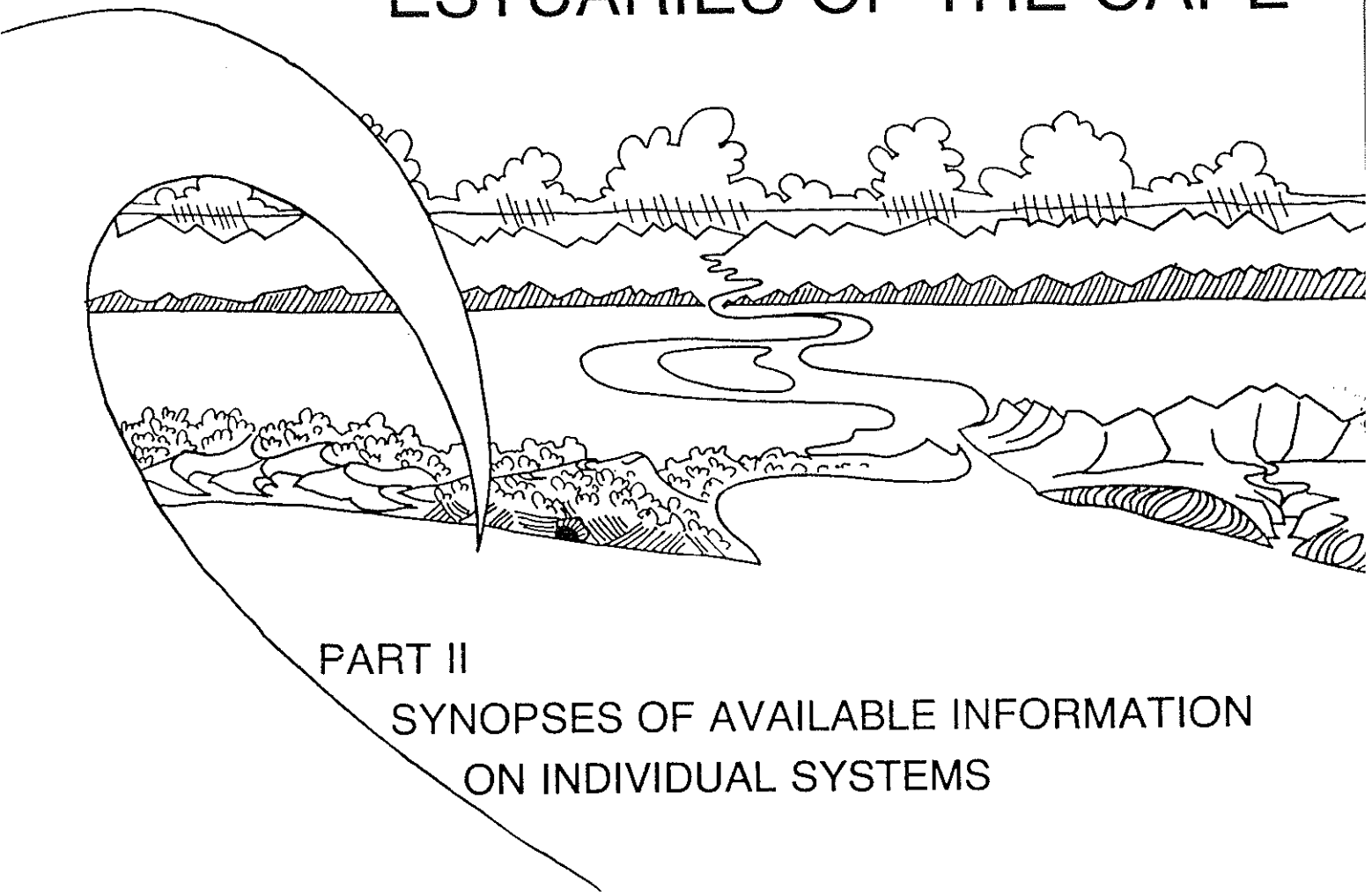
COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY
ESTUARINE AND COASTAL RESEARCH UNIT – ECRU

ESTUARIES OF THE CAPE



PART II
SYNOPSES OF AVAILABLE INFORMATION ON INDIVIDUAL SYSTEMS

REPORT NO. 12

BUFFELS (WES) (CSW 1), ELSIES (CSW 2) SIR LOWRY'S PASS (CSW 8), STEENBRAS (CSW 9) and BUFFELS (OOS) (CSW 11)

CSIR RESEARCH REPORT 411

Stellenbosch, South Africa
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EDITORS:
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ELSIES (CSW 2)
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BUFFELS (OOS) —(CSW 11)

(CSW 1, 2, 8, 9 & 11 — CSIR Estuary Index Numbers)

BY: T J E HEINECKEN, I B BICKERTON AND P D MORANT

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PLATE I: The Buffels (Wes) showing the tidal pool and launching ramp. The hummock dunes in front of the mouth of the river can be seen on the extreme right of the photograph (ECRU 79-10-23).

PLATE II: The Elsies River mouth, showing to what extent the roads and railway line dominate the lower part of the estuary. Open water can be seen in the Vlei and the remnants of the original bare dune belt are visible on the top right-hand corner of the photograph. The Glencairn township is on the left with the new subdivision of Glencairn Heights on the right (ECRU 79-10-23).

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PREFACE

The Estuarine and Coastal Research Unit (ECRU) was established by the National Research Institute for Oceanology (NRIO) of the CSIR in 1979 with the following aims:

- to contribute information relevant to the development of a cohesive management policy for the South African coastline;
- to compile syntheses of all available knowledge on the 167 estuaries of the Cape between the Kei and the Orange rivers;
- to identify gaps in information, to conduct research to fill these and to stimulate Universities, Museums and other institutions to become involved in this kind of work;
- to contribute to *ad hoc* investigations carried out by NRIO on the impacts of proposed developments in the coastal environment, and especially in estuaries.

The Unit was established at the request of the Government, and the Department of Environment Affairs contributes substantially to the running costs.

In 1980 the Unit published its first report under the title "The Estuaries of the Cape, Part I - Synopsis of the Cape Coast. Natural Features, Dynamics and Utilization" (by Heydorn and Tinley)[+]. As the name of the report implies, it is an overview of the Cape Coast dealing with aspects such as climate, geology, soils, catchments, run-off, vegetation, oceanography, and of course, estuaries. At the specific request of the Government, the report includes preliminary management recommendations.

The present report is one of a series on Cape Estuaries being published under the general title "The Estuaries of the Cape, Part II". In these reports all available information on individual estuaries is summarized and presented in a format similar to that used in a report on Natal estuaries which was published by the Natal Town and Regional Planning Commission in 1978. It was found however, that much information is dated or inadequate and that the compilation of Part II reports is therefore not possible without brief prior surveys by the ECRU. These surveys are usually carried out in collaboration with the Botanical Research Institute and frequently with individual scientists who have special interest in the systems concerned. One of these is Prof JR Grindley of the University of Cape Town who is co-editor of the Part II series.

These surveys are, however, not adequate to provide complete understanding of the functioning of estuarine systems under the variable conditions prevalent along the South African coastline. The ECRU therefore liaises closely with Universities and other research institutes and encourages them to carry out longer-term research on selected estuarine systems. In this way a far greater range of expertise is involved in the programme and it is hoped that the needs of those responsible for coastal zone management at Local-, Provincial and Central Government levels can be met within a reasonable period of time.

Finally, the attempt has been made to write the Part II reports in language understandable to the layman. However it has been impossible to avoid technical terms altogether and a glossary explaining these is therefore included in each report.

FP Anderson
DIRECTOR

National Research Institute for Oceanology
CSIR

[+]CSIR Research Report 380

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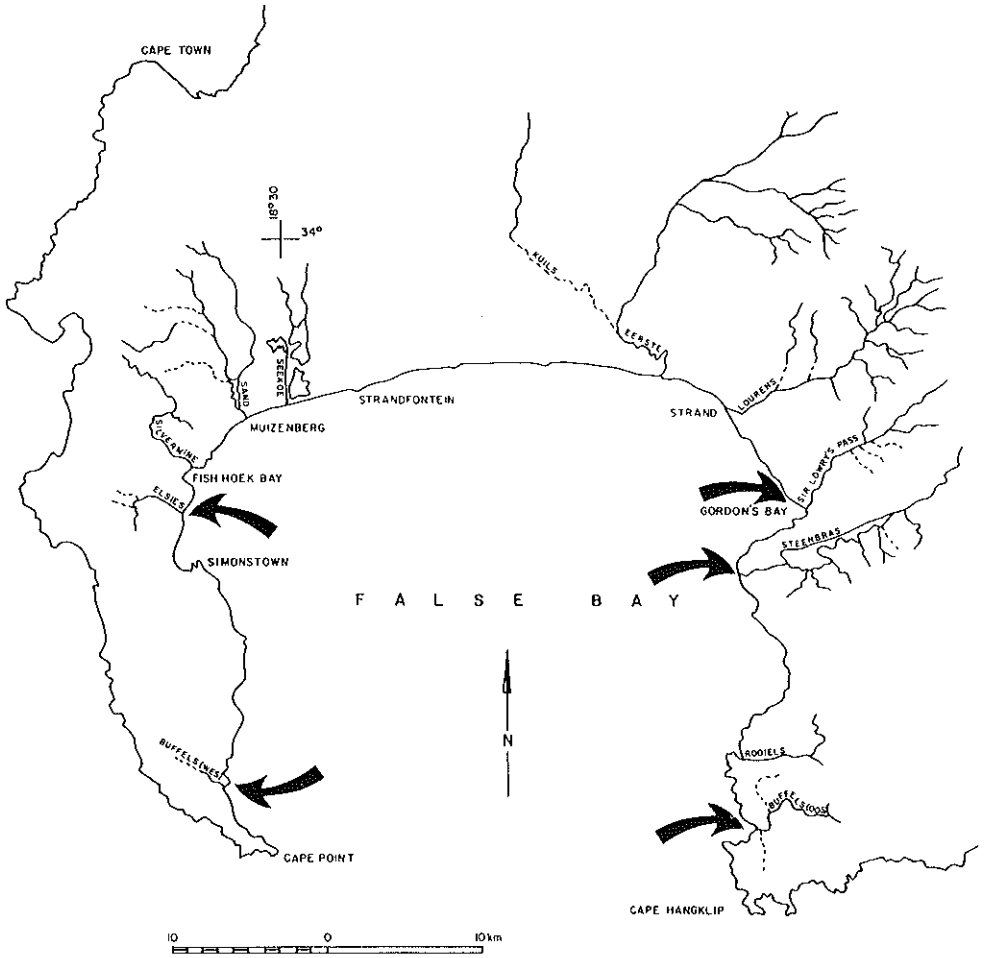
INTRODUCTION

In contrast to the other Part II reports which have been published in this series describing one system per report, this report is a synthesis of all available information on five of the smaller rivers discharging into False Bay combined as a single volume. The rivers dealt with are the Buffels (Wes), Elsies, Sir Lowry's Pass, Steenbras and Buffels (Oos).

False Bay is a large square-shaped bay with an area of more than 1 000 km^2 and a wide mouth which permits free exchange with the open ocean. The Bay can therefore not be considered as an isolated entity but it is rather a part of the wider coastal region within which it occurs (Newman, 1980). The currents in the bay have been studied by Atkins (1970). He identified four basic patterns of water movement and from these he calculated that the residence time of water in False Bay was, on average, 4 to 6 days.

The physical and biological processes in False Bay and their management implications have been described in the proceedings of a symposium on the Future Management of False Bay held in June 1980 (Gasson, 1980).

According to the 1:50 000 Topographical Sheets 3418AB and AD, 3418BA, 3418BB and 3418BD, there are eleven named rivers discharging into False Bay. These are shown in the Figure below from west to east as the Buffels (Wes), Elsies, Silvermine, Sand, Seekoe, Eerste/Kuils, Lourens, Sir Lowrys Pass, Steenbras, Rooiels and Buffels (Oos).



The location of the rivers and estuaries flowing into False Bay.

The data on estuary characteristics and mouth dynamics for this report were supplied by Dr GAW Fromme of the NRIO Sediment Dynamics Division (SDD) while the botanical data were contributed by Mr M O'Callaghan and Mr K Roxburgh of the Botanical Research Institute, Stellenbosch.

1. BUFFELS (WES)

1.1 Historical Background

The Diaz Cross, a commemorative navigation beacon, is situated at Bordjiesrif above the Buffels Bay beach which is at the mouth of the Buffelsrivier (see Figure 1). The beacon carries an inscription indicating that the early Portugese navigator, Bartholomew Diaz, landed at Buffels Bay in 1487 after rounding Cape Point which at the time he thought was the southern-most tip of Africa.

The present Homestead tearoom on the banks of the Buffels stream was originally a farmhouse, owned first by the McKellars and later by the Smiths who farmed the area from the 1700s to about 1939 (Opie, 1967). The stream was used by the early farmers and fishermen as a source of drinking water and to irrigate their gardens.

Avery (1980) records the occurrence of prehistoric tidal fish traps at Bordjiesrif on the northern side of Buffels Bay.

1.2 Location and Local Authorities

The topographical grid reference for the Buffelsrivier mouth is $34^{o}19'S$ and $18^{o}28'E$. It is located on the western side of False Bay near the tip of the Cape Peninsula (see locality map on page 1).

The entire catchment falls within the Cape of Good Hope Nature Reserve. Internal roads serving the Nature Reserve run along either side of the valley through which the stream flows (see Figure 1).

The Nature Reserve is administered and controlled by the Cape Divisional Council and an Advisory Board. It is also financially subsidized by the Cape Department of Nature and Environmental Conservation.

1.3 Abiotic Characteristics

The Buffels, which is hardly more than a seasonal stream, has a spring as its source in a small poorly defined catchment of approximately 5,75 km^2 (DL Clark, ranger, Cape of Good Hope Nat. Res. *in litt.*). The catchment is composed almost entirely of rocks of the Table Mountain Series (TMS) and of the weathered products of the parent rock. Most of the stream beds in the Cape Peninsula follow lines of weakness along joints or faults (Haughton, 1933).

Near its mouth the stream flows into an area of vegetation stabilized windblown sand which has partially filled the lower valley (Opie, 1967. The drift sand has its origins in a small bay situated between two rocky promontories. A band of older sands stretch across the peninsula from Buffels Bay to the western coastline at Brightwater (Opie, 1967).

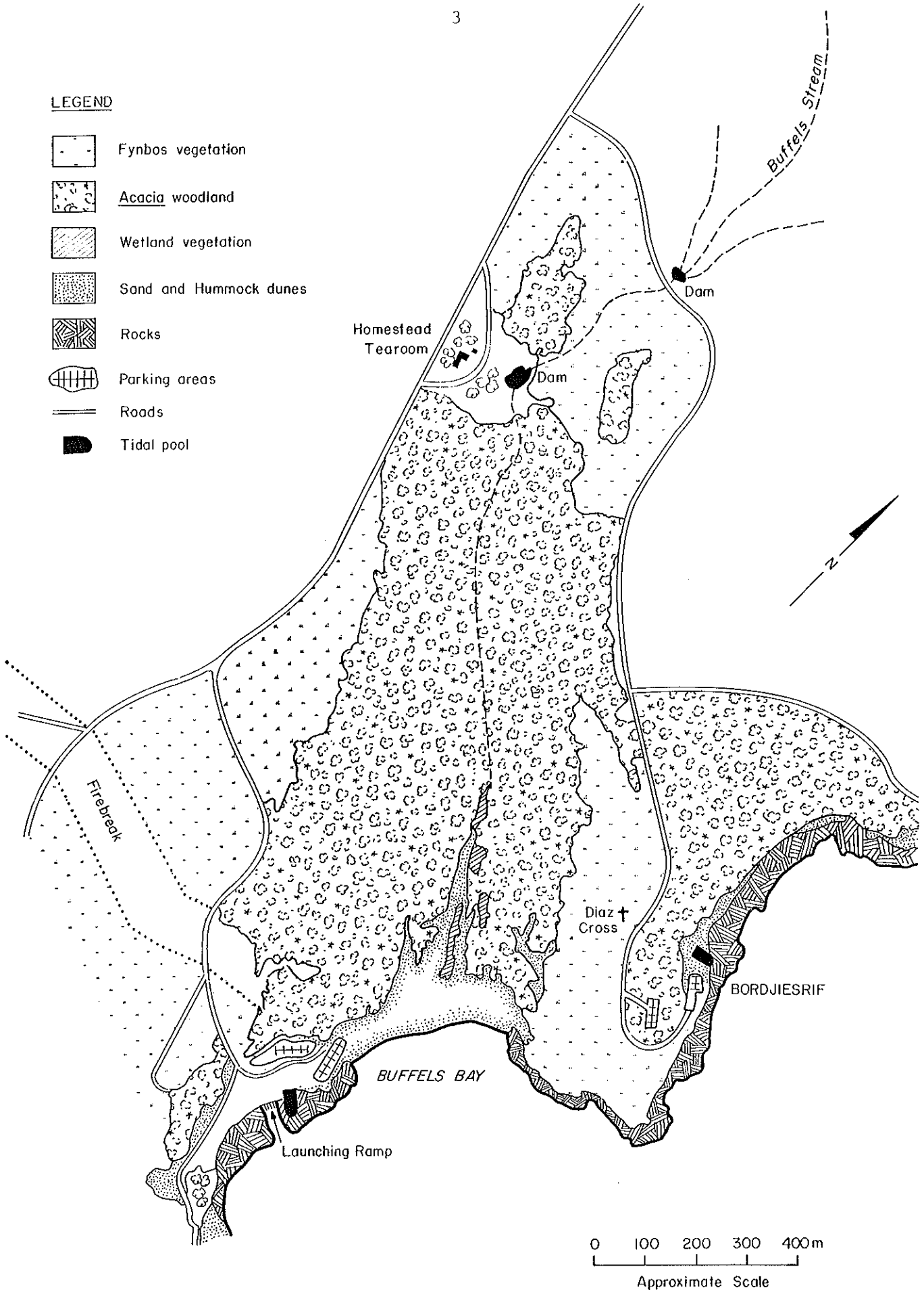


FIG. 1 : The Buffels (Wes) showing the main features at the mouth
(Drawn from aerial photograph 374/3 of Job 326 of April 1979)

The Buffels flows only during the winter months from May to August, and the driest month is February. There is a big local variation in rainfall as the recorded average total annual rainfall for Cape Point over a 57-year period was 355 mm while at Smitswinkel Bay situated 6 km to the north of the Buffels (Wes), it was 698 mm over a 31-year period (Smith-Baille *et al.*, 1976).

According to Oberholzer (1976) an unusual feature of the Buffels is visible surface drainage where it flows over the sand rather than sub-surface seepage.

Landownership/Uses

The Buffels is situated within the popular Cape of Good Hope Nature Reserve which is visited by up to 450 000 visitors per annum (Dept. of Nat. Conservation, 1970/71).

Three small dams of which two are shown in Figure 1, have been built in the upper part of the Buffels (Wes). At its source the stream fills a shallow concrete reservoir. it then flows into a shallow pond formed by the Bordjiesrif road. The water is channelled under the road and flows into an artificial dam below the Homestead tearoom (see Figure 1). Below the tearoom the stream follows its natural course to Buffels Bay through a dense thicket of alien vegetation (mainly *Acacia cyclops, A. saligna* and *A. longifolia*). The alien vegetation was orginally planted to fix a sand dune area which originated at the Buffels estuary and stretches inland in a north-westerly direction up to the tearoom (DL Clark, *in litt.*).

Recreational facilities consisting of a boat launching ramp, a tidal swimming pool and picnic sites are situated at Buffels Bay while another tidal pool and picnic sites are situated at Bordjiesrif to the north of Buffels Bay (see Plate I). These facilities are used by large numbers of people over weekends and during the holidays. A fenced-off security area is situated to the north of the Buffels Bay beach.

Estuary characteristics

The stream drains into a marshy slack of interconnected pools above a ridge of hummock dunes surrounding the edge of Buffels Bay. The steep, high energy beach configuration indicates that the river would at no time be an estuary but only an overflow from the marsh behind the dunes. A diagram drawn by GF van Wyk on the 21 October 1959 indicates a narrow stream approximately 15 cm deep and 1,8 m wide flowing out into Buffels Bay (Van Wyk, 1959, unpublished field notes). Under normal circumstances the marsh drains by sub-surface seepage through the dunes.

It appears that the Buffels Bay beach forms a "closed sedimentary cell" i.e. with an on and offshore movement of sand depending on the local wave and current conditions. A small amount of wind-blown sand is carried inland by the prevailing south-easterly winds during the dry summer months. The inland movement of this sand is today restricted by the vegetation covering the hummock dunes and the dense

thicket of alien vegetation behind these dunes. The average energy wave height[++] for Buffels Bay was calculated to be 1,05 m which classifies it as a medium to high energy beach (Valsbaai Strandverbeteringe 1980 and Swart and Serdyn, 1982).

No physico-chemical data on the stream are available. Van Wyk (1959, unpublished field notes) states that the water of the Buffels is typical brown peat-stained acid water which drains TMS-dominated catchments. No pollution of the system has been observed.

1.4 Biotic characteristics

Flora

The spatial distribution of the vegetation types found in the lower part of the Buffels River is shown in Figure 2 while Appendix I gives some of the species and physical features of each vegetation type, as observed during May 1982.

Numerous marine macrophytic algae were observed at that time on the rocky outcrops on either side of Buffels Bay, the most predominant being the kelps *Ecklonia maxima* and to a lesser extent *Laminaria pallida*. Large quantities of these kelps are washed up onto the beach where they form an important food source for insects and interstitial beach fauna.

The sand around the river course had a greenish tinge which probably indicating the presence of diatoms. The filamentous green alga *Cladophera* sp. was found in the river.

The terrestrial vegetation in the area studied was divided into three types: (a) Hummock Dunes, (b) *Typha capensis/Scirpus nodosus* Wetlands and (c) *Acacia cyclops* Woodland.

(a) The Hummock Dunes are typical of the area with sea wheat *(Agropyron distichum)*, klappiesbrak *(Tetragonia decumbens)*, sea pumpkin *(Arctotheca populifolia)*, strandblommetjie *(Senecio elegans)* and others.

(b) The *Typha capensis/Scirpus nodosus* Wetland area becomes inundated during winter. This vegetation includes numerous wetland and/or marsh species such as *Triglochin striata, Plantago carnosa, Berula thunbergii, Sporobolus virginicus* and others.

(c) *Acacia cyclops* Woodland: The rest of the area studied is completely dominated by rooikrans *(Acacia cyclops)*, although remnants of dune vegetation are still present in some areas (e.g. *Psoralea repens, Geranium incanum, Passerina* sp. (O'Callaghan 98[+] etc.)

[++]Average energy wave height: a value which reflects the distribution of average incident wave energy at inshore sites along the coast, presented as a wave height.

[+] (O'Callaghan 98[+]) indicates species not yet identified at the time of writing.

