C.A.P.E. ESTUARIES MANAGEMENT PROGRAMME

SWARTKOPS INTEGRATED ENVIRONMENTAL MANAGEMENT PLAN

VOLUME I

SITUATION ASSESSMENT
(STATE OF PLAY REPORT)
1st Draft

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EXECUTIVE SUMMARY

INTRODUCTION

This is a situation assessment or state of play report for the Swartkops Estuary as well as the Swartkops and Aloes Nature Reserves and will form the basis from which an Integrated Management Plan (IMP) will be developed. This management plan will be based on the National Estuarine Management Protocol as outlined in the new Integrated Coastal Management Bill. The report describes the historical and current situation both on the estuary and within the nature reserves, and provides an assessment of the legal requirements relevant to the study area, a bio-physical description, a description of land-use patterns, water use and requirements, exploitation of living resources, economic importance, conservation and rehabilitation priorities, institutional arrangements, recommendations for management and the way forward with regards the formulation of the IMP itself. The estuary and nature reserves have also been represented spatially in the form of GIS maps.

BIO-PHYSICAL DESCRIPTION

SWARTKOPS ESTUARY

The Swartkops Estuary is a medium-large, permanently open, warm-temperate, barred estuary with the ichthyofaunal community and water quality rated as good and the aesthetic appeal as moderate. The capacity of the estuary is \(5.1 \times 10^6\) m\(^3\) for high and low tide respectively and has a tidal prism of \(2.9 \times 10^6\) m\(^3\). The system measures approximately 90 m wide in the upper reaches and is characterized by steep banks and winding channels. Towards the middle reaches the banks are steep and the channels are slightly wider and less convoluted. The lower reaches are significantly wider with extensive intertidal mudflats, islands, saltmarshes and sandbanks. The estimated area covered by the estuary is 682 hectares. Depth along the main channel is relatively consistent at approximately 3 m below MSL, with deepest and shallowest readings of 3.75 and 2 meters respectively.

The mouth of the estuary is located north of Port Elizabeth and the system extends 16.4 km inland. The estuary is fed by two major river systems, namely the Swartkops River and its largest tributary, the Elands River, which both have their origin in the Groot Winterhoek mountains. The catchment measures 1360 km\(^2\) and the MAR is \(84.2 \times 10^6\) m\(^3\); frequent flooding occurs. Two tributaries of the Elands River are impounded and the Groendal Dam is located on the Swartkops River approximately 35 km from the estuary. These obstructions are thought to hold back in the region of 16% of the MAR but reduce freshwater inflow by only 5%. The Chatty River is the largest tributary flowing directly into the estuary in the region of the Swartkops Village.

LAND-USE

There are three major residential nodes located immediately adjacent to the estuary, namely Swartkops Village, Redhouse and Amsterdamhoek/Bluewater Bay. The townships of Kwazakele and Motherwell are located further from the estuary but have an indirect affect on the system through pollution. Industrial activities are a major land-use within the immediate estuarine area and include saltpans, Fishwater Flats sewage works, sand/clay mining, brickworks, a power station, the motor industry, wool industry, tanneries,
extractive/beneficiation processes, aquaculture and railway yards and depots, with only limited agriculture taking place. The Swartkops and Aloes Nature Reserve are located on the northern banks of the middle and lower reaches respectively.

SEDIMENT

The main source of sediment in the lower reaches of the estuary is the adjacent beach and large sandbanks characterize the lower reaches. Sediment in the middle to upper reaches is derived from terrestrial origins, mainly the river catchment but also localized runoff. A transition zone of mixed sediments exists from just east of Swartkops Village upstream to Brickfields. Soil erosion due to agricultural practices is not an important feature of the catchment. Excess sediment that accumulates during dry periods is flushed out to sea during floods. The bridges across the Swartkops Estuary represent a partial barrier so that water levels upstream are higher than below the bridges during floods. This results in an accumulation of sediment, which is deposited on the infratidal saltmarsh, posing a threat to their ecological functioning.

FRESHWATER INFLOW

Floods occur fairly frequently in both summer and winter, although severe flooding with associated property damage and habitat destruction is less common and more likely to occur in summer. During extreme flooding, water levels may reach as much as 4 and 1.7 meters above mean tide levels in the upper and lower reaches of the estuary respectively. Significant decreases in certain macrobenthic species have been recorded after flood events. Reasons for this are thought to be a combination of animals leaving their burrows and being flushed out to sea, low salinities leading to hypo-osmotic stress and the deposition of fine silt that smothers the habitat.

SALINITY AND TEMPERATURE GRADIENT

Variability in salinity is high due to a combination of dry periods interspersed with frequent episodic floods. Elevated salinity (42 ‰) has been recorded in the upper reaches and could be due to seepage of high saline waters from the Bar None saltpans, high evaporation rates and low freshwater inflow. Vertical salinity gradient measured in the upper reaches reflect the intrusion of high salinity water far upstream and a well-mixed water column for most of the time. Vertical stratification occurs during and after flood events but is restricted to the upper reaches. Temperatures are similar along the length of the estuary and vary seasonally, with highest recordings in summer months.

OTHER PHYSICO-CHEMICAL PARAMETERS

Oxygen concentrations, saturation levels and pH show no longitudinal gradient. Turbidity decreases towards the mouth region, and the elevated levels often measured min the middle reaches have been attributed to polluted water entering the system via the Motherwell and Markman canals. Phosphate is the only nutrient that significantly increases in concentration from the mouth to the upper reaches. Chlorophyll-a also increases significantly upstream. Nitrite displays an opposite trend but this is not significant. Ammonia remains fairly constant throughout the system; however both nitrate and TPN are highest in the middle reaches. All parameters, except Ammonia and turbidity, are measured at higher mean concentrations in the river above the causeway; Ammonia is marginally lower and turbidity data was not
available. In the upper reaches, where freshwater inflow is at its highest, only nitrite displayed a significant relationship with freshwater; a negative correlation with salinity and a positive correlation with inflow has been recorded. When the estuary as a whole is analyzed, both phosphate and TPN show a negative correlation with salinity, and all nutrients, except phosphate, are positively correlated to freshwater inflow. Chlorophyll-a appears to be positively correlated to high phosphate, low ammonia and high turbidity levels.

POLLUTION

Sewage
Sewage derived waste can be detected by the presence of either *Escherichia coli* (*E. coli*) or the less specific faecal coliforms. Studies during the late 1980s showed that water quality is acceptable at Brickworks and Redhouse, slightly below acceptable standards at the Blue Hole and Swartkops village and greatly exceeds acceptable limits at Perseverance. More recent water quality tests reveal that *E. coli* counts regularly exceed 10 000/100ml at Motherwell Canal and Brickfields, and while they are usually diluted rapidly, levels in excess of 1000/100ml are occasionally measured upstream at the Redhouse Yacht Club and downstream at Swartkops Village.

Trace metals
Of particular concern are the more toxic metals such as copper, lead, zinc and mercury, which are present in high levels in the upper reaches when compared to the mouth region. However, their presence is attributed to their natural occurrence in terrestrial sediments, which have been washed into the system and from localized point source contamination. Overall, metal concentrations are considered to be low and the system is considered not to be polluted.

Persistent chlorinated hydrocarbons
Tests on the flesh of fish in the early 1980s revealed elevated quantities of DDT and PCBs, however they were not considered to be a threat to the health of animals consuming them.

Petroleum hydrocarbons
Pollution from petroleum products is minimal and restricted to accidental spills and exhaust emissions from powerboats and outboard engines, runoff from surrounding industrial areas and roads, and atmospheric fallout.

SWARTKOPS AND ALOES NATURE RESERVES

The need to proclaim the Swartkops Nature Reserve, comprising the intertidal area of the estuary from the LWS mark and extending onto the escarpment to the boundaries of the then Port Elizabeth Municipality and Motherwell township on the northern banks between Brickfields (Motherwell Canal) and Perseverance 6.5 km to the west, was first identified in 1982 after the areas conservation significance was recognized in the early 1970s. As such, the proposed reserve would include a range of habitats from intertidal mudflats to saltmarsh to floodplain (including Redhouse saltpan) and finally the steep escarpment and plateau. The dense valley bushveld found on the escarpment and plateau is in a good condition and provides habitat for a variety of fauna. In addition it provides stabilization for the topsoils and prevents erosion that could alter the ecology and hydrology of the estuary. The reserve, 100 hectares in extent was proclaimed in 1992.
The Aloes Nature Reserve is an as yet unproclaimed protected area consisting of municipal owned land bordered by Amsterdamhoek on the east, Old Grahamstown Road on the west and Wells Estate on the northern side.

Of the nine habitat types that characterize the two reserves four are considered critically endangered and three are vulnerable; with the exception of Sundays Escarpment Valley Thicket, these habitats are poorly conserved at present. Both reserves have been recognized as priority areas for biodiversity conservation and form an integral part of the proposed protected area network within the Nelson Mandela Bay area.

**BIOLOGICAL DESCRIPTION**

**SWARTKOPS ESTUARY FLORA**

**Phytoplankton**
The phytoplankton in the Swartkops Estuary comprises 18 species that are found in the water column and at least 40 others that reside in the sediment. Of these, the dominant size-group is the microplankton (> 12 µm), accounting for more than 60% of total production, which has been estimated at 93.3 mgC/m². Production increases during and immediately after flooding due the introduction of freshwater phytoplankton species into the system.

**Macrophytes**
Eelgrass (*Zostera capensis*) used to be the only major aquatic macrophyte in the system, prior to its complete disappearance from the system by 1984. Partial recovery was evident by 1988 and by 1996 the community appeared to be well on its way to full recovery.

Several other species of macrophytes appear to bloom under certain high nutrient conditions, e.g. dense mats of *Ruppia spiralis* in the Chatty River infestation of water hyacinth in the lower reaches of the Swartkops River; and the brown seaweed *Enteromorpha* spp. is recorded occasionally.

**Intertidal Saltmarsh**
The Swartkops Estuary has the third largest area of saltmarsh in the country. Cord grass (*Spartina maritima*) is the most abundant (50%) of the saltmarsh plants in the estuary. It is found from the mid-tide level and is succeeded up the tidal gradient by several species including *Sarcocornia perennis*, *Chenolea diffusa* and *Limonium linifolium*.

The area covered by intertidal saltmarsh prior to any development has been estimated at 215 hectares, however since then large areas of mostly supratidal marsh have been destroyed and approximately 166 hectares remains to this day.

**Reeds and sedges**
The common reed *Phragmites australis* is the dominant species and extends from Redhouse Village to the head of the estuary, where salinities are low (<15‰) for the most part.
SWARTKOPS FAUNA

Micro-organisms
The biomass of free-living bacteria is low compared to other systems, and has been estimated at 0.0003 gC/m². Bacteria are a major food resource for meiofauna. Similarly, the biomass and production of heterotrophic microflagellates and microzooplankton is low.

Meiofauna
The meiofauna community occurs in the muddy and sandy sediments of the estuary and has a mean standing crop of 0.6 gC/m². Nematodes account for as much as 84% of the total meiofauna biomass followed by harpacticoid copepods, with the remaining components comprising oligochaetes, polychaetes, flatworms and gastrotrichs.

Zooplankton
A total of 54 species of zooplankton have been identified, with 24 remaining unidentified. Zooplankton is dominated by copepods and mysids, whose distribution appears to be mainly determined by salinity. Of these, mysids are the dominant group in terms of biomass, with two species, Mesopodopsis slabberi and Gastroscus brevifissura comprising most of the community.

Benthic macrofauna
A total of 122 species of benthic macrofauna have been recorded in the system; 78% of biomass located within the intertidal region and 22% subtidally. Within the soft sediments of non-marshland regions, the dominant forms are the Upogebia africana, Callianassa kraussi, Cleistostoma spp. and Solen spp. Substrate type and competition for space limit the distribution of the various species. Two detritivorous crab species, Sesarma catenata and Cleistostoma edwardsii and the gastropod Assiminea sp. are the dominant macrobenthic fauna of the saltmarsh habitat.

Ichthyoplankton
Fish larvae are present all year round, but highest abundance is recorded in summer. Diversity is low and densities fluctuate considerably from a low of 0.028 larvae/m³ to a high of 24 728 larvae/m³ in summer. The dominant groups are the Gobiidae (predominantly Caffrogobius nudiceps) and Gilchristella aetna. Larvae of Rhabdosargus holubi, Hepsetia breviceps and Monodactylus falciformis have been frequently caught but in low numbers.

Juvenile and adult fish
There is rich and diverse ichthyofaunal community that displays an even distribution throughout the Swartkops system. This is most likely due to the well mixed water body that ensures high saline waters as far as the head of the estuary except during floods.

A series of surveys dating back to the late 1970s have accounted for 86 species of fish that commonly occur in the system. The majority are marine migrants, such as Argyrosomus japonicus, Pomadasys commersonnii, Lithognathus lithognathus, Rhabdosargus holubi, Lichia amia and a host of mullet species. P. commersonnii is the most abundant of the large fish species, comprising 29 and 17% by mass and numbers respectively, followed by mullet (5 species) comprising 25% by mass. There appears to be no clear seasonal trend in abundance.
Some of the more common estuarine residents found in the system include *Gilchristella aestuaria*, *Atherina breviceps* and *Glossogobius callidus*.

Eelgrass beds are an important habitat for small fish species and provide a nursery area for juveniles. The fish community within the eelgrass beds comprises 39 species and is dominated by *Atherina breviceps* followed by juvenile mullet, *G. aestuaria*, juvenile *R. holubi* and juvenile *Diplodus sargus capensis*.

**Freshwater fishes**

Ten freshwater fish species have been recorded in the Swartkops River and possibly the upper reaches of the estuary after floods. One of these is *Anguilla mossambica*, which spawns at sea and then, together with the juveniles (glass eels) migrates back upstream through the estuary to freshwater. Four species are indigenous, namely *Barbus afer, Sandelia capensis, Barbus pallidus* and *A. mossambica* with the remaining six being considered alien invasives (*Oreochromis mossambicus, Tilapia sparrmanii, Cyprinus carpio, Lepomis macrochirus, Micropterus salmoides* and *M. dolomieu*).

**Amphibians and reptiles**

Five species of frogs and toads, six species of lizards, nine species of snakes, one species of tortoise and two turtle species are listed as being recorded in or can be expected to be found in the estuary, surrounding veld or beach. Amongst the amphibians, several species breed and feed in wetlands and the veld adjacent to estuaries, e.g. *Strongylopus grayii* and *Bufo rangeri*. None of the lizard species are actually found in the estuary but they do inhabit the drylands adjacent to it, e.g. *Pachydactylus maculates, Acelotes anguina* and *Cordylus cordylus*. A few of the more common harmless snakes include *Lamprophis fuliginusus* and *L. inornatus*. Highly venomous snakes such as *Dispholidus tupus* and *Bitis arietans* are common amongst the adjacent bushveld and may be found within suburban settlements. The angulate tortoise (*Chersina angulata*) is very common around Port Elizabeth.

**Birds**

Of the 195 bird species identified in the Swartkops Valley between Perseverance and Algoa Bay in the mid-1980s, 53 were regularly associated with the estuary and 61 were recorded on the Redhouse salt pans above Brickfields. A total of 145 species were listed as being found within the proposed Aloe Nature Reserve, most of which were associated with the Redhouse salt pans. Nine species are listed as being rare, vulnerable or threatened, namely *Spheniscus demersus, Ardea goliath, Ciconia nigra, Mycteria ibis, Phoenicopterus ruber, Phoeniconaias minor, Hieraaetus pennatus, Haliaeetus vocifer* and *Hydroprogne caspia*. The most significant change in the bird community of the Swartkops Estuary over the last century is the total disappearance of freshwater species due to the destruction of freshwater habitats through industrial development and the construction of salt pans on the floodplain.

The Swartkops is one of the most important estuaries for birds in South Africa, and has historically held the most number of birds between Cape Agulhas and Durban. As many as 4 000 birds can be present during summer, with these numbers falling to less than 1 200 in winter due to the departure of the Palaearctic migrant waders and terns. Surveys conducted in the 1980s showed that five species comprised 74% of the estuarine associated birds, namely *Larus dominicanus, Pluvialis squatarola, Numenius phaeopus, Sterna hirundo* and *Calidris ferruginea*. Most birds (92%) utilize the intertidal habitat at low tide as a foraging area, with only 6% and 2% utilizing the subtidal and saltmarsh habitats respectively. In terms of biomass, the mudprawn (*U. africana*) is the most important prey item of many waders,
including the five dominant species, and is consumed at low tide when individuals leave their burrows. The exact effect of bait collection on bird populations is difficult to assess, but it almost certainly does impact negatively. The exploitation of pencilbait may also have knock-on effects for the African black oystercatcher which almost exclusively feeds on this organism in the estuary.

The Redhouse Saltpan is considered to be the most important mainland breeding site for seabirds in the Eastern Cape and has hosted some of the largest breeding colonies in the province for several species, namely white-breasted cormorants, sacred ibises, kelp gulls and grey-headed gulls. Due to a combination of animal and human interference, the breeding success of several species has been severely impacted.

SWARTKOPS AND ALOES NATURE RESERVES

Flora
Much of the terrestrial vegetation in the Swartkops Valley has been severely impacted by man's activities, but there are some areas where vegetation remains relatively unaffected.

Terraces
The areas immediately above the estuarine floodplain are known as terraces and they support a varied floral community, including many of grasses, shrubs and aloes found on the floodplain. In addition, larger species such as *Rhus longispina*, *Schotia afra*, several *Euphorbia* species and the alien invasive *Opuntia ficus indica* are also found here.

Escarpment
A forest-type vegetation occupies this narrow region characterized by dry clay soil. Larger species include *Sideroxylon inerme*, *Ptaeroxylon obliquum* and *Euphorbia* species, while the understorey may include *Pelargonium* spp. and vygies. Invasive species include *O. f. indica* and *Acacia cyclops*.

High ground
The high ground or plateau is characterized by uniformly larger plants, mostly in excess of 2 meters. Numerous aloe species, *S. inerme*, *Pelargonium* spp., *Portulacaria afra*, *Scutia myrtina*, *Carissa bispinosa* and *Acacia karroo* are commonly found.

Fauna
The sub-sections on amphibians, reptiles and birds found on the estuary are also applicable to the nature reserves.

Mammals
A total of 27 species of mammal have been recorded in Swartkops River valley. Those occurring in proximity to the estuary are mostly confined to the upper reaches in the vicinity of the Swartkops Nature Reserve and further inland. Most are seldom seen but *Herpestes pulverulentus*, *Cercopithecus aethiops* and *Rhabdomys pumilio* are observed quite frequently.

ALIEN VEGETATION

The predominant alien plants in the lower estuarine area are *Acacia cyclops*, *Eucalyptus* sp., *Pennisetum clandestinum*, *O.f. indica* and *Myoporum tenuifolium*. Alien plants in the riverine regions include *Salvinia molesta*, *Azolla filiculoida* and *Arundo donax*.
HERITAGE RESOURCES

Only one heritage site is thought to occur in the area, namely Wynrock’s Old Donkey Paddock located in the southern corner of the Aloes Reserve.

LEGISLATION AND PLANNING & DEVELOPMENT STRATEGIES

The purpose of this section is to review all forms of legislation that may have an impact on the management of the Swartkops Estuary and Swartkops and Aloes Nature Reserves. This review incorporates international agreements and strategies as well as all forms of national, regional and local legislation. There is also a section that incorporates all relevant regional and local planning and development strategies.

EXPLOITATION OF LIVING RESOURCES

FISH

Catch composition

Spotted grunter is by far the most dominant catch by club anglers, comprising 87% of the total catch by number and 83% by weight. White steenbras and leervis were the next dominant species. However, when all user groups are combined, it is the Cape stumpnose that dominates the catch numerically, although spotted grunter is a close second by number and still dominates in terms of weight. A survey in the late 1980s estimated cpue at 0.0018 fish/angler/hr, which extrapolates to 12 545 fish per year and a total weight of 11.51 tons.

Species such as white steenbras and dusky kob were more frequent in early 20th century catches when compared to recent surveys by, and spotted grunter only appeared in 2% of anglers catches. The reasons for the change in catch composition were attributed to overfishing in estuaries and the ability of spotted grunter to withstand angling pressure. However, it is more likely that a combination of factors have led to the perceived decline of certain species in anglers catches.

The existing fishery does not vary much from the 1980s scenario, with spotted grunter still dominating the catch of all user groups. However, a change in the way some anglers now fish (e.g. lures) means that piscivorous fish species such as leervis, dusky kob and shad feature more predominantly in this sectors’ catch.

