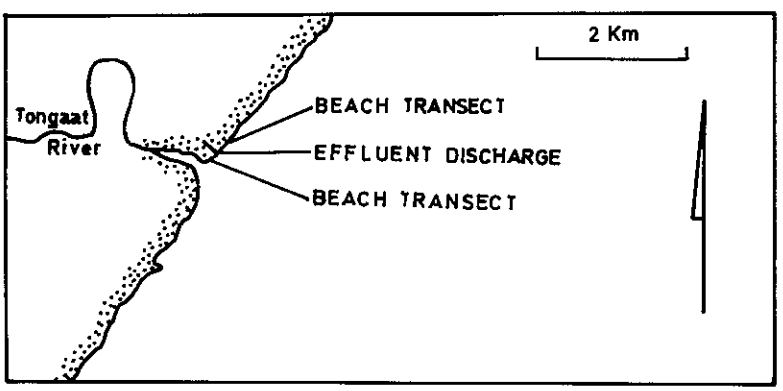

Figure 15. Sampling sites for Tongaat River mouth monitoring programme

16.3 Sampling parameters

Temperature, salinity, dissolved oxygen, oxygen absorbed, phosphate, total phosphorus, nitrate and bacterial composition will be determined on surface water samples (surf zone).

Sediment chemistry analyses : oxygen absorbed, particle size. Meiofaunal analyses will be undertaken on sediment cores from 0-100 mm and 100-200 mm in depth.

Interstitial water (samples taken at the water table) : dissolved oxygen,

oxygen absorbed, salinity, temperature, bacteria, nutrients and toxic metals (cadmium, chromium, copper, iron, mercury, manganese, nickel, lead and zinc).

Chlorinated pesticides and toxic metals will be determined in the rocky shore accumulator species Crassostrea margaritacea or Crassostrea cucullata and Perna perna.

16.4 Environmental parameters

State of tide, wind speed/direction, wave height/direction, season, general weather.

16.5 Frequency of sampling

At least once every three years.

16.6 Responsible organization

NIWR (Durban).

17. REUNION CANAL

17.1 Background

The two streams entering the canal both drain low marshy land on the western side of the Bluff at Durban. The northern branch of the canal receives effluent from the Shell Refinery, and consequently carries some oil. The mouth is tidal and the canal runs into the sea through breaks in a rocky reef platform.

17.2 Sampling sites

A beach transect 100 metres south of the canal, consisting of three equidistant stations down the swash zone between low water springs and mean sea level as shown in Figure 16 (page 36).

17.3 Sampling parameters

Salinity, dissolved oxygen, oxygen absorbed, phosphate, total phosphorus, nitrate and bacterial composition will be determined in surface water samples (surf zone).

Sediment chemistry analyses : oxygen absorbed, particle size. Meiofaunal analyses will be undertaken on sediment cores from 0-100 mm and 100-200 mm depth.

Interstitial water (samples taken at the water table) : dissolved oxygen, oxygen absorbed, salinity, temperature, bacteria, nutrients and toxic metals (cadmium, chromium, copper, mercury, nickel, lead and zinc).

Toxic metals will be determined in the rocky shore accumulator species Crassostrea margaritacea or Crassostrea cucullata and Perna perna.

17.4 Environmental parameters

State of tide, wind speed/direction, wave height/direction, season, general weather.

17.5 Frequency of sampling

A minimum of once every three years.

17.6 Responsible organization

NIWR (Durban).

17.7 References

National Institute for Water Research 1968. A survey of the bacteriology, chemistry and biology of the sea and beaches in the vicinity of Durban - conditions prior to the use of submarine outfalls, period 1964-68. CSIR Contract Report C Wat 19. NIWR, Pretoria.

National Institute for Water Research 1972. Surveys monitoring the sea and beaches in the vicinity of Durban. Part 2. Conditions following the use of the submarine outfalls. CSIR Contract Report C Wat 26. NIWR, Durban.

National Institute for Water Research 1974. Surveys monitoring the sea and beaches in the vicinity of Durban. Part 3. Surveys between 1972-1974. CSIR Contract Report C Wat 30. NIWR, Durban.

18. UMLAAS CANAL MOUTH

18.1 Background

The Umlaas Canal is the lower canalized portion of the Umlaas River. The catchment is large, draining the Hammersdale industrial township and receiving sewage effluent from both the Mpumalange and the Hammersdale sewage works. A considerable amount of industrial waste drains into the catchment and some domestic sewage also enters the river. The lower part of the river has extensive grass and reed beds. The mouth is above high water spring tide and consequently the river is not an estuary.