Oberholzer (1976) recorded that at Buffels Bay there were some well established thickets of milkwood *(Sideroxylon inerme)*.

Other vegetation types in the area have been well described by Taylor (1969, unpublished) and Opie (1967, unpublished).

Fauna

Van Wyk (1959, unpublished) recorded that the stream was of no importance for fish and also that there was no evidence of sand prawn (*Callianassa* sp.) in the streambed where the river flowed out to sea. Checklists of the reptiles, amphibians, birds and mammals which can be expected to occur at the Buffels River are given in Appendices II to IV.

A comprehensive list of birds which occur in the Cape of Good Hope Nature Reserve was given by Middlemiss and Langley (1975) who have recorded a total of 165 species.

The rare Cape clawed frog or Gill's platanna *(Xenopus gilli)* is known to occur in several ponds and dams within the Nature Reserve (Rau, 1978).

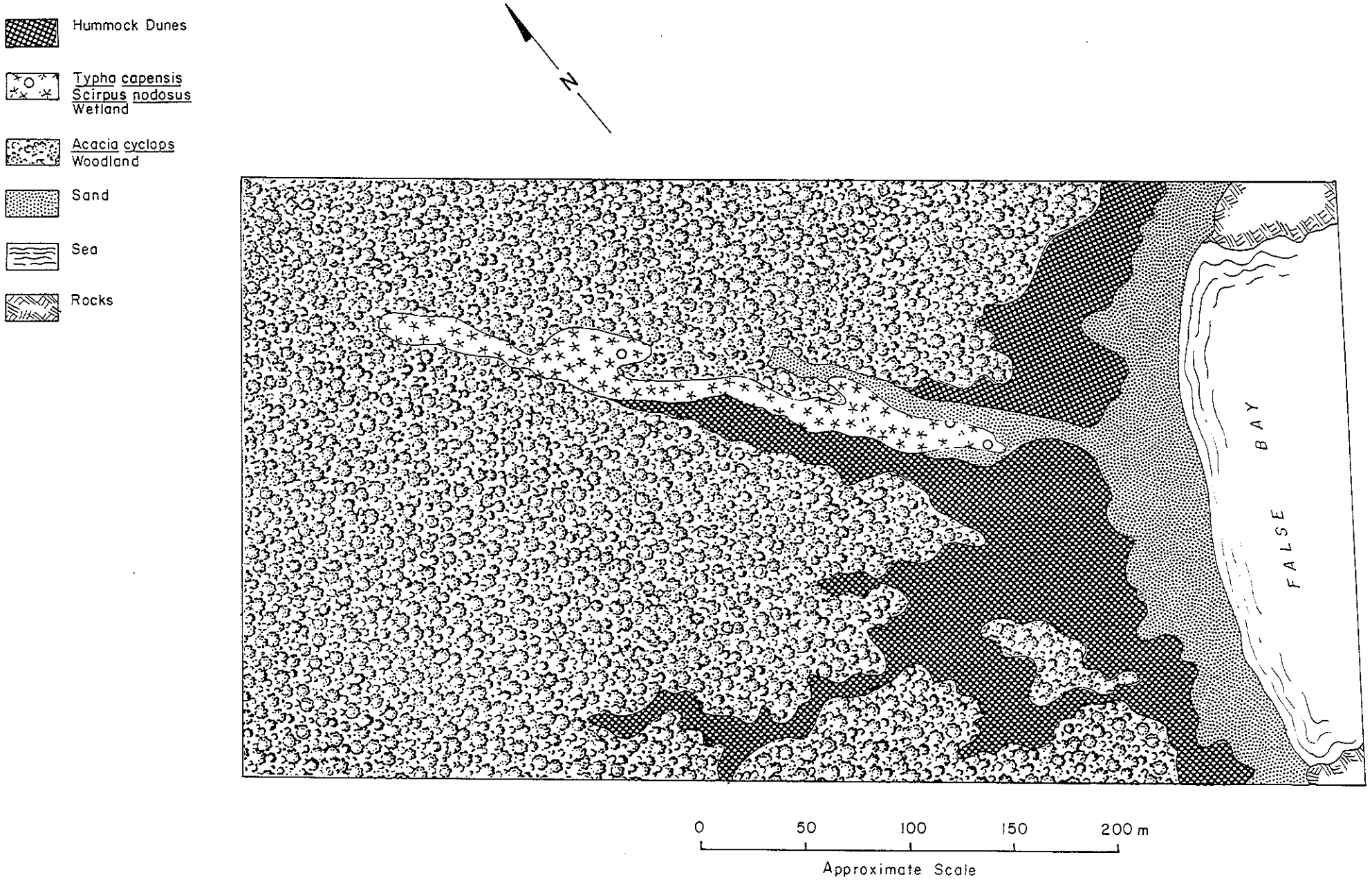
1.5 Synthesis

This small seasonal stream with its typical low pH peat-stained water is of no significance as an estuary. However, the recreational facilities situated at Buffels Bay in close proximity to the river fulfill a growing demand for this type of facility close to the metropolitan area of Cape Town. The authorities controlling the area will have to guard very carefully against over-utilization of this environment to ensure that the features which originally attracted the development are not destroyed. This could probably be achieved most effectively by limiting the numbers of people entering the reserve, as is done in many other areas where environmental quality has to be maintained.

The Nature Reserve with its world-renowned variety of endemic Cape flora can only benefit by preservation of an example of the typical coastal dune vegetation which occurs on the dunes stretching up from Buffels Bay. Every effort should therefore be made to continue with the present programme of eradicating the alien *Acacias* which are steadily encroaching on and displacing the indigenous vegetation.

The eradication programme should be aimed firstly at removing isolated scattered groups of alien vegetation before concentrating on the heavily infested areas.

FIG.2: Vegetation mapping units of the area studied at the Buffels (Wes) River



Appendix I: Species composition and physical features of the vegetation mapping units of the area studied at the Buffels River.

Mapping Unit	+Area (ha)	% of area studied	Cover (%)	Average height
Hummock dunes	2,20	14,5	10	0,1
Typha capensis/Scirpus nodosus Wetland	0,48	3,16	100	0,7
Acacia cyclops Woodland	9,05	59,66	100	0,5
Sand	1,67	11,01		
Sea	1,58	10,42		
Rocks	0,19	1,25		
Total	15,17			

(+Estimated values)

Hummock Dunes

Agropyron distichum (1); *Arctotheca populifolia* (1); *Hebenstretia cordata* (+); *Metalasia muricata* (1); *Passerina* sp. (O'Callaghan 83)(+); *Senecio elegans* (+); *Tetragonia decumbens* (1); *Trachyandra divaricata* (+).

Typha capensis/Scirpus nodosus Wetland

Acacia cyclops (1); *Berula thunbergii* (+); *Conyza pinnatifida* (+); *Cyperus sphaerospermus* (2); *Cyperaceae* (O'Callaghan 98)(2); *Epilobium hirsutum* (+); *Geranium incanum* (1); *Juncellus laevigatus* (1); *Lobelia anceps* (+); *Plantago carnosa* (+); *Plecostachys serpyllifolia* (+); *Psoralea repens* (1); *Samolus valerandi* (1); *Scirpus nodosus* (2); *Senecio maritimus* (+); *Sporobolus virginicus* (2); *Triglochin striata* (+); *Typha capensis* (2).

Acacia cyclops

Acacia cyclops (5).

The symbols in brackets following each species name, represent Braun-Blanquet Cover Classes as follows:

r	-	1 - few individuals, cover less than 0,1% of area
+	-	occasional plants, cover less than 1% of area
1	-	abundant number, cover 1 - 5% of area
2	-	any number, cover 6 - 25% of area
3	-	any number, cover 26 - 50% of area
4	-	any number, cover 51 - 75% of area
5	-	any number, cover 76 - 100% of area.

Appendix II: Reptiles and Amphibians occurring at or near the Buffels River (DL Clark, *in litt.*).

Reptiles

Silver sand lizard	-	*Scelotes bipes*
Ocellated sand lizard	-	*Meroles knoxii (= Scaptira knoxii)*
Cross-marked snake	-	*Psammophis crucifer*

The following may occur:

Common water snake	-	*Lycodonomorphus rufulus*
Herald snake	-	*Crotaphopeltis hotamboei*
Mole snake	-	*Pseudaspis cana*

Amphibians

Cape sand frog	-	*Tomopterna delalandii*
Cape river frog	-	*Rana fuscigula*

Appendix III: Birds sighted at the Buffels River mouth (DL Clark, *in litt.*)

Roberts Number	Common name	Roberts Number	Common name
47	White-breasted Cormorant	235	White-fronted Sandplover
48	Cape Cormorant	686	Cape Wagtail
287	Southern Black-backed Gull	873	Cape Bunting
289	Hartlaubs Gull	581	Cape Robin
291	Common Tern	543	Cape Bulbul
296	Sandwich Tern	-	Cisticola sp.
298	Swift Tern	-	Mouse bird sp.

Appendix IV: Mammals sighted and/or identified from spoor (DL Clark, *in litt.*)

Eland (only 2 in area)	-	*Taurotragus oryx*
Mountain zebra (4 animals (1 herd - occasionally other family groups)	-	*Equus zebra hartmannae*
Grysbok	-	*Raphicerus melanotis*
Chacma baboons (1 resident troop of about 50 animals)	-	*Papio ursinus*
Genet	-	*Genetta* sp.
Grey mongoose	-	*Herpestes pulverulentus*
Marsh mongoose	-	*Atilax paludinosus*
Porcupine	-	*Hystrix africaeaustralis*
Cape dune mole rat	-	*Bathyergus suillis*
Striped mouse	-	*Rhabdomys pumilio*

2 ELSIES

2.1 Historical Background

Although the Elsies River is a small relatively insignificant stream, it played an important part in the early history of the Cape. Water from this river was used in the development of Simonstown which served as a winter anchorage for ships visiting the Cape. In 1743 the Dutch East India Company established an official station and anchorage at Simonstown and a map drawn in 1780 shows the course of the river which was originally known as "Elze Rivier" (Burman, 1962). The property at the upper end of the river is named "Eljes River" (1:50 000 Sheet 3418 AB & AD). According to Burman (1962) this name is probably derived from the "Els" trees (Rooi-els and Wit-els) which would have been found in the wooded kloofs through which the river ran in the early days.

An old water-mill which is presently being restored and incorporated with the South African Navy's Recreation complex was sited on "Wellcome" farm on the banks of the Elsies river at the turn of the century. (Lieut. Sinclair, pers. comm. and Burman, 1962).

In 1912 most of the upper catchment of the river was acquired by the Simonstown Municipality when they bought the farm "Brooklands". This was to ensure a permanent water supply for the town (Burman, 1962). In October 1959 GF van Wyk surveyed the estuary and his sketch map and a photograph of the estuary shows an open stretch of water just above the first road bridge approximately 10 m wide (GF van Wyk, unpublished field notes), (see Figure 1).

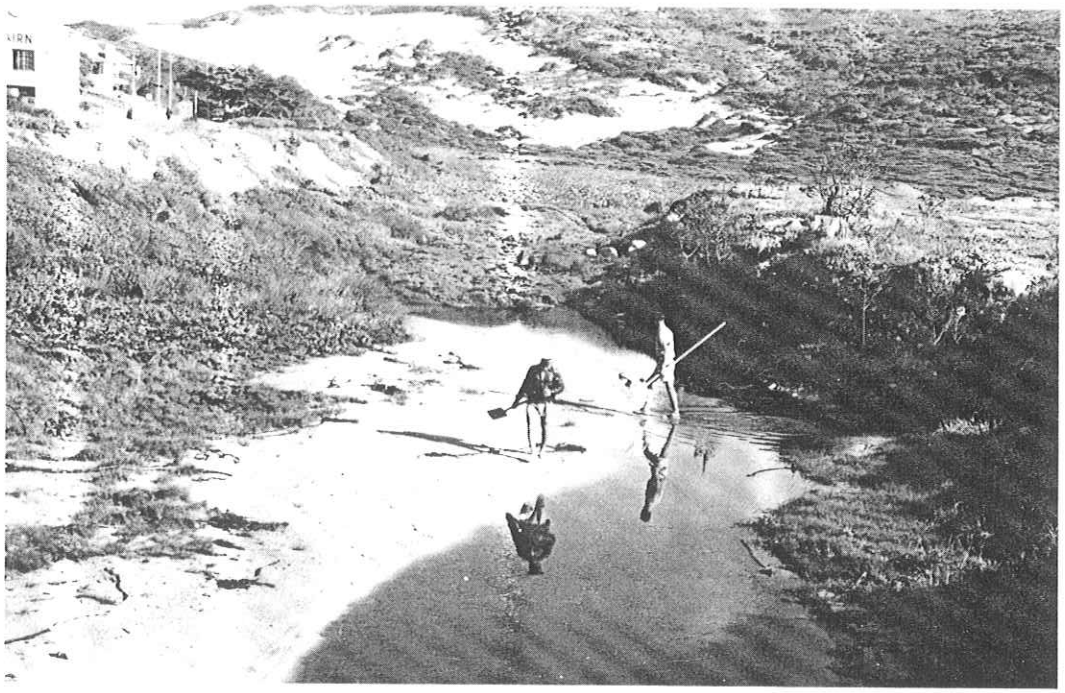


FIG. 1: The Elsies River estuary upstream of the main road bridge on 59-10-21 (GF van Wyk).

Aerial photographs taken in 1944 show a small lagoon upstream of the road bridge and an area of sparsely vegetated vlei-land followed by an extensive bare dune-field stretching north-westwards up the valley (see Figure 2).

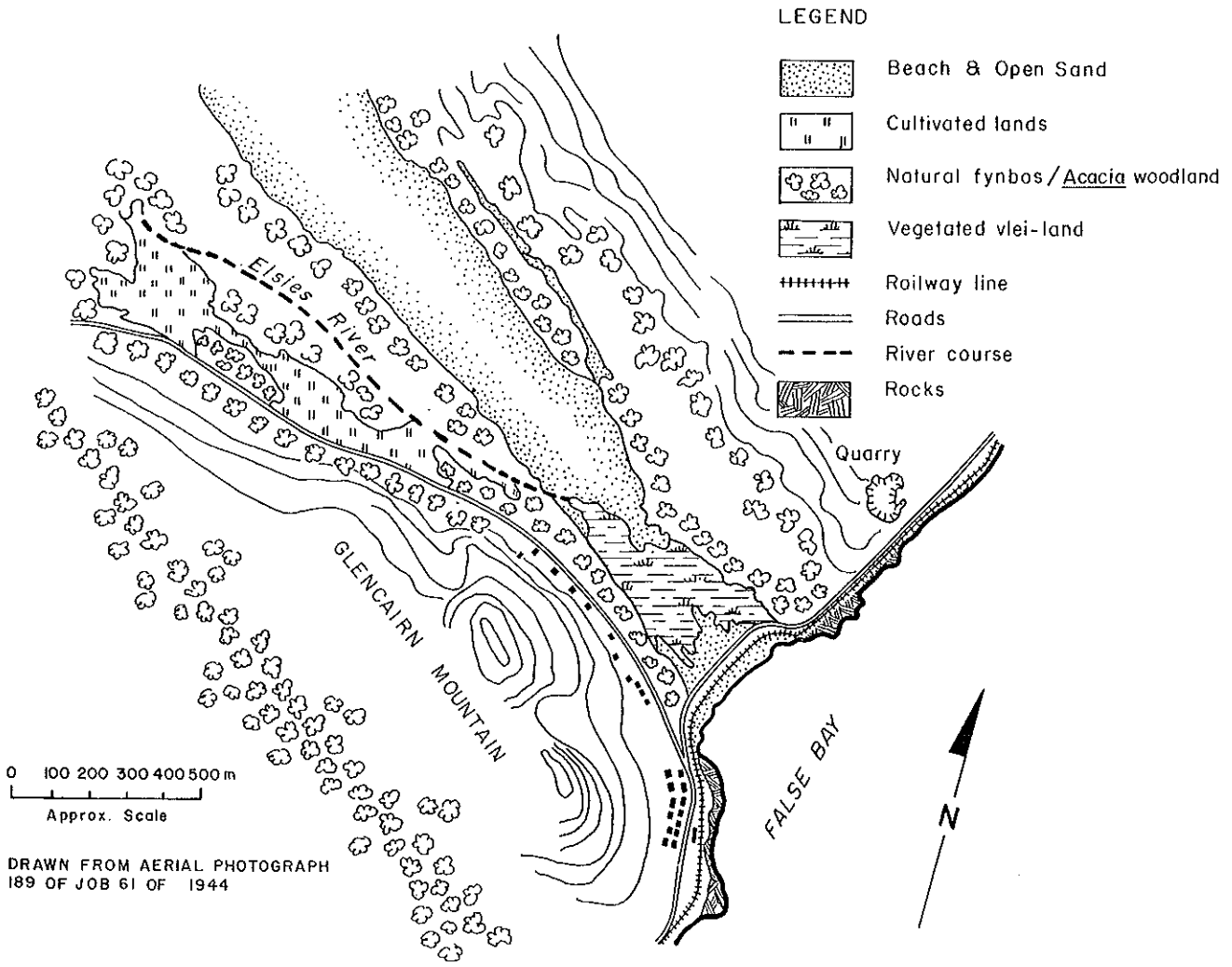


FIG 2: Morphometry of the Elsies River estuary in 1944. (Drawn from aerial photograph No. 189 of Job 61.)

2.2 Location and Local Authorities

The Elsies River mouth is situated within a small bay in the north-western part of False Bay (see locality map page 1). The co-ordinates for the rivermouth are 34°10'S and 18°26'E.

The river runs through an area controlled by four different authorities i.e, the Simonstown Municipality (upper catchment and the mouth region), the State (S.A. Naval residential area of Da Gama Park and the S.A. Navy Recreation Complex), Cape Divisional Council (middle reaches, not controlled by the State) and the S.A. Transport Services (Railway property at the mouth).

Access to the river and rivermouth area is via the main Cape Town to Simonstown road which crosses the river at its mouth. The mouth

region which was previously a marshy vlei-land is now dominated by major road junctions. (see Plate II). These routes serve the week-day commuters to Simonstown from Glencairn, Da Gama Park, and the Southern Suburbs of Cape Town. Over weekends a considerable amouht of traffic to the recreational areas of Simonstown and beyond, is channelled through the Elsies River Valley. (see Figure 3).

2.3 Abiotic Characteristics

River Catchment

he river which is approximately 8 km long, drains a catchment of about 18 km^2. The upper part of the catchment consists of a plateau ringed by low mountains. Numerous small streams which drain this area join to form the Elsies River. From the plateau the river flows down a fairly steep narrow valley which flattens out to form a vlei within the last 1,2 km before reaching the sea (1:50 000 Sheet 3418 AB and AD).

The geology of the upper and middle catchment areas is typified by the dominance of rocks of the Table Mountain Series, while the lower part of the river runs through an area of wind-blown sands (Haughton, 1933). These sands have, in recent years been fixed by means of alien vegetation such as rooikrans *(Acacia cyclops)*. The soils of the Elsies catchment fall within the "Da Gama Zone" of Smith-Baillie *et al.* (1976), who describe them as being shallow, stony, infertile and usually acid with a pH of less than 5. The aeolian (wind-blown) soils are deeper, very sandy and seldom become waterlogged.

According to Mr C Chevalier, the Town Clerk of Simonstown the river is not perennial but flows generally during the months of May to November.

There are no flow records, but the Municipality extracts an average of $1,3 \times 10^6$ m^3 per annum from two supply dams fed by the river in the upper catchment. These are the Lewis Gay dam with a capacity of 182×10^3 m^3 and the Kleinplaas dam with a capacity of $1\ 300 \times 10^3$ m^3 built in 1965 and raised in 1970 (Simonstown Town Engineer - Mr N Grant, pers. comm.). The dams have, up until 1982, met the water supply requirements of the Simonstown Municipality and of the South African Navy. As from 1983 however, this supply will be augmented with water supplied by the Cape Town City Council (N Grant, pers comm.).

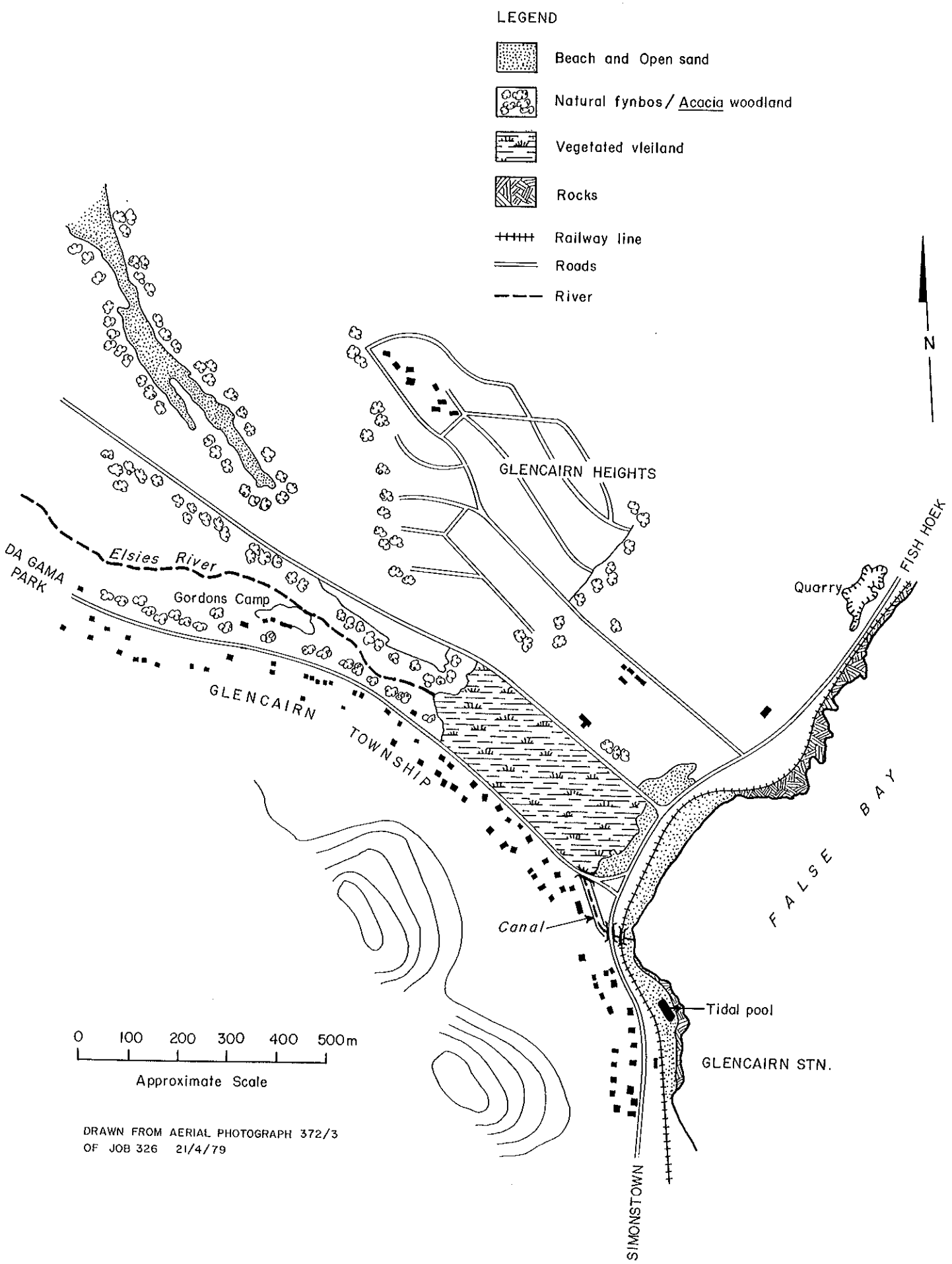
A new dam is planned for the Elsies River above the present Lewis Gay dam. This dam will trap all the water at present not being collected by the Lewis Gay dam and it will also be augmented by a canal from the Klaver River catchment situated to the west of Elsies catchment (N Grant, pers comm.).