Current user groups and levels of effort

Due to its proximity to a major city (Port Elizabeth) and the number of urban and informal settlements adjacent to the estuary, levels of angling effort are exceptionally high. An estimate of 20 boats on any given weekday and at least twice this number on weekends and holidays is an indication of the pressure. Countless shore based fishermen are seen during the week and on week-ends. The exact number of so-called subsistence fishermen is not known, but they are numerous. A lot of boat-based anglers fish at night, especially those who use bait. Boat and shore-based anglers who use artificials tend to fish more during the day and have greater success with species such as dusky kob and leervis. Shore-based anglers mostly fish during the day.
INVERTEBRATES

Target organisms
Numerous invertebrate species are exploited as bait. Organisms are either collected by the fishermen themselves or by subsistence bait collectors who then sell to recreational anglers. There are a number of subsistence collectors who are licensed in accordance with the MLRA to sell their catch but numerous illegal operators are also in play. The most frequently collected species, and those collected in the greatest numbers, include mudprawn, sandprawn, pencilbait and tongue worm. Additional bait organisms include tapeworm, cracker shrimp and bloodworm. Most collecting effort takes place in the lower reaches below the railway bridge, with the dominant area for bloodworm and sandprawn being near the N2 bridge. The rest of the bait organisms are collected on both vegetated and unvegetated intertidal mudbanks.

Collecting methods
A variety of collecting methods are used to collect invertebrate bait organisms, namely pumping, stamping (includes using hands and feet), tins and digging. All methods indirectly impact on the resource due to disturbance of the sediment and trampling.

THE SUBSISTENCE BAIT FISHERY

A licensed subsistence bait fishery has been in place on the Swartkops Estuary since 2002. The idea behind the fishery is to facilitate effective control and provide sustainable benefits to those involved in the collection of marine resources from the estuary and the communities around the estuary. At present, 36 subsistence permits have been issued and holders have to abide by strict permit conditions that include daily bag limits; a ban on the use of forks to collect bait organisms except on Fridays and public holidays; a ban on all bait collecting activities on Tuesdays; a requirement that dug areas be smoothed over; and a specification for minimum sizes that conformed with subsistence/recreational regulations. There are still a number of challenges to be addressed in the implementation of this fishery; the most pressing issue is the ongoing animosity between different stakeholders based on the perception that bait resources are still under threat despite efforts to legalize and monitor the subsistence sector.

Managers, recreational fishers, conservationists and scientists claim that too much bait is being collected, much of it is discarded, and the sediment turnover resulting from bait collecting activities is having a detrimental effect on estuarine function. Subsistence bait collectors on the other hand, claim that there is no reduction in the density of bait organisms, that they harvest on an ad hoc rotational basis, that they need to be allowed to collect more bait, and that the favored (and most efficient) collecting method (forks) poses no ecosystem problems. Adding to the problem is the fact that bait collected and sold at the Swartkops is used extensively in other estuaries, thereby increasing demand and placing additional pressure on the resource.

While the cause for this decline, particularly for mudprawn, is perceived by many to be the result of excessive collecting pressure, long-term monitoring data on water quality, exploitation levels and habitat alteration/destruction is lacking. As such, it is difficult to say with any degree of certainty that subsistence collectors are alone responsible. Other factors contributing to the trend could be:
• Numerous recreational anglers collect their own bait;
• many unlicensed collectors are still active and mostly dig up the mudbanks; they also sell their catch at lower prices compared to the licensed vendors;
• water quality and other natural processes in the estuary and Algoa Bay may have affected breeding and recruitment success;
• habitat loss due to floods, altered flow regimes and climate change; and
• numerous natural predators, most notably birds and fish.

This issue is one of the priority concerns that will be addressed in the ensuing EMP and will need to be approached from both conservation and socio-economic points of view. Numerous recommendations for the management of the bait fishery are provided.

**MONITORING AND COMPLIANCE**

Compliance monitoring with regards the MLRA is conducted by MCM officers, however they have limited capacity considering their area of responsibility, which includes other estuaries and the coastal zone. Recently (February) 22 Honorary Fisheries Control Officers were appointed in terms of the MLRA. These HFCOs comprise angling club members as well as concerned members of the public. They conduct regular patrols and are empowered to issue fines and confiscate illegal fishing gear.

Members from all user groups are guilty of offences in terms of the MLRA. Incidents include unlicensed recreational anglers and bait collectors; unlicensed subsistence bait collectors and sellers; non-compliance with permit conditions by licensed subsistence bait collectors and sellers; digging mudbanks by recreational users; size limits, bag limits and closed seasons for fish; selling of fish and gillnetting.

**WATER QUANTITY AND QUALITY REQUIREMENTS**

This section of the Situation Assessment focuses on the contribution of freshwater systems to the maintenance of the Swartkops Estuary. A significant impact comes from upstream river reaches and catchment activities such as land-use, urban and rural developments and associated activities, point and non-point pollution events, water abstractions, dams, weirs, and streamflow reduction activities such as forestry. This study therefore attempts to quantify the contribution or impact the Swartkops catchment makes to the Swartkops Estuary.

**CATCHMENT DESCRIPTION**

The Swartkops River catchment is located in Water Management Area 15, and is approximately 2 630 km² in size and extends from the Groot Winterhoek mountains. The river drains the M10 catchment, which includes the M10A (KwaZungu), M10B (Elandsrivier), M10C (Swartkops River: Elands Confluence), and M10D (Swartkops River: Despatch – River Mouth) quaternary catchments. Land-use in the upper catchment is predominantly natural area and agriculture. Although the river flows thorough natural and agricultural areas for most of its length, significant portions of the lower catchment are highly urbanized. Large flood events (greater than 1:50 year) result in large-scale flooding and significant damage to the riparian zone and floodplain. Urbanisation that has taken place within the study area below the 1:100 year floodline continues to remain at risk to flooding events.
RIVER STATUS

A national River Health Programme site is located in quaternary catchment M10C, and represents a site designated for river health monitoring that provides information regarding status of the river system according to physical drivers and biotic response indicators such as fish and aquatic macroinvertebrates. The major issues that presently affect the Present Ecological State of the Swartkops River system are the following:

- Kwa-Zungu River: The presence of alien fish and operation of Groendal Dam.
- Elands River: The presence of extensive alien vegetation, the abstraction of water, physical manipulation of the channel and the presence of alien fish species.
- Swartkops River: The river is overall in a highly degraded state due to severe water quality problems, alien vegetation and fish, and physical manipulation of the channel as well as increased low flows.
- Chatty River: The lower Chatty River is also in a highly degraded state and basically functions as a storm and sewage drain.
- Brak River: The section of the river was also in a highly degraded state, with hardly any instream biota. The major problem seems to be extensive alien vegetation.
- Point sources of pollution that include the Motherwell Canal (litter, dead animals and sewage), Markman Canal (industrial waste and litter) and smaller sources from a variety of industries.

SOCIO-CULTURAL IMPORTANCE

There are various resources that are being utilised for cultural purposes within the Swartkops catchment area, namely baptisms by the Zion Christian Church, cleansing ceremonies by traditional healers and harvesting of medicinal plants.

WATER QUANTITY

The Nelson Mandela Bay Municipality (NMBM) is served by the Algoa Water Supply System, with a secondary system comprising the Uitenhage aquifers and dams on a number of rivers, including the Swartkops River, Bulk River and Sand River.

While the Swartkops Estuary is considered well mixed during low rainfall periods, it may become stratified during high flow periods, and with an average depth of 3 m, it is considered to be a shallow estuary. Salinity varies from 35‰ at the mouth to approximately 10‰ near the head of the estuary, indicating the importance of freshwater inflows to the system. The estuary experiences significant tidal water exchange and the tidal prism during spring tides is on average 3x106 m$^3$ and the average flushing time during spring tides about 22 hr.

WATER QUALITY

Three important pollution point sources into the Swartkops Estuary are the Motherwell and Markman Canals, and the Chatty River that flows into the estuary. The Uitenhage / Despatch Sewage Treatment Works are also located in the upstream reaches of the estuary, while informal settlements occur in places on the banks of the estuary. There are also elevated
levels of heavy metals in estuarine sediments where runoff from industrial or informal residential areas, enter the system.

There has been a pronounced increase in phosphate concentrations in the Swartkops River in the recent past, which translates into a phosphate concentration doubling time of less than 5 years. In combination with the high median and rising nitrate levels, the Swartkops presents itself as one of the most threatened freshwater systems in South Africa. Seasonal nutrient profiles indicate that nitrates >400 µg/l persists for at least five months a year in the Swartkops. Conditions favourable to the development of eutrophic conditions are present for most of the year in Swartkops River catchment. Sedimentation of the dams within the catchment due to erosion in the upper catchment region has also been noted as significant.

ECOLOGICAL RESERVE STUDIES

Swartkops desktop reserve assessment
Reserve categories have been set at quaternary catchment level across the country at a desktop, low confidence level. The Present Ecological State (PES) and Ecological Importance and Sensitivity (EIS) were sourced for the quaternary catchments of the Swartkops River and Estuary. The EIS of a river is an expression of its importance to the maintenance of ecological diversity and functioning on local and wider scales. Ecological sensitivity therefore refers to the system’s ability to resist disturbance and its capability to recover from disturbance once it has occurred (resilience). Both abiotic and biotic components of the system are taken into consideration in the assessment of EIS. The desktop PES, EIS and Recommended Ecological Category for the Swartkops Catchment are provided below.

<table>
<thead>
<tr>
<th>QUATERNARY CATCHMENT</th>
<th>PES</th>
<th>EIS</th>
<th>REC</th>
<th>TOTAL EWR FLOWS (MCM/annum)</th>
<th>EWR% OF NATURAL MAR</th>
</tr>
</thead>
<tbody>
<tr>
<td>M10A: KwaZunga</td>
<td>A</td>
<td>High</td>
<td>A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>M10B: Elands</td>
<td>D</td>
<td>High</td>
<td>C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>M10C: Swartkops</td>
<td>E-F</td>
<td>High</td>
<td>D</td>
<td>9.531</td>
<td>11.44</td>
</tr>
<tr>
<td>M10D: Swartkops</td>
<td>E-F</td>
<td>High</td>
<td>D</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

PRESSURES / RISKS / THREATS

Due to the high human densities and variety of human activities in the vicinity of the Swartkops Estuary, a wide range of man made threats to sustainable development and conservation exist in the area. In addition to these, the geology and geomorphology of the area also present certain risks to development and potential future land use. While some of the pressures / threats / risks in the area are generic to both the terrestrial and aquatic/wetland habitats, many of these are specific to the different environments. The following pressures/threats/risks are highlighted:

Escarpmont and Coastal Plain
- Informal residential development
  - Loss of natural habitat
- Pollution due to poor service delivery
  - Improper sanitation, illegal dumping, domestic waste disposal and littering
- Potential soil and water pollution

**Estuary, floodplain and saltmarsh**

- Flow constriction due to causeways, roads, railway lines, pipelines.
  - Potential flooding and damage to property and infrastructure.
  - Prevents flushing of saltmarsh areas resulting in hypersaline soil conditions.
  - Impedes flow to wetland areas resulting in loss of wetland habitat.
- Potential erosion along cattle pathways.
  - Insufficient development setback distances.
  - Potentially necessitates bank stabilization and reclamation due to bank erosion.
  - Risk of damage to property during flooding events.
  - Loss of supratidal saltmarsh habitat.
- Poorly planned hard structures e.g. jetties, slipways, culverts.
  - Unnatural erosion / accretion in channel.
  - Risk of damage during flooding events.
- Discharge of polluted runoff and stormwater from industrial and residential areas, as well as contaminated process water e.g. industrial / sewage effluent.
- Poor land use practices in the catchment resulting in increased sediment input, nutrient enrichment and pollution.
- Uncontrolled water abstraction and impoundment resulting in altered flow regime, i.e. reduced base flow required for ecological functioning, and insufficient freshwater pulses for mouth maintenance.

**CLASSIFICATION, ECONOMIC VALUE, PROTECTION AND REHABILITATION**

**CLASSIFICATION**

The Swartkops Estuary is a warm-temperate, medium-large, permanently open, tidally dominated barred estuary that displays a good ichthyofaunal community and water quality and only moderate aesthetic appeal. The estuary is ranked as the 11th most important estuary in South Africa in terms of biodiversity with an overall importance score of 92 out of a possible 100. The system has been ascribed an A/B management class based on the freshwater requirements.

According to a botanical rating system (area covered by each plant community type, its association with the estuary, its condition and the plant community richness), the Swartkops Estuary was rated 18th overall with a score of 170 (normalised score of 41 out of 100). Within the Eastern Cape region, the Swartkops was rated tied 4th out of eight systems. Amongst the permanently open estuaries, the Swartkops was only rated tied 12th out of 14 systems. Of the four plant community types, the intertidal saltmarsh was most important followed by reeds/sedges, with supratidal saltmarsh and submerged macrophytes both receiving low individual importance scores.

A modification of the botanical rating system that took functional importance, species richness, plant community type richness and plant community type rarity into account resulted in the Swartkops Estuary being ranked 4th in South Africa with a botanical importance rating of 350.
ECONOMIC VALUE

The following economic values have been attributed to the Swartkops Estuary:

**Subsistence** - ranked 1\textsuperscript{st} amongst temperate systems with a value of R808 953 per annum.

**Property** – ranked 19\textsuperscript{th} amongst temperate systems in terms of property value related to estuaries with a value of R155 million.

**Tourism** – ranked 7\textsuperscript{th} amongst temperate systems in terms of tourism value attributed to estuaries with a value of R50 million per year.

**Nursery** – ranked 5\textsuperscript{th} amongst temperate systems with a value of R32.8 million per annum.

**Existence** – does not rank amongst the top 40 temperate estuaries.

PROTECTED AREA STRATEGY AND POTENTIAL

The following can be said about the Swartkops Estuary with regards to requirements in terms of protection:

- The Swartkops is one of the core set of temperate estuaries required to meet the targets for biodiversity protection of estuarine resources; scores (out of 100) that contributed to the overall rating of 92 for the Swartkops were size (100), habitat importance (100), zonal type rarity (20) and biodiversity importance (100).
- The recommended extent of sanctuary protection is HALF of each habitat type within the system.
- The recommended extent of undeveloped margin is 50%; an average score for public perception of optimal level of development around SA estuaries was 40%.
- The recommended minimum water requirement falls under the A/B management class, which means a high priority and requirement.
- The priority for rehabilitation is HIGH.

Preliminary thoughts on a zonation plan for the Swartkops Estuary are that the sand and mudbanks adjacent to the N2 bridge on the north-west side be considered for protection (invertebrates) as well as the Redhouse Salt pans (birds) above the railway bridge. The saltpans are leased to Cerebos at present and negotiations will have to be entered into in this regard. The added attraction is that the saltpan area will effectively link up with the southern boundary of the Swartkops Nature Reserve. However, full stakeholder involvement will be required before any proposals are considered and this will be achieved during the upcoming stakeholder workshop. In addition to the protected areas, the estuary will be zoned for various user groups (e.g. water skiing), designated wake-free areas and no-go areas in terms of future development.

RESTORATION/REHABILITATION

Thirty-nine estuaries, including the Swartkops, were given a HIGH priority status for rehabilitation. According to the consensus opinion at the workshop the requirements for rehabilitation are water quality (pollution), clearing of alien vegetation and restoration of areas that have undergone inappropriate bank stabilization. An additional cause for concern was the disturbance created by bait collectors.
THE WAY FORWARD: OBJECTIVE II

This final section of the report provides a summary of what is to be accomplished in Phase II of the project, namely the formulation of the IMP. It provides details of what is required in terms of forming a local management institution, which will be responsible for the implementation and long-term running of the EMP.

A description of the tasks to be undertaken during Phase II is provided. Essentially these tasks fulfil the requirements for formulating a management plan in accordance with the C.A.P.E. Generic Framework for Estuary Management Plans. These include the setting of a Vision, Strategic Objectives and Management Strategies, preparing an Estuarine Zonation Plan and associated Operational Objectives, identifying Management Action Plans, proposing an institutional structure and time-table for implementation, developing a monitoring and evaluation programme, and finally the identification of research priorities.

THE STAKEHOLDER WORKSHOP

The workshop will be held at Port Elizabeth City Hall at a date yet to be determined and will concentrate on the development of a vision, strategic objectives and management strategies for the Swartkops estuary. An Estuary Zonation Plan (EZP) will also need to be considered in relation to the management strategies. The zonation plan for the two nature reserves devised by SRK (2008b) in the Conservation Development Framework will also be presented for discussion.
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CHAPTER 1 - INTRODUCTION

1.1 INTRODUCTION

Estuarine ecosystems are not isolated systems. They form an interface between marine and freshwater systems and are part of regional, national and global ecosystems either directly via water flows or indirectly through the movement of fauna. In addition to the biota that these estuaries support, they provide a range of goods and services (uses) to the inhabitants of the various regions. Disturbances in one estuary can influence a wide variety of habitats and organisms in the broader freshwater or marine ecosystem. Thus, the interaction between the systems and users creates a delicate balance, the sustainability of which needs to be addressed by some form of management plan.

In order to address this balance in a consistent manner in the Cape Floristic Region (CFR), the Cape Action for People and the Environment (C.A.P.E.) Estuaries Management Programme has developed a holistic and inclusive management process representative of all stakeholders. The programme is governed by a Task Team comprising of officials from C.A.P.E., Cape Nature, Marine and Coastal Management (MCM), the Department of Water Affairs and Forestry (DWAF), the Eastern Cape Parks Board (ECPB) and the Council for Scientific and Industrial Research (CSIR), which heads the technical support group.

The urgent need for Estuary Management Plans (EMPs) became apparent during the development of the new Integrated Coastal Management Bill. Estuaries and the management thereof have not been adequately addressed by past marine, freshwater and biodiversity conservation Acts. Estuaries and estuaries management have been marginalized due to the fact that they do not fit the ambit of any one government Department. Estuaries and the management thereof now form an integral part of the new Integrated Coastal Management Bill, which outlines a National Estuarine Management Protocol. The protocol identifies the need for the development of EMPs, as these would help to align and coordinate estuaries management at a local level.

Enviro-Fish Africa (Pty) Ltd. has been contracted by the Nelson Mandela Bay Municipality to address the development and implementation of an EMP for the Swartkops Estuary. In addition, management plans for the Swartkops and Aloes Nature Reserves, which border sections of the estuary on the northern side, will be developed. The final product will therefore be in the form of an Integrated Management Plan for the three key components. This report fulfills the requirements of Objective 1, namely a Situation Assessment, and is presented in the form of a State of Play or SOP Report.

1.2 TERMS OF REFERENCE

OBJECTIVE 1: SITUATION ASSESSMENT

The consultant is expected to review all existing local information in the form of local research reports and management processes. This information can be obtained from Local Authorities and forums. A map of the Swartkops Estuary and the Swartkops and Aloes Nature Reserves should be developed identifying different habitats and potential and existing management zones. The map should identify and record all developments in at least a 500m
zone surrounding the estuary. The possible direct impacts of these and other local developments should be noted.

The description of the current situation should include information on:
- Legal requirements relevant to the specific estuary
- Requirements stipulated under existing institutional Management Strategies such as Catchment Management Strategies, IDP (including SDF and Water Development Services Plan), Ramsar & National Heritage Site Strategies and Protected Area & Conservation Plans (e.g. C.A.P.E. Estuaries) relevant to the study area
- the Biophysical environment (present ecological health and important physical processes)
- the Socio-Economic environment (e.g. demographics & economic profile, land-use and planning provisions, cultural & heritage resources, water supply & demand, waste management etc.)
- Conservation Planning
- The Exploitation of living resources
- Mariculture activities
- Resource Directed Measures, e.g. Classification, Reserve and RQO
- Current institutional structures governing estuarine issues

The estuary and nature reserves should be represented spatially in the form of GIS Maps indicating the following:
- Important biophysical features
- All protected/conservation areas
- Areas earmarked for rehabilitation
- Land-use and planning provisions of surrounding lands
- Infrastructure
- Cultural & heritage sites
- Recreational activities
- Living resource exploitation
- Mariculture activities
- Wastewater discharges
- Stormwater drains
- Solid waste dump sites.

Finally, an assessment of the opportunities and constraints (e.g. legal obligations, constraints of tenure, prior usage, health and safety, natural hazards) should be done to guide the development of the EMP.