18.2 Sampling sites

Beach transects 100 metres north and south of the canal. The transects will consist of three equidistant stations down the swash zone between low water springs and mean sea level as shown in Figure 16.

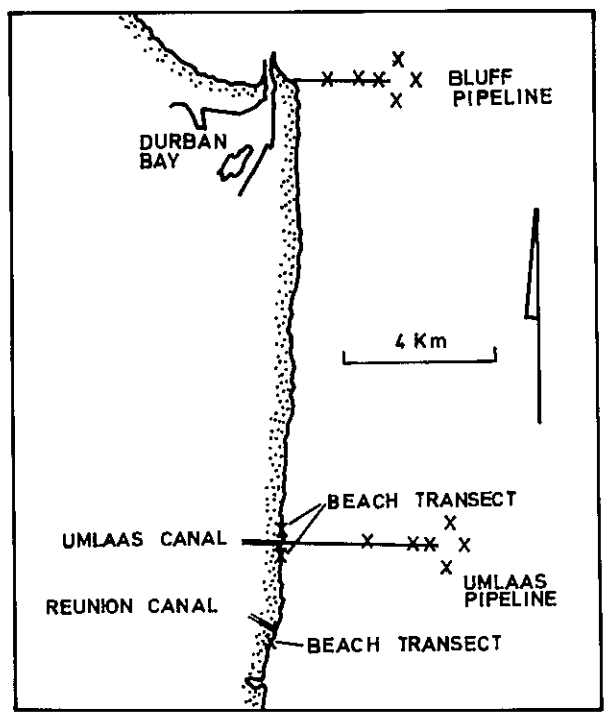

Figure 16. Sample sites for Umlaas Canal, Reunion Canal and Bluff pipeline monitoring programme

18.3 Sampling parameters

Salinity, dissolved oxygen, oxygen absorbed, phosphate total phosphorus, nitrate, bacterial composition and ammonia will be determined on surface water samples (surf zone).

Sediment chemistry analyses : oxygen absorbed, particle size, nitrate, phosphate, total phosphorus and toxic metals (cadmium, chromium, copper, mercury, nickel, lead and zinc). Meiofaunal analyses will be undertaken on sediment cores from 0-100 mm and 100-200 mm depth.

Interstitial water (samples taken at the water table) : dissolved oxygen, oxygen absorbed, salinity, temperature, bacteria and toxic metals (as above).

Toxic metals will be determined in the rocky shore accumulator species Crassostrea margaritacea and Perna perna.

18.4 Environmental parameters

State of tide, wind speed/direction, wave height/direction, season, general weather.

18.5 Frequency of sampling

A minimum of once every three years.

18.6 Responsible organization

NIWR (Durban).

18.7 References

National Institute for Water Research 1968. A survey of the bacteriology, chemistry and biology of the sea and beaches in the vicinity of Durban. Conditions prior to the use of submarine outfalls, period 1964-68. CSIR Contract Report C Wat 19. NIWR, Pretoria.

National Institute for Water Research 1972. Surveys monitoring the sea and beaches in the vicinity of Durban. Part 2. Conditions following the use of the submarine outfalls. CSIR Contract Report C Wat 26. NIWR, Durban.

National Institute for Water Research 1974. Surveys monitoring the sea and beaches in the vicinity of Durban. Part 3. Surveys between 1972-1974. CSIR Contract Report C Wat 30. NIWR, Durban.

19. RICHARDS BAY

19.1 Background

Richards Bay has been divided in two by the construction of a berm wall. A shallow sanctuary area in the south has been set aside for conservation, while the deep water harbour lies to the north. The Umhlatuzi River, which carries a great deal of silt, empties into the southern sanctuary area. Some fluoride enters the bay from the Alusaf and Triomf factories and slime dams of gypsum are being formed at the edge of the harbour by the latter organisation.

19.2 Sampling sites

Twelve sites will be sampled, as shown in Figure 17.