The average total annual rainfall for Simonstown taken over a 23-year period is 809,5 mm (Smith-Baillie *et al.* 1976).

No records of noteworthy floods or of abnormal level fluctuations could be traced, but the steepness of the topography makes the river and particularly the valley-bottom liable to flooding of only short duration during periods of high rainfall.

The land along the river is owned variously by, the State, the Simonstown municipality and private owners.

FIG.3 : The Elsies River Mouth and Vlei in 1981



A certain amount of soil erosion and silt deposition is said to occur at the upper end of the vlei area. This has been ascribed to the clearing of vegetation along the river banks adjoining the Gordon's Camp property, the "dredging" of the river where it flows through the Gordons property, and earth-moving activities alongside the river banks during the development of the sports and recreation complex for the S.A. Navy. It is also maintained that the river banks are trampled by horses stabled at the S.A. Navy sports complex (Department of Environmental Affairs, Internal report, 1982).

Land usage in the catchment consists of the private residential areas of Da Gama Park, Glencairn and the new Glencairn Heights township which at present is largely undeveloped. Glencairn and Glencairn Heights consist of 700 erven of which 250 are developed at present. Additional sub-divisions are also being considered (Mr. Attwell, Simonstown Municipality, per. comm.). All the residential areas are situated on the slopes overlooking the river valley and vlei.

Three of the private riparian owners situated just above the estuarine area are the service organizations of Rotary, Gordon's and the Moths who run holiday camps on their properties.

The two dams constitute obstructions to river flow in the upper catchment, while below the dams there are a few smaller weirs and low-level road crossings of the stream bed, none of which appear to impede the flow of water to any great extent.

Estuary

(For the purposes of this report the vlei and reedswamp will be regarded as part of the estuary - see Figure 3).

In its lower reaches the Elsies River forms a fresh-water wetland or vlei, 500 m long and 200 m wide behind a minor dune barrier bordering a small beach just north of the Glencairn Railway Station (see Figure 3 and Plate II). This dune barrier is dominated by the railway line and road linking Simonstown with Cape Town. There are small sparsely vegetated hummock dunes between the railway line and the beach.

The vlei drains via a canal approximately 130 m long situated against the southern side of the valley (see Figure 3). Seawater seldom flows into the canal and the system cannot really be classified as an estuary.

During dry seasons and because of the dams in the catchment, the vlei often dries out leaving no free standing water, as during the ECRU survey on 25 May 1982.

Two road bridges, each with two spans of 4 m, cross the river at its mouth. These are followed by the railway bridge which is closest to the sea and which has three spans of 7 m each. The railway embankment abutting the bridge is subject to erosion during storms and spring tides as is evidenced by the stone embankment and sleepers placed on the seaward side of this embankment.

When the river does flow, obstruction would be caused mainly by sand washed in from the beach which is deposited in the channel beneath and between the railway bridge and the first road bridge. In addition to this, as was observed at the time of the ECRU Survey on 25 May 1982, a steep beach bar can be formed seaward of the railway bridge which completely cuts off the river from the sea. Drainage of the vlei by general seepage through the sand is probably also impeded by compaction beneath the road and railway line running across the front of the vlei area.

It can thus be said that the dynamics of the Elsies River mouth are governed naturally by a beach bar and artificially by sand accumulation underneath the road and railway bridges. These sand barriers would only be breached after heavy rains and a build-up of water in the vlei.

The beach itself is bounded by rocky headlands on each side. No apparent signs of long-shore sand movement around these headlands could be detected. This could indicate that the Elsies River beach dynamics are dominated to a large extent by "closed sedimentary cell" conditions. Variations in beach profile and sand volume will therefore, largely be the expression of on- and offshore sand movement. Sand eroded from the beach is stored temporarily in the off-shore breaker bar from where it returns to the beach during accretional conditions.

A certain amount of sand is, however, lost from the beach by wind action during the strong south-easterly winds which prevail in summer. This is borne out by the fact that the S.A. Transport Services and the Simonstown Municipality experience problems with drift-sand on the railway line and road respectively (Mr Loubser and N Grant, pers. comm.), (see Figure 4).

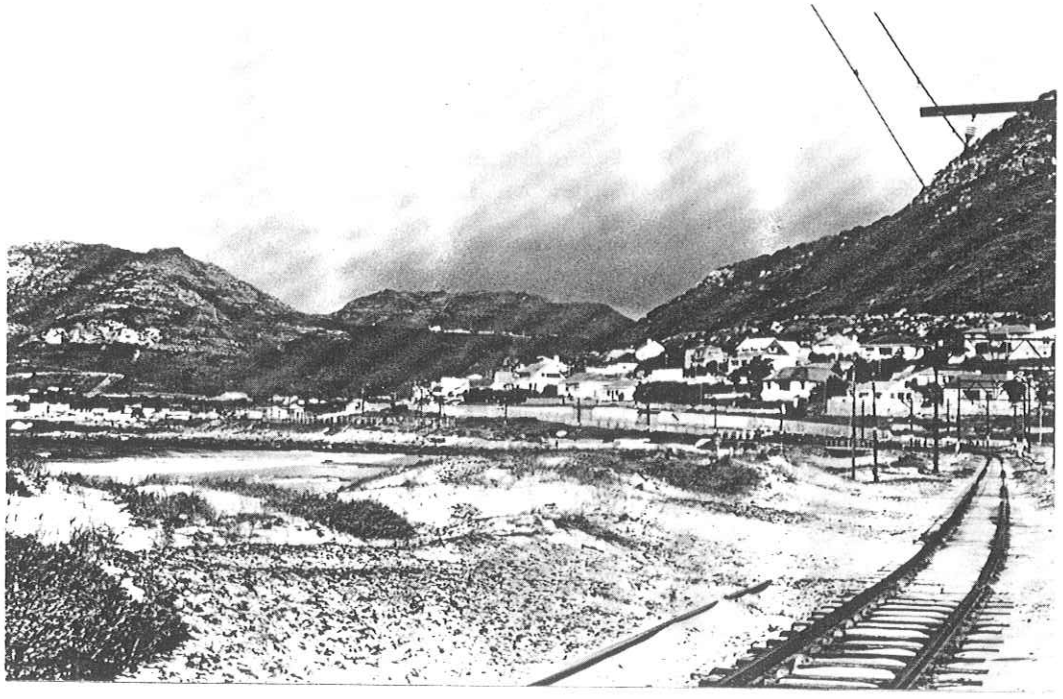


FIG. 4: Hummock dunes and wind blown sand on the railway tracks at the Elsies River mouth (ECRU 82-05-25).

Under present conditions the sand, which blows onto the railway line and road, has to be removed mechanically. Since the beach between the rocky headlands is in equilibrium the fact that sand is lost from the beach due to wind action indicates that some mechanism must exist to replenish this sand. Two possible ways in which this can be done are:

(1) Since the beach slope is very flat it is possible that the beach is replenished with fine sand from a shallow offshore area.

or (2) Some longshore movement of sand around the headlands replenishes the beach, although no signs of such movement could be detected at the time of the ECRU Survey on 25 May 1982.

It is also possible that some combination of these two processes could be taking place.

The average energy wave height[+] for the Glencairn Beach was calculated to be 0,58 m which classifies it as a low energy beach (Valsbaai Strandverbeteringe, 1980 and Swart and Serdyn, 1982).

From early aerial photographs it can be seen that historically, an extensive dunefield stretched up from the beach along the eastern side of the valley and spilled over into the Noordhoek basin (Aerial photography Job No 61 of 1944). This dunefield has now been fixed with vegetation.

Land ownership at the estuary is divided between private riparian owners, S.A. Transport Services, who control the land on which the railway track is situated, and the foreshore up to the HWM, and the Simonstown Municipality who owns the entire vlei area (C Chevalier, pers. comm.).

At present the vlei and marshland are not used but they have an important aesthetic appeal to the township developments which overlook the vlei. Furthermore, the reedbeds serve to filter and damp the effects of floods which occur periodically as a result of the channelling of storm water run-off into the river from the mountain slopes and developing townships.

According to Mr Chevalier of the Simonstown Municipality the vlei area is recognised as an important bird habitat which the Town Council wishes to preserve (C Chevalier, *in litt.*). Limited reclamation of the vlei has taken place at its southern end, in the vicinity of the main Cape Town to Simonstown road.

The Glencairn (Elsies River) beach is an important recreational amenity not only for the residents of Glencairn and Da Gama Park but also for the general public of Cape Town, as it is easily accessible by the suburban train service which runs between Cape Town and Simonstown. This popularity necessitates that certain controls and facilities be provided by the local authorities. The beach at the rivermouth is restricted for bathing only, while surfboards and paddle-skis are permitted towards the eastern side of the beach. A tidal pool is situated on the rocks to the south of the Elsies River mouth,

[+]Average energy wave height: an index which reflects the distribution of average incident wave energy at inshore sites along the coast, presented as a wave height.

and toilet facilities are provided at the tidal pool and on the landward side of the main road next to the river channel.

Pollution and Public health aspects

The majority of dwellings within the Elsies River catchment are connected to Simonstown's water-borne sewerage system. A sewerage pump station is situated at the rivermouth and on rare occasions when pump failure occurs raw sewage is discharged into the river-course.

According to the Simonstown Town Engineer, the "floc" from the reservoir water treatment plant is discharged directly into the Elsies River below the dams. It has been reported that discoloured water and die-off of riverine vegetation has occurred in the vicinity of the S.A. Navy Sports Centre. This was attributed to the discharges of flocculants from the water treatment plant (Sports Officer, SA Naval Command, pers comm.).

Water samples taken by the Cape Divisional Council, Water Pollution Control Branch on 13 July 1982 at two stations on the river situated just upstream of the main road bridge (see Figure 3) and approximately 2,5 km further upstream, gave the following results: Total phosphorous values of 0,5 mg/ℓ and 0,7 mg/ℓ, and ammonia nitrogen - N in mg/ℓ of <0,1 respectively. These values are low and from the above-mentioned data it appeared that the system was unpolluted. The role of wetland vegetation in absorbing excess nutrients must, however, not be overlooked.

2.4 Biotic Characteristics

Flora

The spatial distribution of the vegetation mapping units is shown in Figure 5, while Appendix I shows some of the species in, and physical features of, each unit.

Algae: Numerous macrophytic marine algae are present on the rocks in the inter-tidal area to the south of the river mouth. At the time of the ECRU survey on 25 May 1982 kelp had been washed up onto the beach and under the bridges. This consisted mainly of *Ecklonia maxima* with some *Laminaria pallida* and *Macrocystis angustifolia*.

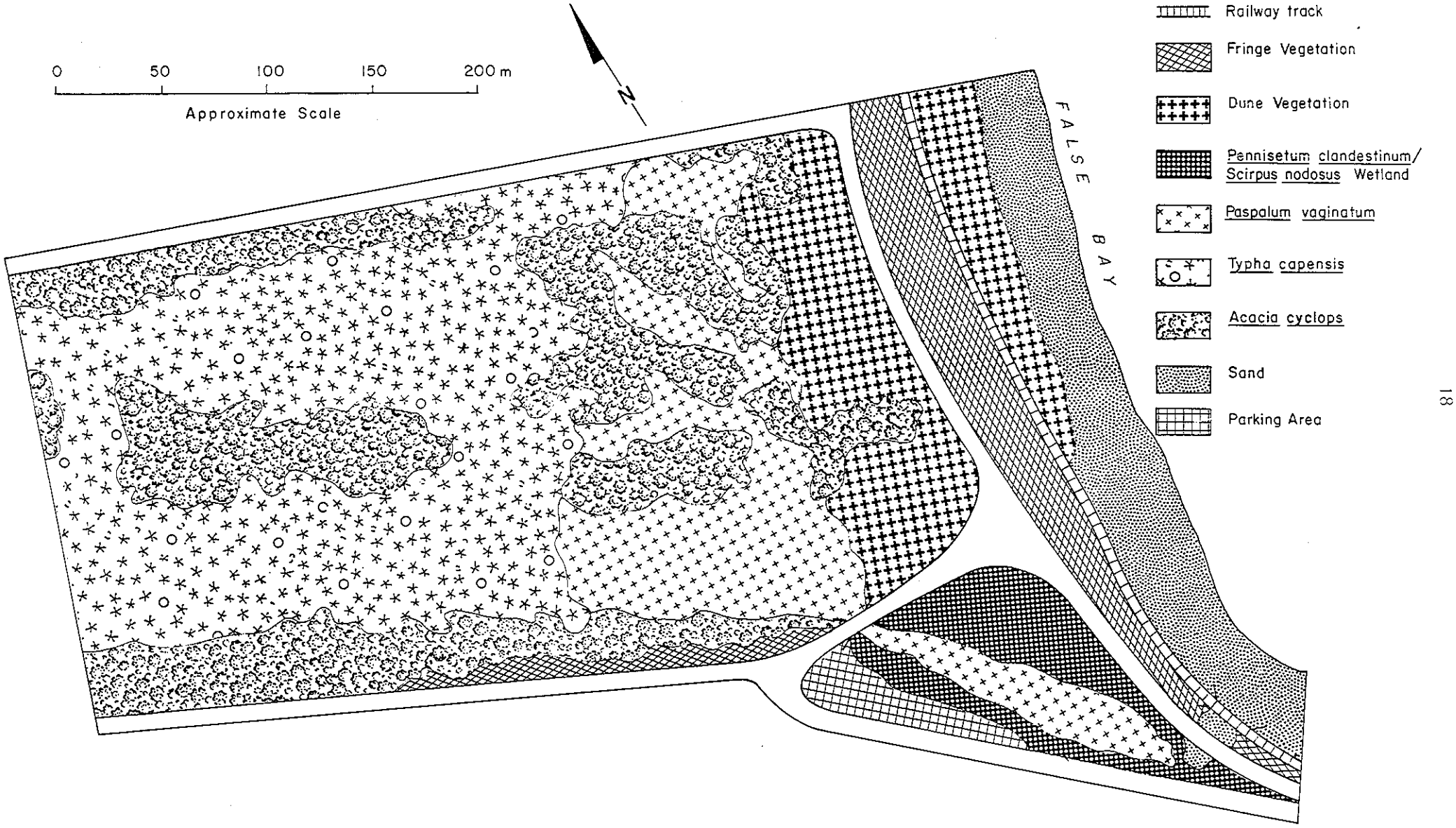
The terrestrial vegetation has been divided into six mapping units (see Figure 5) which are briefly described below:

(a) Fringe Vegetation: The area between the main road and the railway track has become dominated by kikuyu *(Pennisetum clandestinum)* and Bermuda quick grass *(Cynodon dactylon)*. However, there are still a number of natural dune plants in this area, such as Hottentots fig *(Carpobrotus edulis)* kinkelbossie, *(Tetragonia fruticosa)*, gousblomme *(Gazania rigens)* etc.

The Da Gama Park road is fringed with a similar vegetation type in some areas, but with fewer species.

(b) Dune Vegetation: The hummock dunes on the seaward side of the railway line are covered mainly with sea wheat *(Agropyron distichum)*, klappiesbrak *(Tetragonia decumbens)* and soutbossie *(Chenolea diffusa)*.

FIG.5: Vegetation mapping units of the area studied at the Elsies River



To the west of the main road, typical back-dune vegetation includes numerous shrubs such as blombos, *(Metalasia muricata)*, *Plecostachys serpyllifolia* and others.

(c) The area described as *Pennisetum clandestinum/Scirpus nodosus* Wetland is adjacent to the lower part of the river. From some of the plants still present in the area, it would seem that this area was once a dune shrubland. However, this area has been disturbed and domestic and alien plants have been allowed to become established.

(d) Extensive areas at the lower part of the river have become dominated by *Paspalum vaginatum*. This grass generally grows in very wet areas or in areas that become inundated during the rainy season.

(e) Large areas higher up the river course are dominated by bullrushes *(Typha capensis)*.

Paspalum and Typha could be very important in stabilizing sand and utilizing nutrients in the water which enters these wetland areas.

(f) Rooikrans *(Acacia cyclops)* is spreading rapidly as is indicated by Aerial Photography Job No 61 of 1944 and Job No 391 of 1981.

Fauna

According to GF van Wyk there were no burrowing bait species present in the estuarine area on 21 October 1959. He noted, however, numerous shoals of "small fish" in the shallow water. These would probably have been shoals of small mullet (*Mugil* sp.).

C Gaiger of the Cape Department of Nature and Environmental Conservation surveyed the system on the 1 September 1982 and also found no signs of any burrowing bait organisms.

Complete checklists for the reptiles and amphibians recorded within the area covered by the 1:50 000 quarter degree grid squares of the Cape Penisula 3418 AB & AD are given at the end of the overall report. This covers the estuarine area as well as the entire catchment of the Elsies River.

According to Mr T Oatley, a local resident at Glencairn, the frog life is abundant when there is water in the system and he has also recorded the following snakes at the vlei; Mole snake *(Pseudaspis cana)*, russet garden snake *(Duberria lutrix)*, Herald snake *(Crotaphopeltis hotamboeia)* and the Brown water snake *(Lycodonomorphus rufulus)*.

The birds and mammals recorded by Mr Oatley at the Elsies River vlei are cited in Appendices II and III. The birds recorded are only those found within the confines of the vlei and its marginal vegetation. Some species, indicated in Appendix II by an asterisk, are entirely dependent on the vlei and will leave the area if the vlei is destroyed.

A checklist of the mammals recorded from the entire 1:50 000 quarter degree grid squares of the Cape Peninsula 3418 AB and AD is given at the end of this report.

2.5 Synthesis

Although a relatively small stream, the Elsies River assumed some importance soon after European settlement in the Cape in the early 1700s. This was because fresh water was required for the developing village of Simonstown. The stream also supplied irrigation water to the farms which were established along its banks. The attractive slopes overlooking the stream and at the head-waters eventually became the residential areas of Glencairn and Da Gama Park.

The necessity to provide access links between Cape Town and Simonstown resulted in the bridges for the railway line and road being built across the mouth of the river where it flows out into False Bay. The subsequent need to provide for improved access and traffic flow to and from the developing residential areas along the Elsies River valley led to further road works at the mouth of the river and the filling in of a lower portion of the vlei.

Despite this major manipulation of the lower part of the Elsies River valley and the extensive development that has, and is, taking place on the banks of the stream. The vlei and the valley retain the aesthetically pleasing appeal which originally attracted the residential development. Furthermore the vlei and the reedbeds serve a vital function in dampening the effects of floods and filtering out excess silt and nutrients which enter the system. Increasing residential and recreational development in the catchment with the concommitant increase in storm water run-off reinforces the need to retain the vlei and stream together with its riverine vegetation in as natural a state as possible.

The encroachment of rooikrans and other alien plant species must be controlled. If this is not done these species will eventually dominate the entire riverine and wetland areas, completely altering the habibat for the present bird and mammal communities as well as eliminating the inherent desirable characteristics of the indigenous vegetation.

The vlei area and reedbeds support an interesting community of wetland birds and small mammals. The valley has a number of historical features such as: the old watermill on Wellcome farm which the South African Navy intends restoring together with the stream in its natural state for incorporation within their recreation complex. An old chapel and "Mans" built in 1903 at the top end of the vlei and the original Ohlsons glass factory and silica mine on the northern side of the valley near the mouth. All these features justify the retention of the vlei and the stream as public open space which at the same time will meet the needs of environmental education and nature conservation.

The value of the vlei and the river for the purposes outlined above, requires very careful consideration within the context of the need for water for the Simonstown Municipality. This relates to the plans by the Municipality for a third dam in the catchment of the Elsies River. It is recommended that before the plans for this dam reach an advanced stage, a full environmental assessment be made on the impact of the dam on the Elsies River and Vlei.

Appendix I: Species composition and physical features of the vegetation mapping units of the area studied at the Elsies River.

	Mapping Units	Area[+] (ha)	% of area studied	Cover (%)	Average height (m)
(a)	*Pennisetum clandestinum/ Cynodon dactylon* Fringe Vegetation	0,87	6,21	85	0,1
(b)	Dune Vegetation	1,32	7,82	70	0,2
(c)	*Pennisetum clandestinum/ Scirpus nodosus* Wetland	0,53	3,70	100	0,2
(d)	*Paspalum vaginatum*	1,52	10,70	100	0,5
(e)	*Typha capensis*	3,76	26,32	100	1,2
(f)	*Acacia cyclops*	3,01	21,00	95	1,2
	Roads and Rail	1,53	10,87		
	Residential	0,67	4,77		
	Sand	1,13	7,98		
	Total	14,34			

([+]Estimated values)

(a) Fringe Vegetation

Carpobrotus edulis (1); *Cynodon dactylon* (1); *Gazania rigens* (+); *Oxalis pes-caprae* (+); *Pelargonium capitatum* (+); *Pennisetum clandestinum* (5); *Sisymbrium capense* (+); *Solanum quadrangulare* (+); *Sporobolus viriginicus* (+); *Stenotaphrum secundatum* (+); *Tetragonia fruticosa* (+).

(b) Dune Vegetation

Acacia saligna (+); *Agropyron distichum* (1); *Arctotheca populifolia* (1); *Chenolea diffusa* (1); *Gazania rigens* (r); *Geranium incanum* (2); *Hebenstretia cordata* (+); *Helichrysum* sp (O'Callaghan 65) (+); *Malva parviflora* (+); *Metalasia muricata* (+); *Pelargonium capitatum* (+); *Plantago carnosa* (+); *Plecostachys serpyllifolia* (+); *Polygonum maritimum* (+); *Senecio elegans* (+); *Tetragonia decumbens* (2).