1.3 PROJECT TEAM

Overall responsibility for the project lies with Enviro-Fish Africa (Pty) Ltd (EFA). The project and team will be managed by Dr Tim Andrew of EFA; Dr Aidan Wood from Gleneagles Environmental Consulting CC is the project coordinator and will also provide specialist input with regards living resource exploitation and bio-physical & socio-economic aspects; Drs Patsy Scherman and Brian Colloty from Scherman Colloty & Associates will provide specialist input with regards the catchment, water use and water requirements; and Mr Russell Chalmers from EFA will be responsible for all mapping and GIS work.
CHAPTER 2 - PHYSICAL DESCRIPTION

2.1 SWARTKOPS ESTUARY

The Swartkops Estuary is a Type F (MAR > 15 x 10^6 m^3) medium-large, permanently open, warm-temperate, barred estuary with the ichthyofaunal community and water quality rated as good and the aesthetic appeal as moderate (Harrison et al. 2000). Whitfield (2000) rates the overall condition of the system as fair and states it is ecologically viable despite extensive urban development and floodplain modification. The capacity of the estuary has been estimated at 5.1 and 2.2 x 10^6 m^3 for high and low tide respectively and has a tidal prism of 2.9 x 10^6 m^3 (Reddering and Esterhuysen 1988). The system measures approximately 90 m wide in the upper reaches and is characterized by steep banks and winding channels. Towards the middle reaches the banks are still steep but the channels are slightly wider and less convoluted. The lower reaches below Brickfields are significantly wider (up to 350 m) with extensive intertidal mudflats, islands, saltmarshes and sandbanks (Baird et al. 1986). The estimated area covered by the estuary is 682 hectares (Talbot 1982) comprising 142 ha subtidal habitat (channel), 360 ha intertidal habitat and 180 ha supratidal floodplain. Depth along the main channel is relatively consistent at approximately 3 m below MSL throughout the system, with deepest and shallowest readings of 3.75 and 2 meters respectively (Reddering and Esterhuysen 1981).

The mouth of the estuary is located north of Port Elizabeth (Plate 2.1) and the system extends 16.4 km inland to a causeway one kilometer east of Perseverance. The estuary is fed by two major river systems, namely the Swartkops River and its largest tributary, the Elands River, which both have their origin 155 km away in the Groot Winterhoek mountains (Baird et al. 1986; Scharler et al. 1997). The upper reaches of the Swartkops River flow over the quartzites of the Table Mountain Group, in contrast to the Elands River, which flows over shales of the Bokkeveld Group (Baird et al. 1986). Downstream of their confluence, the Swartkops River flows over weakly consolidated shales of the Uitenhage Group. The catchment measures 1360 km² and the MAR is 84.2 x 10^9 m³. Mean annual rainfall is estimated at <700 mm/year with no clear seasonal pattern. Frequent flooding occurs when monthly rainfall falls over a period of a few days. Two tributaries of the Elands River, the Sand and Bulk Rivers, are impounded and the Groendal Dam (capacity 12 x 10^6 m³) is located on the Swartkops River approximately 35 km from the estuary. These obstructions are thought to hold back in the region of 16% of the MAR but reduce freshwater inflow by only 5% (Baird et al. 1986). The Chatty River (now restricted to a narrow channel as a result of the establishment of saltpans at Veeplaas) is the largest tributary flowing directly into the estuary in the region of the Swartkops Village and is one of the main point sources of pollution entering the system. The other major point sources of pollution are the Markman and Motherwell canals.

2.1.1 OBSTRUCTIONS

Apart from the causeway at Perseverance, four additional causeways span the Swartkops River below the Groendal Dam and act as weirs that impede freshwater flow. Apart from a retaining wall at one bridge near Despatch, which also acts as a weir, the other bridges on the Swartkops River do not impede flow. Saltpans at Redhouse hold back floodwaters and localized erosion can lead to downstream sand deposition. The Wylde Bridge and railway bridge at Swartkops Village obstruct floodwaters but do not appear to significantly affect normal tidal flows, although the major side arm of Tippers Creek has been blocked. The N2
bridge confines flow to the northern bank at the mouth and the southern causeway has impeded the natural migration tendencies of the main channel (Fromme 1988; Plate 2.2).

Plate 2.1 Geographic location of the Swartkops Estuary north of Port Elizabeth. The estuary mouth is indicated by the yellow arrow and the head of the estuary at Perseverance is indicated by the white arrow.

2.1.2 LAND-USE

There are three major residential nodes located immediately adjacent to the estuary, namely Swartkops Village, Redhouse and Amsterdamhoek/Bluewater Bay. The townships of Kwazakele and Motherwell are located further from the estuary but have an indirect affect on the system through pollution (Plate 2.3). Industrial activities are a major land-use within the immediate estuarine area and include salt pans, Fishwater Flats sewage works, sand/clay mining, brickworks, a power station, the motor industry, wool industry, tanneries, extractive/beneficiation processes, aquaculture and railway yards and depots (Baird et al. 1986), with only limited agriculture (dairy farming and market-gardening) taking place. The Swartkops and Aloes Nature Reserve (still to be officially proclaimed) are located on the northern banks of the middle and lower reaches respectively.
2.1.3 SEDIMENT

The main source of sediment in the lower reaches of the estuary is the adjacent beach, and it enters the system mainly on the flood tide and to a lesser extent via wind transport. Large sandbanks (also referred to as flood-tide deltas; Plate 2.4) characterize the lower reaches (Reddering and Esterhuysen 1981; 1988). Sediment in the middle to upper reaches is derived from terrestrial origins (fluvial deposits), mainly the river catchment but also localized runoff. A transition zone of mixed sediments exists from just east of Swartkops Village upstream to Brickfields. Overall, the sedimentation rate in the system is low and it is unlikely that the mouth (tidal inlet) will ever be blocked due to the accumulation of riverine or marine sediments (Fromme 1988).

Soil erosion due to agricultural practices is not an important feature of the catchment. Much of the lower catchment is characterized by the Uitenhage Group, which comprises mostly shale and which forms muddy deposits when eroded. Excess sediment that accumulates during dry periods is flushed out to sea during floods.

The bridges across the Swartkops Estuary represent a partial barrier so that water levels upstream are higher than below the bridges during floods. This results in an accumulation of
C.A.P.E. Estuaries Management Programme; Swartkops Integrated Environmental Management Plan: Draft Situation Assessment

sediment, which is deposited on the infratidal saltmarsh, posing a threat to their ecological functioning. The reduction in the scouring effect of flood waters between these bridges and Brickfields also means that sediment is not effectively removed from the channels on a regular basis (Reddering and Esterhuysen 1981; 1988). The change in flow dynamics during flooding below the bridges has caused the downstream migration of the main sandbar opposite Swartkops Village over the past 100 years.

Plate 2.3 Land-use patterns around the Swartkops Estuary. The major urban centers of Bluewater Bay (B), Amsterdamhoek (A), Motherwell (M), Swartkops Village (S) and Redhouse (R) are indicated.

2.1.4 FRESHWATER INFLOW

Freshwater inflow measured at the causeway on the Swartkops Estuary between April 1993 and June 1994 revealed a mean inflow of 1.52 m$^3$.s$^{-1}$ (130 x 10$^3$ m$^3$/day) during spring tides over the period. However, if an unusually high discharge in October 1993 is excluded, mean inflow is reduced to 0.82 m$^3$.s$^{-1}$. Over neap tide, mean inflow was measured at 0.71 m$^3$.s$^{-1}$, and 0.44 m$^3$.s$^{-1}$ if peak flows in March 1994 are excluded.

Floods occur fairly frequently in both summer and winter, although severe flooding with associated property damage and habitat destruction is less common and more likely to occur in summer. Historically, the most severe floods have been recorded in 1879, 1912, 1914, 1971 (when an overflow of 425 m$^3$/sec was recorded at the Groendal Dam spillway) and 1979 (Baird et al. 1986). During extreme flooding, water levels may reach as much as 4 and 1.7 meters above mean tide levels in the upper and lower reaches of the estuary respectively.
Significant decreases in certain macrobenthic species have been recorded after flood events. Populations of *Upogebia africana*, *Solen cylindraceus* and *Callianassa kraussi* in the middle and upper reaches all exhibited decreases when compared to pre-flood estimates (Hanekom 1989). Reasons for this are thought to be a combination of animals leaving their burrows and being flushed out to sea, low salinities leading to hypo-osmotic stress and the deposition of fine silt that smothers the habitat.

The effect of freshwater inflow on overall estuary ecology is illustrated by a comparison between the Swartkops and Kromme systems. Both are permanently open, similar in size and occur in the same bio-geographic region, and while they are tidally dominated, the Swartkops receives an order of magnitude more freshwater inflow than the Kromme. As a result, the freshwater deprived Kromme exhibits a benthic-based food web while the Swartkops has a significantly stronger pelagic component (Schlacher and Wooldridge 1996).

Plate 2.4 Large sandbanks (also known as flood-tide deltas) characterize the lower reaches of the Swartkops Estuary.

### 2.1.5 SALINITY AND TEMPERATURE GRADIENT

Overall mean salinity and temperature, and the seasonal mean salinity and temperature for the Swartkops Estuary measured at spring and neap tide between April 1993 and June 1994 is presented in Table (2.1; Scharler *et al.* 1997). The salinity values in the table represent the longitudinal gradient. Variability is high due to a combination of dry periods interspersed with frequent episodic floods. Elevated salinity (in the region of 42 ‰) has been recorded in the upper reaches (Marais 1975; Grindley 1976 in Baird *et al.* 1986) and could be due to seepage of high saline waters from the Bar None saltpans, high evaporation rates and low...
freshwater inflow. Vertical salinity gradient measured in the upper reaches reflect the intrusion of high salinity water far upstream and a well-mixed water column for most of the time. Vertical stratification occurs during and after flood events but is restricted to the upper reaches.

Temperatures are similar along the length of the estuary and vary seasonally, with highest recordings in summer months (December to March).

**Table 2.1** Mean (SD) temperature (°C) and salinity (‰) values for the Swartkops Estuary measured between April 1993 and June 1994.

<table>
<thead>
<tr>
<th></th>
<th>Lower reaches</th>
<th>Middle reaches</th>
<th>Upper reaches</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Summer</td>
<td>Winter</td>
<td>Overall</td>
</tr>
<tr>
<td>Salinity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spring</td>
<td>31.1 (4.5)</td>
<td>34.4 (0.7)</td>
<td>33.2 (3.6)</td>
</tr>
<tr>
<td>Neap</td>
<td>33.9 (1.4)</td>
<td>33.5 (2.4)</td>
<td>33.6 (2.1)</td>
</tr>
<tr>
<td>Temperature</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spring</td>
<td>21 (3.7)</td>
<td>16.8 (3.2)</td>
<td>18.4 (3.8)</td>
</tr>
<tr>
<td>Neap</td>
<td>21.9 (2)</td>
<td>17.4 (1.9)</td>
<td>18.8 (2.8)</td>
</tr>
</tbody>
</table>

### 2.1.6 OTHER PHYSICO-CHEMICAL PARAMETERS

Mean values for physico-chemical parameters measured in the Swartkops Estuary and River (just above the causeway) between June 1993 and June 1994 are provided in Table 2.2 (Scharler *et al.* 1997). Values are for the more common nutrients, phytoplankton (Chlorophyll-a), pH, oxygen and turbidity. No recent data is available.

**Table 2.2** Mean (SD) physico-chemical parameters for the Swartkops Estuary measured between June 1993 and June 1994.

<table>
<thead>
<tr>
<th></th>
<th>Lower reaches</th>
<th>Middle reaches</th>
<th>Upper reaches</th>
<th>Overall (estuary)</th>
<th>Swartkops River</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phosphate (ug/l)</td>
<td>24.1 (3.7)</td>
<td>80.2 (26.9)</td>
<td>120.7 (58.6)</td>
<td>84.7 (69.6)</td>
<td>210.5 (122)</td>
</tr>
<tr>
<td>Nitrate (ug/l)</td>
<td>173.2 (174.8)</td>
<td>198.2 (168.8)</td>
<td>173.5 (185.1)</td>
<td>191.8 (199.2)</td>
<td>326.6 (390.5)</td>
</tr>
<tr>
<td>Nitrite (ug/l)</td>
<td>10.6 (12.2)</td>
<td>10.4 (12.5)</td>
<td>5.6 (5.7)</td>
<td>9 (10.6)</td>
<td>9.7 (6)</td>
</tr>
<tr>
<td>Ammonia (ug/l)</td>
<td>100.8 (32.8)</td>
<td>105.4 (82)</td>
<td>94.9 (64.1)</td>
<td>100.2 (63.8)</td>
<td>96.3 (69.3)</td>
</tr>
<tr>
<td>Total Particulate Nitrogen</td>
<td>35.8 (28.4)</td>
<td>48.8 (46.1)</td>
<td>46.4 (39.5)</td>
<td>44.9 (38.8)</td>
<td>59.7 (36.4)</td>
</tr>
<tr>
<td>Chlorophyll-a (ug/l)</td>
<td>4.1 (4.4)</td>
<td>6.7 (4.1)</td>
<td>8.6 (5)</td>
<td>7.8 (8.6)</td>
<td>22.3 (22.7)</td>
</tr>
<tr>
<td>pH</td>
<td>8 (0.1)</td>
<td>7.9 (0.3)</td>
<td>7.6 (0.1)</td>
<td>7.8 (0.3)</td>
<td>8 (0.8)</td>
</tr>
<tr>
<td>Oxygen (mg/l)</td>
<td>7 (1.9)</td>
<td>7.2 (0.9)</td>
<td>6.9 (1.9)</td>
<td>7.2 (1.7)</td>
<td>9.2 (2.3)</td>
</tr>
<tr>
<td>% Oxygen Saturation</td>
<td>91 (8)</td>
<td>88 (8)</td>
<td>87 (12)</td>
<td>90 (11)</td>
<td>106 (20)</td>
</tr>
<tr>
<td>Turbidity (Secchi Disc; cm)</td>
<td>86 (31)</td>
<td>98 (56)</td>
<td>102 (65)</td>
<td>96 (47)</td>
<td>Not available</td>
</tr>
</tbody>
</table>

Oxygen concentrations, saturation levels and pH show no longitudinal gradient. Turbidity decreases towards the mouth region, and the elevated levels often measured in the middle reaches have been attributed to polluted water entering the system via the Motherwell and Markman canals. Phosphate is the only nutrient that significantly increases in concentration from the mouth to the upper reaches. Chlorophyll-a (as a measure of phytoplankton) also increases significantly upstream. Nitrite displays an opposite trend but this is not significant.
Ammonia remains fairly constant throughout the system; however both nitrate and TPN are highest in the middle reaches. All parameters, except Ammonia and turbidity, are measured at higher mean concentrations in the river above the causeway; Ammonia is marginally lower and turbidity data was not available.

In the upper reaches, where freshwater inflow is at its highest, only nitrite displayed a significant relationship with freshwater; a negative correlation with salinity and a positive correlation with inflow has been recorded. When the estuary as a whole is analyzed, both phosphate and TPN show a negative correlation with salinity, and all nutrients, except phosphate, are positively correlated to freshwater inflow. Chlorophyll-a appears to be positively correlated to high phosphate, low ammonia and high turbidity levels.

**Phosphate**
The primary source of phosphate for the estuary is the Swartkops River, and there is net uptake of phosphate towards the mouth with a net export to sea (outwelling) of 24.4 tons being reported in 1983/84 (Winter and Baird 1991). Concentrations measured by Scharler *et al.* 1997 were low compared to other studies, which recorded mean levels of between 300 and 4210 \( \mu g/l \), with the highest levels being recorded in the upper reaches directly opposite point sources (e.g. 13 150 \( \mu g/l \); Emmerson 1985; Hilmer 1984). Contamination with phosphates from anthropogenic influences does not appear to play a major role.

**Nitrate and Nitrite**
Freshwater inflow at the tidal head of the estuary is an important source of nitrate, but the Motherwell canal (and to a lesser extent the Chatty River) is thought to be responsible for elevated concentrations in the middle reaches. Nitrate concentration tends to increase after strong river (and canal) flows, and elevated levels between 240 and 820 \( \mu g/l \) have been recorded (Emmerson 1985).

Nitrite concentrations appear to be independent from the rate of freshwater inflow and are not greatly influenced by floods. Although concentrations as high as 30 \( \mu g/l \) have been reported from the middle reaches (Hilmer 1984), a decrease towards the head of the estuary is the norm.

**Ammonia**
Freshwater inflow does not influence ammonia concentrations to any great extent in the estuary and there does not appear to be a net uptake towards the mouth, probably due to excess being supplied by the Motherwell canal and Chetty River. Variations in levels have been recorded in different studies, with the highest concentrations being attributed to a failure at the Uitenhage sewage works (Watling 1982).

**Chlorophyll-a**
Turbidity seems to be the major limiting factor of Chlorophyll-a in the estuary while changes in freshwater inflow have a less immediate effect. Due to high phosphate levels, it is assumed that phytoplankton production is nitrogen limited. Low variability and the lack of phytoplankton blooms are attributed to the well-mixed water column throughout the estuary. In terms of primary producers, the macrophytes are dominant over phytoplankton.

Overall, nutrients in the Swartkops Estuary, as in other systems (Kromme and Sundays) are primarily supplied by rivers or freshwater inflow from other sources, e.g. Motherwell canal and Chetty River. The contribution from saltmarshes is also an important aspect but it has not
been quantified. Concentrations of all dissolved inorganic nutrients are higher during the wet season when freshwater inflow from a variety of sources is at its highest. There is also a net export of certain nutrients from the estuary into the marine environment. These include ammonia, nitrate, nitrite and phosphate, with a total export value of between 4.7 to 6.8 tons per day (Emmerson 1985).

2.1.7 POLLUTION

Sewage
Sewage derived waste can be detected by the presence of either *Escherichia coli* (*E. coli*) or the less specific faecal coliforms (Lord and Thompson 1988). According to samples collected from five sites along the estuary (Emmerson 1985; Thompson *et al.* 1986 in Lord and Thompson 1988), water quality is acceptable at Brickworks and Redhouse, slightly below acceptable standards at the Blue Hole and Swartkops village and greatly exceeds acceptable limits at Perseverance.¹ Mean levels of 640/100ml have been recorded (Emmerson 1985) with a maximum of 9 900/100ml linked to surface runoff at Swartkops Village. The occasional occurrence of the cholera causing bacteria *Vibrio cholerae* has also been detected. Given that these studies were conducted over 20 years ago and that the incidence of informal developments and contaminated runoff (e.g. Motherwell Canal; Plate 2.5) have in all likelihood increased there should be cause for concern. This concern is reflected in recent water quality tests that regularly show faecal coliform and *E. coli* counts in excess of 10 000/100ml at the Motherwell Canal and downstream at Brickfields, with counts well in excess of 200 000/100ml being detected at the Motherwell Canal. These levels are mostly diluted fairly rapidly both upstream and downstream of the two sites but on occasion levels in excess of 1000/100ml are measured upstream at the Redhouse Yacht Club and downstream at Swartkops Village. The threat is to recreational users and to certain industries (e.g. aquaculture) that require uncontaminated water.

According to a rating system from AfriCoast and SRK (2004), the Swartkops Estuary and adjacent beaches range from poor to unsuitable with regards human recreational activities such as swimming. This is based on faecal coliform counts of between 500 and 2000/ml (poor) and >2000/ml (unsuitable; see Emmerson 1985).

Trace metals
Industrial pollution can be detected by the presence of elevated levels of trace metals in the sediment. Of particular concern are the more toxic metals such as copper, lead, zinc and mercury. Although Watling and Watling (1982) detected high levels of these trace metals in the upper reaches when compared to the mouth region, and from samples taken from oysters cultured at the mouth, their presence was attributed to their natural occurrence in terrestrial sediments which have been washed into the system and from localized point source contamination (Sewartkops, Redhouse, Amsterdamhoek and Brickfields). Overall, metal concentrations were considered to be low and the system was not considered to be polluted.

Levels of trace metals have recently (November 2008) been measured in the sludge from the vicinity of the Markman Canal and significant levels of iron, manganese, aluminium, chromium, zinc and silicate have been detected at all sites. Levels of copper and lead were

¹ Limits are defined according to recommended maximum faecal coliform levels for the recreational use of estuaries (Lusher 1984).
not cause for concern except for lead (149.6 mg/kg) in the stormwater drain opposite Pelt Products.

Plate 2.5 Point source pollution, at points such as the Motherwell Canal, is a major factor affecting water quality in the Swartkops Estuary.

**Persistent chlorinated hydrocarbons**
De Kock (1984) measured PCH levels in the flesh of several fish species between 1981 and 1984, and although elevated quantities of DDT and PCBs were detected in a few fish, they were not considered to be a threat to the health of animals consuming them. Sources are likely to be from surface run-off, freshwater inflow or rainfall.

**Petroleum hydrocarbons**
Pollution from petroleum products is minimal and restricted to accidental spills and exhaust emissions from powerboats and outboard engines, runoff from surrounding industrial areas and roads, and atmospheric fallout (Hilmer and Bate 1987). Fuel spills appear influence the ability of some microalgae to photosynthesize.