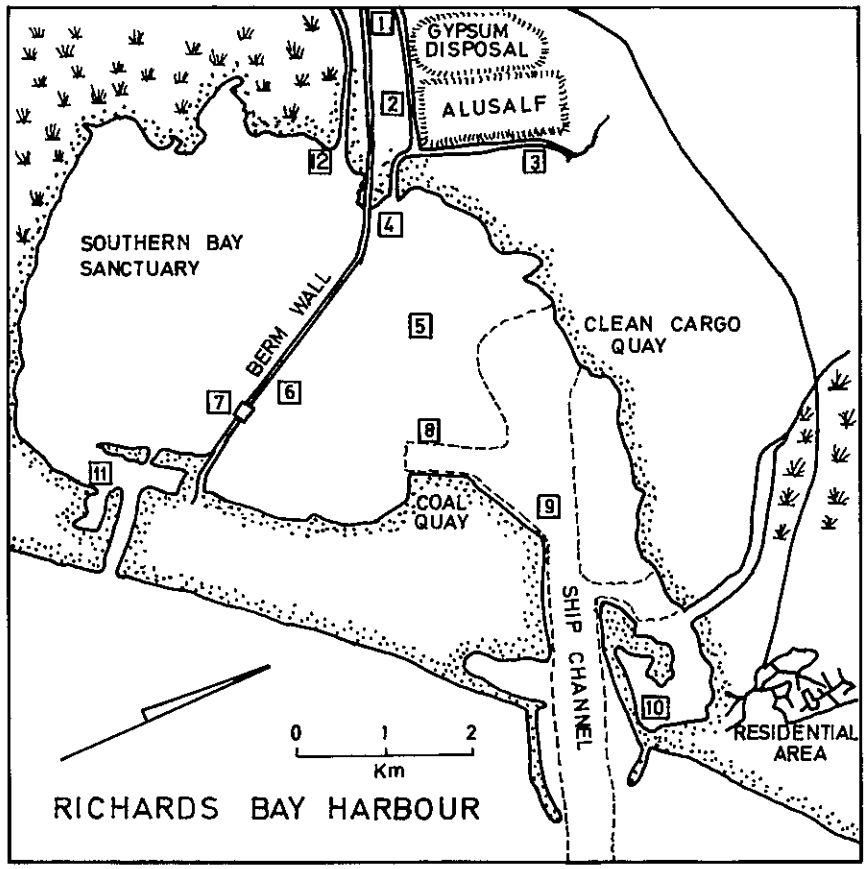

Figure 17. Sampling sites for Richards Bay monitoring programme

19.3 Sampling parameters

Salinity, temperature, dissolved oxygen, oxygen absorbed, nutrients (nitrate, phosphate and total phosphorus), bacteria, toxic metals (cadmium, copper, iron, mercury, nickel, lead and zinc) and fluoride will be determined in surface and near bottom water samples.

Particle size, oxygen absorbed, faunal composition and density, toxic metals (as above), chlorinated pesticides and oil will be determined on sediment and faunal samples.

Chlorinated pesticides and toxic metals will be determined in Mugilid spp, Pomadasys commersonni and Elops machnata.

Plankton samples will be collected using a D net and their composition and density determined.

19.4 Environmental parameters

State of tide, wind speed/direction, wave height/direction, season, general weather.

19.5 Frequency of sampling

Once every three years.

19.6 Responsible organization

NIWR (Durban).

19.7 References

National Institute for Water Research 1977. Marine disposal of effluents. Progress report no 33 presented at the thirty-fourth Steering Committee Meeting, 2 May 1977. Part I, p 127. NIWR, Durban.

20. KOSI BAY

20.1 Background

Kosi Bay is a system of interlinked lakes and an estuary discharging to the sea. It has been examined on two previous occasions. The estuary is extensive with a rich fauna, but two of the lakes have an anoxic hypolimnion. The condition of the system is at present good, although somewhat elevated pesticide levels, especially DDT and its analogs, can be found in the sediments and in mullet from the estuary.

20.2 Sampling sites

Eight stations between the mouth and freshwater in mid-estuary, as are shown in Figure 18.

20.3 Sampling parameters

Chlorinated pesticides will be determined on sediment and faunal samples, as well as in the accumulator species Pomadasys commersonni, Elops machnata and Mugilid species.

20.4 Environmental parameters

State of tide, wind speed/direction, wave height/direction, season, general weather.

20.5 Frequency of sampling

At least once every three years.

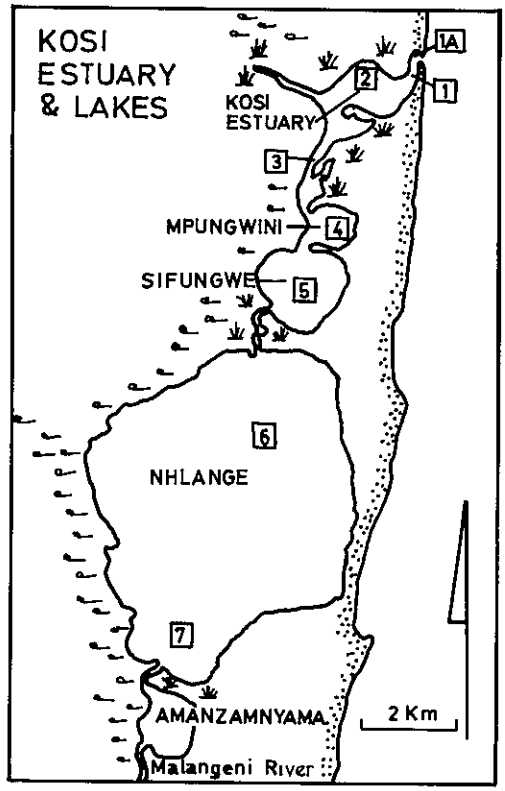

Figure 18. Sampling sites for the Kosi Bay monitoring programme

20.6 Responsible organization

NIWR (Durban).