(c) *Pennisetum clandestinum/Scirpus nodosus* Wetland

Acacia cyclops (3); *A. saligna* (+); *Carpobrotus edulis* (+); *Chrysanthemoides monolifera* (1); *Cynodon dactylon* (1); *Fumaria officinalis* (+); *Myoporum serratum* (+); *Oxalis pes-caprae* (1); *Pennisetum clandestinum* (4); *Plecostachys serpyllifolia* (2); *Scirpus nodosus* (3); *Senecio* cf *angularis* (+); *Tropaeolum majus* (1); *Zantedeschia aethiopica* (3).

(d) *Paspalum vaginatum*

Paspalum vaginatum (5).

(e) *Typha capensis*

Typha capensis (5).

(f) *Acacia cyclops*

Acacia cyclops (5).

The symbols in brackets following each species name, represent Braun-Blanquet Cover Classes as follows:

r - 1/few individuals, cover less than 0,1% of area
\+ - occasional plants, cover less than 1% of area
1 - abundant, cover 1 - 5% of area
2 - any number, cover 6 - 25% of area
3 - any number, cover 26 - 50% of area
4 - any number, cover 51 - 75% of area
5 - any number, cover 76 - 100% of area

Appendix II: Birds of the Elsies River vlei recorded from April 1981 to January 1983 (T Oatley, *in litt.*).

Roberts No.	Common name	Roberts No.	Common name
54	Grey Heron	604	+Cape Reed Warbler
55	Black-headed Heron	609	+Cape Sedge Warbler
61	+Cattle Egret	618	Grassbird
69	+Night Heron	638	+Grey-backedCisticola
72	Hamerkop	646	+Le Vaillants' Cisticola
130	Black-shouldered Kite	651	Karoo Prinia
181	Cape Francolin	655	Dusky Flycatcher
245	Blacksmith Plover	682	Paradise Flycatcher
289	Hartlaubs Gull	686	Cape Wagtail
316	Cape Turtle Dove	707	Fiscal Shrike
317	+Laughing Dove	709	Boubou Shrike
357	+Burchells' Coucal	722	Bokmakierie
390	Speckled Coly	733	European Starling
394	Pied Kingfisher	760	Lesser Double-Collared Sunbird
395	+Giant Kingfisher	775	Cape White-eye
397	+Malachite Kingfisher	786	Cape Sparrow
432	Pied Barbet	799	Cape Weaver
543	Cape Bulbul	810	Cape Bishop
551	Sombre Bulbul	843	Common Waxbill
553	Olive Thrush	857	Cape Canary
581	Cape Robin	863	Bully Canary

+Species likely to leave the area if the vlei is destroyed.

Appendix III: Mammals recorded at the Elsies River vlei (T Oatley, *in litt.*).

Striped Field mouse	-	*Rhabdomys pumilio*
Pygmy mouse	-	*Mus minutoides*
Vlei rat	-	*Otomys irroratus*
Cape Dune molerat	-	*Bathyergus suillus*
Cape Golden mole	-	*Chrysochloris asiatica*
Genet	-	*Genetta* sp
Cape Grey mongoose	-	*Herpestes pulverulentus*
Cape Clawless otter	-	*Aonyx capensis*
Grysbuck	-	*Rhaphicerus melanotis*
Porcupine	-	*Hystrix africaeaustralis*

3. SIR LOWRY'S PASS RIVER

3.1 Historical Background

The Sir Lowry's Pass River takes its name from the pass over the Hottentots Holland Mountains which connects the Cape Flats with the Overberg.

Sir Lowry's Pass which was opened in July 1830 replaced the precipitous Hottentots Holland Kloof route (Burman, 1963). The catchment was explored early in the European occupation of the Cape. It was called the Hottentots Holland apparently because of its beauty and fertility (Heap, 1970). Land grants to settlers were made in the early Eighteenth Century. In 1711 Fortuin (now Broadlands) was established and by the end of the century most of the land had been apportioned to settlers (Heap, 1970). Gordon's Bay village at the mouth of the river was formally established in 1855 although the bay had long been used by fishermen, whalers and sailors as shelter and as a watering place (Heap 1970).

3.2 Location and Local Authorities

The Sir Lowry's Pass River drains the western slopes of the southern portion of the Hottentots Holland Mountains and enters the north-east corner of False Bay at Gordon's Bay. The mouth itself lies on the western side of Gordon's Bay village at $34^{\circ}09'S$; $18^{\circ}52'E$.

3.3 Abiotic Characteristics

The river rises in Katjiesboskloof on the slopes of the Langkloofberg in the Hottentots Holland Mountain range at an altitude of approximately 1 300 m (1:50 000 topographic sheet 3418 BB Somerset West). The western margin of the catchment is ill-defined whereas to the east the Hottentots Holland Mountain scarp forms a sharp boundary. The northern boundary is formed by a spur running westwards from the Langkloofberg to the Skapenberg. The area of the catchment is approximately 23 km^2. The main Sir Lowry's Pass River is 14 km long and the only perennial tributary is the 5 km-long Cottage Stream draining the slopes of Verkykerskop.

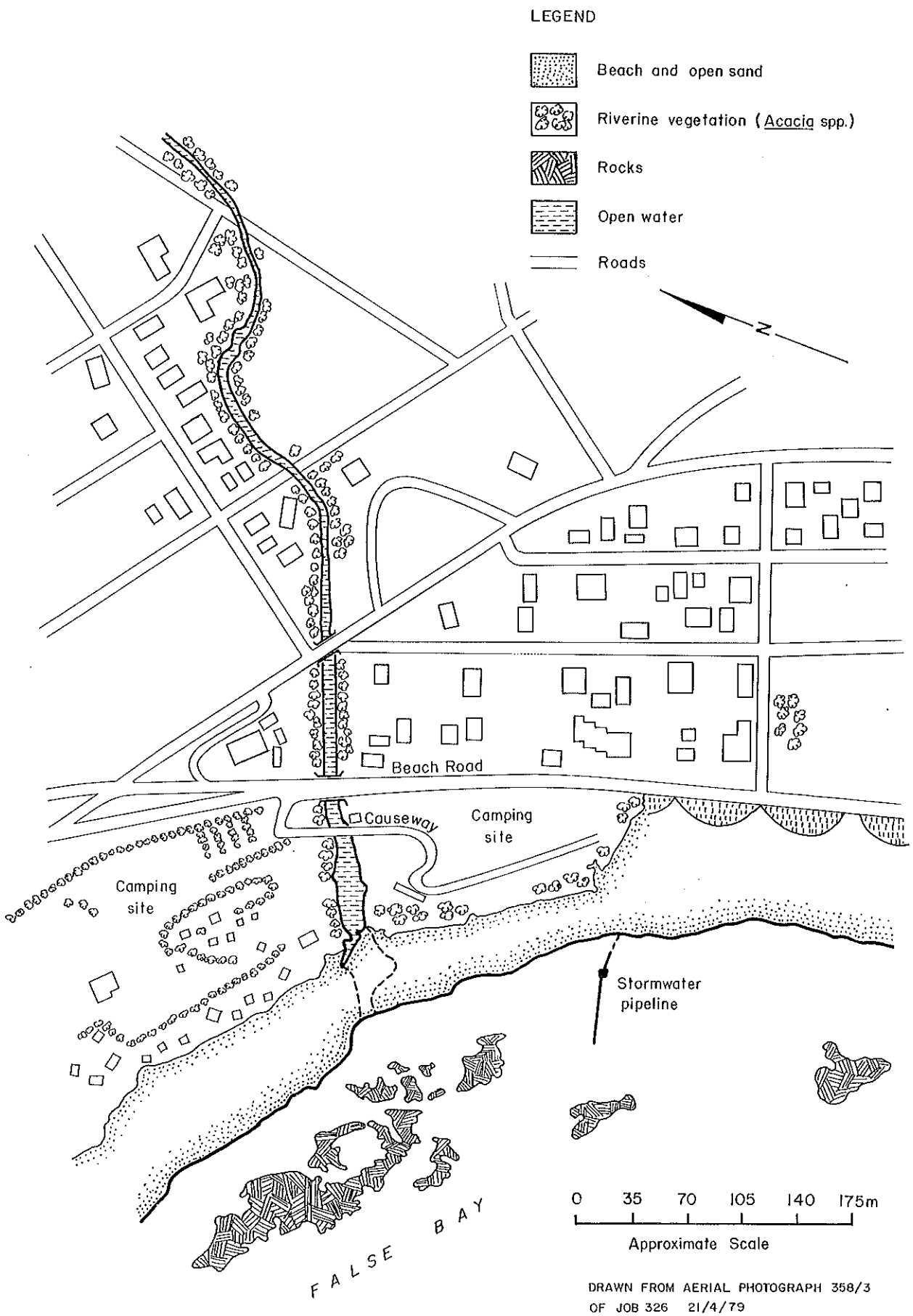
For much of its lower reaches the river is contained between earth banks stabilized with vegetation. A square-section pipe discharges the overflow from the lower dam of the Steenbras pumped-storage electricity generation scheme into the Sir Lowry's Pass River, just upstream of the bridges at the western entrance to Gordon's Bay village.

Dams and Obstructions

No dams have been built on the main Sir Lowry's Pass River. However, there are several large farm (earth) dams on the tributaries. Water is also abstracted directly from the river for agricultural and domestic purposes.

Seven bridges span the river, including that in Sir Lowry's Pass Village, the national road (N2/Settler's Way) and two in Gordon's Bay township itself (Figure 1). Also in Gordon's Bay are three concrete

FIG. 1 : The Sir Lowry's Pass River Mouth



drifts or fords over which the river flows and the two parts of the campsite on the beachfront are connected by a low causeway under which the stream usually flows.

Land Ownership/Uses

The catchment area falls under the administration of the Stellenbosch Divisional Council and the lower reaches and mouth are within the Gordon's Bay Municipality. Land use in the catchment ranges from Declared Mountain Catchment in the uppermost reaches to vineyards around Sir Lowry's Pass Village and mainly mixed vegetable farming in the lower reaches above Gordon's Bay. About 80 per cent of the catchment is farmed. Water from the River is used to supply several farms in the catchment (F. Smit, Agricultural Technical Services, pers. comm.).

Geology

The geology of the Sir Lowry's Pass River catchment is characterized by quartzite, sandstone and thin bands of shale of the Table Mountain Group in the upper reaches. The middle reaches consist of intrusive rocks believed to be, in age, between the Malmesbury Group and the Klipheuwel Formation. Finally, the lower reaches consist of greywackes, shales, conglomerates and quartzites of the Malmesbury Group (Stellenbosch Divisional Council, Streeksontwikkelingskema, 1973).

Rainfall

The Sir Lowry's Pass River catchment lies in the winter rainfall region which has a Mediterranean-type climate (Schulze, 1965). The mean annual rainfall over the catchment varies from 900 mm on the shores of False Bay to about 2 000 mm in the uppermost mountain reaches. The latter areas receive an appreciable proportion of the precipitation during the summer months in the form of orographic rainfall during periods of strong southerly winds.

The run-off pattern can be expected to follow the rainfall pattern. The river has a fairly steep profile and drains impervious quartzitic sandstones in its upper reaches. The river flow rate therefore responds rapidly to rainfall with maxima during or shortly after storms. Reversion to normal flow rates occurs soon after the cessation of rain.

Estuary characteristics

The Sir Lowry's Pass River is a small stream which flows for the last half-kilometre through the western end of Gordon's Bay village. The river is partially canalized along this section. After passing under the two road bridges at the western end of Gordon's Bay the river emerges onto the beach at the caravan park where it forms a small lagoon some 80 m long, 20 m wide and approximately 0,5 m deep (Figure 1).

The lagoon lies in an elevated area which formerly consisted of small coastal dunes which were flattened during construction of the caravan park. Although the inflow is weak during most of the year, the lagoon has an almost perennial outflow in the form of a small stream meandering across the flat backshore to the rocky barrier which occupies the foreshore zone along the Gordon's Bay coastline. The

rocks consist of fissured compact black Malmesbury shales through which the river finds its way to the sea.

Aerial photographs show that in the past, when the river apparently had a stronger discharge than at present, the lagoon extended beyond its present basin with elongated backshore arms of 75 to 200 m length and 20 to 30 m width spreading either to the west (1961, 1966/7, 1973) or to the east of the main lagoon pool (1944). Usually, these side arms of the lagoon had broken out of the slack of the backshore area at their distant ends to form small streams running down to the rocks of the foreshore.

Dark grey sand horizons on the backshore found by core sampling in 300 to 600 mm depth 40 m west and 65 m east of the centre of the present lagoon pool during the ECRU survey on 28 April 1982, confirm the existence of previous stagnant water bodies in this area which is now covered by marine sand.

Later aerial photographs from 1979 and 1981 show a more direct line of outflow from the lagoon pool down to the rocky foreshore. Delta formations 80 m in diameter or runnels spreading 200 m to the east can be seen on these photographs.

During the ECRU survey medium sized marine sand underlain by anoxic silt was found in the centre of the lagoon, while on the backshore, coarse beach sand was predominant.

Littoral dynamics depend on the wave climate on the coast. The inshore wave energy for the Gordon's Bay coast, including the river mouth, was 40 per cent lower than the mean energy calculated for the ten other river mouths entering False Bay. The average energy-wave height was 0,58, which identifies this area as a low energy coast. The mouth is also protected against wave attack by a rocky barrier in the foreshore zone which prevents the formation of sandbars and erosional features. Harris (1978) refers to current measurements by Atkins (1970) which indicate a confined clockwise eddy during south-easterly winds in Gordon's Bay. It has been reported that during westerly winds there is a west-going nearshore current. This was also observed during the ECRU survey (28 April 1982). Retief (1970) reported a net eastward sediment movement in Gordon's Bay. A narrow light-coloured streak extending approximately 0,5 km seawards from a point about 200 m east of the river mouth has been observed on a number of occasions (Aerial photograph of 21 April 1979; LANDSAT & NIMBUS - 7 Satellite images of 73-01-19, 78-06-22, 78-12-01, 81-03-17, 81-07-03, 81-08-08, 81-11-06 and 81-11-24 - V.Shannon, Sea Fisheries Research Institute, pers. comm.). This feature might be an indication of a large rip current system taking the eastward travelling longshore sediment out to sea. This would explain why there is no surplus of sand at the beaches between the pavilion and the harbour at Gordon's Bay, as would happen if the eastward longshore sediment drift could carry on uninterruptedly around the southward bend of the beach.

Physico-chemical characteristics

A survey of the river mouth was undertaken by the Marine Chemistry Division of NRIO on 28 April 1982. The data obtained are presented in Table I. Although the water is dark brown, characteristic of acid,

peat-stained, mountain water, the pH values obtained showed it to be slightly alkaline. The alkalinity is due to the presence of appreciable amounts of calcium (140 p.p.m.) probably released by the breakdown of granites or leached from shales in the catchment. Salinity values were 2,5 - 3,0 parts per thousand. However, these are not due to the incursion of sea-water since the sodium:calcium ratio was found to be 1:1,7 whereas in seawater it is 26:1. As mentioned above, the calcium is probably derived from rocks in the catchment. The water at sampling stations 1, 2 and 3 (Table 1) was well oxygenated and nutrient levels indicated an unpolluted system both in terms of inorganic and organic compounds.

Pollution

Heinecken *et al.* (1983) reported that the estuary is unpolluted. However, during a visit on 15 March 1983 (PD Morant, pers. obs.) it appeared that the lagoon suffers from nutrient enrichment. Unsightly filamentous algae were attached to the grass *Sporobolus virginicus* in the water.

There is a stormwater/sewage outfall nearby to the east of the estuary (Station 4, Table 1). No effluent was emerging from the end of the pipe but a small flow was issuing from a break further along the pipe. The effluent was undoubtedly sewage and was causing local pollution of the beach (NRIO survey, 28 April 1982).

Agricultural pesticides and herbicides are used in the catchment so that they or their residues may be present in the water, but there are no data available on contamination levels.

Bacteriological counts for the Sir Lowry's Pass River performed by the Gordon's Bay Municipality in April and May 1982, yielded maximum values for total coliforms/100 mℓ of 2 400 and *Escherichia coli*/100 mℓ of 34 (B. Johnson, Health Inspector, Gordon's Bay Municipality, pers. comm.). These values are within the EEC standards for bathing waters (Edington & Edington, 1977).

Gordon's Bay is served by sewage works situated to the west of the Sir Lowry's Pass River mouth. The main pipeline carrying raw sewage from the town to the sewage works runs beneath the mouth of the river. The final purified effluent from the sewage works enters False Bay under permit or is used for irrigation. The main sewage pumping station is situated near the Van Riebeeck Hotel in Gordon's Bay and occasionally pump malfunctions cause sewage to overflow, necessitating its removal by tanker (B Johnson, pers. comm.).

3.4 Biotic Characteristics

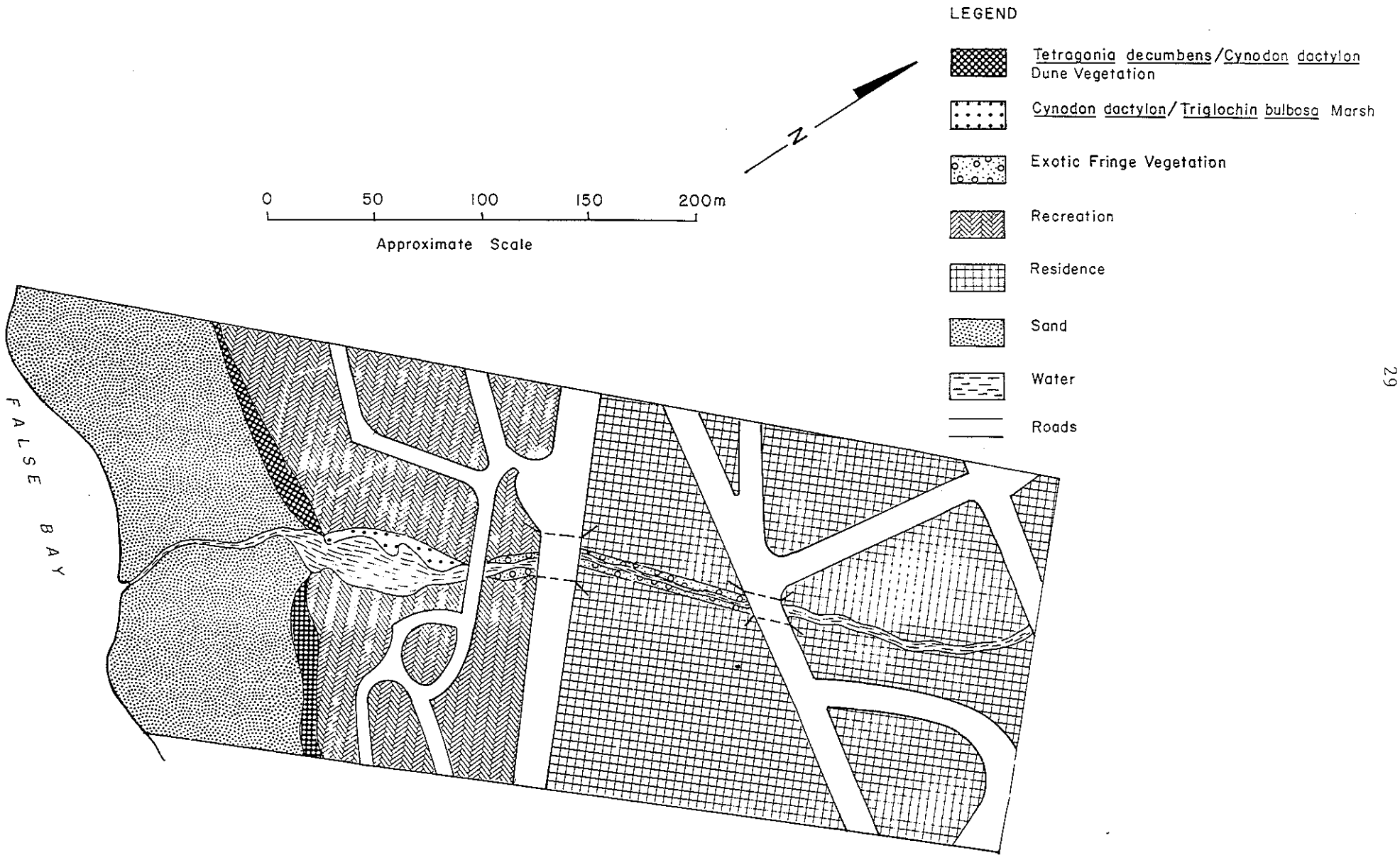
Flora

Algae

Algae, mainly *Codium* sp. from the nearby rocky shore wash up on the beach.

Enteromorpha sp. and other filamentous algae were found attached to litter and grass in the lower parts of the river.

FIG.2: Vegetation mapping units of the area studied at the Sir Lowry's Pass Estuary



Aquatic Vegetation

No aquatic angiosperms were noted in the river during May 1982.

Semi-Aquatic Vegetation

Some of the vegetation becomes inundated during winter and might thus be regarded as semi-aquatic. However, these are discussed under "Terrestrial Vegetation" below.

Terrestrial Vegetation

Figure 2 shows the spatial distribution of terrestrial vegetation around the Sir Lowry's Pass River, the most important species and physical features of each unit are listed in Appendix I.

(a) *Tetragonia decumbens/Agropyron distichum* Dune Vegetation:

A narrow fringe between the beach and caravan park is covered with typical dune plants. These include klappiesbrak *(Tetragonia decumbens)*, sea wheat *(Agropyron distichum)*, Bermuda quick *(Cynodon dactylon)* and others.

(b) *Cynodon dactylon/Triglochin bulbosa* Marsh:

This area, adjacent to the lower part of the river, becomes inundated during winter. This unit includes a number of typical marsh species, such as arrow grass *(Triglochin bulbosa)*, gansgras *(Cotula corinopifolia)* and *Scirpus maritimus*. Numerous terrestrial species are also found here, e.g. *Cliffortia lanceolata*, buffalo grass *(Stenotaphrum secundatum)*, etc. However, kikuyu *(Pennisetum clandestinum)* has encroached from the camp area and may overrun this vegetation.

(c) Exotic Fringe Vegetation:

Where the river has been canalized between Beach Road and Faure Marine Drive, many exotics have become established. These include species such as stinging nettle *(Urtica urens)*, thorn apple (*Datura* sp.), *Paspalum urvillei* and others.

Higher up along the river, *Pennisetum clandestinum* covers the banks and numerous trees fringe the river course.

The vegetation fringing the river along its course plays an important role in stabilizing the river banks, thus keeping the river course relatively open. Between the roads the river is stabilized artificially. The vegetation growing in this canal will serve to accumulate silt and litter, so it would therefore be beneficial if vegetation, as well as sand that has been deposited in the canal, were to be removed.