**2.1.8 WATER QUALITY MONITORING**
The following institutions are responsible for water quality monitoring (aspects relevant to estuary and catchment only):

- NMBM – point sources, e.g. Chatty River, Motherwell Canal, Fish Water Flats and all stormwater runoff sites.
- DEDEA – sedimentation.
- DWAF – catchment, riverine and estuarine health.
2.1.9 CLIMATE CHANGE

The primary concern with regards climate change and the Swartkops Estuary is the predicted sea level rise\(^2\). This will have wide ranging consequences for the estuary itself (ecosystem functioning) as well as the surrounding land and infrastructure (property destruction). All future developments need to be evaluated in the context setback lines that take into account predicted sea level rises. The following projected impacts are relevant (after SRK 2008):

- Increased exposure to extreme events such as storm surges (recent examples include September 1\(^{st}\) and December 24\(^{th}\) 2008; and June 24\(^{th}\) 2009).
- Increased saltwater intrusion and raised groundwater tables.
- Higher tidal levels and increased flooding.
- Increased coastal erosion (collapse of riparian banks; increased sedimentation).

2.2 SWARTKOPS AND ALOES NATURE RESERVES

The need to proclaim the Swartkops Nature Reserve, comprising the intertidal area of the estuary from the LWS mark and extending onto the escarpment to the boundaries of the then Port Elizabeth Municipality and Motherwell township on the northern banks between Brickfields (Motherwell Canal) and Perseverance 6.5 km to the west, was first identified in 1982 after the areas conservation significance was recognized in the early 1970s. As such, the proposed reserve would include a range of habitats from intertidal mudflats to saltmarsh to floodplain (including Redhouse saltpan) and finally the steep escarpment and plateau. The dense valley bushveld found on the escarpment and plateau is in a good condition and provides habitat for a variety of fauna. In addition it provides stabilization for the topsoils and prevents erosion that could alter the ecology and hydrology of the estuary. The reserve, 100 hectares in extent was proclaimed in 1992 (Plate 2.6 and 2.7).

Plate 2.6 View of the Swartkops Nature Reserve looking north from the Motherwell Canal (left) and the Aloes Nature Reserve looking north-east from the Tippers Creek road (right).

\(^2\) Nelson Mandela Bay has been identified as one of four high risk areas in terms of vulnerability to sea level rise in South Africa (SRK 2008).
The Aloes Nature Reserve (Plate 2.6) is an as yet unproclaimed protected area consisting of municipal owned land bordered by Amsterdamhoek on the east, Old Grahamstown Road on the west and Wells Estate on the northern side.

Of the nine habitat types that characterize the two reserves (SRK 2008b; Figure 2.8), four are considered critically endangered (saltmarsh, estuary, supratidal floodplain and salt pans), two are endangered (Motherwell Karroid Thicket and Sundays Doringveld Thicket) and three are vulnerable (Grassridge Bontveld, Sundays Valley Thicket and Sundays Escarpment Valley Thicket). Agricultural and residential developments have resulted in the loss of these habitat types, in particular the salt pans, Motherwell Karroid Thicket and Sundays Doringveld Thicket, and all, with the exception of Sundays Escarpment Valley Thicket, are poorly conserved at present. Both reserves have been recognized as priority areas for biodiversity conservation and form an integral part of the proposed protected area network within the Nelson Mandela Bay area.

**Plate 2.8** The location of the Swartkops (S) and Aloes (A) Nature Reserves (from SRK 2008b). The mouth of the Swartkops Estuary is indicated by the arrow.
Plate 2.7 Panoramic view of the Swartkops Nature Reserve.
CHAPTER 3 - BIOLOGICAL DESCRIPTION

3.1 SWARTKOPS ESTUARY

A comprehensive summary of the density, biomass and productivity of flora and fauna (excluding birds, reptiles, amphibians and mammals) associated with the Swartkops Estuary is provided in Appendix 1 of Scharler et al. (1997). Species lists of all the major groups are also provided in Appendices in Baird et al. (1986). These lists are exhaustive and will not be reproduced in their entirety for this report. However, examples have been used in various instances where key species are discussed.

3.1.1 FLORA

The vegetation associated with the Swartkops Estuary has been impacted on by extensive urban and industrial developments. These impacts include physical elimination of plant community types and changes to the physical environment such as obstruction of water flow in the supratidal regions that have resulted in invasion by terrestrial plant species (Colloty et al. 2000).

Phytoplankton

The phytoplankton in the Swartkops Estuary comprises 18 species, belonging to the Prasinophyceae, Chrysophyceae and Haptophyceae, that are found in the water column and a host of others that reside in the sediment. This latter group comprises naviculoid diatoms (34 species), desmids (3 species), chlorophyta (2 species) and a single foraminifera species (Masson and Marais 1975). Of these, the dominant size-group is the microplankton (> 12 µm), accounting for more than 60% of total production (Hilmer et al. 1998). Annual phytoplankton production has been estimated at 93.3 mgC/m², which is equivalent to 298 tons of carbon. By comparison, the macrophytes Spartina maritima and Zostera capensis contributed 202 and 21 tons of carbon per year respectively (Pierce 1983). The contribution of Z. capensis to the overall production was only 4% and its loss from the system does not impact significantly on the available carbon.

Production increases during and immediately after flooding due the introduction of freshwater phytoplankton species into the system. These species survive longest in the mid- to upper-reaches while salinity is reduced and bloom as a result of increased nitrogen levels and irradiance. As salinity increases to pre-flood levels the freshwater species die and production returns to normal levels.

Macrophytes

Eelgrass (Zostera capensis) used to be the only major aquatic macrophyte in the system, covering an estimated area of 15 hectares (MacNae 1957). It colonized subtidal sandbanks of the upper reaches but was most abundant on intertidal mudbanks in the middle and lower reaches. During a survey in 1981 (Talbot and Bate 1987) up to 10% of the Swartkops Estuary mudflats were covered by this plant, with total cover varying between 13.7 hectares in winter and 16.1 hectares in summer. However, by 1984 it had completely disappeared from the system (Hilmer et al. 1988), only to reappear in 1988 at 4% of its original population size (approximately 0.6 hectares) and only in the mouth region. The reasons for this decrease are not known but could be attributed to fungal infection or a combination of flood damage (scouring), siltation (smothering), eutrophication and grazing. The impact of this loss on associated fauna has not been ascertained but it has been shown to provide a habitat, nursery
area function, refuge and food source for a variety of invertebrate and fish species. By 1996 the community appeared to be on its way to recovery, with an estimated 12.5 hectares cover being recorded (Colloty et al. 2000).

Several other species of macrophytes appear to bloom under certain conditions, mostly when high nutrient loads enter the system and stagnant conditions prevail. Dense mats of *Ruppia spiralis* have been reported in the polluted waters of the Chatty River; infestation of water hyacinth (*Eichhornia crassispes*) occurs in the lower reaches of the Swartkops River and has been attributed to sewage spills from the Uitenhage sewage works; and the brown seaweed *Enteromorpha* spp. is recorded occasionally.

**Intertidal Saltmarsh**
The Swartkops Estuary has the third largest area of saltmarsh in the country (Baird et al. 1986). Large areas of the lower reaches of the system are characterized by saltmarsh, which extends from the mid-tide level to the mean high spring tide level (Pierce 1979). Cord grass (*Spartina maritima*) is the most abundant of the saltmarsh plants in the estuary, comprising as much as 50% of the total marsh vegetation (Plate 3.1). According to some authors it is also an exotic, which is able to oust indigenous species such as *Z. capensis* (Pierce 1983). It is found from the mid-tide level and is succeeded up the tidal gradient by species such as *Triglochin bulbosa* (not abundant), *Sarcocornia perennis*, *Chenolea diffusa* and *Limonium linifolium*. The latter three species together account for the majority of the remaining saltmarsh area not covered by *S. maritima*.

**Plate 3.1** The extensive intertidal saltmarsh that characterizes the lower sections of the Swartkops Estuary is dominated by *Spartina maritima* (white arrow) with species such as *Sarcocornia perennis* (yellow arrow) being found higher up the tidal gradient.

The area covered by intertidal saltmarsh prior to any development has been estimated at 215 hectares (Colloty et al. 2000), but by 1939 approximately 45 hectares were lost when the
Swartkops and Redhouse Villages were developed. By 1957 additional areas were lost to developments and saltmarsh covered an area of 168 hectares. Since then the area covered appears to have stayed fairly constant, and by 1996 saltmarsh occupied 166 hectares.

According to Baird and Winter (1992), who studied the flux of inorganic nutrients and particulate carbon between a saltmarsh and the Swartkops Estuary main channel, the marsh acts as a sink for ammonia, nitrate and nitrite and exports phosphate into the main system. The marsh also imports small amounts of POC and PIC (<1.5 mm) on flood tides but exports larger particles (>1.5 mm) on the ebb tide. If all saltmarshes within the estuary function this way, it means they retain most of their own primary production and are capable of functioning as independent ecosystems within this context.

Reeds and sedges

Reed and sedge beds are found in the upper reaches where salinity is less than 15 ‰ for most of the time (Plate 3.2). The common reed *Phragmites australis* is the dominant species in the Swartkops Estuary and extends from Redhouse Village to the head of the estuary at the Perseverance causeway. The pristine coverage of reeds, until 1957, has been estimated at 10 hectares, after which a series of floods and bank erosion reduced the cover to 6 ha by 1983. Further floods and quarrying in the channel and floodplain for stone at the head of the estuary reduced the cover to 4.5 ha in 1997 (Colloty *et al*. 2000).

Plate 3.2 The common reed *Phragmites australis* along the banks in the upper reaches near perseverance.

Changes in botanical community

Colloty *et al*. (2000) used a botanical importance rating to assess the changes, due to human impacts, to the estuarine flora in the Swartkops Estuary. In a pristine state the botanical importance score was the highest possible (100%). By 1939 the importance rating had
decrease dramatically by 49% due to the extensive developments that had taken place, with a large proportion of the supratidal saltmarsh in particular having been lost. Additional developments subsequent to this have resulted in a further decrease in the rating to a score of 45%. The loss of habitat has been estimated on direct loss of area covered due to development. The effect of other anthropogenic influences on still existing habitats has not been included in the rating as their impact on productivity is difficult to assess. Aspects such as bait digging and pumping, trampling, footpaths, littering and mooring of boats all impact negatively on the vegetation communities.

Nitrogen fixation
Inert N\textsubscript{2} is made available to plants via a process known as nitrogen fixation. In the Swartkops Estuary, all habitat types with the exception of the water column itself have the potential for nitrogen fixation, which is in turn affected by carbon and moisture content of the soil, sediment type and interstitial nitrogen levels (Talbot 1982). The grass \textit{S. maritima} contributes in excess of 60% of the fixed nitrogen in the system, although other species have higher rates of fixation but have a more restricted distribution. Fixation peaks in summer and declines in winter due to decreases in light intensity and temperature.

Estuarine (supratidal floodplain)
The area covered by supratidal saltmarsh prior to development in the Valley has been estimated at 40 hectares (Colloty \textit{et al.} 2000). By 1957, 31 hectares had been lost to development and by 1997 a further 4 hectares had been lost, leaving only 5 hectares of this habitat type.

This floodplain area in the lower and middle reaches remains reasonably intact and supports healthy communities of succulents and herbs, with the dominant species being brakgrass (\textit{Sporobolus virginicus}), sharp ruch (\textit{Juncus kraussi}), \textit{Asparagus capensis}, saltbush (\textit{Atriplex vestita}) and inkbos (\textit{Suaeda maritima}). In the upper reaches the community is different and comprises a number of grass species such as rooigras (\textit{Themeda triandra}) and kweekgras (\textit{Cynodon dactylon}), sand loving plants such as the sour fig (\textit{Carpobrotus} sp.), shrubs such as brown sage (\textit{Salvia aurea}) and numerous \textit{Aloe} species.

3.1.2 FAUNA

Micro-organisms
The biomass of free-living bacteria in the Swartkops Estuary is low compared to other systems and has been estimated at \(10^4\) cells/ml, which equates to a total biomass of 0.0003 gC/m\textsuperscript{2} (Hilmer and Bate unpublished in Baird 1988). Bacteria are a major food resource for meiofauna.

There is a paucity of information on heterotrophic microflagellates (2 – 20 \(\mu\)m) and microzooplankton (20 – 30 \(\mu\)m) but it is assumed that, like bacteria, their biomass and production is low.

Meiofauna
The meiofauna community occurs in the muddy and sandy sediments of the estuary and has a mean standing crop of 0.6 gC/m\textsuperscript{2} (Dye and Furstenberg 1978). According to Dye (1978) they are more abundant on exposed sand banks compared to non-vegetated intertidal mudflats, but the highest densities are found amongst the saltmarshes. Nematodes account for as much as
84% of the total meiofauna biomass followed by harpaticoid copepods (11.5%), with the remaining components comprising oligochaetes, polychaetes, flatworms and gastrotrichs. Peak densities occur in spring and autumn, with low oxygen in summer and low temperatures in winter being the limiting factors.

**Zooplankton**

According to Baird *et al.* (1986) 54 species of zooplankton were identified in the Swartkops Estuary and another 24 remain unidentified. The zooplankton community, with a mean biomass of 0.22 gC/m², is dominated by copepods and mysids (Wooldridge 1979), whose distribution appears to be determined by salinity while also exhibiting seasonal trends that may help reduce competition. The most dominant of the permanently planktonic copepods are *Pseudodiaptomus hessei*, *Acartia natalensis* and *A. longipatella*. Maximum abundance for *A. natalensis* is attained during summer and autumn, while *A. longipatella* reaches maximum abundance in winter and spring (Wooldridge and Melville-Smith 1979). The third species, *P. hessei*, is considered a pioneer species that colonizes the system after floods or strong freshwater inflows. Mysids are the dominant group in terms of biomass (>70%), with *Mesopodopsis slabberi* dominating the lower reaches and *Gastrosaccus brevifissura* the middle to upper reaches. Zooplankton fulfill a vital link in the food chain as they consume mainly detritus and phytoplankton and are in turn eaten by larger invertebrates, fish larvae, small fish species.

**Benthic macrofauna**

A total of 122 species of benthic macrofauna have been recorded in the system (Emmerson *et al.* 1982; Grindley 1974 in Baird *et al.* 1986 – see Appendix VII for full list). Of this, 78% of the biomass is located within the intertidal region and 22% subtidally (Hanekom *et al.* 1988). Within the soft sediments of non-marshland regions, the dominant forms are the mudprawn (*Upogebia africana*; Plate 3.3), sandprawn (*Callianassa kraussi*), grapsoid crabs (*Cleistostoma* spp.) and pencilbait (*Solen* spp.) comprising 82, 10, 3 and 4% (3% *S. capensis*; 1% *S. cylindraceus*) respectively of the standing biomass. Substrate type (mud, sand and particle size) and competition for space limit the distribution of the various species. Densities and distribution of the dominant species are as follows (from Hanekom 1980; Hanekom *et al.* 1988):

- **Upogebia africana** – muddy intertidal regions of the lower reaches with mean densities of between 200 and 300 individuals/m². Approximately 85% of this species' somatic production occurs in the intertidal zone, making it vulnerable to natural predators (birds and fish) and man.
- **Callianassa kraussi** - intertidal sandbanks in the mouth region and sub- and inter-tidal sandbanks in the upper reaches, with maximum densities of approximately 90 and 100-200 individuals/m² respectively.
- **Cleistostoma** spp. – *C. algoense* prefers silty *Zostera* beds (up to 70 individuals/m²) and *C. edwardstii* prefers more solid sand and mud substrate (up to 20 individuals/m²).
- **Solen** spp. – *S. capensis* restricted to sandy areas downstream of Wylde bridge (up to 6 individuals/m²) and *S. cylindraceus* found in muddy areas in creeks and above the bridge (up to 20 individuals/m²).
Plate 3.3 The mudprawn (*Upogebia africana*) is the dominant form amongst the benthic macrofauna and is a choice prey item if fish and sought after by bait collectors.

Several other species of note, the clams *Dosinia hepatica* and *Macoma litoralis* and the tongue worm *Ochaetostoma capense* (all mudbanks), tapeworm *Polybrachiorynchus dayi* (sandbanks) and cracker shrimp *Alpheus crassimanus* (fine mud and *Zostera* beds) are also found in the middle reaches. There appears to be a degree of spatial separation amongst *D. hepatica*, with larger individuals migrating to substrates lower down the tidal range (Hanekom 1986). They exhibit a slow growth rate and have a potential life span of eight to nine years, with growth rates being fastest in spring and early summer. Similar seasonal growth patterns are exhibited by *M. litoralis* and *S. corneus* in the Swartkops (McLachlan 1974).

Two detritivorous crab species, *Sesarma catenata* and *Cleistostoma edwardsii* and the gastropod *Assiminea* sp. are the dominant macrobenthic fauna of the saltmarsh habitat with densities of 53, 99 and 1912 individuals/m² respectively being recorded (Baird and Winter 1979 in Baird et al. 1986; Els 1982). Fecundity in *S. catenata* increases with size (Baird 1978), with mean number of eggs ranging from 1 440 (carapace width: 9.1 – 10.5 mm) to 9 190 (carapace width: 15.1 – 16.5 mm). Early stage zoea larvae of *S. catenata* are exported from saltmarshes and dispersed out to sea, where they may become entrained in the surf zone (a similar larval retention mechanism may be utilized by *U. africana*). Later staged megalopa larvae are carried back into the system on flood tides where they recruit back into the saltmarsh environment (Pereyra Lago 1993).

The estuary mud crab *Scylla serrata* occupies intertidal burrows in the middle to upper reaches and feeds predominantly in the main channel area.

A recent survey by Fielding (2009; data collected in 2008) compared densities of the more common invertebrate bait organisms downstream of the railway bridge to the data from
Hanekom (1980). Table 3.1 provides a summary of the data combined from all sample sites and clearly shows while sand prawn and pencilbait has increased substantially, mudprawn and cracker shrimp populations have declined significantly. While habitat loss or change may account for some of the observed losses, particularly for cracker shrimp, which prefer very fine mud and *Zostera* beds (which have all but disappeared), exploitation by bait collectors is thought to be largely responsible for the mudprawn decline. There was no comparable data from Hanekom (1980) for bloodworm or tapeworm.

### Table 3.1 Comparison of estimates of total bait organism numbers in the Swartkops Estuary below the railway bridge for Fielding (2009) and Hanekom (1980) (after Fielding 2009).

<table>
<thead>
<tr>
<th>Organism</th>
<th>Total No. x10³ (Fielding 2009)</th>
<th>Total No. x10³ (Hanekom 1980)</th>
<th>% Original stock</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mud prawn</td>
<td>103611.45</td>
<td>174340.581</td>
<td>59.43</td>
</tr>
<tr>
<td>Pencil Bait</td>
<td>7565.18</td>
<td>1188.214</td>
<td>636.68</td>
</tr>
<tr>
<td>Sand Prawns</td>
<td>19442.6073</td>
<td>6720.547</td>
<td>289.3</td>
</tr>
<tr>
<td>Blood Worm</td>
<td>20.776153</td>
<td>No comparative data</td>
<td></td>
</tr>
<tr>
<td>Tape Worm</td>
<td>136.903914</td>
<td>No comparative data</td>
<td></td>
</tr>
<tr>
<td>Cracker Shrimp</td>
<td>1793.05795</td>
<td>3944.722</td>
<td>45.45</td>
</tr>
<tr>
<td>Tongue Worm</td>
<td>2140.4</td>
<td>1145.325</td>
<td>186.88</td>
</tr>
</tbody>
</table>

**Ichthyoplankton**

The main factor controlling fish larval distribution in estuaries appears to be food resources, with highest densities often associated with high concentrations of the plankton on which they feed (Scharler *et al.* 1997). Indirectly, freshwater inflow plays an important role in determining ichthyoplankton density, as it is a vital source of nutrient and phytoplankton production.

Melville-Smith and Baird (1980) recorded 17 individual species of larval fish in the Swartkops Estuary, and some additional unidentified representatives from the Gobiidae and Blenniidae. Larvae were present all year round, but the highest abundance was recorded in summer (November to February). Diversity is low and densities fluctuate considerably from a low of 0.028 larvae/m³ to a high of 24 728 larvae/m³ in summer. The dominant groups were the Gobiidae (59%; predominantly *Caffrogobius nudiceps*) and the estuarine round herring *Gilchristella aestuaria* (31%; lower and middle reaches). Larvae from *Rhabdosargus holubi*, *Hepsetia breviceps* and *Monodactylus falciformis* were frequently caught but in low numbers.