20.7 References

National Institute for Water Research 1975. National Marine Pollution Monitoring Programme, East Coast Section. Progress Report 2, Part 111(b)1. NIWR, Durban.

National Institute for Water Research 1976. National Marine Pollution Surveys, East Coast Section. Second Annual Report. Section C, Part VI. NIWR, Durban.

21. OCEAN SAMPLING OFF UMKOMAAS (SAICCOR)

21.1 Background

A factory producing cellulose from timber is sited at Umkomaas. Industrial waste, consisting largely of lignosulphonates from the sulphite digestion process, is discharged into the sea via a 1,6 km long submarine pipeline. The discharge of approximately 80 Mld^{-1} is stable under

oxidizing conditions, but degrades under anaerobic conditions. It is also highly coloured and foams when agitated. Previous surveys have found little disturbance but it is considered wise to monitor the area at infrequent intervals in the future.

21.2 Sampling sites

A grid of four stations 0,5 km around the pipe-end and one in the centre is shown in Figure 19.

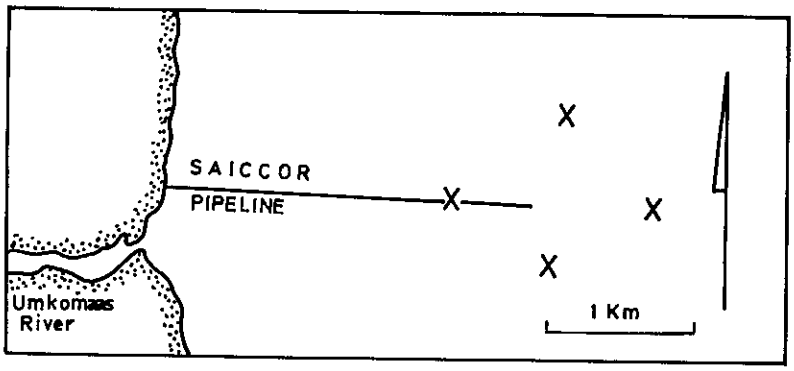

Figure 19. Sampling sites for the SAICCOR pipeline monitoring programme

21.3 Sampling parameters

Water samples will be taken at the surface, 10 and 20 metres depth. Salinity, temperature, oxygen absorbed, nutrients (nitrate, phosphate, total phosphorus and silica), dissolved oxygen and lignin will be determined on each sample.

Toxic metals (cadmium, copper, mercury, nickel, lead and zinc) will be determined in water samples taken at 20 metres depth.

Particle size, oxygen absorbed, toxic metals (as above), faunal density and composition will be determined on grab or cone dredged sediment samples.

21.4 Environmental parameters

State of tide, wind speed/direction, wave height/direction, season, general weather.

21.5 Frequency of sampling

At least once every three years.

21.6 Responsible organization

NIWR (Durban).

21.7 References

National Institute for Water Research 1966. Final report on conditions at Umkomaas before the commissioning of the pipeline by Saiccor, 30 June, 1966. CSIR Contract Report C Wat 12. NIWR, Pretoria.

National Institute for Water Research 1972. Report on chemical and biological conditions in the discharge area of the Saiccor submarine pipeline. CSIR Contract Report C Wat 28. NIWR, Durban.

22. OCEAN SAMPLING OFF SA TIOXIDE PIPELINE, UMBOGINTWINI

22.1 Background

A chemical plant at Umbogintwini producing titanium oxide discharges an acidic ferrous sulphate waste to sea by submarine pipeline. The line is 1,7 km long and discharges 1 325 kld^{-1}. The waste is denser than sea-water and hugs the sea-bed. Surveys have been carried out in the past which have shown disturbance only near the pipe-end. Environmental effects will be monitored at infrequent intervals to detect any slow-occurring deleterious changes.

22.2 Sampling sites

A grid of four stations 0,5 km around the pipe-end and one in the centre is shown in Figure 14 (page 32).