Fauna

With the exception of the observation that bait collectors obtain the sand prawn *Callianassa kraussi* from the vicinity of the river mouth (I Bickerton, ECRU, *in litt.*) nothing has been recorded on the fauna of the Sir Lowry's Pass River. RC Boycott and AL de Villiers *(in litt.)* have listed the amphibians and reptiles that occur in the

quarter-degree square 3418 BB Somerset West (see Checklists 1 and 2 at the end of this report). In view of the development around the estuary itself it is unlikely that many of these species will be found there. Various bird species forage around the estuary, especially scavengers such as Hartlaub's Gulls and European Starlings. There is too much human activity to permit continuous use of the estuary by birds.

3.5 Synthesis

The Sir Lowry's Pass River and estuary constitute a minor, slightly polluted system. The activities in the catchment are primarily rural and thus present little threat to the river system. The estuary is bounded on the landward side by Beach Road bridge and to the east and west by caravan sites and recreational areas. The condition of the estuary is important mainly for aesthetic and in particular health reasons, as it is situated in the middle of an intensively used recreational area. The estuary appears to suffer from slight nutrient enrichment and filamentous algae are present in the upper reaches. The bacteriological quality of the water should be checked regularly since the most frequent users are children from the campsites.

The old effluent pipeline, lying to the east of the Sir Lowry's Pass River mouth is a source of pollution and may be a public health hazard particularly since it is also sited in an area heavily used for recreational purposes. This pipe should either be removed or replaced.

The lower reaches of the river in Gordon's Bay village are infested with alien vegetation particularly rooikrans *(Acacia cyclops)*, Port Jackson *(A. saligna)* and *Sesbania*. The latter grows in the river bed itself and may impede flow when the river is in spate, and could possibly cause local flooding.

The Sir Lowry's Pass Estuary is a minor system which is of aesthetic and recreational value. Environmental problems could be eliminated at relatively little expense by management measures well within the capability of the Local Authority.

TABLE 1: Sir Lowry's Pass Estuary: physico-chemical data

Station Number	Salinity (parts per thousand (µmol/ℓ)	Phosphate (µmol/ℓ)	Silicate (µmol/ℓ)	Nitrite (µmol/ℓ)	Nitrate (µmol/ℓ)	Oxygen Absorbed (mg/g)	Dissolved Oxygen (mg/kg)	Temp (°C)	pH	Total carbon (mg/ℓ)	Inorganic carbon (mg/ℓ)	Organic carbon (mg/ℓ)	NH_4^+ (µmol/ℓ)
1	3,0	0,47	20,47	0,1	3,65	0,005	9,78	17,6	8,4	10,20	4,22	5,98	4,75
2	2,5	0,47	25,84	0,1	3,74	0,008	10,62	17,5	8,4	9,80	4,89	4,91	1.07
3	2,5	0,47	56,2	0,1	4,10	0,004	9,55	17,9	7,3	13,47	6,67	6,80	1,43
4	-	52,5	41,95	1,5	15,20	0,019	0	-	7,5	48,57	29,56	19,01	285,00

Location of sampling stations (see Figure 1):

1. At mouth of lagoon
2. Immediately downstream of camping site causeway
3. Immediately upstream of Beach Road bridge
4. Stormwater/sewage outfall east of the estuary.

Appendix I. Species composition and physical features of the mapping units identified at the Sir Lowry's Pass River and Estuary

Mapping Unit	Area[+] (ha)	% of area studied	Cover (%)	Average Height (m)
Tetragonia decumbens/Agropyron distichum Dune Vegetation	0,15	1,69	20	0,5
Cynodon dactylon/Triglochin bulbosa Marsh	0.04	0,45	100	0.2
Exotic Fringe Vegetation	0,6	6,74	50	1,5
Recreation	1,66	18,65		
Residence	3,03	34,05		
Roads	1,51	16,97		
Sand	1,74	19,55		
Water	1,17	1,90		
Total	8,90			

Tetragonia decumbens/Agropyron distichum Dune Vegetation

Agropyron distichum (2); *Cynodon dactylon* (2); *Hebenstreitia cordata* (+); *Pennisetum clandestinum* (+); *Senecio* cf *littoreus* (+); *Tetragonia decumbens* (3); *Trachyandra divaricata* (+).

Cynodon dactylon/Triglochin bulbosa Marsh

Acacia mearnsii (+); *Aster subulatus* (+); *Cliffortia lanceolata* (r); *Cotula coronopifolia* (r); *Cynodon dactylon* (2); *Juncus rigidus* (+); *Pennisetum clandestinum* (3); *Polygonum salicifolium* (+); *P. strictus* (+); *Stenotaphrum secundatum* (+); *Scirpus maritimus* (+); *Triglochin bulbosa* (1).

Exotic Fringe Vegetation

Acacia longifolia (+); *A. mearnsii* (+); *Asclepias plysocarpa* (r); *Cynodon dactylon* (1); *Datura stramonium* (+); *Juncus punctorius* (r); *Paspalum curvillei* (+); *Pinus* sp. (r); *Pseudognaphalium lutea-album* (r); *Urtica urens* (r); *Solanum nigrum* (r).

([+]estimated values)

4. STEENBRAS

4.1 Historical Background

Prof CFJ Muller in his historical account of the Hangklip Hottentots Holland region mentions that the Steenbras River was crossed for the first time by the early explorers of the eastern shores of False Bay in the mid-1600s. At that time the river was known as the "Steenbraazems Rivier" (Muller, 1972). It is assumed that the name of this river is derived from that of the fabled and popular angling fish, the "Red Steenbras" *(Petrus rupestris)* which could be caught in the deep waters along the rocky shores through which the river enters the sea.

The need to provide water for Cape Town and its suburbs resulted in the damming of the Steenbras River during the early 1900s (Burman, 1969). The original dam with a capacity of $2,7 \times 10^6$ m^3 was completed in 1921. The dam wall was raised in 1928 and again in 1954 to increase the capacity of the original Steenbras Dam to $34,3 \times 10^6$ m^3. A second dam, the Upper Steenbras dam, with a capacity of $31,8 \times 10^6$ m^3 was built in 1978 (Cape Town City Engineer, pers. comm.). The filtration plant and road from Gordon's Bay to the dam were constructed during the Second World War and were finally completed in 1946 (Cape Town City Engineer, undated internal report and Burman, 1969).

4.2 Location and Local Authorities

The co-ordinates of the Steenbras River mouth are 34°12'S and 18°49'E and the main tarred road between Gordon's Bay and Hangklip crosses the river approximately 200 m from where it opens out to the sea.

The Steenbras River and its entire catchment fall within the boundaries of the Caledon Divisional Council, while the Stellenbosch Divisional Council owns and controls a small portion of ground on the northern banks at the mouth of the river (Mr JC Adendorff, Stellenbosch Divisional Council, pers. comm.).

4.3 Abiotic Characteristics

River catchment

The main catchment of the Steenbras River is approximately 70 km^2 (inclusive of the dam surfaces) and is situated between the Hottentots Holland Mountains and Koëlberg (1:50 000 Sheet 3418 BB). According to Haughton (1933) the Steenbras stream prior to the building of the dams, meandered slightly through a comparatively broad open valley. From the dam wall it flows through a steep-sided valley which cuts through the mountain-ridge and into the narrow coastal shelf. It appears as if the headwarderosion of the comparatively young Steenbras stream has captured the upper part of a river which was formerly part of the Palmiet River system. The Upper and Lower Steenbras Dams with surface areas of 332 ha and 352 ha, respectively, incorporate most of the former main river channel (Cape Town City Engineer, pers. comm.). These dams are fed by numerous steeply graded young mountain streams with waterfalls and gorges which drain the surrounding mountains (Haughton, 1933). The total length of the main stream inclusive of the dams is 17 km (1:50 000 Sheet 3418 BB).

The geology of the Steenbras catchment is characterized by quartzitic sandstone, thin bands of shale and conglomerate of the Table Mountain

Group (TMG), (1:125 000 Geological Map 3319 C Worcester, 3419 A Caledon).

Haughton (1933) divides the Table Mountain Series lithologically as follows; Upper Sandstone, Upper Shale Band, Glacial Band, Main Sandstone and Lower Shale Band. The Glacial Band and Upper Shale Band can be seen in the Steenbras catchment as well as in the Upper Sandstones occurring between the Upper Shale Band and the Bokkeveld Beds of the overall Cape System. He also mentions a deposit of rounded boulders resting on a wave-cut terrace 21 m (70 ft) above sea level in a cove south of the Steenbras River mouth.

The mean annual rainfall for the Steenbras Dam for the period 1963 to 1981 was 984 mm (Cape Town City Engineers Reports, 1972 - 1981). In the upper reaches of the catchment the mean annual rainfall increases to approximately 2 000 mm (Stellenbosch Divisional Council - Streeksontwikkelingskema, 1973).

The long-term average run-off into the river is given as 50 x 10^6 m^3 by the Cape Town City Engineer's Department (The Cape Town City Engineer, Annual Report, 1981).

Almost the entire Steenbras river catchment falls under the ownership of the Cape Town City Council; this corresponds mainly with the cadastral boundaries except in the upper catchment where the national road (N2) crosses the river. Here the boundary follows the road itself (Cape Town City Engineer, pers. comm.). The Directorate of Forestry controls the upper catchment above the national road (N2); of this 418 ha are under pine plantation and the remainder forms part of a State Forest Reserve. A large part of the catchment controlled by the Cape Town City Council is also afforested. This area together with the Upper and Lower Steenbras dams which are regularly stocked with trout by the Cape Department of Nature and Environmental Conservation is used for outdoor recreational purposes (McVeigh, 1979). Permits obtainable from the Cape Town City Council are required to enter the area and for fishing. The roads serving the dam and the water treatment and filtration plants above Gordon's Bay are classed as scenic drives (Cape Town City Engineer, undated Internal report). The remainder of the area consists of natural mountain fynbos veld and mountain catchment.

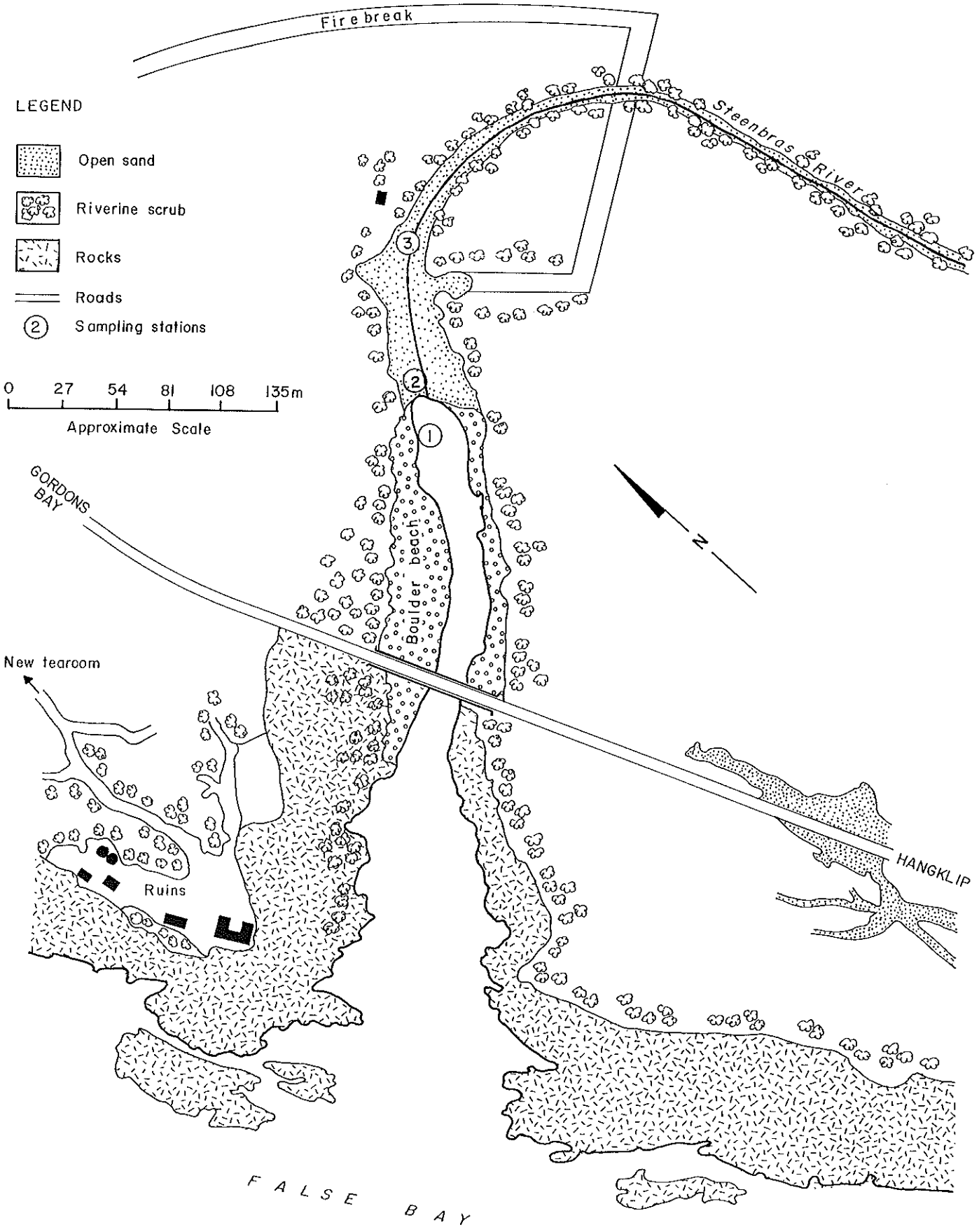
Obstructions in the catchment consist of the two dams previously mentioned and the national road (N2) bridge at the top end of the Upper Steenbras dam. The Upper dam was constructed in 1978, while the first stages of the Lower dam were built in 1921 (see Historical Background).

The water of the Steenbras river is an acid brown water which, according to the Cape Town City Engineer (undated Internal Report), is "extremely soft and of low mineral content". Van Wyk (1958 unpublished) states that the water is of a typical "tea-colour" with no mud.

Estuary

The Steenbras River mouth cannot be regarded as an estuary. It is a small "fjord-like" valley incised into a rocky coastal strip. The sea and waves reach right up to the upper end of this tidal inlet which is approximately 360 m long, 50 m wide and 10 to 20 m deep (see Figure 1).

FIG. 1 : Morphology of the Steenbras River mouth



The sides of the inlet, below the road bridge, are almost vertical down to the waters edge. On the northern side of the inlet above the bridge, is a narrow bank of rounded boulders and cobbles, approximately 30 m wide. A narrower seam of similar materials occurs along the southern banks. At the limit of tidal penetration is an area of coarse sand. This sand is black in colour a short distance below the surface i.e. (> 30 cm), which is probably due to decaying organic matter trapped in the inlet or brought down by the stream. GF van Wyk's field notes of 1958 made no mention of sand in the inlet. His overall description of the rivermouth is however, similar to that given above.

It can be assumed that because of the adjacent rocky shores there is little or no sediment influx worth mentioning from the sea. The sand in the Steenbras inlet may therefore be mainly a product of wave action on the cobbles and boulders within the inlet.

It has been calculated that the inshore wave energy at the Steenbras River mouth is 30 percent above the mean energy calculated for the other False Bay rivers. The average energy-wave height is 1,08 m which makes this a medium to high-energy section of coastline (Swart & Serdyn, 1982 and Valsbaai Strandverbeteringe, 1980).

According to Shipley (1964) this section of coastline has earned the name of the "Death Coast" due to the number of anglers who have been washed off the rocks by freak waves. These waves are caused by the refraction and concentration of south-westerly swells around the shallow "Rocky Bank" shoal situated at the mouth of False Bay, onto the steep sloping shore. This results in occasional abnormally high waves.

The direction and magnitude of the inshore currents at the Steenbras River mouth are highly variable and will depend on wind direction, wave direction and the state of the tide. North-going currents predominate.

Land ownership at the Steenbras River mouth is vested in the Cape Town City Council in so far as the southern banks and upper reaches are concerned. The Stellenbosch Divisional Council owns a small portion of land on the northern banks of the river which is given out on long lease to private individuals or concerns. At present, part of this land is used for a tea-room, holiday bungalows, camping and picnicking while a second portion is utilized by a youth organization for holiday camps. The original tea-room complex which was situated closer to the mouth burnt down during the late 1970s (Mr De Waal, Stellenbosch Divisional Council, pers. comm.). At present all that remains of these former buildings are the foundations and concrete floors (see Figure 1). The Defence Force also owns a small portion above the coastal road on the southern side of the river mouth (JC Adendorff, pers. comm.). The coastal road bridge (the Benning bridge) which crosses the inlet, spans the entire gorge without creating any obstruction to river or tidal flow. This bridge was built in 1935. There are signs of tidal erosion under the northern span of the bridge (ECRU Survey 28 April 1982).

The physico-chemical properties measured and analysed by PD Bartlett of the Marine Chemistry Division of NRIO during the ECRU Survey on

28 April 1982 at low tide, showed that the pH was variable for the stations sampled. It became acidic at Station 3 (see Figure 1) indicating the acidic nature of the water flowing from the catchment. The temperatures ranged from 17°C to 16,6°C while the salinities decreased rapidly with distance upstream i.e. from Station 1 where it was 26,5 parts per thousand to 1,5 parts per thousand at Station 3. This indicated a limited degree of penetration by sea water at low tide. The system was well oxygenated with a minimum saturation of 82 percent.

Nutrient values within the inlet varied with high nitrate and ammonia levels at Station 1. Silicate levels were highest at Station 2 but decreased sharply to Station 3. None of these levels indicated any source of pollution. The higher levels of nitrate and ammonia at Station 1 and silicate at Station 2 are probably of marine origin. This area of False Bay is very productive and the marine life carried into the inlet decays giving rise to high concentrations.

The OA value (Oxygen Absorbed) was highest at Station 1, possibly due to decaying marine debris. The dissolved organic carbon was more or less constant (3,29 - 4,46 mg/ℓ) throughout the inlet and indicated no organic pollution.

4.4 Biotic Characteristics

Flora

No data are available on phytoplankton and diatoms. Of the small amount of algal debris seen in the inlet during the botanical survey in June 1982 most consisted of kelp *(Ecklonia maxima)* from the adjacent rocky shores.

No aquatic angiosperms or semi-aquatic vegetation were noted where the stream flowed into the inlet.

The terrestrial vegetation adjacent to the lower part of the river can be divided into four basic types, namely Riverine Forest, Wet Mountain Fynbos, Drier Mountain Fynbos and Riverine Scrub. The spatial distribution of these is shown in Figure 2 while Appendix I shows some of the species and physical features of each mapping unit.

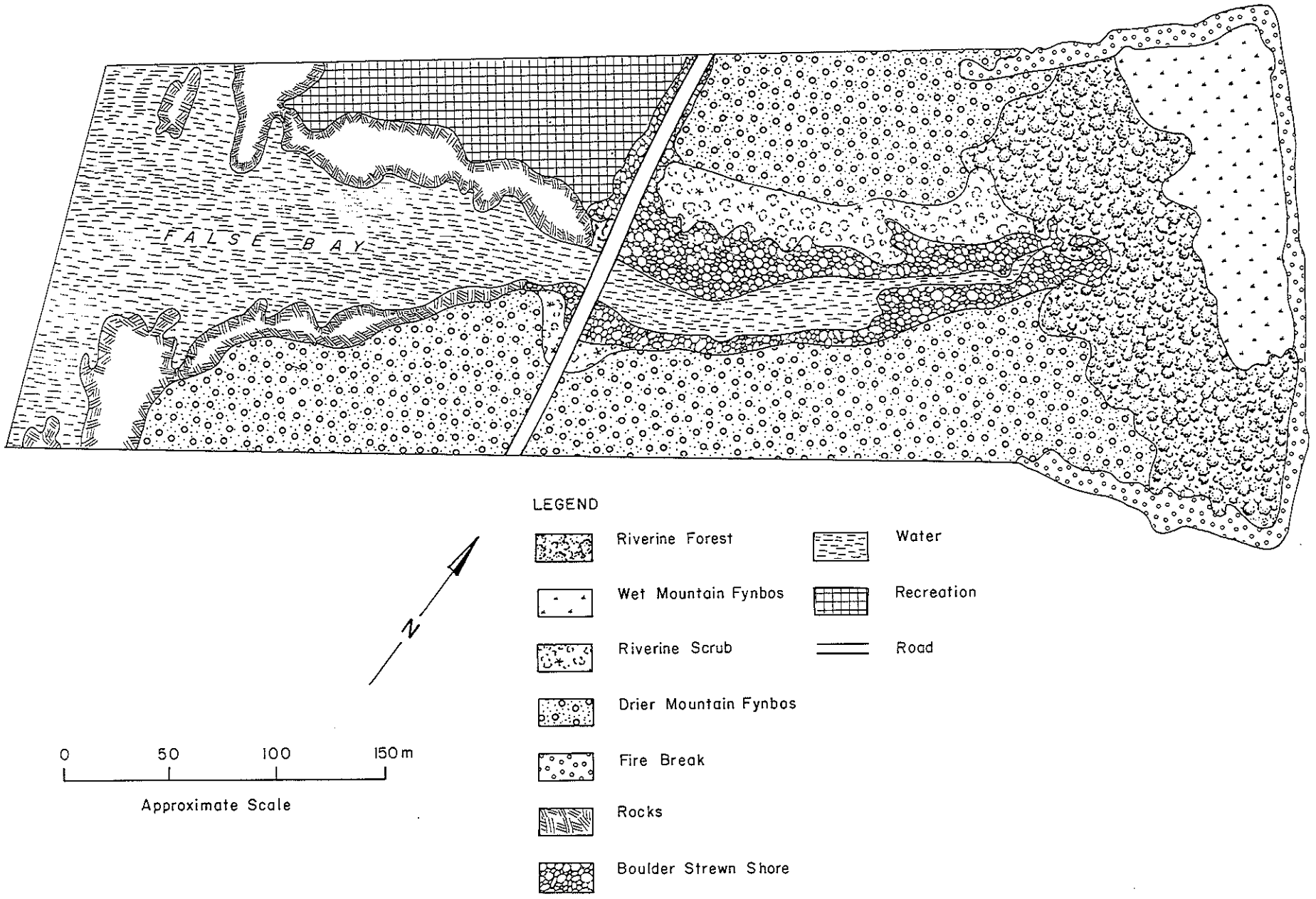
(a) Riverine Forest: This dense vegetation occurs immediately adjacent to the river. It contains numerous tree species such as sand olive *(Dodonea viscosa)*, coast cabbage tree *(Cussonia thyrsiflora)*, flossy taaibos *(Rhus lucida)* and *Metrosideros angustifolia*. Numerous herbs and shrubs are also present while *Restio subverticullatus* is common at the water's edge.

Some wattles, *Acacia longifolia* and *A. saligna* are found here and should be removed before they become dominant in the area.

(b) Wet Mountain Fynbos: With increasing distance away from the river onto the damp south-west facing slope, the vegetation gradually changes to a wet fynbos type. Numerous restioids and proteoids are found here with other herbs and shrubs. Cluster pine *(Pinus pinaster)* and stone pine *(P. pinea)* are present but do not cover extensive areas.