Estuarine resident goby species such as *Caffrogobius multifasciatus* and *Psammogobius knysnaensis* have benthic eggs that adhere to the substrate and are thus retained in the estuary. Their planktonic larvae, however, are passively carried out of the system on ebb tides with a proportion being swept back into the estuary by the flood tide (Beckley 1985). Late-stage larvae and early juveniles of marine migrants such as *R. holubi* and *Liza richardsoni*, which utilize the estuary as a nursery area, enter the system on the flood tide. Larvae and juveniles of several species appear to migrate towards the banks and the bottom where water movement is slower to prevent being swept out to sea on ebb tides.

**Juvenile and adult fish**

According to the list provided in Appendix 1 of Scharler *et al.* (1997), 60 species of fish have been recorded in the Swartkops Estuary. In addition there are numerous unidentified species,
namely *Caranx* spp. and several Gobiidae, Soleidae and Mugilidae species. Seine net catches in the lower reaches between 1980/81 by Beckley (1983) revealed an additional 16 species not appearing in Scharler *et al.* (1997). This total in excess of 76 species concurs with the findings of Marais and Baird (1980a;b) and Winter (1979) who collectively accounted for more than 70 species. Baird *et al.* (1986; Appendix IX) list 86 species of fish that commonly occur in the system.

The majority of fish species found in the Swartkops Estuary are marine migrants, i.e. they spend only parts of their life cycle in the system and all return to the marine environment in order to breed. Representatives of this group include the dusky kob (*Argyrosomus japonicus*), spotted grunter (*Pomadasys commersonnii*), white steenbras (*Lithognathus lithognathus*), springer (*Elops machnata*), Cape stumpnose (*Rhabdosargus holubi*), leervis (*Lichia amia*), riverbream (*Acanthopagrus vagus*) and all the mullet species (Plate 3.4). Between September 1975 and January 1979, gillnet catches in the Swartkops revealed that *P. commersonnii* was the most abundant of the large fish species, comprising 29 and 17% by mass and numbers respectively, followed by mullet (5 species) comprising 25% by mass. Although the mullet as a group constituted 42% of all fish caught by number, individual species each accounted for less than spotted grunter. There was no clear seasonal trend in abundance.

**Plate 3.4** Three of the more common marine migrant species found in the Swartkops Estuary; spotted grunter and Cape stumpnose (left) and leervis (right).

**Photos: Chris Schoultz**

Freshwater migrants are fish that live primarily in freshwater but can withstand higher salinities and may venture into and even spawn in estuarine waters. Examples include the Mozambique tilapia (*Oreochromis mossambicus*) and banded tilapia (*Tilapia sparrmanii*).
There are no records of this group of fishes in the estuary, possibly due to the barrier formed by the causeway, which marks the head of the estuary.

Estuarine residents are fish that spend all or part of their lives in estuaries and spawn in estuaries but some are also common in the marine environment. Some of the more common estuarine residents found in the system include the estuarine round herring (*Gilchristella aestuaria*; numerically the most abundant species in the estuary), Cape silverside (*Atherina breviceps*) and the river goby (*Glossogobius callidus*).

According to Marais (1987), there is rich and diverse ichthyofaunal community that displays an even distribution throughout the Swartkops system. This is most likely due to the well mixed water body that ensures high saline waters as far as the head of the estuary except during floods. Beckley (1983) reported on the importance of eelgrass beds as a habitat for small fish species and as a nursery area for juveniles. The fish community within the eelgrass beds comprised 39 species and was dominated by *Atherina breviceps* (46.1%) followed by juvenile mullet (mostly *Liza dumerilii*, *L. richardsoni* and *Mugil cephalus*), *G. aestuaria*, juvenile *R. holubi* and juvenile blacktail (*Diplodus sargus capensis*). The extent to which the decrease of eelgrass since 1984 has had an impact on this nursery function is yet to be determined.

**Freshwater fishes**

Appendix IX in Baird *et al.* (1986) lists 10 freshwater fish species that have been recorded in the Swartkops River and in the upper reaches of the estuary after floods. One of these is the longfin eel *Anguilla mossambica*, which spawns at sea and then, together with the juveniles (glass eels) migrates back upstream through the estuary to freshwater. Four species are indigenous, namely *Barbus afer*, *Sandelia capensis*, *Barbus pallidus* and *A. mossambica* with the remaining six being considered alien invasives (*O. mossambicus*, *T. sparrmanii*, *Cyprinus carpio*, *Lepomis macrochirus*, *Micropterus salmoides* and *M. dolomieu*). An additional species, the sharptooth catfish (*Clarias gariepinus*) is also know to occur.

**Amphibians and reptiles**

Five species of frogs and toads, six species of lizards, nine species of snakes (including the sea snake *Pelamis platurus*), one species of tortoise and two turtle species are listed in Baird *et al.* (1986; Appendix XI and XII) as being recorded in or can be expected to be found in the estuary, surrounding veld or beach. Amongst the amphibians, several species breed and feed in wetlands and the veld adjacent to estuaries, e.g. clicking stream frog (*Strongylopus grayii*) and the raucous toad (*Bufo rangeri*). None of the lizard species are actually found in the estuary but they do inhabit the drylands adjacent to it, feeding amongst the undergrowth or along the high tide debris line, e.g. spotted gecko (*Pachydactylus maculates*), legless skink (*Acelotes anguina*), rock agama (*Agama atra*) and the common girdled lizard (*Cordylus cordylus*). A few of the more common harmless snakes include the brown house snake (*Lamprophis fuliginusus*) and olive house snake (*L. inornatus*). Highly venomous snakes such as the boomslang (*Dispholidus tupus*) and puff adder (*Bitis arietans*) are common amongst the adjacent bushveld and may be found within suburban settlements, with the Cape cobra (*Naja nivea*) being more restricted to undisturbed bush areas. The angulate tortoise (*Chersina angulata*) is very common around Port Elizabeth.

**Birds**

Of the 195 bird species identified in the Swartkops Valley between Perseverance and Algoa Bay in the mid-1980s (Martin 1988), 53 were regularly associated with the estuary and 61
(including six Red Data species) were recorded on the Redhouse salt pans above Brickfields. A total of 145 species were listed as being found within the proposed Aloe Nature Reserve, most of which were associated with the Redhouse salt pans (Martin and Baird 1988a). McGill (1985 in Baird et al. 1986) recorded 167 species of birds either on or adjacent to the estuary in the early 1980s, nine of which were listed as being rare, vulnerable or threatened. These are the jackass penguin (*Spheniscus demersus*), goliath heron (*Ardea goliath* Plate 3.5), black stork (*Ciconia nigra*), yellow billed stork (*Mycteria ibis*), greater flamingo (*Phoenicopterus roseus* Plate 3.5), lesser flamingo (*Phoeniconaias minor*), booted eagle (*Hieraaetus pennatus*), African fish eagle (*Haliaeetus vocifer*) and Caspian tern (*Hydroprogne caspia*).

The most significant change in the bird community of the Swartkops Estuary over the last century is the total disappearance of freshwater species due to the destruction of freshwater habitats through industrial development and the construction of salt pans on the floodplain.

The Swartkops is one of the most important estuaries for birds in South Africa, and has historically held the most number of birds between Cape Agulhas and Durban (Martin 1988). As many as 4 000 birds can be present during summer, with these numbers falling to less than 1 200 in winter due to the departure of the Palearctic migrant waders and terns. Surveys conducted in the 1980s (Martin and Baird 1987) showed that five species comprised 74% of the estuarine associated birds, namely kelp gull (*Larus dominicanus*; 21%), grey plover (*Pluvialis squatarola*; 21%), whimbrels (*Numenius phaeopus*; 12%), common tern (*Sterna hirundo*; 10%) and curlew sandpiper (*Calidris ferruginea*; 10%). The latter four species are all Palearctic migrants. Numbers of some Palearctic migrants appear to vary depending on breeding success during the northern hemisphere summer. Reductions in numbers of turnstones, knots, curlew sandpipers, little stints and bartailed godwits that visit the Swartkops estuary have been linked to high levels of predation in their breeding grounds by Arctic foxes in years when their natural prey (lemmings) is scarce (Martin and Baird 1988b). Other Palearctic migrants are not affected as they larger breeding areas when compared to the others.

The seasonal difference is well evident from bird counts conducted in summer (February) and winter (July) of 2008 at a variety of sites from the mouth to above Redhouse (Paul Martin unpublished data). In summer, a total of 3426 Palearctic migrants were recorded comprising 18 species, with 1644 resident birds from 23 species. In winter just 5 months later, a total of 369 Palearctic migrants comprising 6 species were recorded. With 2067 resident birds from 26 species.

Most birds (92%) utilize the intertidal habitat at low tide as a foraging area, with only 6% and 2% utilizing the subtidal and saltmarsh habitats respectively. In terms of biomass, the mud prawn (*U. africana*) is the most important prey item of many waders, including the five dominant species, and is consumed at low tide when individuals leave their burrows (Martin 1988). The exact effect of bait collection on bird populations is difficult to assess, but it almost certainly does impact negatively. Illegal digging results in large areas of unconsolidated sediment, which cannot be used for burrows, and even legal methods disturb and trample the sediment. Although some birds opportunistically consume left-overs close to bait collectors the long-term effects may limit the numbers of prey available to them. The exploitation of pencil bait (*S. capensis*) may also have knock-on effects for the African black oystercatcher (*Haematopus moquini*), which almost exclusively feeds on this organism in the estuary.
Plate 3.5 Bird species that are found on the Swartkops Estuary include flamingoes (top left pictured on the Redhouse saltpans), white-breasted cormorants (top right), goliath herons (bottom left) and African black oystercatchers (bottom right; adult and juvenile).

(Photos of white-breasted cormorant, goliath heron and African black oystercatchers by Anne Williams.)

Longitudinal distribution sees a concentration of birds (87%) between the N2 road bridge and the area upstream of the Chatty River confluence. Roosting sites include the saltmarsh habitat between the N2 bridge and Swartkops/railway bridges, the Chatty and Redhouse Saltpan and the sandy beaches adjacent to the mouth (Martin and Baird 1987; Martin and Randall 1987).

The Redhouse Saltpan is considered to be the most important mainland breeding site for seabirds in the Eastern Cape and has hosted some of the largest breeding colonies in the province for several species, namely white-breasted cormorants, sacred ibises, kelp gulls and greyheaded gulls (Martin and Randall 1987). Due to a combination of animal (dogs) and human (egg thieves) interference, the breeding success of several species has been severely
impacted. Details of breeding success of some species on the Redhouse Saltpan and Swartkops Estuary are provided below (from Crawford et al. 2009).

**White-breasted cormorant (Plate 3.5)**

**Kelp gull**
A total of 679 breeding pairs were recorded on the Swartkops Estuary and Saltpan in 2003/04. A new colony of 20 pairs formed at Tippers Creek in 2006/07 and by the 2007/08 season there were 60 nests in the 2007/08 season. At present there are five colonies on the Swartkops Estuary (Brickfields Island and Tippers Creek) and adjacent pans (includes Redhouse, Bar None and Chatty; Plate 3.6).

![Plate 3.6 Breeding kelp gulls nesting on Brickfields Island (September 2009).](image)

**Hartlaub’s gull**
First indications of breeding was the sight of single birds feeding young at Chatty saltpans in 2000/01 and by 2002 there were at least two birds confirmed breeding in 2002. In July 2007 a mixed Hartlaub’s x grey-headed gull pair was seen with a fledged chick at the estuary and a female was observed actively mating grey-headed gull at the Chatty saltpans.

**Grey-headed gull**
First reports of nesting were documented in 1979, and a breeding colony (28 pairs) became established at Redhouse salt pans by 1982. Breeding took place at this site in 12 of the 17 years between 1982 and 1998 with a maximum of 95 pairs in 1990. This colony was also recorded breeding at three other localities on the Swartkops floodplain (power station, Chatty salt pan and Bar None salt pan) in 1993, 2000 and 2004–2007. In 2006, 608 pairs bred at Bar None salt pans.
Caspian tern
In 1982, breeding was observed at Redhouse salt pans, where the colony grew from nine pairs in 1982 to 58 pairs in 1987. The number of pairs breeding at this locality has subsequently fluctuated from 0–50 pairs, becoming erratic between 2000 and 2008 when 21, 1, 28, 0, 4, 47, 1, 0 and 18 pairs were recorded respectively. On occasion between one and two pairs have bred on the Chatty or Bar None salt pans.

Damara tern
This species does not appear to utilize the Swartkops Estuary to any great extent, with a single adult being observed with a juvenile on 16 December 2003 at the mouth and a pair with a flying juvenile on 28 January 2007.

African black oystercatcher (Plate 3.5)
In recent years there has been first an increase and then a subsequent maintenance in the number of territories occupied by breeding pairs; 13 in 2001/02 and 14 in 2008/09 (Paul Martin unpublished data).

The estuary is used extensively by humans for a variety of recreational activities. While most of these do not appear to impact on bird populations, some are cause for concern. Excessive numbers of bait collectors, power boating and dogs may disturb feeding birds over the low tide and thus restrict the time available for foraging.

Urban development, both within the estuarine area and in the catchment is likely to alter flow patterns, sediment dynamics and ultimately the ecology of the system. The end result is that habitats are altered or lost and prey items are affected with serious consequences for bird populations.

3.2 SWARTKOPS AND ALOES NATURE RESERVES

3.2.1 FLORA
Much of the terrestrial vegetation in the Swartkops Valley has been severely impacted by man’s activities, but there are some areas where vegetation remains relatively unaffected (description below is predominantly after Jacot-Guillarmod 1974 in Baird et al. 1986).

Terraces
The areas immediately above the estuarine floodplain are known as terraces and they support a varied floral community, including many of grasses, shrubs and aloes found on the floodplain. In addition, larger species such as taaibos (*Rhus longispina*), boerboon (*Schotia afra*) and several *Euphorbia* species, as well as the alien invasive prickly pear (*Opuntia ficus indica*) are also found here (Plate 3.6).

Escarpment
A forest-type vegetation occupies this narrow region characterized by dry clay soil. Larger species include milkwoods (*Sideroxylon inerme*), sneezewood (*Ptaeroxylon obliquum*) and *Euphorbia* species, while the understorey may include wild geraniums (*Pelargonium* spp.) and vygies (*Aizoaceae*). Weed species including prickly pear and rooikrans (*Acacia cyclops*) are also evident.
High ground
The high ground or plateau is characterized by uniformly larger plants, mostly in excess of 2 meters. Milkwoods, numerous aloe species, boerboon, wild geranium, spekboom (*Portulacaria afra*), katdoring (*Scutia myrtina*), forest num-num (*Carissa bispinosa*) and the soetdoring (*Acacia karroo*) are commonly found.

![Plate 3.6](image)

**Plate 3.6** A view of the terraces of the Swartkops nature Reserve, comprising dense bush and dominated by *Euphorbia* and *Aloe* species.

3.2.2 FAUNA

The sub-sections on amphibians, reptiles and birds in Section 3.1.2 above are also applicable to the nature reserves.

**Mammals**

A total of 27 species of mammal have been recorded in Swartkops River valley (Stuart 1981; Stuart *et al.* 1980 – both in Baird *et al.* 1986). Those occurring in proximity to the estuary are mostly confined to the upper reaches in the vicinity of the Nature Reserve and further inland. Most are seldom seen but the Cape grey mongoose (*Herpestes pulverulentus*), vervet monkey (*Cercopithecus aethiops*) and striped mouse (*Rhabdomys pumilio*) are observed quite frequently. In addition to the grysbok and bushpig listed by Baird *et al.* (1986) as occurring in the valley, two additional herbivores were listed by Martin and Baird (1988), namely bushbuck and blue duiker.

3.3 ALIEN VEGETATION

The predominant alien plants in the lower estuarine area are rooikrans (*Acacia cyclops*), gum tree (*Eucalyptus* sp.), kikuyu (*Pennisetum clandestinum*), prickly pear (*Opuntia ficus-indica*) and manatoka (*Myoporum tenuifolium*). Alien plants in the riverine regions include Kariba

### 3.4 HERITAGE RESOURCES

The CDF study (SRK 2008b) referred to only one heritage site in the area, namely Wynrock’s Old Donkey Paddock located in the southern corner of the Aloes Reserve. It was not, however considered too significant (sensitivity value of 2) as it does not contain any artifacts and is characterized by degraded Sundays Valley Thicket.
CHAPTER 4 – LEGISLATION AND PLANNING & DEVELOPMENT STRATEGIES

The purpose of this section is to review all forms of legislation that may have an impact on the management of the Swartkops Estuary and Swartkops and Aloes Nature Reserves. This review incorporates international agreements and strategies as well as all forms of national, regional and local legislation.

4.1 INTERNATIONAL OBLIGATIONS (Table 4.1)

Table 4.1 Summary of International obligations and their relevance to estuarine management.

<table>
<thead>
<tr>
<th>International Obligations</th>
<th>Short Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Convention on Wetlands of International Importance especially as Waterfowl Habitat (1971) (Ramsar Convention)</td>
<td>The broad aims of this Convention are to stem the loss and to promote wise use of all wetlands (including estuaries).</td>
</tr>
<tr>
<td>Agenda 21 (1992) as reaffirmed at the United Nations World Summit on Sustainable Development - Johannesburg Summit (2002)</td>
<td>This is not a legally binding document, but Agenda 21 is an internationally accepted strategy for sustainable development; the principles of sustainable development are easily applied to the estuarine scenario.</td>
</tr>
<tr>
<td>United Nations Convention on Biological Diversity (1992)</td>
<td>The objectives of convention include the conservation of biological diversity; the sustainable use of biological resources; and the fair and equitable sharing of benefits arising from the use of genetic resources.</td>
</tr>
<tr>
<td>United Nations Framework Convention on Climate Change (1992)</td>
<td>This framework sets an “ultimate objective” of stabilizing greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. This has particular relevance to estuaries when considering changes in rainfall, storm severity and flood levels and frequencies.</td>
</tr>
<tr>
<td>Global Programme of Action for the Protection of the Marine Environment from Land-based Activities (GPA) (1995)</td>
<td>The GPA is designed to assist states in taking action to prevent, reduce, control or elimination the degradation of the marine environment (including estuaries), and to assist in its recovery or rehabilitation from the impacts of land-based activities.</td>
</tr>
</tbody>
</table>

4.2 NATIONAL LEGISLATION (Table 4.2) AND POLICY (Table 4.3)
Table 4.2 Summary of national legislation and its relevance to estuarine management in general and the Swartkops in particular. OBJ = Setting Resource Objectives; L&D = Land-use and Infrastructure Development; WQQ = Water Quantity and quality; ELR = Exploitation of Living Resources (from Taljaard 2007).