22.3 Sampling parameters

Water samples will be taken at the surface, 10, 20 and 30 metres depth. Salinity, temperature, oxygen absorbed, nutrients (nitrate, phosphate, total phosphorus and silica) and dissolved oxygen will be determined in each sample.

Toxic metals (cadmium, chromium, vanadium, cobalt, copper, iron, mercury, manganese, nickel, lead and zinc) will be determined in water samples taken at 20 metres depth.

Sediment samples, where obtainable, will be taken using a grab or cone dredge. Particle size, oxygen absorbed, toxic metals (as above), faunal density and composition will be determined in each sample.

22.4 Environmental parameters

State of tide, wind speed/direction, wave height/direction, season, general weather.

22.5 Frequency of sampling

Once every three years.

22.6 Responsible organization

NIWR (Durban).

22.7 References

National Institute for Water Research 1963. Report on a survey monitoring the discharge of effluent from the S A Titan Product's pipeline off Umbogintwini. NIWR, Durban.

National Institute for Water Research 1970. Fourth report on surveys monitoring the discharge of effluent from the S A Titan Product's pipeline off Umbogintwini. NIWR, Durban.

23. OCEAN SAMPLING OFF DURBAN SEWAGE PIPELINES

23.1 Background

Durban discharges treated sewage to sea by two pipelines. The one sited near the end of the Bluff off Central Works handles 145 Mld^{-1} of settled sewage. It discharges through diffusers on the sea bed 3,1 km offshore. The second pipeline from Southern Works discharges 20 Mld^{-1} secondary treated effluent and industrial effluents.

The areas at the end of the pipelines have been extensively examined in the past and no disturbances were detected. Monitoring will be undertaken at infrequent intervals to ensure that growth of the city, with a corresponding increase in flow of waste, does not have deleterious effects on the environment.

23.2 Sampling sites

A grid of four stations 0,5 km around the pipe-end and one in the centre as shown in Figure 16 (page 36).

23.3 Sampling parameters

Water samples will be taken at the surface, 10, 20 and 30 metres depth. Salinity, temperature, oxygen absorbed, nutrients (nitrate, phosphate, total phosphorus and silica) will be determined in each sample.

Toxic metals (cadmium, chromium, copper, mercury, nickel, lead and zinc) will be determined in water samples taken at 20 metres depth.

Sediment samples, where obtainable, will be collected using a grab or cone dredge. Particle size, oxygen absorbed, toxic metals (as above), faunal density and composition will be determined in each sample.

23.4 Environmental parameters

State of tide, wind speed/direction, wave height/direction, season, general weather.

23.5 Frequency of sampling

Once every three years.

23.6 Responsible organization

NIWR (Durban).

23.7 References

National Institute for Water Research 1968. A survey of the bacteriology, chemistry and biology of the sea and beaches in the vicinity of Durban. Conditions prior to the use of submarine outfalls, period 1964-68. CSIR Contract Report C Wat 19. NIWR, Pretoria.

National Institute for Water Research 1972. Surveys monitoring the sea and beaches in the vicinity of Durban. Part 2. Conditions following the use of the submarine outfalls. CSIR Contract Report C Wat 26. NIWR, Durban.

National Institute for Water Research 1974. Surveys monitoring the sea and beaches in the vicinity of Durban. Part 3. Surveys between 1972-1974. CSIR Contract Report C Wat 30. NIWR, Durban.

24. WEST COAST OCEAN TRANSECT

24.1 Background

Reference transect.

24.2 Sampling sites

Stations 3, 8, 40, 70 and 100 km due west of Saldanha Bay are shown in Figure 20.

24.3 Sampling parameters

Water samples will be collected at the surface, 10, 20, 30, 50, 75, 100, 150, 200, 250, 300 and 400 metres (depth permitting). Temperature, salinity, dissolved oxygen, oxygen absorbed, phosphate, nitrate and total phosphorus will be determined in each sample. Water samples will also be collected at 20, 50, 75, 100, 200, and 400 metres and toxic metals (cadmium, copper, iron, mercury, manganese, nickel, lead and zinc) will be determined in them.

Oxygen absorbed, particle size distribution, faunal composition and density, toxic metals (as above) and, where applicable, estimations of bacteria composition will be determined on sediments collected by box-corer at selected stations.

Plankton samples will be collected by special nets at selected stations and will be analysed for density and composition. Toxic metals (as above) will also be determined in each sample.

Surface oil (tar ball) concentrations will be measured at each daylight station.

24.4 Environmental parameters

State of tide, wind speed/direction, wave height/direction, season, general weather.

24.5 Frequency of sampling

Seasonally once every five years.

24.6 Responsible organization

NRIO.