(c) Riverine Scrub: This vegetation type contains a number of species also found in the riverine forest, e.g. *Rhus lucida*,

FIG. 2 : Vegetation mapping units of the area studied at the Steenbras River mouth.



Cussonia thyrsiflora, etc. However, when it grows in drier areas, this vegetation type does not reach the height of the forest. Nearer the road are aliens such as rooikrans, *Acacia cyclops*, Port Jackson willow *(A. saligna)* and stinkboon *(Albizia lophantha)*.

(d) Drier Mountain Fynbos: Most of the rest of the area is dominated by small shrubs such as *Nagelocarpus serratus, Sympieza articulata, Erica longifolia* with restioids *Tetraria cuspidata, Thamnochortus gracillis*, proteoids and taller shrubs *(Protea repens, Leucospermum bolusii, Olea capensis, Widdringtonia nodiflora)*. On the summit of the southern bank is, a fairly large stand of Acacias and *Eucalyptus globulus*.

Many similarities exist between the vegetation surrounding the river and some of the communities described by Boucher (1978) for the Hangklip area. However, numerous aliens occur around the Steenbras River mouth, and attempts should be made to remove these before they displace the indigenous as has happened in so many other coastal areas.

Fauna

There is very little information available on the fauna specifically from the Steenbras River mouth area. During the ECRU survey on 24 April 1982, a group of Cape dassie *(Procavia capensis)* were seen at the bridge pylons.

The reptiles, amphibians and mammals occurring within the area covered by the 1:50 000 quarter degree grid square of Somerset West 3418 BB are given in the Checklists 1 and 2 at the end of the report. Some of these species are likely to occur at the Steenbras River mouth in areas of suitable habitat.

4.5 Synthesis

The Steenbras River mouth is of little significance as an estuary and even if the river had not been dammed it would constitute only a fast running mountain stream entering the sea via a "fjord-like" inlet. The inlet does, however, form part of the spectacular rugged scenery along the coastal road running from Gordon's Bay to Cape Hangklip.

From the point of view of outdoor recreation, the tea-room with the bungalows, picnicking and camping sites on the northern side of the mouth form an ideal situation for this type of development which should, however, be executed in such a manner that it fits in with the surrounding environment. Unfortunately the present development has fallen into a state of disrepair which detracts from the surroundings.

Angling from the rocky coastline is an important form of recreation in this area but the dangerous conditions caused by freak waves should continually be brought to the attention of anglers. Environmental education is also needed to curb littering and destruction of the indigenous vegetation. This requires the provision of facilities such as parking or viewing areas with adequate fire places and rubbish bins of appropriate design which should be emptied regularly.

Alien vegetation should be removed systematically from the mountain slopes and from the Steenbras River gorge. It is accepted that eucalyptus and rooikrans trees need to be retained to provide shade in the vicinity of the recreation area.

By using sound landscape architectural methods and with proper control, the Steenbras River mouth area, which is a relatively stable environment, could be developed into a popular recreational resort fulfilling a growing demand for this type of facility close to the metropolitan centre of Cape Town.

Appendix I: Species and physical features of the vegetation mapping units identified around the Steenbras River mouth.

Mapping Unit	+Area (ha)	% of area studied	Cover (%)	Average height (m)
Riverine Forest	1,28	13,2	90	3,0
Wet Mountain Fynbos	1,76	18,6	80	1,5
Drier Mountain Fynbos	0,88	9,3	40	1,0
Riverine Scrub	0,86	8,9	50	1,8
Fire Break	0,37	3,8		
Rocks	1,11	11,6		
Boulder Strewn Shore	0,69	7,2		
Water	1,88	19,5		
Recreation	0,59	6,1		
Road	0,13	1,3		
Total	9,55			

(+Estimated values)

Riverine Forest

Acacia longifolia (1); *A. saligna* (+); *Brabejum stellatifolium* (+); *Brachylaena nerifolia* (+); *Carpobrotus acinaciformis* (r); *Cassine peragua* (+); *Chrysanthemoides monolifera* (1); *Colpoon compressum* (r); *Cullumia setosa* (+); *Cussonia thyrsiflora* (1); *Dodonea viscosa* (2); *Ehrharta villosa* (+); *Heeria argenteum* (+); *Juncus acutis* (+); *Maytenus oleoides* (+); *Metrosideros angustifolia* (2); *Pelargonium angulosum* (1); *Podalyria calyptrata* (r); *Psoralea pinnata* (+); *Pycreus polystachys* (+); *Restio subverticullatus* (1); *R. purpurascens* (+); *Rhus glauca* (+); *R. laevigata* (1); *R. lucida* (2); *R. tormentosa* (1); *Scirpus nodosus* (1); *Secamone alpinii* (+); *Struthiola myrsinites* (+); *Widdringtonia nodiflora* (1).

Wet Mountain Fynbos

Agathosma cf *capensis* (1); *Asparagus* cf *rubicundus* (r); *Colpoon compressum* (+); *Chironia baccifera* (+); *Cliffortia ruscifolia* (1); *Erica longifolia* (+); *Erica plunkenetti* (+); *Leucodendron salignum* (1); *Olea capensis* (r); *Passerina vulgaris* (1); *Pinus pinaster* (r); *P. pinea* (r); *Protea nerifolia* (+); *P. nitida* (+); *Restio cuspidatus* (1); *Sympieza articulata* (+); *Thamnochortus* cf *gracilis* (1); *Thamochortus* cf *punctatus* (+).

Riverine Scrub

Acacia cyclops (+); *A. saligna* (+); *Albizia lophantha* (+); *Aloe* sp (r); *Carpobrotus acinaciformis* (+); *Cassine peragua* (1); *Chasmanthe aethiopica* (+); *Cussonia thyrsiflora* (+); *Rhus glauca* (1); *R. incisa* (1); *R. lucida* (1); *Secamone alpinii* (+); *Tetragonia fruticosa* (1); *Zantedeschia aethiopica* (1);

Drier Mountain Fynbos

Acacia cyclops (1); *Cassine peragua* (r); *Chironia baccifera* (r); *Clutia verbicaulis* (+); *Cliffortia ruscifolia* (+); *Colpoon compressum* (+); *Erica longifolia* (+); *Eucalyptus globulus* (1); *Hypolaena* cf *digitata* (1); *Leucospermum bolusii* (+); *Nagelocarpus serratus* (+); *Olea capensis* (1); *Passerina* sp (+); *Phylica buxifolia* (+); *P. paniflora* (+); *Protea repens* (1); *Rhus glauca* (1); *Saltera sarcocolla* (+); *Sympieza articulata* (1); *Tetraria* cf *cuspidata* (+); *Thamnochortus gracilis* (1); *Widdringtonia nodiflora* (+).

Note: The symbols in brackets following each species name represent Braun-Blanquet Cover Classes as follows:

r - 1/few individuals, cover less than 0,1% of area
\+ - occasional plants, cover less than 1% of area
1 - abundant, cover 1 - 5% of area
2 - any number, cover 6 - 25% of area
3 - any number, cover 26 - 50% of area
4 - any number, cover 51 - 75% of area
5 - any number, cover 76 - 100% of area.

5. BUFFELS (OOS)

5.1 Historical Background

Muller (1972) gave a detailed account of the early history of the Cape Hangklip area in which the Buffels (Oos) is situated. Cape Hangklip was originally called "Kaap Vals" after it had frequently been mistaken for the Cape of Good Hope by unsuspecting mariners. The area was first mapped in 1779. The western approaches to Cape Hangklip from Strand were poorly known in offical circles because of the difficult passage along the sheer coastlines and thus Cape Hangklip became a refuge for escaped slaves, Hottentots and Strandlopers. Early access was mainly from the east via Botriviervlei.

In 1777, Captain Gordon and Lieutenant Paterson made the journey from Hottentots Holland to Pringle Bay and Cape Hangklip and then travelled eastwards. They found poor grazing but buffalo and eland were seen in the area and buffalo paths ran eastwards from Pringle Bay toward the vleis at Betty's Bay. The sighting of buffalo probably gave the Buffels its name. It is referred to as the Buffels (Oos) in this report to avoid confusion with the Buffels (Wes) River which enters False Bay near Cape Point.

For a long time the sea was the easiest access route to the eastern side of False Bay and during the late 18th century/early 19th century gangs of robbers inhabited the area, making a living by plundering travellers traversing the Overberg to the north.

Pringle Bay into which the Buffels (Oos) flows was named after Admiral Pringle who first surveyed the bay in 1796-1797.

In 1936 Pringle Bay Township was established (CPA, Cape Coastal Survey, 1973). However it was not until observation stations were set up along the eastern side of False Bay to check German submarine activity during the Second World War, that a coastal road was built to connect the eastern part to the western part of False Bay.

5.2 Location and Local Authorities

The Buffels (Oos) River enters False Bay on its south-eastern side at Pringle Bay. The co-ordinates of the rivermouth are $34^{\circ}20'S$ and $18^{\circ}50'E$.

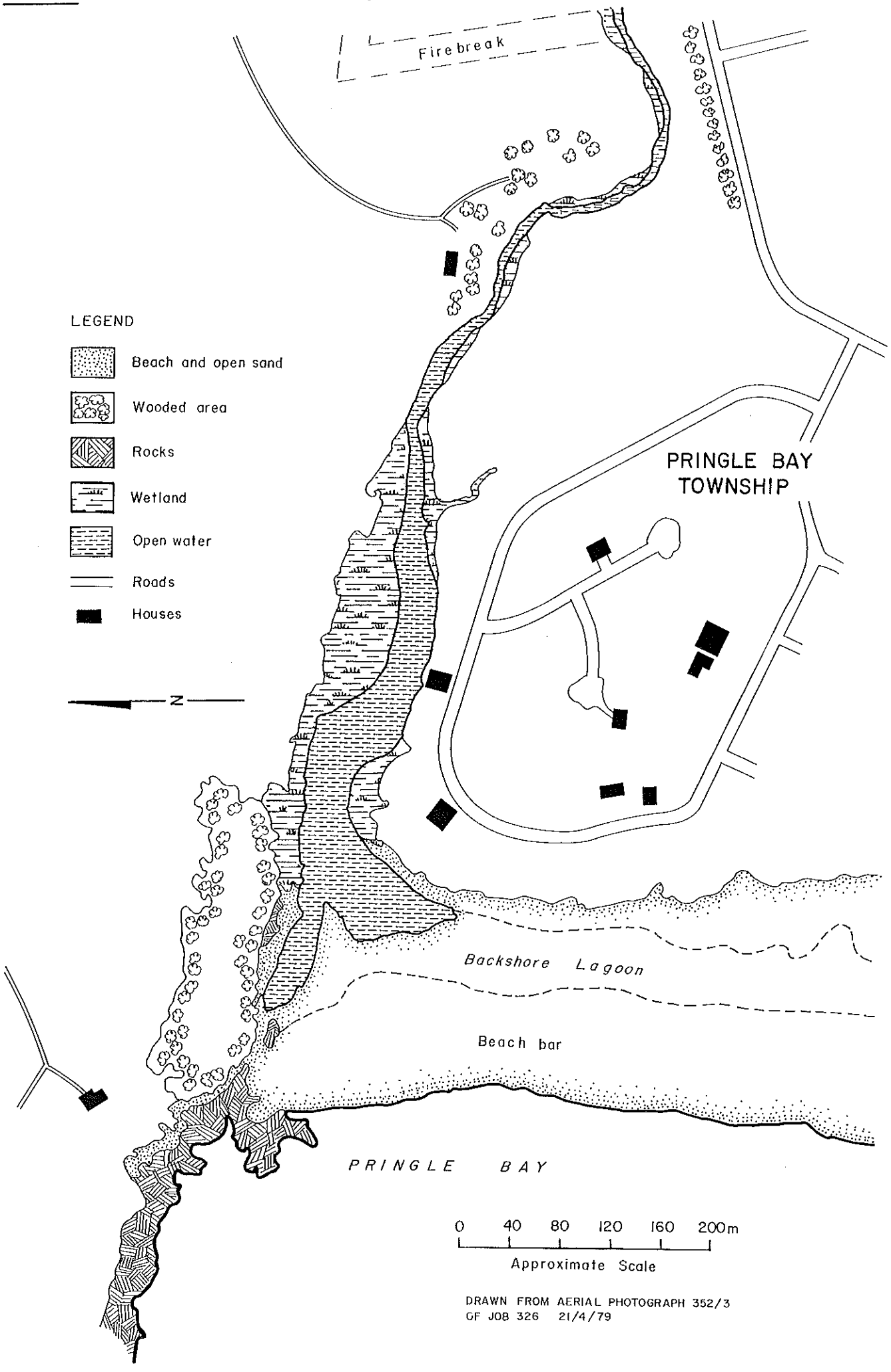
The main coastal road from Gordon's Bay and Rooiels to Betty's Bay and Kleinmond crosses the Buffels approximately 1,5 km from its mouth. The turn-off to Pringle Bay and the mouth of the Buffels is approximately 500 m to the south of the bridge crossing (Betty's Bay side).

5.3 Abiotic Characteristics

River catchment

The Buffels River has a catchment of approximately 23 km^2 and is about 8 km long from its mouth to the source of its major tributary which rises just below Spitskop on the eastern side of the Buffelstalberg. This acid blackwater system then flows in a south-westerly direction to its mouth on the northern side of Pringle Bay (1:50 000 Sheet 3418 BD).

FIG. 1 : The Buffels (Oos) Estuary



According to the geological map in Boucher (1978) the upper catchment is characterized by Cedarberg Formation shale bands and tillite of the Pakhuis Formation. Lower down, the river flows over sandstones and quartzites of the Peninsula Formation and for the last 3 km over Tertiary sands. Immediately south of the Buffels (Oos) Estuary a strip of recent dune sand borders on the central part of Pringle Bay.

Land ownership/uses

The river and its catchment are controlled by the Caledon Divisional Council. A part of the upper catchment is a restricted Defence Force area.

The catchment area is largely undeveloped. The river is, however, dammed about 3 km upstream of its mouth by the Buffels Dam which has a capacity of 1 520 Mℓ (McVeigh unpublished). The dam was built in 1972 and supplies water to Rooiels, Pringle Bay and Betty's Bay Townships. To the south of the river near its mouth lies the holiday township of Pringle Bay (see Figure 1) which was established in 1936 with 561 erven and was only 7 percent developed in 1972 (Cape Coastal Survey Report No 2, 1973). Development since then has not been rapid.

Rainfall and run-off

There are no published flow records for the Buffels River but rainfall figures for Silver Sands (Boucher, 1978), situated on the coast 5 km to the south-east of the mouth of the Buffels (Oos), indicate that peak flows occur from June to August in keeping with the winter rainfall region within which it is situated. The mean annual rainfall for Silver Sands is 700 mm but the mean annual rainfall in the Buffels (Oos) catchment probably exceeds this figure. GAW Fromme of the Sediment Dynamics Division of NRIO *(in litt.)* measured the river discharge at the mouth as being 1,26 m^3/sec. on 23 August 1982.

Estuary characteristics

The Buffels (Oos) usually forms a shallow lagoon behind the sandbar of the Pringle Bay beach. The estuary consists of two components. As can be seen in Figures 1 and 2 these are:

(a) A permanent narrow lagoon, 50 to 60 m wide and 0,5 to 1 m deep, with a muddy bed situated between the rugged cliffs on the northern side of the valley and the vegetated dune area of Pringle Bay which has been partially developed.

(b) A temporary backshore lagoon at right angles to the river course, which sometimes inundates the whole backshore slack of the Pringle Bay beach pocket. This backshore lagoon can extend to a length of 800 m, is 50 to 100 m wide and very shallow (average water depth 0,3 m) with a clean sandy bottom.

An open mouth is formed temporarily during the winter flood season, usually at the northern end of the beach, but an overflow from the backshore lagoon at the southern end also occurs. If the mouth is open, the lagoon is tidal up to 400 m upstream of the rocks at the northern end of the beach (see Figures 1 and 2) where, during the survey of 23 August 1982, sea debris indicated the limit of sea water influx.

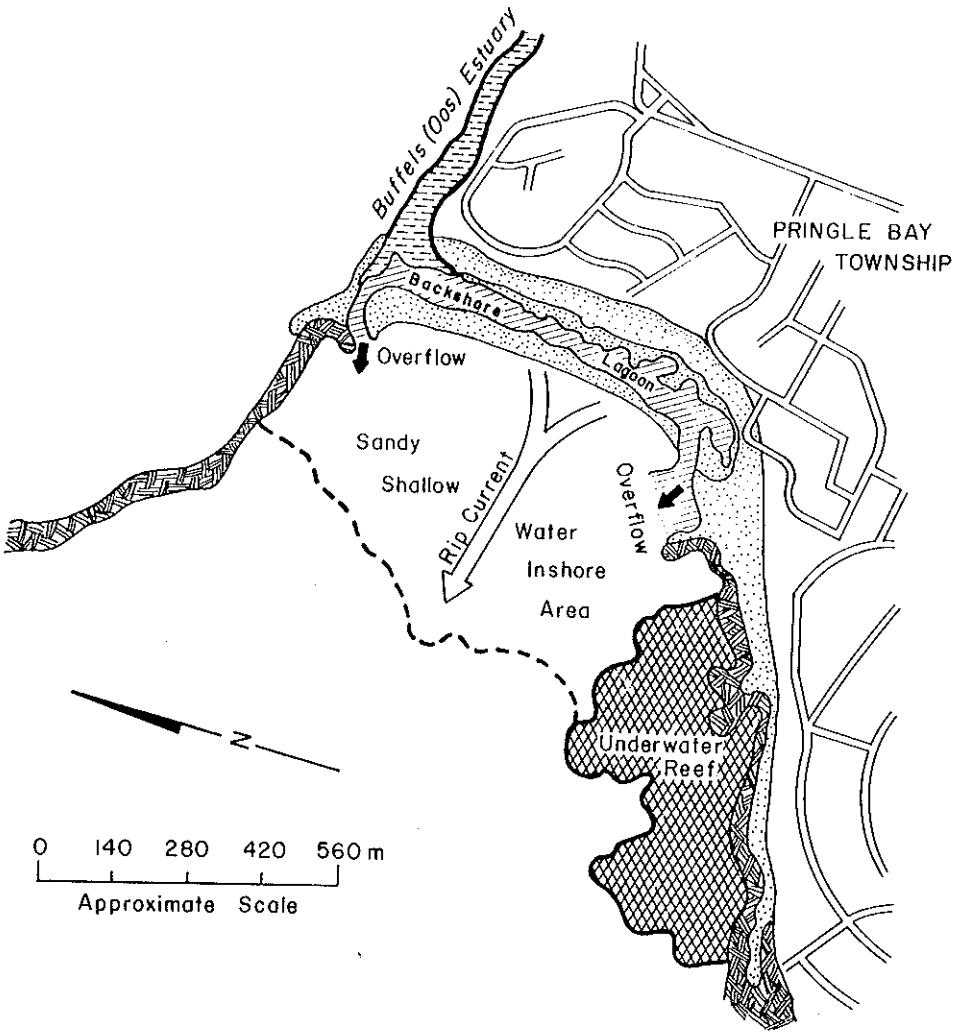


FIG. 2: Schematic diagram of the mouth dynamics of the Buffels (Oos) Estuary.

During winter flood conditions the water in the lagoon rises and floods the backshore slack area which eventually causes breaching of the sandbar. This happens at the rocky northern end of the beach in line with the lower course of the river. Before such breaching occurs, excess water is usually discharged through a wide shallow overflow from the backshore lagoon at the southern end of the beach (see Figure 2). Both of these mouths can be active simultaneously. However, as soon as the water level drops sufficiently, the backshore lagoon becomes depleted and only the northern mouth remains open. The rocks at the northern mouth prevent complete scouring of its sandbar and the consequent draining of the main lagoon. With subsiding flow during the dry summer season, the northern mouth is closed by sand washed up from the sea.

The Pringle Bay beach can be described as a rocky cove beach, approximately 1 km long and 200 m wide, relatively flat with its sea face sloping to the water's edge at an angle of 2 to 3 degrees. The main landward part of the beach consists of a slack area containing the backshore lagoon (see Figure 2). The aerial photograph (Photo No 352/3 of Job 326, 1979) on which Figure 2 is based, distinctly shows a shallow water inshore area 200 m wide on the northern side of the bay and 350 m wide in the south where the sand shoal was apparently building up against an underwater reef. This indicated longshore sand movement from north to south. A rip current in the centre of the bay is visible in several aerial photographs of Pringle Bay and is schematically depicted in Figure 2. Because of its sheltered position, Pringle Bay receives only diffracted and refracted deep sea waves from the Atlantic Ocean. The predominant nearshore wave incidence was determined to be 35 percent for west and 13,5 percent for west south-west (Valsbaai Strandverbeteringe, 1980 and Swart and Serdyn, 1982). Direct waves from the sector west to north-west, which are generated over a fetch of only 32 to 42 km in False Bay, may also enter Pringle Bay. They cause, however, only a minor energy influx onto this coast.

The average energy-wave height is 0,99 m (seven percent above the False Bay average) which identifies Pringle Bay as a medium-energy beach (Valsbaai Strandverbeteringe, 1980 and Swart and Serdyn, 1982).

Land ownership/uses

The land ownership around the estuary consists of privately-owned small-holdings on the northern bank and privately-owned erven of the Pringle Bay Township. The estuary and surrounding area are controlled by the Caledon Divisional Council and Pringle Bay Township is represented by the Pringle Bay Ratepayers Association.