<table>
<thead>
<tr>
<th>National Legislation</th>
<th>Lead Agent</th>
<th>Short Description</th>
<th>Relevance to the Swartkops Estuary</th>
</tr>
</thead>
<tbody>
<tr>
<td>National Environmental Management: Biodiversity Act (Act 10 of 2004)</td>
<td>DEAT</td>
<td>This Act provides for the conservation of biological diversity, regulates the sustainable use of biological resources and ensures a fair and equitable sharing of the benefits arising from the use of genetic resources.</td>
<td>OBJ L&amp;D WQQ ELR</td>
</tr>
<tr>
<td>National Health Act (No. 61 of 2004)</td>
<td>Delegated to Provincial and Local authorities from Department of Health</td>
<td>Delegated to Provincial and Local authorities from Department of Health</td>
<td>OBJ L&amp;D WQQ ELR</td>
</tr>
<tr>
<td>National Environmental Management: Protected Areas Act (Act 57 of 2003)</td>
<td>DEAT</td>
<td>This Act provides for the protection and conservation of ecologically viable areas representative of South Africa’s biological diversity and its natural landscapes and seascapes; for the establishment of a national register of all national, provincial and local protected areas; for the management of those areas in accordance with national norms and standards; for intergovernmental co-operation and public consultation in matters concerning protected areas.</td>
<td>OBJ L&amp;D WQQ ELR</td>
</tr>
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### Table 4.2 continued

<table>
<thead>
<tr>
<th>National Legislation</th>
<th>Lead Agent</th>
<th>Short Description</th>
<th>Relevance to the Swartkops Estuary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disaster Management Act (No. 57 of 2002)</td>
<td>Act is administered by a Cabinet member designated by the President</td>
<td>To provide for an integrated and coordinated disaster management policy that focuses on preventing or reducing the risk of disasters, mitigating the severity of disasters, emergency preparedness, rapid and effective response to disasters and post-disaster recovery; the establishment of national, provincial and municipal disaster management centers; disaster management volunteers; and matters incidental thereto</td>
<td>X</td>
</tr>
<tr>
<td>Local Government: Municipal Systems Act (Act 32 of 2000)</td>
<td>Department of Provincial and Local Government</td>
<td>This Act deals with Integrated Development Planning (IDP), which is intended to encompass and harmonize planning over a range of sectors such as water, transport, land use and environmental management.</td>
<td>X</td>
</tr>
<tr>
<td>Development Facilitation Act (Act 67 of 1995)</td>
<td>Same</td>
<td>This Act requires the setting of Land Development Objectives and the principles of this Act have also been incorporated into the Municipal Systems Act.</td>
<td>X</td>
</tr>
<tr>
<td>Local Government Transition Second Amendment Act (Act 97 of 1996)</td>
<td>Same</td>
<td>This Act requires that all municipalities, local and district councils, draw up IDPs for the integrated development and management of their areas of jurisdiction.</td>
<td>X</td>
</tr>
<tr>
<td>Local Government Municipal Structures Act (No. 117 of 1998, amended by Act 33 of 2000)</td>
<td>Same</td>
<td>This Act provides for “the establishment of municipalities in accordance with the requirements relating to categories and types of municipality; to establish criteria for determining the category of municipality in an area” and other related matters.</td>
<td>X</td>
</tr>
<tr>
<td>National Environmental Management Act (Act 107 of 1998)</td>
<td>DEAT</td>
<td>This Act provides for the conservation of biological diversity, regulates the sustainable use of biological resources and to ensures a fair and equitable sharing of the benefits arising from the use of genetic resources.</td>
<td>X</td>
</tr>
</tbody>
</table>
### Table 4.2 continued

<table>
<thead>
<tr>
<th>National Legislation</th>
<th>Lead Agent</th>
<th>Short Description</th>
<th>Relevance to the Swartkops Estuary</th>
</tr>
</thead>
<tbody>
<tr>
<td>National Environmental Management: Integrated Coastal Management Act (Act 28 of 2008)</td>
<td>DEAT (Marine &amp; Coastal Management)</td>
<td>This Act aims to establish a system of integrated coastal and estuarine management in South Africa, including norms, standards and policies, to promote the conservation of the coastal environment, the ecological sustainable development of the coastal zone, to define rights and duties in relation to coastal areas, to determine responsible organs of state in relation to coastal areas and to give effect to South Africa’s international obligations in relation to coastal matters.</td>
<td>X  X</td>
</tr>
<tr>
<td>National Veld and Forest Fire Act (No. 101 of 1998)</td>
<td>DWAF</td>
<td>Sets out to reform the law on veld and forest and provides for matters relating to fire protection, and fighting, offences and penalties and enforcement.</td>
<td>X</td>
</tr>
<tr>
<td>National Water Act (Act 36 of 1998)</td>
<td>DWAF</td>
<td>This Act ensures protection of the aquatic ecosystems of water resources, including estuaries. It requires policies to be in place that provide guidance in developing resource quality objectives, i.e. specifying aspects such as freshwater inflow, water quality, habitat integrity, biotic composition and functioning requirements.</td>
<td>X  X  X  X  X</td>
</tr>
<tr>
<td>National Forests Act (No. 84 of 1998)</td>
<td>DWAF</td>
<td>This Act recognizes that natural forests and woodlands (including riparian vegetation) form an important part of the environment, and need to be conserved and developed according to the principles of sustainable management.</td>
<td>X</td>
</tr>
<tr>
<td>Marine Living Resources Act (Act 18 of 1998)</td>
<td>DEAT (MCM)</td>
<td>This Act deals with the utilization, conservation and management of marine living resources, the need to protect whole ecosystems, preserve marine biodiversity and minimize marine pollution as well as to comply with international law and agreements and to restructure the fishing industry.</td>
<td>X  X</td>
</tr>
</tbody>
</table>
### Table 4.2 continued

<table>
<thead>
<tr>
<th>National Legislation</th>
<th>Lead Agent</th>
<th>Short Description</th>
<th>Relevance to the Swartkops Estuary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water Services Act (No. 108 of 1997)</td>
<td>DWAF</td>
<td>Right of access to basic water supply and sanitation; control of water services; preparation of WSDPs.</td>
<td>X</td>
</tr>
<tr>
<td>The Constitution (Act 108 of 1996)</td>
<td>National Government</td>
<td>The Constitution is the supreme law of the land and provides the legal framework for legislation regulating environmental management in general. The most pertinent fundamental right in the context of estuarine management is the Environmental Right which provides that: &quot;Everyone has the right: to an environment that is not harmful to their health or well-being; and • to have the environment protected, for the benefit of present and future generations through reasonable legislative and other measures that – • prevent pollution and ecological degradation; • promote conservation; and • secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development.</td>
<td>X</td>
</tr>
<tr>
<td>Local Government Transition Second Amendment Act (Act 97 of 1996)</td>
<td>Department of Provincial and Local Government</td>
<td>This Act (<a href="http://www.info.gov.za/documents/acts/1996.htm">www.info.gov.za/documents/acts/1996.htm</a>) also requires that all municipalities, local and district councils, draw up IDPs for the integrated development and management of their areas of jurisdiction.</td>
<td>X</td>
</tr>
<tr>
<td>Tourism Act (No. 72 of 1993, as amended in 1996 &amp; 2000)</td>
<td>DEAT</td>
<td>No details.</td>
<td>X</td>
</tr>
<tr>
<td>Development Facilitation Act (Act 67 of 1995)</td>
<td>Department of Provincial and Local Government</td>
<td>This Act requires the setting of Land Development Objectives and the principles of this Act have also been incorporated into the Municipal Systems Act.</td>
<td>X</td>
</tr>
<tr>
<td>National Legislation</td>
<td>Lead Agent</td>
<td>Short Description</td>
<td>Relevance to the Swartkops Estuary</td>
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<td>------------</td>
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<td>------------------------------------</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>OBJ</td>
</tr>
<tr>
<td>Local Government Transition Act (No. 209 of 1993)</td>
<td>Department of Provincial and Local Government</td>
<td>To provide for revised interim measures with a view to promoting the restructuring of local government, and to provide for the establishment of Provincial Committees for Local Government in respect of the various provinces.</td>
<td>X</td>
</tr>
<tr>
<td>Environmental Conservation Act (No. 73 of 1989)</td>
<td>DEAT</td>
<td>Although many of the provisions of this Act have been repealed by NEMA, the regulation on Sensitive Coastal Areas remains in force until replaced with new regulations.</td>
<td>X</td>
</tr>
<tr>
<td>Sea Fishery Act 12 of 1988</td>
<td>DEAT (Marine &amp; Coastal management)</td>
<td>This act includes estuaries and the estuary bed and has been used to proclaim marine reserves along certain sections of our coast.</td>
<td></td>
</tr>
<tr>
<td>Conservation of Agricultural Resources Act (No. 43 of 1983)</td>
<td>Department of Agriculture</td>
<td>This Act provides for the conservation of the natural agricultural resources of the Republic by the maintenance of the production potential of land, by the combating and prevention of erosion and weakening or destruction of the water sources (including estuaries), and by the protection of the vegetation and the combating of weeds and invader plants.</td>
<td></td>
</tr>
<tr>
<td>Marine Pollution (Control and Civil Liability) Act (No. 6 of 1981)</td>
<td>Department of Transport (prevention) and DEAT (combating)</td>
<td>This Act provides for the protection of the marine environment from pollution by oil and other harmful substances, the prevention and combating of such pollution.</td>
<td></td>
</tr>
<tr>
<td>National Buildings Regulations and Building Standards Act (No. 103 of 1977)</td>
<td>Unknown</td>
<td>Sets requirements for the approval and installation of storm water drains. These regulations must be read together with the South African Bureau of Standard’s code of practice, which also lays down detailed requirements for the design of storm water drainage systems.</td>
<td></td>
</tr>
<tr>
<td>National Legislation</td>
<td>Lead Agent</td>
<td>Short Description</td>
<td>Relevance to the Swartkops Estuary</td>
</tr>
<tr>
<td>----------------------</td>
<td>------------</td>
<td>--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>-----------------------------------</td>
</tr>
<tr>
<td>National Parks Act (No. 57 of 1976)</td>
<td>DEAT; SANP</td>
<td>The National Parks Act provides for the establishment of National Parks. National Park status establishes the strongest claim to permanent protection that is possible. Areas above and below the intertidal zone may be included in a National Park.</td>
<td>X</td>
</tr>
<tr>
<td>Lake Areas Development Act (No. 39 of 1975)</td>
<td>DWAF</td>
<td>This law (rarely used since enactment) provides for the establishment of Lake Areas (which includes estuaries). The effectiveness of this law is questionable, as only two such areas have been proclaimed under it. Those Lake Areas are managed by the SANP by virtue of provisions in the National Parks Act</td>
<td>X</td>
</tr>
<tr>
<td>Sea Bird and Seal Protection Act (No. 46 of 12973)</td>
<td>DEAT (MCM)</td>
<td>This Acts governs the protection and control of the capture, killing and products produced from seabirds and seals.</td>
<td>X</td>
</tr>
<tr>
<td>Hazardous Substances Act (No. 15 of 1973)</td>
<td>Department of Health and Welfare</td>
<td>To provide for the control (including the prevention of dumping) of substances which may cause injury or ill health to, or death, of human beings by reason of their toxic, corrosive, irritant, strongly sensitizing or flammable nature.</td>
<td>X</td>
</tr>
<tr>
<td>Foodstuffs, Cosmetics and Disinfectant Act (No. 54 of 1972)</td>
<td>Department of Health and Welfare</td>
<td>In South Africa standards (i.e. concentration limits of constituents required by law) specifying the limits of chemical and microbiological constituents in the flesh of different marine organisms used for human consumption are covered under this Act and are listed as the regulation - Marine food, 2 November 1973 (re Bacteriological contamination) and the regulation related to metals and foodstuffs.</td>
<td>X</td>
</tr>
</tbody>
</table>
Table 4.2 continued

<table>
<thead>
<tr>
<th>National Legislation</th>
<th>Lead Agent</th>
<th>Short Description</th>
<th>Relevance to the Swartkops Estuary</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>OBJ</td>
</tr>
<tr>
<td>Physical Planning Act (No. 88 of 1967)</td>
<td>Department of Provincial and Local Government</td>
<td>The Act provides for Guide Plans that could influence the planning and location of storm water drains.</td>
<td>X</td>
</tr>
<tr>
<td>Seashore Act (No. 21 of 1935)</td>
<td>DEAT/Cape Nature</td>
<td>This Act provides that ownership of the seashore (which includes the water and land between the low-water mark and the high-water mark in estuaries and the sea is vested in the State.</td>
<td>X</td>
</tr>
<tr>
<td>Marine Notice 16 of 2006</td>
<td>SAMSA</td>
<td>Dictates SAMSA policy on small vessel surveys, certification and numbering, and skipper qualification and certification terms of the Merchant Shipping (Small Vessel Safety) Regulations of 2002 (as amended).</td>
<td></td>
</tr>
</tbody>
</table>

3 Marine Notice 16 of 2006 does not apply to any of the major aspects of estuary management *per se* but are relevant because they prescribe the requirements for small boat safety and certification of skippers.
Table 4.3 Summary of national policies (white papers) relevant to estuarine management (from Taljaard 2007).

<table>
<thead>
<tr>
<th>White Paper</th>
<th>Year</th>
<th>Short Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>White Paper for Sustainable Coastal Development in South Africa</td>
<td>2000</td>
<td>This paper sets out a policy which aims to achieve sustainable coastal development in South Africa through integrated coastal management. The key messages of the white paper are: 1) the value of the coast must be recognized, 2) sustainable coastal management must be facilitated; 3) the Coastal management must be co-coordinated and integrated; 4) the Government must adopt a co-operative style of management.</td>
</tr>
<tr>
<td>White Paper on a National Water Policy for South Africa</td>
<td>1997</td>
<td>This paper sets out the policy for the management of both quality and quantity of South Africa’s water resources (including estuaries). The National Water Act (No. 36 of 1998) gives legal status to this White Paper.</td>
</tr>
<tr>
<td>White Paper on Marine Fisheries Policy for South Africa</td>
<td>1997</td>
<td>The White Paper sets out the main policy principles that the Department of environmental Affairs and Tourism will endeavor to implement through its marine fisheries management institutions in order to achieve this overall policy objective. The objective is to improve the overall contribution of the fishing industry to the South Africa’s economy. The Marine Living Resources Act (No. 18 of 1998) gives legal status to this White Paper.</td>
</tr>
<tr>
<td>White Paper on Environmental Management Policy</td>
<td>1998</td>
<td>The White Paper contains the government’s environmental management policy and includes an introduction that sets out the concept of environment used in the policy, the scope and purpose of the policy, new vision for environmental policy and the mission of the DEAT with respect to the new policy, policy principles that must be applied in developing and testing policy, government's strategic goals and supporting objectives to begin sustainable use of resources, government's approach to governance, setting out the powers and responsibilities of the different spheres and agencies of government and the regulatory approach to environmental management. The National Environmental Management Act (No. 107 of 1998) gives legal status to this White Paper.</td>
</tr>
<tr>
<td>White Paper on Spatial Planning and Land-use Management</td>
<td>2001</td>
<td>This White Paper addresses the development of policies, which will result in the best use and sustainable management of land, improvement and strengthening planning, management, monitoring and evaluation, strengthening institutions and coordinating mechanisms, creation of mechanisms to facilitate satisfaction of the needs and objectives of communities and people at local level. Sustainable land management plans should ensure that development and developmental programmes are holistic and comprehensive, all activities and inputs are integrated and coordinated, all actions are based on a clear understanding of the natural and legitimate objectives and needs of individual land users to obtain maximum consensus and institutional structures are put in place to develop debate and carry out proposals.</td>
</tr>
</tbody>
</table>
### Table 4.3 continued

<table>
<thead>
<tr>
<th>White Paper</th>
<th>Year</th>
<th>Short Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>White Paper on Integrated Pollution and Waste Management for South Africa</td>
<td>2002</td>
<td>This paper outlines a management approach that envisages pollution prevention, waste minimization, managing the environmental impacts associated with waste and pollution, remediating damaged environments and integrating the management of various sources of waste. The white paper proposes a number of tools to implement the objectives, including a legislative programme that will culminate in new pollution and waste legislation. A National Waste Management Strategy, which will form the basis for translating the goals and objectives of this policy into practice, has also been developed. The <strong>National Environmental Management: Waste Management Bill</strong> will give legal status to this White Paper.</td>
</tr>
<tr>
<td>White Paper on Development and Promotion of Tourism in South Africa</td>
<td>1996</td>
<td>The White Paper provides the government’s stance on Tourism and describes the following: Role of tourism in South Africa, Problems around tourism, Way towards a new tourism, Vision, objectives and principles, How to ignite tourism growth, Roles of the key player, Organizational structures. Based on an assessment of the problems, constraints and opportunities facing the South African tourism industry, the concept of &quot;Responsible Tourism&quot; emerged as the most appropriate concept for the development of tourism in South Africa.</td>
</tr>
<tr>
<td>White Paper on the Conservation and Sustainable Use of South Africa’s Biological Diversity</td>
<td>1998</td>
<td>South Africa’s initial response to addressing the United Nations Convention on Biological Diversity; it specifically recognizes the importance of estuaries and commits the government to a number of strategies to protect these areas. The strategies suggested cut across a number of legislative sectors such as water law, resource conservation and planning. These include: facilitating the development of appropriate legislation to secure the conservation of South Africa’s wetlands, and to maintain their ecological and socio-economic function, promoting the establishment of a National System of Protected Wetlands, preventing inappropriate activities and development around wetlands, ensuring that adequate buffer strips are retained around wetlands, recognizing the functions and values of wetlands in resource planning, management and decision-making, determining the impact of commercial, recreational and subsistence fishery practices on fisheries, fish, and their habitats, and develop guidelines for managing such fisheries. <strong>The National Environmental Management: Biodiversity Act (No. 10 of 2004)</strong> gives legal status to this White Paper.</td>
</tr>
</tbody>
</table>
### Table 4.3 continued

<table>
<thead>
<tr>
<th>White Paper</th>
<th>Year</th>
<th>Short Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Policy on Sustainable Forest Development in SA</td>
<td>1997</td>
<td>This paper provides synergy to the three strains of Indigenous Forest Management, Commercial Forestry and Community Forestry. Elements of the policy include: setting nine guiding principles, future goals and overall policy to govern the place of forestry in the management of land, water, and other natural resources. This paper provides policy for: industrial forestry; community forestry; the conservation of our natural forests and woodland; South Africa's response to global concerns about forests; research, education and training; South Africa's relationships with states in the Southern African Development Community.</td>
</tr>
</tbody>
</table>
4.3 LOCAL (MUNICIPAL) LEGISLATION

Municipal bylaws relating to the Swartkops and Sundays Rivers are enforced in accordance with Provincial Notice No. R1852/10/8/1990, which deals with contraventions in terms of the Sea Shore Act (21 of 1935). With this Act now being repealed in favor of the NEM: ICMA, and with the issue of Marine Notice 13 of 2006 governing boat licensing and safety, these bylaws will need to be revisited. New bylaws relating to Public Amenities, which include rivers, estuaries and Reserves controlled by the Municipality have been developed and are currently available for public comment. They will be enacted under the provisions of Section 156 of the Constitution of the Republic of South Africa.

Enforcement of the municipal bylaws is the responsibility of the Environmental Management sub-directorate within the NMBM, in particular the Swartkops Depot. They have at their disposal two vehicles and a boat. While boat patrols seem to be conducted when deemed necessary (e.g. busy week-ends) an estimated average of 10 hours per week is spent on estuary patrols (Ken Priestly; Johan Robertse pers.comm.).

4.4 EXISTING MANAGEMENT PLANS, DEVELOPMENT STRATEGIES, POLICIES AND CONSERVATION INITIATIVES.

4.4.1 NELSON MANDELA BAY MUNICIPALITY: INTEGRATED DEVELOPMENT PLAN (JUNE 2008)

The Integrated Development plan (IDP) is the key strategic plan of the municipality and as such prioritizes projects and determines financial planning and budgets for these projects. The Estuary Management Plan will need to be incorporated into the IDP so that Management Actions Plans (MAPs) that require financial input from the municipality can be recognized and be allocated the necessary funding.

Estuaries are not referred to specifically anywhere in the IDP. The document does, however recognize that the NMBM does have a responsibility for ensuring a clean, safe and healthy environment for all. The Environmental Services division is responsible for this aspect and their functions include waste management, environmental health and environmental management, all of which have relevance to the functioning of the Swartkops Estuary. For example, one of the projects under environmental health is pollution prevention – this includes water pollution monitoring with a 2008/09 target of 100% compliance with standards. There is also a specific reference to strict adherence to the Coastal Management Plan under the environmental health function.

Several major projects have been identified for Nelson Mandela Bay (NMB) and these will be guided by the MSDF principles. Some of these projects have the potential to have far reaching consequences for the Swartkops Estuary.

**Motherwell Urban Renewal Programme**

This programme has potential positive impacts for the estuary as it aims to upgrade amenities and services in the impoverished settlement. This will reduce the serious environmental impacts arising from pollution entering the estuary via the Motherwell Canal. However,
immediate efforts (2008/09 targets) are being aimed at improving the socio-economic situation of residents and it seems the pollution issue will be dealt with at a later stage.

**Zanemvula Project**
The project focuses on creating a new settlement for the approximately 3 000 families living in the Soweto-on-Sea Veeplaas floodplain. Once again pollution will be reduced and flood related damage can be avoided.

The IDP also refers to the development of an Integrated Planning Matrix, which will allow for coordinated planning and implementation of activities. Theoretically this should facilitate cooperation between the various Directorates such as Health & Environmental Services and Infrastructure & Engineering to help resolve issues such as pollution point sources like the Motherwell Canal.

The Directorate of Health & Environmental Services, which will be largely responsible for ensuring the successful implementation of many aspects of the EMP, receives only a small fraction of the annual capital budget. In 2008/09 its allocation was a mere 4% and this reflects the low priority for projects under their jurisdiction.

Ward 60 includes the residential areas closest to the Swartkops Estuary, namely Amsterdamhoek, Swartkops, Bluewater Bay and Wells Estate. According to the IDP the priorities for Ward 60 include crime, tarring & upgrading of roads, housing, upgrading of sports facilities, development of a taxi rank and the development of a community hall (Wells Estate).

### 4.4.2 METROPOLITAN SPATIAL DEVELOPMENT FRAMEWORK (MSDF)

The MSDF is an integral part of the IDP and outlines the desired spatial development of the entire municipal area. It is a framework that gives strategic guidance with regards to the location and nature of future development. The MSDF provides the basis upon which local SDFs are based. These local SDFs then provide specific guidelines for sustainable development and land use in the form of Sustainable Community Unit Plans and Layout Plans for individual developments. A key product of the MSDF is the development of a Land Use Management System comprising a single set of regulations and procedures that are applicable throughout the municipal area.