25. SOUTH COAST OCEAN TRANSECT

25.1 Background

Reference transect.

25.2 Sampling sites

Stations 3, 8, 40, 70 and 100 km due south of Cape Infanta are shown in Figure 20.

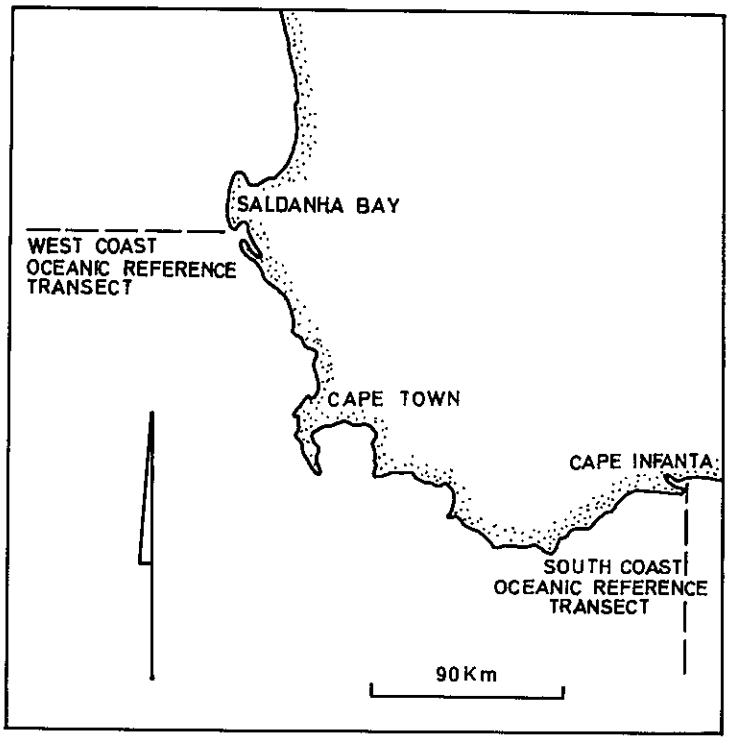

Figure 20. Sampling sites for the south and west coast oceanic reference transect monitoring programmes

25.3 Sampling parameters

Water samples will be collected at the surface, 10, 20, 30, 50, 75, 100, 150, 200, 250, 300 and 400 metres (depth permitting). Temperature, salinity, dissolved oxygen, oxygen absorbed, phosphate, nitrate and total phosphorus will be determined in each sample. Water samples will also be taken at 20, 50, 75, 100, 200 and 400 metres and toxic metals (cadmium, copper, iron, mercury, manganese, nickel, lead and zinc) will be determined in these.

Oxygen absorbed, particle size distribution, faunal composition and density, toxic metals (as above) and, where applicable, estimations of bacteria composition will be determined on sediments collected by box-corer at selected stations.

Plankton samples will be collected by special nets at selected stations and will be analysed for density and composition. Toxic metals (as above) will also be determined in each sample.

Surface oil (tar ball) concentrations will be measured at each daylight station.

25.4 Environmental parameters

State of tide, wind speed/direction, wave height/direction, season, general weather.

25.5 Frequency of sampling

Seasonally once every five years.

25.6 Responsible organization

NRIO.

26. EAST COAST OCEAN TRANSECT

26.1 Background

A considerable amount of information was obtained up till 1979 on conditions along the east coast. Consequently, monitoring frequency will be once during the three year period 1979-1982.

An additional station will be established in ± 1 300 metres at about 150 km offshore as an open ocean reference station in the Indian Ocean.

26.2 Sampling sites

Stations 2, 4, 6, 8, 10, 25, 50 and 150 km offshore on a line east (128°T) off Cooper Light (Durban) are shown in Figure 21.

26.3 Sampling parameters

Water samples will be taken at the surface, 10, 30, 50, 100, 150, 200, 300, 400 and 500 metres (depth permitting). Salinity, temperature, dissolved oxygen, oxygen absorbed, nutrients (nitrate, phosphate, total phosphorus and silica) will be determined in each sample.

Toxic metals (cadmium, copper, iron, mercury, manganese, nickel, lead and zinc) will be determined in water samples taken at 20 metres and 100 metres (or near bottom).

Open ocean reference station at 150 km : water samples taken at 20 metres below the thermocline and near the bottom will be analysed for toxic metals (as above).

Sediment samples, where obtainable, will be collected using a grab or cone dredge. Particle size, oxygen absorbed, toxic metals (as above), faunal density and composition will be determined in each sample.

Plankton samples will be collected using a Bé net at selected stations and will be analysed for species density and composition. Toxic metals (as above) will also be determined in each sample.