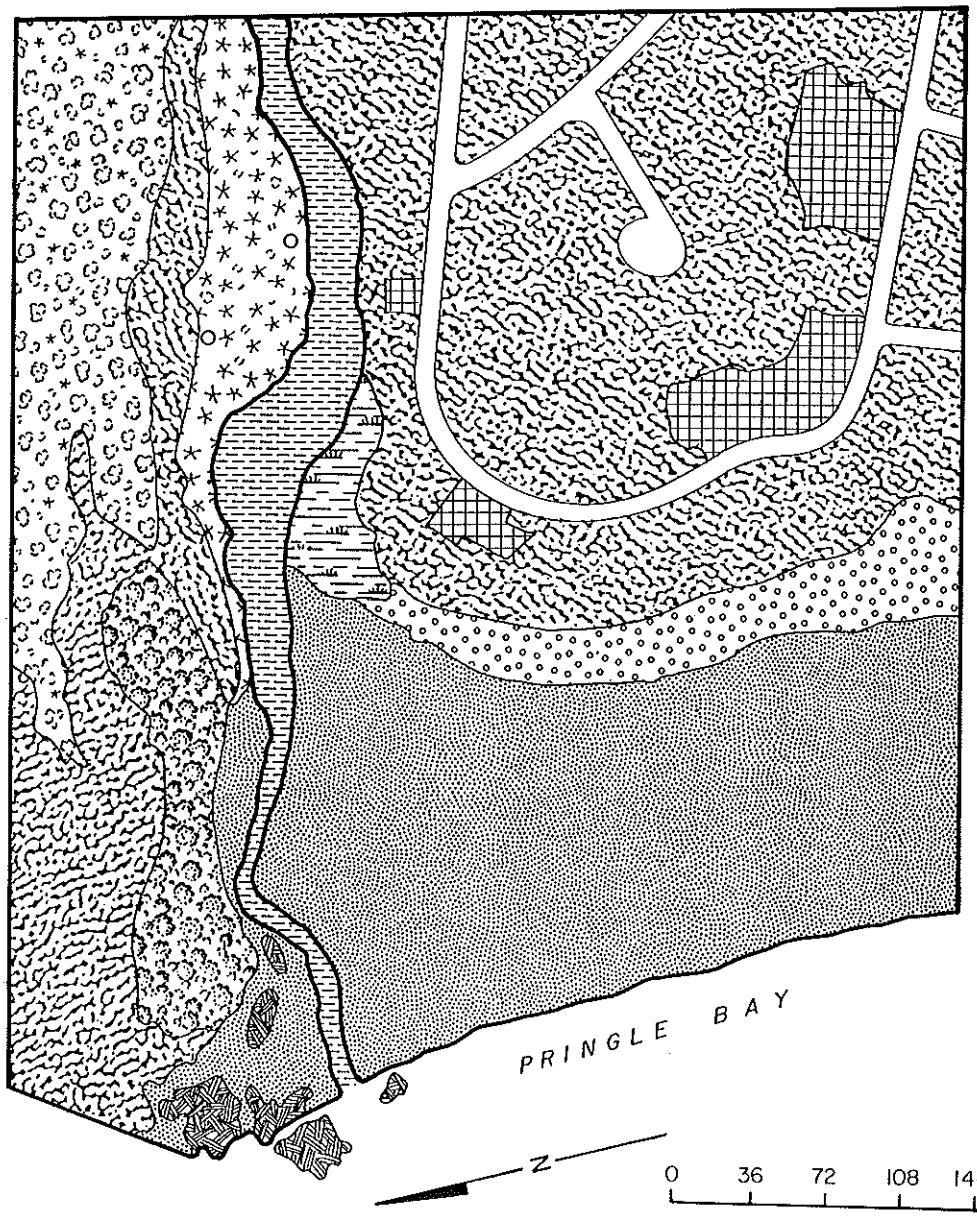
The estuary is not used for any particular purpose other than general seaside recreation but it is obviously aesthetically important in terms of the properties which overlook it. It is an integral part of Pringle Bay which is the main attraction for the township.

Physico-chemical characteristics

Physical- and chemical data for the Buffels (Oos) Estuary collected during the ECRU survey by the Marine Pollution Monitoring Group of the NRIO are shown in Appendix I. The data indicate that the estuary is unpolluted (PD Bartlett, Marine Chemistry Division, NRIO *in litt.*). The higher pH and salinity values at the seaward end of the estuary suggest that there was a strong marine influence in its lower reaches. During a follow-up survey on 23 December 1982, marked salinity layering was measured in the lagoon. Salinities of 1 part per thousand on the surface and 14 parts per thousand at the bottom were recorded in depths of 1 m. McVeigh (1979) gave the pH of the Buffels River Dam as 6,1 which probably reflects the pH of the streams in the upper catchment.

There may be some sub-surface seepage of septic tank effluent from developed properties situated on the southern bank of the estuary as the dunes on which the properties are situated consist of porous sand.

FIG. 3: Schematic representation of vegetation mapping units described at the Buffels (Oos) Estuary



5.4 Biotic Characteristics

Flora

Algae. During the botanical survey on 23 December 1982, the estuary was open to the sea. This allowed numerous marine algae to be deposited in the estuary, consisting mainly of the kelp *Ecklonia maxima* with some *Laminaria pallida*. Some kelp material had also been deposited on the beach.

Filamentous green algae were found growing on the estuarine substrate and attached to aquatic plants. These appeared to be *Enteromorpha* sp. and *Cladophera* sp. or both.

Aquatic vegetation: The only angiosperm found in this estuary was *Ruppia maritima*, growing at a depth of about 80 cm.

Semi-aquatic vegetation: Two semi-aquatic vegetation mapping units were noted, namely *Paspalum vaginatum/Juncus kraussii* Low Shrubland and *Phragmites australis* Reed Swamp.

(a) *Paspalum vaginatum/Juncus kraussii* Low Shrubland: This vegetation unit is situated to the south of the mouth and would become flooded during high tides. It is dominated by grasses such as *Paspalum vaginatum* and buffalo grass *(Stenotaphrum secundatum)* with numerous sedges - *Juncus kraussii, Carex ecklonii, Juncellus laevigatus* and shrubs on the drier sand - *Orphium frutescens, Polygala* sp., *Samolus porosus*.

(b) *Phragmites australis* Reed Swamps: These reeds grow on the northern side of the estuary as emergents. Further upstream, *P. australis* lines much of the river banks.

Terrestrial vegetation: Boucher (1978) has described the vegetation of this area in some detail. During this survey (Dec. 1982), the following units were identified (after Boucher, 1978):

Erharta-Ficinia Strand Pioneers,
Colpoon-Rhus Dune Scrub,
Sideroxylon inerme Dune Scrub,
Acid Sand Flat Communities.

(a) *Ehrharta-Ficinia* Dune Pioneers: This vegetation is relatively sparse, occurring on the most seaward dunes. In this area, the vegetation is dominated by sea wheat *(Agropyron distichum)* and pypgras *(Ehrharta villosa)* with numerous herbs such as sea pumpkin *(Arctotheca populifolia)*, klappiesbrak *(Trachyandra divaricata)*, *Tetragonia decumbens* and others.

(b) *Colpoon-Rhus* Dune Scrub: This scrub is found on the more stable dunes after an overlap zone with the vegetation above. Common species are slangbos *(Stoebe plumosa)*, slanghout *(Olea exasperata)*, blombos *(Metalasia muricata)*, *Colpoon compressum*, aarbei-bossie *(Chironia baccifera)* and others.

To the north of the river, this vegetation type seems to be better protected and moister containing species such as duineraaibos *(Rhus laevigata)*, bruinsalie *(Salvia aurea)*, katstertriet *(Restio eleocharis)*, tabakbos *(Senecio halimifolius)* and others.

(c) *Sideroxylon inerme* Dune Scrub: This dune scrub forest is present adjacent to the northern bank of the river mouth. It consists of a taller (approximately 4 m) canopy of milk wood *(Sideroxylon inerme)* and *Cussonia thyrsiflora* with a sparse understorey of shrubs *(Asparagus* sp., *Metalasia muricata)* and grasses (e.g. *Briza maxima*).

(d) Acid Sand Flat Communities: This vegetation type is found further inland to the north of the river. It seems to be complex between coastal and coastal-mountain fynbos and is on stony sands. It contains species such as *Stoebe sphaerocephala, Plecostachys serpyllifolia, Phylica buxifolia, Erica coccinea* and others

Aerial photographs show that significant alien infestation has taken place during the last 20 years. Rooikrans *(Acacia cyclops)* has become all too common in the residential area of Pringle Bay while cluster pine *(Pinus pinaster)* has achieved a foothold in the fynbos to the north. If timely steps are taken to remove these aliens, the vegetation could be restored to its natural state.

Fauna

There is no published information on the aquatic fauna of the Buffels (Oos) Estuary.

Gaigher *(in litt.)* described the distribution of the burrowing sand prawn *Callianassa kraussi* in the estuary as being widespread but very sparse. During a survey of bait organisms he observed densities of eight prawns per twenty cores with counts of four burrow openings per square metre. During the ECRU survey on 23 December 1982, sampling of the lagoon approximately 400 m upstream of the mouth using a beam trawl, revealed the presence of an amphipod and an isopod species in the *Ruppia* beds. Also present were the estuarine round herring *Gilchristella aestuarius*, the Knysna sandgoby *Psammogobius knysnaensis* and a *Caffrogobius* species. During an earlier survey on 28 April 1982, shoals of juvenile mullet were observed in the shallows near the mouth.

In the catchment, rainbow trout *(Salmo gairdneri)*, brown trout *(S. trutta)* and hybrid tiger trout *(S. trutta X fortinalis)* have been introduced into the Buffels River Dam and the Cape galaxias *Galaxias zebratus* is indigenous (McVeigh, 1979).

As the Buffels (Oos) Estuary is similar to the Rooiels situated 4 km to the north of it, the aquatic fauna of both estuaries should have a similar species composition. Heinecken (1982) gives a comprehensive account of this aspect of the Rooiels.

Complete checklists of the amphibians and reptiles recorded within the area covered by the 1:50 000 quarter degree grid square of Hangklip 3418 BD are given at the end of the overall report. This covers the estuarine area as well as the entire catchment of the Buffels (Oos).

The Buffels (Oos) does not appear to be an important estuary for birds according to the results of bird counts carried out there. No birds were observed during a count on 5 January 1981 (Underhill and Cooper, 1982). Bird counts carried out during the ECRU surveys were as follows:

82-04-28: 4 Black Oystercatchers, 2 White-fronted Sandplovers, 300 Swift Terns (roosting) and 1 Pied Kingfisher.

82-12-23: 1 Black Oystercatcher, 1 Sandwich Tern.

The development of Pringle Bay Township and consequent human disturbance may be the reason for the low bird counts recorded for the Buffels (Oos).

A checklist of the mammals recorded for the Rooiels Estuary (Heinecken, 1982), 4 km north of the Buffels (Oos) is given at the end of this overall report. These mammals can be expected to occur at the Buffels (Oos).

5. SYNTHESIS

The Buffels (Oos) Estuary is a small but ecological healthy system which has only recently been subject to the influence of development. This is probably largely because the area was relatively inaccessible before the Second World War. The major impact on the system has been brought about by the construction of the Buffels River Dam in 1972, which has probably affected the flow regime and reduced the annual run-off. Because of this, the times during which the mouth is open have probably been reduced.

During times of flooding, the rocks through which the mouth opens on the northern side of the Pringle Bay beach, prevent excessive scouring of the beach bar and consequent draining of the estuary once flood flows have subsided. The estuary/beach equilibrium is an important feature of the dynamics of the mouth of the Buffels (Oos) and should not be interfered with.

The estuary is an integral part of Pringle Bay and contributes greatly to the aesthetic appeal of the area. It is as yet virtually undisturbed and is a valuable amenity to Pringle Bay Township, in particular to those properties which overlook it. There is, however, danger of erosion of the steep-sided, vegetated dunes on the southern banks of the estuary due to trampling by people walking to the lagoon from the properties immediately above (see Figure 4). Although attempts have been made to prevent slumping of the sand using a sleeper palisade, wooden access walkways will have to be built if more serious erosion and sandblows are to be prevented.

Although Pringle Bay Township was established in 1936 and an extensive road network was constructed throughout the township in the early 1970's, very few of the erven have been developed. Those that have been developed are mainly situated on the southern side of the township where some degree of protection from the south-easterly wind is afforded by Pringle Bay Peak and Hangklip Mountain.

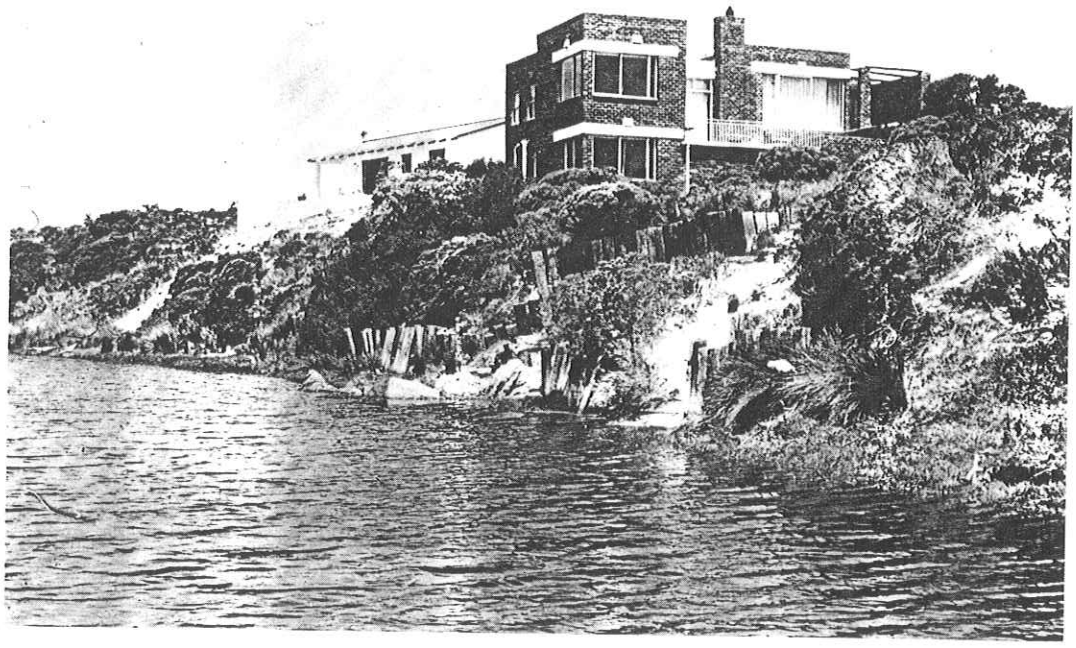


FIG. 4: Southern Bank of the Buffels (Oos) Estuary showing slumping of the dune and erosion due to human access routes. The efforts to prevent this using a sleeper palisade can be seen (ECRU 82-12-23).

The central part of the township adjacent to the beach, is however open to south-easterly winds and this is probably a factor contributing to the lack of development there.

A problem associated with the township is the spread of alien plants in particular rooikrans, within the road network. The coastal area between the Steenbras and Palmiet Rivers has been proposed as a Nature Area by the Betty's Bay Trust, largely because this area contains undisturbed Coastal and Mountain Fynbos and is relatively free of alien invasive species. This proposal is receiving Government attention at present. The natural coastal communities and species in the proposed area are being threatened by invasion of aliens (in particular rooikrans) from the township areas such as Pringle Bay. Because of this, such alien plants should be controlled within the Township.

Generally the Buffels (Oos) is in good ecological condition. It has great aesthetic appeal and there are no health hazards in terms of its recreational utilization. Maintenance of these attributes is of great importance in terms of the future development of Pringle Bay Township. Practices such as the trampling of its steep-sided banks should therefore be avoided. If more properties are developed along its banks, seepage from septic tanks could also constitute a danger, particularly in view of the present suitability of the estuary as a safe bathing area for children. It is not known what the military activities in the catchment involve and it is to be hoped that these will not have deleterious effects on the estuary in future.

Appendix I: Physico-chemical data for the Buffels (Oos) Estuary collected during the ECRU Survey during a rising neap tide on 82-04-28. The positions of sampling stations are described. (Data collected by the Marine Pollution Monitoring Group, NRIO.)

Sampling station locality	Salinity (parts per thousand	Phosphate (µmol/ℓ)	Silicate (µmol/ℓ)	Nitrite as N (µmol/ℓ)	Nitrate as N (µmol/ℓ)	OA mg/g	Dissolved oxygen (mg/kg)	Temp. (°C)	pH	Total carbon (mg/ℓ)	Inorganic carbon (mg/ℓ)	Organic carbon (mg/ℓ)	Ammonia as N (µmol/ℓ)
Backshore lagoon 250 m south of main channel to northern mouth	24,0	0,47	16,28	0,20	5,34	0,005	10,13	16,2	8,2	30,61	25,11	5,50	7,07
At open mouth on north side of beach	24,0	0,47	16,28	0,20	2,93	0,013	9,88	16,5	8,1	28,57	23,11	5,46	6,68
260 m upstream of the northern mouth	22,5	0,00	16,28	0,00	3,93	0,007	9,25	17,0	7,9	20,00	14,67	5,33	4,79
340 m upstream of the northern mouth	20,0	0,19	12,92	0,30	0,33	0,007	7,47	17,0	7,4	28,57	20,00	8,57	7,86

Appendix II: Some species and physical features of the vegetation around the Buffels (Oos) River.

Mapping Unit	Area[+] (ha)	% of Area Studied	Height (m)	Cover %
Paspalum vaginatum/Juncus kraussii Low Shrubland	0,12	1,48	0,10	90
Phragmites australis Reed Swamps	0,35	4,31	1,50	90
Ehrharta-Ficinia Strand Pioneers	0,36	4,43	0,10	10
Colpoon-Rhus Dune Scrub	3,34	41,08	1,20	80
Sideroxylon inerme Dune Scrub	0,35	4,31	3,00	100
Acid Sand Flat Communities	0,75	9,22	1,00	80
Water	0,45	5,53		
Sand	2,26	27,80		
Rocks	0,15	1,84		
Total	8,13			

Paspalum vaginatum/Juncus kraussii Low Shrubland

Carex ecklonii (r); *Carpobrotus acinaciformis* (r); *Chenolea diffusa* (r); *Conyza* sp. (r); *Dianthus* sp. (+); *Helichrysum crispum* (+); *Juncellus laevigatus* (1); *Juncus kraussii* (2); *Nidorella foetida* (+); *Orphium frutescens* (1); *Paspalum vaginatum* (5); *Phragmites australis* (+); *Polygala fruticosa* (1); *Samolus porosus* (+); *Senecio elegans* (+); *Sonchus oleraceus* (+); *Stenotaphrum secundatum* (3); *Tetragonia fruticosa* (+).

Phragmites australis Reed Swamps

Phragmites australis (5).

Ehrharta-Ficinia Strand Pioneers

Agropyron distichum (2); *Arctotheca populifolia* (+); *Ehrharta villosa* (1); *Ficinia lateralis* (+); *Heteroptilis suffruticosa* (r); *Myrica cordifolia* (+); *Sporobolus virginicus* (3); *Senecio elegans* (+); *S. littoreus* (+); *Tetragonia decumbens* (+); *Trachyandra divaricata* (+).

Colpoon-Rhus Dune Scrub

Acacia cyclops (3); *Agathosma* sp. (1); *Carpobrotus acinaciformis* (+);

([+]estimated values)

Chironia baccifera (1); *Chrysocoma coma-aurea* (+); *Chrysanthemoides monolifera* (+); *Colpoon compressum* (1); *Helichrysum metalasiodes* (+); *H. crispum* (1); *Heliophylla* sp. (r); *Lobelia valida* (+); *Manulea tomentosa* (+); *Metalasia muricata* (+); *Nemesia psammophila* (+); *Nylandtia spinosa* (1); *Olea exasperata* (1); *Passerina* spp. (1); *Psoralea capensis* (+); *Stenotaphrum secundatum* (1); *Stoebe plumosa* (2); *Thesidium fragile* (+); *Viscum capensis* (+).

Also found on northern side of river:

Cullumia setosa (+); *Euclea racemosa* (+); *Haemanthus* sp. (+); *Juncus kraussii* (1); *Mariscus* sp. (+); *Ostea africana* (+); *Polygonum* sp. (+); *Pelargonium capitatum* (+); *Rhus laevigata* (+); *Restio eleocharis* (3); *Salvia aurea* (+); *Senecio halimifolius* (2); *Scirpus nodosus* (+); *Typha capensis* (+).

Sideroxylon inerme Dune Scrub

Asparagus sp. (1); *Briza maxima* (+); *Cussonia thyrsiflora* (3); *Metalasia muricata* (+); *Pentsia pilulifera* (+); *Sideroxylon inerme* (4).

Acid Sand Flat Communities

Crassula sp. (r); *Erica coccinia* (+); *Helipterum vestitum* (+); *Olea capensis* (+); *Passerina* sp. (1); *Pelargonium cuculatum* (+); *Phylica buxifolia* (+); *Plecostachys serpyllifolia* (1); *Pteracelastrus tricuspidatus* (+); *Selago spuria* (1); *Stoebe sphaerocephala* (1).

6. ACKNOWLEDGEMENTS

As this report deals with smaller rivers entering False Bay from Cape Point in the West to Hangklip in the East it covers a diverse area involving a number of different local authorities and organizations. Thanks are therefore extended to the following persons for the information and data they supplied; Messrs G Wright and D Clark of the Cape Point Nature Reserve, Messrs C Chevalier and N Grant of the Simonstown Municipality, Mr F Smit of Agricultural Technical Services Extension Officer, Stellenbosch, Mr JC Adendorff of the Stellenbosch Divisional Council, Mr G Boddington of the Cape Town City Engineers Dept. and Mr B Johnson the Health Inspector of the Gordons Bay Municipality.

Mr T Oatley of Glencairn is thanked for his data on the fauna at Elsies River and Messrs C Gaigher and A de Villiers of the Cape Department of Nature and Environmental Conservation for their information on bait organisms, fish, reptiles and amphibians for all the rivers dealt with in this report.

The survey was carried out at the request of the Department of Environment Affairs. The encouragement of this Department, the NRIO Steering Committee for Estuarine and Coastal Research and of the SA National Committee for Oceanographic Research is gratefully acknowledged.