A host of sectoral plans are incorporated into the MSDF, including a Coastal Management Plan and an Environmental Policy Plan. It is anticipated that the EMP will be added to this component once completed. The EMP will also make use of existing sectoral plans to inform the proposed operational objectives and management action plans.

### 4.4.3 STRATEGIC ENVIRONMENTAL ASSESSMENT (SEA)

The SEA is conducted to assess the impact that the proposed SDF will have on the environment. The document promotes development through the facilitation of EIAs and provides information on the environmental constraints to development within the municipal area. The SEA further provides the basis for an overall Environmental Management Plan that aims to ensure sustainable development.
4.4.4 COASTAL MANAGEMENT PROGRAMME

The Coastal Management Programme (CMP) provides a framework for the sustainable, equitable, cooperative and collaborative management of the coastal zone in Nelson Mandela Bay (SRK 2008a). The CMP deals with management within five key themes, namely governance & policy, the National asset, coastal planning & development, natural resources and pollution control & waste management. The report recommends the establishment of a Coastal Management Unit to facilitate the implementation of the CMP. The following key actions, relevant to the management of the Swartkops Estuary, were identified:

- Coastal Action Plans (CAP) need to be developed for pollution control & waste management, natural resource management and awareness & education. A coastal land use planning and management action plan was developed as part of the report.
- The Regional Coastal Working Group needs to be restructured to include senior managers, and their TOR need to be formalized.
- Land use and management guidelines must be developed in accordance with the ICM Act regulations.
- No development within dynamic coastal process areas (includes estuarine area) unless for the purpose of protecting those areas.
- Inappropriately located infrastructure should be relocated and/or demolished.
- Management plans need to be developed for all conservation areas.
- Increase capacity of conservation staff (both numbers and education).
- A resource economics study is required to guide decision-making.
- Reserve determinations must be conducted for all estuaries.
- Abstraction rights from riverine systems need to be reviewed.
- Those responsible for environmental degradation must be held liable for rehabilitation (polluter pays principle).
- Illegal waste disposal and littering needs to be minimized via pro-active and reactive means.

4.4.5 CONSERVATION DEVELOPMENT FRAMEWORK FOR THE ALOES AND SWARTKOPS NATURE RESERVES AND SURROUNDS

The Conservation Development Framework (CDF) was developed to highlight sensitive and valuable areas within the two reserves, provide a zonation plan and provide a series of management guidelines and land use recommendations (SRK 2008b). The main recommendations from the CDF were:

- Development and land use within the reserves should be planned and managed in accordance with the CDF zonation plan and management recommendations.
- No development to occur within the Core Conservation Zones (incorporating critically endangered and endangered habitats and species of special concern), which should be recognized as Special Management Areas and are to be used only for non-consumptive activities or sustainable consumptive uses.
- Tourist-based activities need to be developed within the Eco-Tourism Amenity Zones through public-private partnerships that deliver benefits to previously disadvantaged communities.
- Funding needs to be sourced and made available for the effective management of the reserves.
- An integrated management plan needs to be developed for both reserves.
The results of a sensitivity-value analysis were used to develop a Management Zonation Plan (Plate 4.1 from SRK 2008b). It is clear that most of the area comprising the two reserves should be managed as a Core Conservation Zone, with a few designated Eco-Tourism Amenity Zones. Portions of some of the adjacent privately owned land should be managed as a Voluntary Conservation Zone.

**Plate 4.1** Proposed Zonation Plan for the Swartkops and Aloes Nature Reserves and surrounding areas. The majority of the area has been recommended as a Core Conservation Zone (from SRK 2008b).

In addition to the zones within and adjacent to the reserves, Special Management Areas were identified, comprising severely degraded land that require specific intervention. These include the Amsterdamhoek waste transfer site and the land adjacent to the access point to the Swartkops Eco-Tourism Zone.
4.4.6 WATER SERVICES DEVELOPMENT PLAN (WSDP; UPDATE AUGUST 2006)

Industrial developments are a major feature of the Swartkops River Valley and it is expected that additional industries will be developed (or expanded) in the future. This has direct implications for the Swartkops Estuary as some industries pose a threat to the health of the system, mostly as a result of water pollution that is either direct (point source) or indirect (runoff). Table 4.4 provides the existing and expected additions to industrial areas within the estuarine and lower catchment area (from AEI 2006).

According to the WSDP, there is a policy adopted by the NMBM that stipulates that no industry is allowed to return effluent directly to the sea or rivers (includes estuaries). All effluent is conveyed to the various waste water treatment works and only after treatment is it released back to the source. However, in the same section of the WSDP it clearly states that effluent from industry may be returned to the source as long as a permit has been issued; the report continues to list 280 industries (some within the Swartkops Valley close to the estuary and lower catchment) that have such permits. This appears to be a contradiction and almost certainly poses a threat to the estuary via contaminated discharges that do not adhere to DWAF or municipal water quality guidelines.

Table 4.4 Existing (2006) and expected additions to industrial development in areas close to the Swartkops Estuary and lower catchment (after AEI 2006).

<table>
<thead>
<tr>
<th>Name</th>
<th>Existing Area (ha)</th>
<th>Proposed Area (ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Markman</td>
<td>200</td>
<td>200</td>
</tr>
<tr>
<td>Perseverance</td>
<td>150</td>
<td>162</td>
</tr>
<tr>
<td>Swartkops</td>
<td>450</td>
<td>46</td>
</tr>
<tr>
<td>Brickfields</td>
<td>21</td>
<td>148</td>
</tr>
<tr>
<td>Cuyler Manor, Uitenhage</td>
<td>137</td>
<td>-</td>
</tr>
<tr>
<td>Jagtvlakte, Uitenhage</td>
<td>105</td>
<td>1 141</td>
</tr>
<tr>
<td>Cape Road Industrial Area, Uitenhage</td>
<td>124</td>
<td></td>
</tr>
<tr>
<td>Curry Industrial Area, Uitenhage</td>
<td>34</td>
<td></td>
</tr>
<tr>
<td>H. van Eck Rd, Riverside Industrial Area, Uitenhage</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>Alexander Park Industrial Area, Uitenhage</td>
<td>166</td>
<td></td>
</tr>
</tbody>
</table>

4.4.7 CAPE ACTION FOR PEOPLE AND THE ENVIRONMENT

The Cape Action for People and the Environment (C.A.P.E.) is a project developed in partnership with the Global Environment Facility (GEF) to secure the future of the Cape Floral Kingdom. The C.A.P.E. project was made possible by a grant from the GEF and established to develop a long-term strategy to conserve biodiversity in the terrestrial, marine and freshwater ecosystems of the Cape Floral Kingdom (Table 4.5).

Table 4.5 Themes and Strategic Components of C.A.P.E. (after DMP 2004).

<table>
<thead>
<tr>
<th>THEMES</th>
<th>STRATEGIC COMPONENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conserving biodiversity in priority areas</td>
<td>a) Strengthening on- and off-reserve conservation</td>
</tr>
<tr>
<td></td>
<td>b) Supporting bioregional planning</td>
</tr>
<tr>
<td>Using resources sustainably</td>
<td>a) Conserving biodiversity and natural resources in catchments</td>
</tr>
<tr>
<td></td>
<td>b) Improving the sustainability of harvesting</td>
</tr>
<tr>
<td></td>
<td>c) Promoting sustainable nature-based tourism</td>
</tr>
</tbody>
</table>
C.A.P.E. has produced a Strategy and Action Plan, specific objectives of which include the following (after DMP 2004):

- Establishing an effective reserve network, enhancing off-reserve conservation, and supporting bioregional planning.
- Developing methods to ensure sustainable yields, promoting compliance with laws, integrating biodiversity concerns into catchment management, and promoting nature-based tourism.
- Strengthening institutions, policies and laws, enhancing co-operative governance and community participation, and supporting continued research.

4.4.8 SUBTROPICAL THICKET ECOSYSTEM PLAN

(Description taken from DMP 2004)

The Subtropical Thicket Ecosystem Plan (STEP) was a three-year project co-funded by the GEF to identify priority areas for conservation actions in the thicket biome and to ensure that national, provincial and local authorities implement the conservation plan.

The STEP project focuses on the core area of the Thicket Biome, which occurs between the Groot-Gouritz river system in the west, the Kei River in the east, and the Great Escarpment in the hinterland in the vicinity of Graaff-Reinet in the west to Queenstown in the Eastern Cape.

The region includes the Albany Centre of plant endemism and overlaps in the west with the Succulent Karoo Centre. Both are centres of diversity and endemism for succulents and bulbs and are floristically the most important parts of the Thicket Biome. The Albany Centre is a recognised WWF-IUCN global centre of plant biodiversity, and nearly all of its plant endemics are components of the Thicket Biome. The Thicket Biome in this region is thought to contain the most species-rich formations of woody plants in South Africa. It overlaps with the Cape Floristic Region, which is the subject of a major strategic conservation planning exercise.

The overall aim of STEP is to:

- Provide a detailed spatial analysis of the various thicket types.
- Assess the extent of their transformation and develop a better understanding of the threats.
- Locate and design conservation areas to achieve explicit representation goals.
- Suggest and prioritise explicit conservation actions.
- Provide information for incorporation into regional Structure Plans and national Environmental Management Frameworks.
- Provide a capacity building service in GIS-based conservation planning.
- Guide investors from the public and private sectors in the selection of land for commercial enterprises, e.g. game-based ventures.
- Create an awareness of the value and plight of the Thicket Biome.
4.4.9 EXISTING MANAGEMENT PLANS

There is currently no specific management plan for the Swartkops Estuary. However, management related issues are currently dealt with by relevant government departments, e.g. DEAT:MCM and DEDEA, and various municipal departments. The Zwartkops Trust, the oldest such organization in South Africa, is a non-profit organization whose main aim is the protection of the Swartkops River and Estuary. Far from being a watchdog institution, the Trust is actively involved in conservation and education initiatives and campaigns for the management of the system on a daily basis. The Trust comprises members of the public as well as representatives from government (National and Municipal) and various NGOs. It is envisaged that the Trust will play a leading role in the implementation of the management plan through the formation of an Estuary Management Forum.

The Aloes Reserve has never been gazetted and, despite the formal recognition of the Swartkops Nature Reserve and the drafting of a management plan (Martin and Baird 1988), neither can be said to have benefited to any great extent from the effective implementation of a management plan.

The first management plan developed for the Swartkops Nature Reserve (Martin and Baird 1988) highlighted the conservation value of the various habitats and described in detail the abiotic and biotic components. The management goals and objectives were discussed and a zoning map produced that recommended conservation areas and public use areas. Management activities were divided into three sections, namely resource conservation, public utilization and service development.
CHAPTER 5 - EXPLOITATION OF LIVING RESOURCES

5.1 FISH

5.1.1 CATCH COMPOSITION

A fishery survey conducted between 1972 and 1978 (Marais and Baird 1980a; b) revealed that spotted grunter was by far the most dominant catch by club anglers, comprising 87% of the total catch by number and 83% by weight (Plate 5.1). Between 1972 and 1975 the average catch of spotted grunter by Swartkops angling clubs was 127 fish per month. White steenbras and leervis were the next dominant species, comprising 3% by number and weight each (4 white steenbras per month by SAC between 1972 and 1975). A later survey (Tregoning unpublished in Marais 1988) that included other user groups such as unaffiliated anglers and subsistence fishers showed that overall Cape stumpnose dominated the catch numerically (33%) but that spotted grunter was a close second by number (30%) and still dominated in terms of weight (37%). Tregoning’s survey also estimated cpue at 0.0018 fish/angler/hr, which extrapolates to 12,545 fish per year and a total weight of 11.51 tons. Interviews with angling clubs during the current study indicated that spotted grunter were still the dominant catch and main target species.

Species such as white steenbras (WS) and dusky kob (DK) were more frequent in early 20th century catches when compared to the surveys by the above authors, and spotted grunter (SG) only appeared in 2% of anglers catches (Marais 1988). The reasons for the change in catch composition were attributed to over-fishing in estuaries and the ability of spotted grunter to withstand angling pressure. However, it is more likely that a combination of factors have led to the perceived decline of certain species in anglers catches, namely;

- The exploitation of DK and WS by other sectors of the fishery, such as trek netters (WS), rock & surf (both species) and ski-boat (DK). The stocks of both species are considered to be in a state of collapse.
- The availability of DK and WS in the estuary is more seasonal when compared to SG, which appears to be available all year round.
- Anglers methods and priorities may have changed, where SG are actually targeted most of the time (bait used and areas fished).
- Many of the estuaries in KwaZulu-Natal are in a poor state of health and the temporarily open/closed systems may not breach on a regular basis any more (e.g. St Lucia is the largest estuarine system in the country and has historically been a place where SG are abundant; recently it has not been open to sea for long periods of time and therefore not available as a nursery for SG). It is conceivable that more and more SG have gravitated to the Eastern Cape to utilize the estuaries, which by comparison are in a healthier state.

Interestingly, the springer (Elops machnata) used to be caught frequently in the system but now is almost absent from catches. This appears to be a trend in other estuaries in the region as well. Experienced anglers remember this happening in the past as well, with the species again featuring in catches after a prolonged absence. This may indicate a behavior not related to the health of the system or fishing pressure.

The existing fishery does not vary much from the 1980s scenario, with spotted grunter still dominating the catch of all user groups. However, a change in the way some anglers now fish (e.g. lures – see below) means that piscivorous fish species such as leervis (Lichia amia),
dusky kob (Plate 5.1) and shad feature more predominantly in this sectors’ catch. Information recently obtained from fishermen alludes to the fact that *L. amia* juveniles use the estuary extensively in winter months. Large numbers of these fish seem to migrate up the system with the tide and can be caught right up as far as the causeway at Perseverance.

Plate 5.1 Spotted grunter is the most commonly caught species (left), while dusky kob are more frequently caught by anglers using artificial-type baits such as dropshot, rapalas, jigs and spoons (right).

Photos: Chris Schoultz

5.1.2 CURRENT USER GROUPS AND LEVELS OF EFFORT

Due to its proximity to a major city (Port Elizabeth) and the number of urban and informal settlements adjacent to the estuary, levels of angling effort are exceptionally high, and whether it is a weekday or weekend, numerous boats and shore-based anglers can be seen fishing in the system. An estimate of 20 boats on any given weekday and at least twice this number on weekends and holidays is an indication of the pressure. Countless shore based fishermen are seen during the week and on week-ends (Plate 5.2). Over a two-hour period on the 4th September 2009, 18 boats and 53 shore-based anglers were counted below the Railway Bridge. The exact number of so-called subsistence fishermen (licensed and unlicensed) is not known, but they are numerous. There are two angling clubs (The Rod Club [TRC] and Hook & Reel Club) based at Tiger Bay near Swartkops Village. An additional club (Pikkewyn) uses TRC facilities, and two others namely Combined Forces Angling Club and Mackay Bridge (based at Sundays) also fish the system regularly. The number of jetties and slipways on the estuary provide a good indication of the potential levels of use purely by boat-based users (Plate 5.3). Granted, some boat-based users do not exploit living resources, but when one considers that one angling club (TRC) alone has in excess of 400 members, it is clear that their majority of boat owners utilize the system for its living resources.

A lot of boat-based anglers fish at night, especially those who use bait. Boat and shore-based anglers who use artificials tend to fish more during the day and have greater success with
species such as dusky kob and leervis. Shore-based anglers mostly fish during the day. Fishing pressure is heavy along most of the length of the estuary, but few boat-based anglers fish the upper reaches near Perseverance.

Plate 5.2 The Swartkops Estuary experiences high levels of fishing effort almost every day from both boat-based and shore anglers.

The Swartkops Estuary is well known for anglers who use a variety of artificials in order to catch fish. This includes flyfishing, lures (rapalas and spoons) and dropshot. The relatively low turbidity of the system lends itself to flyfishing, a feature also observed in other nearby and similarly clear systems such as the Kariega and Bushmans Estuaries.

5.1.3 BAIT (OTHER THAN INVERTEBRATES)

Live bait, mostly mullet species but also Cape stumpnose, are collected using a cast net. Some anglers may use whole Cape silverside or estuarine round herring and may also occasionally use fillets of larger fish as dead bait. Many of the mullet are used by shore anglers (rock & surf) to catch sharks.

Pilchard is used extensively in the system as it is cheaper than buying bait from the subsistence collectors and is always available. It is used with a large amount of success to catch a variety of species, including spotted grunter.

5.2 INVERTEBRATES

5.2.1 TARGET ORGANISMS

Numerous invertebrate species are exploited as bait. Organisms are either collected by the fishermen themselves or by subsistence bait collectors who then sell to recreational anglers. There are a number of subsistence collectors who are licensed in accordance with the MLRA to sell their catch but numerous illegal operators are also in play. The most frequently collected species, and those collected in the greatest numbers, include mudprawn, sandprawn,
pencilbait and tongue worm. The mudprawn comprises one of the major dietary items for spotted grunter, and together with a variety of crabs constitute 67% of the diet (Van der Westhuizen and Marais 1977). It is little wonder that it is most heavily exploited bait organism in the estuary. Additional bait organisms include tapeworm, cracker shrimp and bloodworm. Cuttlefish are found in the system but do not appear to be exploited by many people, as they are more elusive during the day and night fishing for them is not allowed. Octopus is taken on occasion (particularly on spring low tides), either for bait (recreational users) or food in the case of the subsistence and informal fishermen.

Most collecting effort takes place in the lower reaches below the railway bridge, with the dominant area for bloodworm and sandprawn being near the N2 bridge. The rest of the bait organisms are collected on both vegetated and unvegetated intertidal mudbanks.

Mud crabs (*Scylla serrata*) are also exploited, but the extent to which this happens has not been determined.

### 5.2.2 COLLECTING METHODS

A variety of collecting methods are used to collect invertebrate bait organisms, namely pumping, stamping (includes using hands and feet), tins and digging. The latter method is illegal in terms of the MLRA regulations. In an experiment to test the efficacy of the various techniques in collecting mudprawns at two sites (Middlebank and Phone Box), Fielding (2009) showed that digging was by far the most effective method. Digging was between 1.5 and 2 more effective than stamping and 3 and 5 times more effective than pumping. There was, however no difference in size of prawn captured by each method. Similar results were obtained by Daniel (1992) who also showed that recovery times in areas where forks are used is at least twice that of areas where pumps are used. All methods indirectly impact on the resource due to disturbance of the sediment and trampling (Plate 5.4).

### 5.3 THE SUBSISTENCE BAIT FISHERY

Much of the following description has been taken from Fielding (2009).

With the publication of the MLRA in 1998, subsistence fishers were for the first time formally recognized as a user group in terms of the regulations (Chapter 3, Part 2; Section 19). This allowed informal bait collectors to apply for legal collecting permits. In 2000, the Marine & Coastal Management (MCM) Branch of the Department of Environmental Affairs & Tourism (DEAT) set up a Subsistence Fisheries Management Unit (SFMU) in order to formalise and improve management of subsistence fisheries throughout the country. Early in 2002, the head of the SFMU indicated that the Swartkops Estuary should be regarded as a priority site for MCM management intervention because of the increasing numbers of bait collectors, and a deteriorating situation regarding compliance in the estuary. The SFMU appointed an extension officer in the western part of the Eastern Cape whose mandate was to engage with the subsistence fishers, document their number and details, establish a committee of subsistence bait collectors and, once the fishers had received permits, initiate joint management plans. It was during this time that a co-management arrangement was initiated at the Swartkops Estuary through the support of the NORSA Programme at MCM.

In December 2002, MCM launched the Swartkops Estuary Subsistence Bait Fishery. The stated goal of the fishery was as follows:
Plate 5.3 Jetties located along the Swartkops Estuary (lower reaches at top; upper reaches at bottom).
Plate 5.4 Slipways located along the Swartkops Estuary (lower reaches top; upper reaches bottom). Many of these slipways are in a very poor state of repair and are likely not used.
Plate 5.5 The collection of bait organisms leads to the disturbance of the habitat, which may have knock-on effects. The mudbank pictured above clearly shows evidence of damage in the form of trampled area and large depressions caused by both digging and pumping.

“The informal bait fishery in the Swartkops estuary be transformed into a legal, well-managed and orderly fishery that provides sustainable benefits to those involved in the collection of marine resources from the estuary, the communities around the estuary, and indeed the Nelson Mandela Metropole. It also should be able to serve as a model for managing similar urban subsistence-level fisheries”.