Tar balls will be sampled by Neuston net.

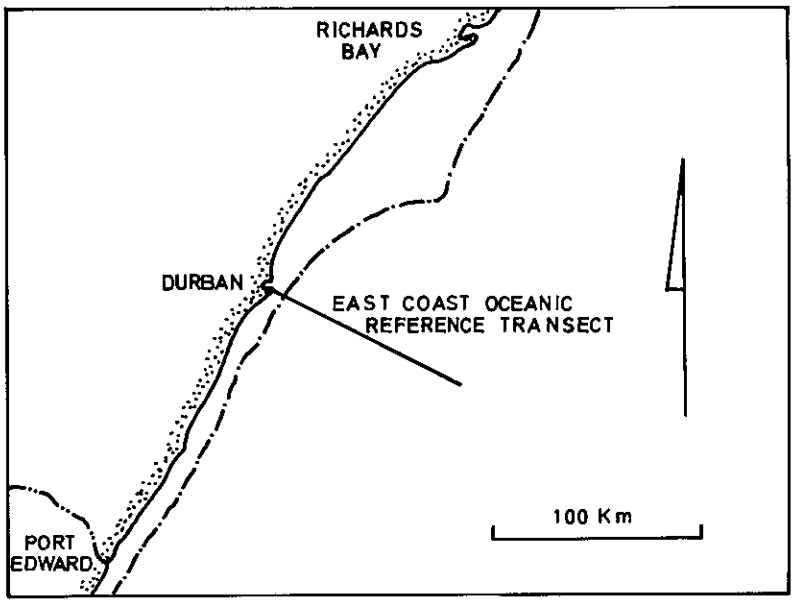

Figure 21. Sampling sites for east coast oceanic reference transect monitoring programme

Special station : other parameters at 20 metres, on the thermocline and near bottom.

26.4 Environmental parameters

State of tide, wind speed/direction, wave height/direction, season, general weather.

26.5 Frequency of sampling

Seasonally once every five years.

26.6 Responsible organization

NIWR (Durban).

26.7 References

National Institute for Water Research 1975. National Marine Pollution Monitoring Programme, East Coast Section. Progress Report 2, Part IV. NIWR, Durban.

National Institute for Water Research 1976. National Marine Pollution Surveys, East Coast Section. Second Annual Report. Section D, p 147. NIWR, Durban.

National Institute for Water Research 1978. Marine disposal of effluents. Progress report no 35 presented at the thirty-sixth Steering Committee Meeting, 12 April 1978. Part IV, p 75. NIWR, Durban.

National Institute for Water Research 1978. National Marine Pollution Surveys, East Coast Section. Third Annual Report. Section D, p 65. NIWR, Durban.

TITLES IN THIS SERIES

1. *A description of the Savanna Ecosystem Project, Nylsvley, South Africa. December 1975. 24 pp.

2. *Sensitivity analysis of a simple linear model of a savanna ecosystem at Nylsvley. W M Getz and A M Starfield. December 1975. 18 pp.

3. *Savanna Ecosystem Project - Progress report 1974/1975. S M Hirst. December 1975. 27 pp.

4. Solid wastes research in South Africa. R G Noble. June 1976. 13 pp.

5. *Bibliography on marine pollution in South Africa. D A Darracott and C E Cloete. June 1976. 131 pp.

6. *Recycling and disposal of plastics waste in South Africa. R H Nurse, N C Symington, G R de V Brooks and L J Heyl. June 1976. 35 pp.

7. *South African Red Data Book - Aves. W R Siegfried, P G H Frost, J Cooper and A C Kemp. June 1976. 108 pp.

8. South African marine pollution survey report 1974-1975. C E Cloete and W D Oliff (editors). September 1976. 60 pp.

9. Modelling of the flow of stable air over a complex region. M T Scholtz and C J Brouckaert. September 1976. 42 pp.

10. Methods and machinery for pulverising solid wastes. M J Simpkins. October 1976. 29 pp.

11. *South African Red Data Book - Small mammals. J A J Meester. November 1976. 59 pp.

12. Savanna Ecosystem Project - Progress report 1975/1976. B J Huntley. March 1977. 41 pp.

13. Disposal and recovery of waste paper in South Africa. G R de V Brooks. April 1977. 35 pp.

14. South African Red Data Book - Fishes. P H Skelton. July 1977. 39 pp.

15. *A checklist of the birds of the Nylsvley Nature Reserve. W R Tarboton. September 1977. 14 pp.

16. *Grondsoorte van die Nylsvley-natuurreservaat. H J von M Harmse. September 1977. 64 pp.