7. GLOSSARY OF TERMS USED IN PART II REPORTS

abiotic: non-living (characteristics).
aeolian (deposits): materials transported and laid down on the earth's surface by wind.
alien: plants or animals introduced from one environment to another, where they had not occurred previously.
alluvium: unconsolidated fragmental material laid down by a river or stream as a cone or fan, in its bed, on its floodplain and in lakes or estuaries, usually comprised of silt, sand or gravel.
anaerobic: lacking or devoid of oxygen.
anoxic: the condition of not having enough oxygen.
aquatic: growing or living in or upon water.
arcuate: curved symmetrically like a bow.
barchanoid (dune): crescent-shaped and moving forward continually, the horns of the crescent pointing downwind.
bathymetry: measurement of depth of a water body.
benthic: bottom-living.
berm: a natural or artificially constructed narrow terrace, shelf or ledge of sediment.
bimodal: having two peaks.
biogenic: originating from living organisms.
biomass: a quantitative estimation of the total weight of living material found in a particular area or volume.
biome: major ecological regions (life zones) identified by the type of vegetation in a landscape.
biotic: living (characteristics).
breaching: making a gap or breaking through (a sandbar).
calcareous: containing an appreciable proportion of calcium carbonate.
calcrete: a sedimentary deposit derived from coarse fragments of other rocks cemented by calcium carbonate.
Chart Datum: This is the datum of soundings on the latest edition of the largest scale navigational chart of the area. It is -0,900 m relative to land levelling datum which is commonly called Mean Sea Level by most land surveyors.
coliforms: members of a particularly large, widespread group of bacteria normally present in the gastro-intestinal tract.
community: a well defined assemblage of plants and/or animals clearly distinguishable from other such assemblages.
conglomerate: a rock composed of rounded, waterworn pebbles 'cemented' in a matrix of calcium carbonate, silica or iron oxide.
cusp: a sand spit or beach ridge usually at right angles to the beach formed by sets of constructive waves.
"D" net: a small net attached to a "D" shaped frame riding on skids and pulled along the bottom of the estuary, used for sampling animals on or near the bottom.
detritus: organic debris from decomposing plants and animals.
diatoms: a class of algae with distinct pigments and siliceous cell walls. They are important components of phytoplankton.
dynamic: relating to ongoing and natural change.
ecology: the study of the structure and functions of ecosystems, particularly the dynamic co-evolutionary relationships of organisms, communities and habitats.
ecosystem: an interacting and interdependent natural system of organisms, biotic communities and their habitats.
eddies: a movement of a fluid substance, particularly air or water, within a larger body of that substance.
endemic: confined to and evolved under the unique conditions of a particular region or site and found nowhere else in the world.
enon: most striking formation in the Cape. Crammed with pebbles and boulders, phenomenally embedded and massive, yellow or brilliantly red in colour, producing remarkable hills. Curiously carved into crags and hollows.

epifauna: animal life found on the surface of any substrate such as plants, rocks or even other animals.

epiphyte: a plant living on the surface of another plant without deriving water or nourishment from it.

episodic: sporadic and tending to be extreme.

estuary: a partially enclosed coastal body of water which is either permanently or periodically open to the sea and within which there is a measurable variation of salinity due to the mixture of sea water with fresh water derived from land drainage (Day 1981).

eutrophication: the process by which a body of water is greatly enriched by the natural or artificial addition of nutrients. This may result in both beneficial (increased productivity) and adverse effects (smothering by dominant plant types).

flocculation (as used in these reports): the settlement or coagulation of river borne silt particles when they come in contact with sea water.

fluvial (deposits): originating from rivers.

food web: a chain of organisms through which energy is transferred. Each "link" in a chain feeds on and obtains energy from the preceding one.

fynbos: literally fine-leaved heath-shrub. Heathlands of the south and south-western Cape of Africa.

geomorphology: the study of land form or topography.

gill net: a vertically placed net left in the water into which fish swim and become enmeshed, usually behind the gills.

habitat: area or natural environment in which the requirements of a specific animal or plant are met.

halophytes: plants which can tolerate salty conditions.

HAT (Highest Astronomical Tide) and LAT (Lowest Astronomical Tide): HAT and LAT are the highest and lowest levels respectively, which can be predicted to occur under average meteorological conditions and under any combination of astronomical conditions; these levels will not be reached every year. HAT and LAT are not the extreme levels which can be reached, as storm surges may cause considerably higher and lower levels to occur (South African Tide Tables 1980).

hummock (dune): a low rounded hillock or mound of sand.

hydrography: the description, surveying and charting of oceans, seas and coastlines together with the study of water masses (flow, floods, tides etc.).

hydrology: the study of water, including its physical characteristics, distribution and movement.

indigenous: belonging to the locality; not imported.

intertidal: generally the area which is inundated during high tides and exposed during low tides.

isohyets: lines on maps connecting points having equal amounts of rainfall.

isotherms: lines on maps joining places having the same temperature at a particular instant, or having the same average, extremes or ranges of temperature over a certain period.

lagoon: an expanse of sheltered, tranquil water. (Thus Langebaan lagoon is a sheltered arm of the sea with a normal marine salinity; Knysna lagoon is an expanded part of a normal estuary and Hermanus lagoon is a temporarily closed estuary (Day 1981)).

limpid: clear or transparent.

littoral: applied generally to the seashore. Used more specifically it is the zone between high- and low-water marks.

longshore drift: a drift of material along a beach as a result of waves breaking at an angle.

macrophyte: any large plant as opposed to small ones. Aquatic macrophytes may float at the surface or be submerged and/or rooted on the bottom.

marls: crumbly mixture of clay, sand and limestone, usually with shell fragments.

matrix: medium in which a structure is embedded.

meiofauna: microscopic or semi-microscopic animals that inhabit sediments but live quite independently of the macrofauna, or benthos.

metamorphic: changes brought about in rocks within the earth's crust by the agencies of heat, pressure and chemically active substances.

MHWS (Mean High Water Springs) and MLWS (Mean Low Water Springs): the height of MHWS is the average, throughout a year when the average maximum declination of the moon is 23°, of the height of two successive high waters during those periods of 24 hours (approximately once a fortnight) when the range of the tide is greatest. The height of MLWS is the average height obtained by the two successive low waters during the same periods (South African Tide Tables 1980).

morphometry: physical dimensions such as shape, depth, width, length etc.

osmoregulation: the regulation in animals of the osmotic pressure in the body by controlling the amount of water and/or salts in the body.

pathogenic: disease producing.

photosynthesis: the synthesis of carbohydrates in green plants from carbon dioxide and water, using sunlight energy.

phytoplankton: plant components of plankton.

piscivorous: fish eating.

plankton: microscopic animals and plants which float or drift passively in the water.

quartzite: rock composed almost entirely of quartz recemented by silicon. Quartzite is hard, resistant and impermeable.

riparian: adjacent to or living on the banks of rivers, streams or lakes.

rip current: the return flow of water which has been piled up on the shore by waves, especially when they break obliquely across a longshore current.

salinity: the proportion of salts in pure water, in parts per thousand by mass. The mean figure for the sea is 34,5 parts per thousand, written 34,5°/$_{oo}$.

secchi disc: a simple instrument used to measure the transparency of water.

sheet flow: water flowing in thin continuous sheets rather than concentrated into individual channels.

slipface: the sheltered leeward side of a sand-dune, steeper than the windward side.

teleost: modern day bony fishes (as distinct from cartilaginous fishes).

trophic level: a division of a food chain defined by the method of obtaining food either as primary producers, or as primary, secondary or tertiary consumers.

trough: a crescent shaped section of beach between two cusps.

wetlands: areas that are inundated or saturated by surface or ground water frequently enough to support vegetation adapted to life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs and similar areas.

zooplankton: animal components of plankton.

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CHECKLIST 1: Amphibians and Reptiles recorded from the areas covered by the 1:50 000 quarter degree grid squares of; the Cape Peninsula 3418 AB and AD, Somerset West 3418 BB and Hangklip 3418 BD (RC Boycott and A de Villiers, *in litt.* - compiled from Cape Department Nature and Environmental Conservation records, Boycott pers. obs., Broadley 1975, Broadley and Greer 1969, Dyer pers. comm., FitzSimons 1943, FitzSimons 1962, Greig and Burdett 1976, Greig *et al.* 1979, Poynton 1964 and Rose 1962).

Cape Peninsula 3418 AB and AD (Buffels (Wes) and Elsies Rivers)

Amphibia (frogs and toads):

Common platanna	-	*Xenopus laevis*
*Gill's platanna	-	*Xenopus gilli*
Sand toad	-	*Bufo anqusticeps*
Leopard toad	-	*Bufo pardalis*
Cape mountain toad	-	*Capensibufo rosei*
Cape rain frog	-	*Breviceps gibbosus*
Cape mountain rain frog	-	*Breviceps montanus*
Sand rain frog	-	*Breviceps r. rosei*
Cape sand frog	-	*Tomoptena delalandii*
Cape rana	-	*Rana fuscigula*
Spotted rana	-	*Rana grayii*
Cape grass frog	-	*Rana montana*
Dainty frog	-	*Cacostemum boettgeri*
Cape caco	-	*Cacostemum capense*
Cape chirping frog	-	*Arthroleptella lightfooti*
*Arum frog	-	*Hyperolius horstockii*

Reptilia (snakes):

Pink earth snake	-	*Rhinotyphlops lalandei*
Black worm snake	-	*Leptotyphlops nigricans*
Brown water snake	-	*Lycodonomorphus rufulus*
Yellow-bellied house snake	-	*Lamprophis fuscus*
Aurora house snake	-	*Lamprophis aurora*
Olive house snake	-	*Lamprophis inornatus*
Un-named	-	*Prosymna sundevellii*
Mole snake	-	*Pseudaspis cana*
Russet garden snake	-	*Duberria lutrix*
Common egg-eating snake	-	*Dasypeltis scabra*
Herald snake	-	*Crotaphopeltis hotamboeia*
Cape many-spotted snake	-	*Amplorhinus multimaculatus*
Boomslang	-	*Dispholidus typus*
Spotted skaapsteker	-	*Psammophylas rhombeatus*
Whip snake	-	*Psammophis notostictus*
Leighton's sand snake	-	*Psammophis leightoni*
Cross-marked sand snake	-	*Psammophis crucifer*
Garter snake	-	*Elaps lacteus*
Rinkals	-	*Hemachatus haemachatus*
Cape cobra	-	*Naja nivea*
Puff adder	-	*Bitis arietans*
Berg adder	-	*Bitis atropos*
Many-horned adder	-	*Bitis cornuta*

Reptilia (lizards):

Marbled gecko	-	*Phyllodactylus porphyreus*
Ocellated gecko	-	*Pachydactylus geitjie*

CHECKLIST 1: (Cont.)

Reptilia (lizards):

Rock agama	-	*Agama atra*
Spiny agama	-	*Agama hispida*
*Cape dwarf chameleon	-	*Bradypodion pumilum*
Silver sand lizard	-	*Scelotes bipes*
Speckled skink	-	*Mabuya homalocephala*
Common skink	-	*Mabuya capensis*
Golden sand lizard	-	*Acontias meleagris*
Yellow-throated plated lizard	-	*Gerrhosaurus flavigularis*
Plated lizard	-	*Tetradactylus seps*
Long-tailed seps	-	*Tetradactylus tetradactylus*
Ocellated sand lizard	-	*Meroles knoxii*
Anguine lizard	-	*Chamaesaura anguina*
Girdled lizard	-	*Cordylus cordylus*

Reptilia (Tortoises):

Angulate tortoise	-	*Chersina angulata*
Padloper	-	*Homopus areolatus*
Cape terrapin	-	*Pelomedusa subrufa*

Somerset West 3418 BB (Sir Lowry's Pass and Steenbras Rivers)

Amphibia (frogs and toads):

Common platanna	-	*Xenopus laevis*
Cape ghost frog	-	*Heleophryne purcelli*
Sand toad	-	*Bufo angusticeps*
Raucous toad	-	*Bufo rangeri*
Cape rain frog	-	*Breviceps gibbosus*
Strawberry rain frog	-	*Breviceps acutirostris*
Cape sand frog	-	*Tomopterna delalandii*
Cape rana	-	*Rana fuscigula*
Spotted rana	-	*Rana grayii*
Cape grass frog	-	*Rana montana*
Dainty frog	-	*Cacosternum boettgeri*
Chirping frog	-	*Arthroleptella lightfooti*

Reptilia (snakes):

Pink earth snake	-	*Rhinotyphlops lalandei*
Brown water snake	-	*Lamprophis aurora*
Mole snake	-	*Pseudaspis cana*
Russet garden snake	-	*Duberria lutrix*
Herald snake	-	*Crotaphopeltis hotamboeia*
Spotted skaapsteker	-	*Psammophylax rhombeatus*
Cross-marked sand snake	-	*Psammophis crucifer*
Dwarf garter snake	-	*Elaps lacteus*
Rinkals	-	*Hemachatus haemachatus*
Cape cobra	-	*Naja nivea*

Reptilia (lizard):

Marbled gecko	-	*Phyllodactylus porphyreus*
Rock agama	-	*Agama atra*
Cape spiny agama	-	*Agama hispida*

CHECKLIST 1: (Cont.)

Reptilia (lizard):

*Cape dwarf chameleon	-	*Bradypodion pumilum*
Speckled skink	-	*Mabuya homalocephala*
Common skink	-	*Mabuya capensis*
Plated lizard	-	*Tetradactylus seps*
Girdled lizard	-	*Cordylus cordylus*

Reptilia (tortoises):

*Geometric tortoise	-	*Psammobates geometricus*
Angulate tortoise	-	*Chersina angulata*
Padloper	-	*Homopus areolatus*
Cape terrapin	-	*Pelomedusa subrufa*

Hangklip 3418 BD (Buffels River (Oos))

Amphibia (frogs and toads):

Cape chirping frog	-	*Arthroleptella lightfooti*
Common platanna	-	*Xenopus laevis*
Cape ghost frog	-	*Heleophryne purcelli*
Raucous toad	-	*Bufo rangeri*
Cape sand frog	-	*Tomopterna delalandii*
Cape river frog	-	*Rana fuscigula*
Clicking stream frog	-	*Rana grayii*
Banded stream frog	-	*Rana montana*
Common caco	-	*Cacosternum boettgeri*

Reptilia (snakes):

The Black House Snake, *Lamprophis inornatus* and the Spotted House Snake, *Boaedon guttatus* have been recorded by the Cape Department of Nature Conservation whereas FitzSimons records the following species from neighbouring grid localities:

Common water snake	-	*Lycodonomorphus rufulus*
Black house snake	-	*Lamprophis inornatus*
Common mole snake	-	*Pseudaspis cana*
Common egg-eater	-	*Dasypeltis scabra*
Boomslang	-	*Dispholidus typus*
Cross-marked grass snake	-	*Psammophis crucifer*
Cape cobra	-	*Naja nivea*
Aurora house snake	-	*Lamprophis aurora*
Spotted house snake	-	*Boaedon guttatus*
Russet garden snake	-	*Duberria lutrix*
Herald snake	-	*Crotaphopeltis hotamboeia*
Spotted skaapsteker	-	*Psammophylax rhombeatus*
Dapple-backed sand snake	-	*Psammophis notostictus*
Spotted dwarf garter snake	-	*Elaps lacteus*
Common puff-adder	-	*Bitis arietans*

Pelamis platurus, the yellow and black sea-snake, may occasionally be washed up on the beaches in the area.

CHECKLIST 1: (Cont.)

Reptilia (tortoises):

Two species which are likely to occur in the region are the Angulate Tortoise, *Chersina angulata* and the Padlopertjie or Parrots-beak Tortoise, *Homopus aerolatus* which were recorded by Greig and Burdett (1976, unpublished), from a neighbouring grid locality.

CHECKLIST 2: Mammals recorded from the areas covered by the 1:50 000 quarter degree grid squares of the Cape Peninsula 3418 AB and AD, Somerset West 3418 BB and Hangklip 3418 BD (Stuart *et al.*, unpubl. and Stuart, 1981).

Cape Peninsula 3418 AB and AD (Buffels (Wes) and Elsies Rivers)

Bat	-	*Miniopterus schreibersi*
Bat	-	*Eptesicus capensis*
Bat	-	*Rhinolophus clivosus*
Forest shrew	-	*Myosorex varius*
Red musk shrew	-	*Crocidura flavescens*
Cape golden mole	-	*Chrysochloris asiatica*
Chacma baboon	-	*Papio ursinus*
Cape fur seal	-	*Arctocephalus pusillus*
Leopard seal	-	*Hydrurga leptonyx*
Cape dassie	-	*Procavia capensis*
*Hartmanns zebra	-	*Equus zebra harmannae*
Common duiker	-	*Sylvicapra grimmia*
Red hartebeest	-	*Alcelaphus buselaphus*
Bontebok	-	*Damaliscus dorcas dorcas*
Springbok	-	*Antidorcas marsupialis*
Steenbok	-	*Raphicerus campestris*
Grysbok	-	*Raphicerus melanotis*
Grey rhebuck	-	*Pelea capreolus*
Vlei rat	-	*Otomys irroratus*
Saunders vlei rat	-	*Otomys saundersae*
Krebs fat mouse	-	*Steatomys krebsi*
Striped mouse	-	*Rhabdomys pumilio*
Cape spiny mouse	-	*Acomys subspinosus*
Pygmy mouse	-	*Mus minutoides*
House mouse	-	*Mus musculus*
*Verreauxs rat	-	*Praomys verreauxi*
Black rat	-	*Rattus rattus*
Cape porcupine	-	*Hystrix africaeaustrali.*
Cape dune-mole rat	-	*Bathyergus suillus*
Cape mole rat	-	*Georychus capensis*
American grey squirrel	-	*Sciurus carobipensis*
Striped polecat	-	*Ictonyx striatus*
Small-spotted genet	-	*Genetta genetta*
Large-spotted genet	-	*Genetta tigrina*
Cape grey mongoose	-	*Herpestes pulverulentus*
Water mongoose	-	*Atilax paludinosus*
Wild cat	-	*Felis libyca*
Caracal	-	*Felis caracal*

Species not occurring naturally in the area and which have been introduced to the Cape Point Nature Reserve are underlined.

CHECKLIST 2: (Cont.)

Somerset West 3418 BB (Sir Lowry's Pass and Steenbras Rivers)

Bat	-	*Eptesicus melckorum*
Bat	-	*Rhinolophus clivosus*
Bat	-	*Rousettus aegyptiacus*
Dwarf shrew	-	*Suncus etruscus*
Chacma baboon	-	*Papio ursinus*
Southern elephant seal	-	*Mirounga leonina*
Grysbok	-	*Raphicerus melanotis*
*Cape greater gerbil	-	*Tatera afra*
*Verreaux's rat	-	*Praomys verreauxi*
Black & white dormouse	-	*Graphiurus ocularis*
Cape dune-mole rat	-	*Bathyergus suillus*
Cape clawless otter	-	*Aonyx capensis*
Wild cat	-	*Felis libyca*
*Leopard	-	*Panthera pardus*

Hangklip 3418 BD (Buffels (Oos))

The only mammal recorded in this locality by Stuart (1981) was the leopard *Panthera pardus*. Heinecken (1982) however, records the following mammals from the Rooiels estuary and it can be expected that these mammals would also occur at the Buffels (Oos).

Baboon	-	*Papio ursinus*
Klipspringer	-	*Oreotragus oreotragus*
Cape clawless otter	-	*Aonyx capensis*
Water mongoose	-	*Atilax paludinosus*
Dassie	-	*Procavia capensis*
Grey mongoose	-	*Herpestes pulverulentus*

*Footnote:

The species of fauna listed in the South African Red Data books as being either rare or endangered are as follows:

Reptiles and Amphibians (Mc Lachlan 1978):

Gill's platanna *(Xenopus gilli)*, Arum frog *(Hyperolius horstockii)*, Cape dwarf chameleon *(Bradypodion pumilum)* and the Geometric tortoise *(Psammobates geometricus)*.

Small Mammals (Meester, 1976):

Verreaux's rat *(Praomys verreauxi)*, Cape greater gerbil *(Tatera afra)*, Black and white dormouse *(Graphiurus ocularis)*.

Large mammals (Skinner, *et al.*, 1977).

Leopard *(Panthera pardus)* and Hartmanns zebra *(Equus zebra hartmannae)*.

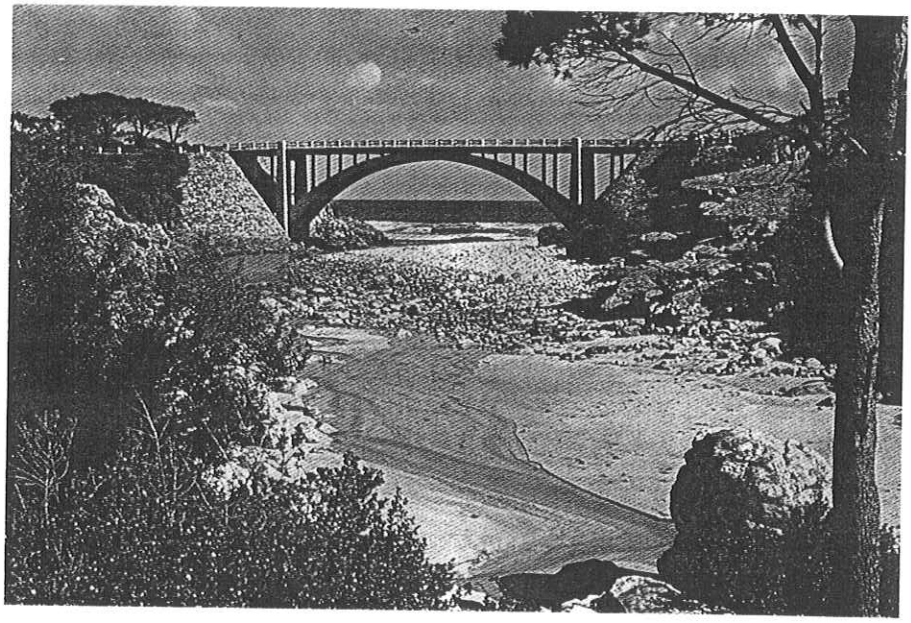
Although none of the above mentioned species have been recorded specifically from any of the estuaries covered in this report, the likelihood of them, particularly the amphibians, being present at the estuaries cannot be ruled out. As habitat alteration is generally the main reason for the disappearance of a species, plans for any major habitat changes should take cognizance of rare or endangered species which may be present in the area to be altered.

PLATE III:

The Sir Lowry's Pass Estuary taken from an altitude of 150 m. Note the channel meandering across the sandy beach behind the rocky infratidal zone (ECRU 79-08-15).

PLATE IV:

The Steenbras River inlet, taken from just above the head of tidal effect (ECRU 82-04-28).



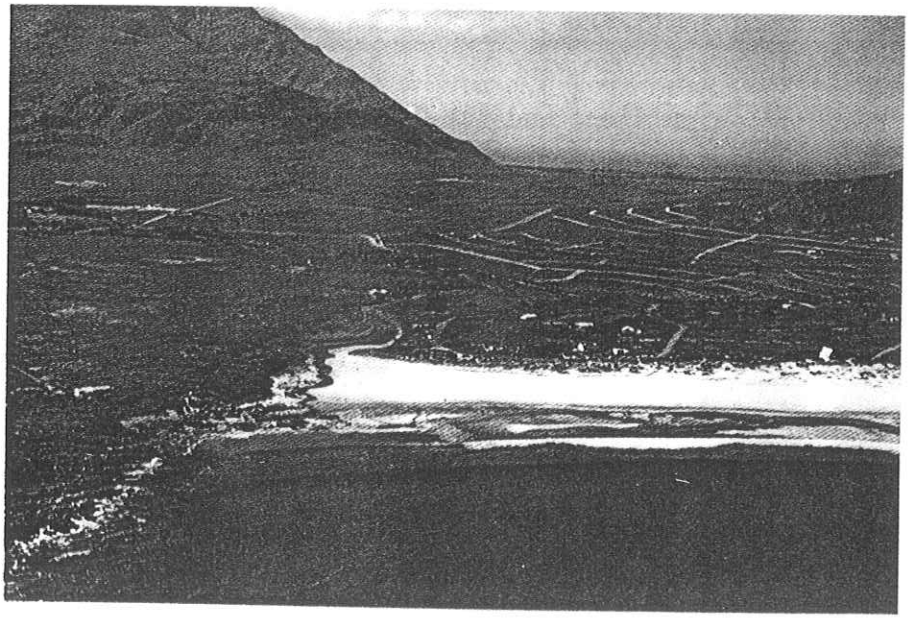


PLATE V:

The Buffels (Oos) Estuary (looking due east) with Pringle Bay Township on the right of the photograph. Altitude - 150 m (ECRU 79-08-15).