17. Description and manual for the use of DRIVER - an interactive modelling aid. P R Furniss. September 1977. 23 pp.

18. South African Red Data Book - Large mammals. J D Skinner, N Fairall and J du P Bothma. November 1977. 29 pp.

19. Introducing you to satellite operated Data Collection Platforms (DCP's). C C Stavropoulos. September 1977. 9 pp.

20. A phytosociological classification of the Nylsvley Nature Reserve. B J Coetzee, F van der Meulen, S Zwanziger, P Gonsalves and P J Weisser. December 1977. 31 pp.

21. An annotated checklist of the amphibians, reptiles and mammals of the Nylsvley Nature Reserve. N H G Jacobsen. December 1977. 65 pp.

22. *Cooperative National Oceanographic Programme. SANCOR. January 1978. 19 pp.

23. South African Red Data Book - Reptiles and amphibians. G R McLachlan. February 1978. 53 pp.

24. *Guidelines for the disposal of dangerous and toxic wastes so as to minimize or prevent environmental and water pollution. R T Rudd. January 1978. 12 pp.

25. Richards Bay mesometeorological data. Vertical profiles of air temperature and wind velocity and surface wind statistics. M T Scholtz, E T Woodburn, C J Brouckaert and M Mulholland. March 1978. 104 pp.

26. *Studies of mineralization in South African rivers. G C Hall and A H M Gorgens (editors). March 1978. 24 pp.

27. Nylsvley - A South African Savanna Ecosystem Project: objectives, organization and research programme. March 1978. 37 pp.

28. A description of the Fynbos Biome Project. June 1978. 25 pp.

29. Savanna Ecosystem Project - Phase I summary and Phase II progress. B J Huntley and J W Morris. July 1978. 52 pp.

30. Review of Coastal Currents in Southern African Waters. T F W Harris. August 1978. 106 pp.

31. Report of the Task Group on Fermentation Technology. R J Andrews, J A de Villiers, P M Lategan, F G Neytzell-de Wilde, J P van der Walt and Professor D R Woods. September 1978. 16 pp.

32. South African programme for the SCOPE mid-term project on the ecological effects of fire. September 1978. 36 pp.

33. Fire in South African ecosystems: an annotated bibliography. G U Schirge and A H Penderis. October 1978. 114 pp.

34. *Inland water ecosystems in South Africa : a review of research needs. R G Noble and J Hemens. November 1978. 150 pp.

35. South African Antarctic Research Programme, 1978-1982. SASCAR. December 1978. 39 pp. Out of print but replaced by No 50.

36. Aboveground biomass subdivisions in woody species of the Savanna Ecosystem Project Study Area, Nylsvley. M C Rutherford. January 1979. 33 pp.

37. Marine Line Fish Research Programme. SANCOR. April 1979. 17 pp.

38. *The Southern Ocean - South African Cooperative Research Programme. SANCOR. May 1979. 26 pp.

39. The Transfer of Pollutants in Two Southern Hemispheric Oceanic Systems. Proceedings of a workshop held at Plettenberg Bay, South Africa, 23-26 April 1979. 188 pp.

40. Fynbos ecology : a preliminary synthesis. J Day, W R Siegfried, G N Louw and M L Jarman. December 1979. 166 pp.

41. Bibliography of Marine Biology in South Africa. D A Darracott and A C Brown. 250 pp.

42. Advances in understanding phosphorus cycling in inland waters - their significance for South African limnology. A J Twinch and C M Breen. March 1980. 22 pp.

43. Terrestrial ecology in South Africa - project abstracts for 1978. February 1980. 92 pp.

44. A manual of methods for use in the South African Marine Pollution Monitoring Programme. R J Watling. July 1981. 82 pp.

45. Threatened plants of Southern Africa. A V Hall, M de Winter, B de Winter and S A M van Oosterhout. May 1980. 244 pp.

46. South African legislation with respect to the control of pollution of the sea. André Rabie, January 1981. 73 pp.

47. Terrestrial ecology in South Africa and South West Africa - project abstracts for 1979. May 1981. 107 pp.

48. A bibliography of seabirds in the waters of southern Africa, the Prince Edward and Tristan Groups. J Cooper and R K Brooke. In preparation.

49. National Geoscience Programme. The Evolution of Earth Resource Systems. SACUGS. June 1981. 42 pp.

50. South African Antarctic Biological Research Programme. SASCAR. July 1981. 54 pp.

51. South African Marine Pollution Monitoring Programme 1979-1982. R J Watling and C E Cloete (editors). July 1981. 52 pp.

*Out of print.