Key objectives of the programme included:

- Bringing the majority of current bait collectors into a legal framework
- Enabling collectors to sell their catches without fear of reprisal.
- Creating partnership between subsistence bait collectors and other stakeholders
- Implementing a sustainable fishery
- Securing the trust of bait collectors through consultation and involvement in the management of the fishery
- Reducing habitat deterioration and illegal activities
- Formalising points of sale

At the launch of this initiative, MCM officials stated that they recognised that the Swartkops Estuary supported a wide range of activities and declared that these should be managed in a co-ordinated manner, and that the estuary should be looked after to make sure that activities were sustainable. The issue of exemption permits was aimed at bringing informal bait collection activities into a legal framework so that they could be properly managed and controlled, and this was seen as a first step towards giving long term fishing rights to the collectors. Bait collectors previously identified by the MCM extension officer were informed of the conditions attached to the issue of their exemption permits, a good quality stainless steel prawn pump was presented to each of 65 permit recipients, and the fishery was
launched. Permit conditions included daily bag limits on the collection of the most commonly harvested bait organisms; a ban on the use of forks to collect bait organisms except on Fridays and public holidays; a ban on all bait collecting activities on Sundays; a requirement that dug areas be smoothed over; a specification for minimum sizes that conformed with subsistence/recreational regulations; and a notification that sales would soon be restricted to designated selling points. MCM officials appealed to bait collectors not to collect in new areas and to inform the authorities if any of them acquired employment that would make bait collecting unnecessary as a means of generating income. A promise to include further training and opportunities for bait collectors also formed a part of the permit conditions.

In 2002 the number of permits was reduced to 45 and now (2009) only 36 have been issued; permits these are valid until 31 December of each year. Of these, 32 have been collected from MCM and are active. The permit conditions are provided in Appendix I of this report and include restrictions on collecting methods, times and bag limits. The use of forks is still only permitted on Fridays and Public Holidays (subject to review), and the closed (no collecting or sale unless from December to February or during school holidays) day has been changed from Sunday to Tuesday. There are still a number of challenges to be addressed in the implementation of this co-management arrangement. The most pressing issue is the ongoing animosity between different stakeholders based on the perception that bait resources are still under threat despite past efforts to legalize the subsistence sector.

Managers, recreational fishers, conservationists and scientists claim that too much bait is being collected, much of it is discarded, and the sediment turnover resulting from bait collecting activities is having a detrimental effect on estuarine function. Subsistence bait collectors on the other hand, claim that there is no reduction in the density of bait organisms, that they harvest on an ad hoc rotational basis, that they need to be allowed to collect more bait, and that the favored (and most efficient) collecting method (forks) poses no ecosystem problems. The situation is a classic conflict of social and ecological interests. Scientists and management agencies quote historical research, while subsistence bait collectors quote their historical experience, local knowledge and current socio-economic conditions. The stock assessment study by Fielding (2009) made use of licensed subsistence collectors to gather data and showed that densities of mudprawn and cracker shrimp has been drastically reduced since the 1980s.

Adding to the problem is the fact that bait collected and sold at the Swartkops is used extensively in other estuaries such as the Gamtoos, Kromme and Sundays. This is because it is freely available and allows anglers to arrive at another estuary and start fishing immediately without having to waste time collecting bait. This allows anglers to fish at night (when collection is illegal) or at any tide (collecting not feasible at high tide). Essentially the resources of the Swartkops are being used to supply more than just users of that system and this places additional pressure on the resource.

While the cause for this decline, particularly for mudprawn, is perceived by many to be the result of excessive collecting pressure, long-term monitoring data on water quality, exploitation levels and habitat alteration/destruction is lacking. As such, it is difficult to say with any degree of certainty that subsistence collectors are alone responsible. Other factors contributing to the trend could be:

- Numerous recreational anglers collect their own bait;
many unlicensed collectors are still active and mostly dig up the mudbanks; they also sell their catch at lower prices compared to the licensed vendors;

- water quality and other natural processes in the estuary and Algoa Bay may have affected breeding and recruitment success;
- habitat loss due to floods, altered flow regimes and climate change; and
- numerous natural predators, most notably birds and fish.

Estimates of total numbers and biomass of bait organisms removed by subsistence collectors and a comparison of these data with the total standing stocks in the estuary are provided in Table 5.1 (Fielding 2007; 2009). The following statement from the Fielding (2009) report summarizes the data:

“Clearly subsistence bait collectors remove a very small percentage of the stock of mud prawns and sand prawns. The subsistence collecting effort on sand and mud prawns could double and would still make very little impact on the prawn stocks in terms of the number of animals removed. Larger percentages of pencil bait, blood worm and tape worm in the intertidal area below Train Bridge are removed, but in terms of total stocks available, these percentages are still fairly small.”

Table 5.1 Estimates of total annual off take of the main bait organisms by subsistence bait collectors in the Swartkops estuary below the Train Bridge (TB), based on an estimate of 285 collecting days a year (data from Fielding 2007); and estimates of the proportion of bait organisms harvested by subsistence bait collectors each year 1. As a percentage of intertidal stocks below Train Bridge, 2. As a percentage of intertidal stocks above and below Train Bridge, and 3. As a percentage of the total intertidal and subtidal population above and below train Bridge. Data for estimates of populations subtidally and above Train Bridge are from Hanekom (1980); nd = No data.

<table>
<thead>
<tr>
<th>Individual daily catch (No.)</th>
<th>No. of collectors/day</th>
<th>No. organisms collected/day</th>
<th>No. organisms collected/yr</th>
<th>Wt of individual organism (g)</th>
<th>Total Wt harvested/y (Kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mud prawn</td>
<td>342</td>
<td>34</td>
<td>11628</td>
<td>3313980</td>
<td>4.53</td>
</tr>
<tr>
<td>Sandprawn</td>
<td>250</td>
<td>3</td>
<td>750</td>
<td>213750</td>
<td>3.4</td>
</tr>
<tr>
<td>Pencil bait</td>
<td>158</td>
<td>34</td>
<td>5372</td>
<td>1531020</td>
<td>24.7</td>
</tr>
<tr>
<td>Blood worm</td>
<td>19</td>
<td>2.2</td>
<td>42</td>
<td>11913</td>
<td>20.7</td>
</tr>
<tr>
<td>Tape worm</td>
<td>8</td>
<td>9.7</td>
<td>78</td>
<td>22116</td>
<td>8.8</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>No. organisms collected/yr</th>
<th>1. As % of intertidal stocks below TB</th>
<th>2. As % of intertidal stocks above &amp; below TB</th>
<th>3. As % of total intertidal &amp; subtidal stocks above &amp; below TB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mud prawn</td>
<td>3313980</td>
<td>3.2</td>
<td>2.71</td>
</tr>
<tr>
<td>Sandprawn</td>
<td>213750</td>
<td>1.09</td>
<td>0.97</td>
</tr>
<tr>
<td>Pencil bait</td>
<td>1531020</td>
<td>20.23</td>
<td>17.54</td>
</tr>
<tr>
<td>Blood worm</td>
<td>11913</td>
<td>57.34</td>
<td>nd</td>
</tr>
<tr>
<td>Tape worm</td>
<td>22116</td>
<td>16.15</td>
<td>nd</td>
</tr>
</tbody>
</table>

Estimates of the sustainability of current exploitation rates are preliminary and simplistic, but indicate that bloodworm is the bait organism most vulnerable to over-exploitation (Fielding 2009). However, the knock-on effects of collecting activities and methods appears to have
contributed to a decline in the stock as a result of larger-scale changes in ecosystem processes.

This issue is one of the priority concerns that will be addressed in the ensuing EMP and will need to be approached from both conservation and socio-economic points of view. Fielding (2009) makes numerous recommendations for the management of the Swartkops Estuary, mostly with regards the bait fishery, and these are summarized below:

- The Swartkops estuary requires the development of a holistic management plan that addresses as far as possible the numerous impacts on the estuarine ecosystem.
- A research programme should be initiated to examine impacts on the Swartkops estuarine ecosystem that are not related to bait collection.
- The collection of bait organisms is probably affecting the intertidal benthic component of the estuary in a way that could have long-term negative ecosystem impacts. However, it is important to see the impacts associated with bait collection within the context of other negative impacts that probably need addressing with greater urgency.
- The most effective way to counter or control negative impacts associated with subsistence collection of bait organisms is to negotiate permanently closed areas.
- A research program should be instituted to find and collate all the available biological data relating to the bait organisms collected in the Swartkops estuary.
- The use of forks for the general collection of bait should not be increased beyond Fridays and Public Holidays. However, certain areas could be set aside for the legal collection of tapeworm using forks outside these times, in return for the complete closure of other areas.
- The use of hands and feet to collect mud prawns is almost as destructive as the use of forks. However, given that forks would still be permitted on certain days it would be difficult to ban the use of hands and feet.
- Any management action to regulate bait resource use should not relegate bait fishers to even poorer socio-economic circumstance than they already enjoy. The development of viable alternative livelihoods for subsistence bait collectors would greatly reduce the impacts associated with current bait collecting practices.
- It should be noted that subsistence bait collectors in other estuaries mainly use pumps and tins, and a long term strategy aimed at changing collector perceptions about suitable tools should be considered.
- Economic benefits derived by bait collectors from the sale of their catches would be significantly enhanced if the green bait selling containers at Truck Stop and Train Bridge were fully functional, e.g cooling systems to prolong survival of collected organisms. In tandem a program should be developed to encourage buyers to purchase only from these places.
- Although the harvest proportion of most of the commonly collected bait organisms is a very small proportion of the total stock, the current bag limits for bait organisms should not be increased.
- The monitoring of subsistence bait collector catches is imperative and should be re-instated once appropriate changes have been made.
- In a context of uncertainty, it is imperative to develop and establish a legal framework formalizing community responsibility in the management process.
5.4 CURRENT AND PROPOSED LEGISLATION PERTAINING TO LIVING RESOURCES

National legislation prohibits scuba diving, spearfishing, fishing without a permit and the use of fishnets other than a landing net or casting net in all estuaries. In addition, no fish captured in an estuary may be sold.

Besides the municipal by-laws, which prohibit jetskiing and delimit skiing areas and wake-free zones, there are no restrictions on the type of vessel, size of engine or powerboating activities on the Swartkops Estuary. As such the estuary displays a multi-recreational user pattern, with many users not partaking in the exploitation of living resources.

Linefish and bait regulations, as defined by the MLRA, are provided in Table 5.2 together with subsistence bait bag limits and proposed local restrictions aimed at further conserving these national resources. In addition to the restrictions noted in Table 5.2, no fish captured in the estuary may be sold for any purpose. Bait organisms may, however be sold by licensed subsistence collectors at selected selling points (Plate 5.6).

Table 5.2 National linefish and bait regulations, subsistence bag limits and proposed local regulations for the Swartkops Estuary.

<table>
<thead>
<tr>
<th>Common Name</th>
<th>Size limit</th>
<th>Bag Limit (MLRA)</th>
<th>Additional regulations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cape stumpnose</td>
<td>20cm</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Shad/Elf</td>
<td>30cm</td>
<td>4*</td>
<td></td>
</tr>
<tr>
<td>Leervis</td>
<td>70cm</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Dusky kob</td>
<td>60cm</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Mullet (all species)</td>
<td>None</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>Spotted grunter</td>
<td>40cm</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Springer</td>
<td>None</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>White steenbras</td>
<td>60cm</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Bloodworm</td>
<td>None</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Cuttlefish</td>
<td>None</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Mud crab</td>
<td>140mm</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Tape worms</td>
<td>None</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Pencil bait</td>
<td>None</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>Mud prawn</td>
<td>None</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>Sand prawn</td>
<td>None</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>Swimming prawns</td>
<td>None</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>Tongue worm</td>
<td>None</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Octopus</td>
<td>None</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>

* Indicates closed season (1st October to 30 November).

Note that subsistence collectors are restricted to five tapeworm whereas recreational collectors may collect 10. The combined number of mudprawn and sandprawn may not exceed 200 for subsistence collectors and 60 pencil bait may be collected unless other items are collected at the same time in which case only 20 are allowed.
Table 5.3 lists the selling price for bait organisms collected by subsistence fishers.

**Table 5.3** Selling price for bait organisms as at 16 July 2009.

<table>
<thead>
<tr>
<th>Bait item</th>
<th>Price</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mud prawn</td>
<td>R1 per prawn</td>
<td>Sold in packets or plastic bottles</td>
</tr>
<tr>
<td>Sand prawn</td>
<td>R1.20 to R2 per prawn</td>
<td>Sold in bottles with water</td>
</tr>
<tr>
<td>Bloodworm</td>
<td>R4 - R8 per worm</td>
<td>R4 for smaller (15cm) worms</td>
</tr>
<tr>
<td>Pencil bait</td>
<td>60 c each</td>
<td>Sold in plastic packets</td>
</tr>
<tr>
<td>Tongue worm</td>
<td>R1 each</td>
<td>Sold in plastic packets</td>
</tr>
<tr>
<td>Tape worm</td>
<td>R100 for five or a &quot;nip&quot;</td>
<td>&quot;nip&quot; is a small hip-flask size bottle.</td>
</tr>
</tbody>
</table>

Plate 5.6 Invertebrate bait organisms including sandprawn (top left) and pencilbait (top right) are sold by licensed operators at designated selling points comprised of shipping containers within a fenced-off area (bottom).
5.5 MONITORING AND COMPLIANCE

Compliance monitoring with regards the MLRA is conducted by MCM officers, however they have limited capacity considering their area of responsibility, which includes other estuaries and the coastal zone. Recently (February) 22 Honorary Fisheries Control Officers were appointed in terms of the MLRA. These HFCOs comprise angling club members as well as concerned members of the public. They conduct regular patrols and are empowered to issue fines and confiscate illegal fishing gear.

Members from all user groups are guilty of offences in terms of the MLRA. Incidents include unlicensed recreational anglers and bait collectors; unlicensed subsistence bait collectors and sellers; non-compliance with permit conditions by licensed subsistence bait collectors and sellers (includes quotas and collecting methods); digging mudbanks by recreational users; size limits, bag limits and closed seasons for fish (all user groups); selling of fish (all user groups); and gillnetting. It is also thought that unlicensed and licensed subsistence operators work together at times, sharing the collecting and selling responsibilities, with illegal sellers also being allowed to operate from the selling points.

The extent to which these activities take place and their impact on the resource and ecosystem functioning is not clear. For example, gillnetting is known to occur, as nets are often seen and removed by other users (Plate 5.7), but the offtake is unknown; gillnets laid across the estuary in the upper reaches near Perseverance will most likely catch mullet as well as juveniles of species such as leervis that utilize the area as a nursery.

Plate 5.7 Poles such as these are used to anchor gillnets across the estuary channel. These were removed from a 50 m stretch of estuary approximately 14 km from the mouth.

Photo: Chris Schoultz
5.6 HONORARY FISHERIES CONTROL OFFICERS

The HFCOs appointed in terms of the MLRA are not full-time operators and carry out patrols on their own time both during the day and night. Night patrols are usually carried out when the low-tide period falls during this period as many illegal activities take place under cover of darkness. Although all user groups are monitored for compliance, the subsistence bait collectors are mainly targeted due to the perception that they are responsible for the majority of offenses. Table 5.4 provides a summary of the reports submitted by the HFCOs to MCM since February 2009.

Table 5.4 Summary of HFCOs activities on the Swartkops Estuary since their appointment from February to the first week of August 2009.

<table>
<thead>
<tr>
<th>Monitoring period</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>February – April</td>
<td>Confiscated 47 garden forks; 4 crab cages; 4 gillnets; unlicensed castnets (number unspecified); 2 unlicensed prawn pumps; assorted illegal gear used to catch fish and collect bait.</td>
</tr>
<tr>
<td>May - July</td>
<td>Confiscated 30 garden forks; issued Id cards with photos and numbered vests to 22 of the licensed subsistence operators; 8 fines issued to subsistence operators for non-compliance with permit conditions; 2 gillnets removed and anchor stakes found at 7 sites; unspecified number of fines issued to unlicensed recreational bank anglers; incidents of intimidation towards HFCOs.</td>
</tr>
<tr>
<td>August</td>
<td>Removed 3 drag (seine nets); 100, 40 and 20 m long.</td>
</tr>
</tbody>
</table>

Bait organisms that are confiscated by the HFCOs are returned alive to the estuary at carefully chosen sites. However, while survival of prawn and worm species is considered to be high, the pencilbait cannot be liberated as the method used to collect it (hooked wire) proves to be lethal to the animal.

It must be noted at this point, that while the presence of the HFCOs is considered to be a good thing by most people, they are regarded with contempt by the subsistence sector. This due to the perception that they are targeted more than the other user groups and they claim they are assaulted by the HFCOs on a regular basis. This statement is based on interviews with subsistence users and must thus be considered hearsay; nevertheless if this does take place, it could be a potential source of conflict that could result in the HFCOs authority and impartiality being called into question. As such, it is mentioned as part of this report.

5.7 THE WAY FORWARD

There is a distinct feeling amongst the majority of river users that the fish and bait stocks are declining and that the current regulations or the non-compliance with regulations should be addressed at a local level. However, since the current national linefish regulations have been developed for the whole country, they are not area specific. The EMP provides an opportunity to propose and implement regulations specific to the exploitation of living resources on the Swartkops estuary. At this stage, estuary-specific regulations for fish do not appear necessary but management tools such as protected areas and rotational collecting areas may be considered appropriate for the protection of bait organisms. Ultimately, however, it is
the capacity to enforce both existing and newly proposed regulations that needs to be addressed.

The current regulations governing the exploitation of living resources are generally not considered effective in areas with poor enforcement capacity. Due to the proximity of the Swartkops Estuary to a major center and the availability of HFCOs, it is envisaged that effective enforcement can be achieved through monitoring of all user groups. When deciding on the most appropriate strategies during the stakeholder workshop, it will be critical to consider each proposed regulation in its entirety, including its socio-economic consequences, benefit to the environment, general acceptance amongst users and the practicality of enforcement.
CHAPTER 6 - WATER QUANTITY AND QUALITY REQUIREMENTS

6.1 INTRODUCTION

This section of the Situation Assessment focuses on the contribution of freshwater systems to the maintenance of the Swartkops Estuary. Estuaries are critical interfaces between the freshwater and nearshore marine environment, and are therefore influenced by factors from both these environments. A significant impact comes from upstream river reaches and catchment activities such as land-use, urban and rural developments and associated activities, point and non-point pollution events, water abstractions, dams, weirs, and streamflow reduction activities such as forestry. This study therefore attempts to quantify the contribution or impact the Swartkops catchment makes to the Swartkops Estuary.

6.2 MANAGEMENT OF THE CATCHMENT

The Swartkops catchment’s management structures consist of a number of national, provincial and municipal structures. These can be listed as follows:

- Department of Environmental Affairs (DEA) – Marine & Coastal Management (MCM): National government.
  - Responsible for ensuring compliance with MLRA.
- Department of Economic Development and Environmental Affairs (DEDEA): Provincial level.
  - Responsible for the management of estuaries in terms of the ICMA and EIA regulations.
- Department of Water & Environmental Affairs (DWEA) - previously the Department of Water Affairs and Forestry (DWAF): National and Provincial level.
  - Responsible for all water-related issues, i.e. catchment management, Resource Directed Measures (RDM) for protection of freshwater resources (i.e. determining Ecological Water Requirements (EWR) and setting the Reserve), planning, infrastructure, monitoring river health, enforcing discharge standards, dam safety etc.
- Other national and provincial offices of departments / directorates, e.g. Agriculture & Forestry, Tourism and Land Affairs
- Nelson Mandela Bay Municipality (NMBM); Local level.
  - As the delegated authority NMBM is currently responsible for the overall management of both the Swartkops and Aloes Nature Reserves.
  - Responsible for enforcing municipal by-laws on all river/estuary systems.

There is also a Co-management Forum, which was established to oversee issues of mutual interest, implement procedures that ensure the preservation of the natural resources, identify risks and non-compliance, and report these to relevant authorities. Additional stakeholders represented on the Co-management Forum, as at June 2008, are as follows:

- Nelson Mandela Metropolitan University (NMMU) – Developmental Studies.
- Subsistence bait collectors and fishermen.
- Cape Action for People and the Environment (C.A.P.E.).
• Zwartkops Trust: The Trust has undertaken the task of cleaning the Swartkops River and Motherwell Canal through joint initiatives with corporations such as South African Breweries.

6.3 CATCHMENT DESCRIPTION

The Swartkops River catchment is located in Water Management Area (WMA) 15 in the Nelson Mandela Bay metropolitan area in the Eastern Cape. It is approximately 2,630 km² in size and extends from the Groot Winterhoek mountains. The Mean Annual Runoff (MAR) for the catchment is approximately 636 mm. The river drains the M10 catchment, which includes the M10A (KwaZunga), M10B (Elandsrivier), M10C (Swartkops River: Elands Confluence), and M10D (Swartkops River: Despatch – River Mouth) quaternary catchments. Land-use in the upper catchment is predominantly natural area and agriculture. Although the river flows thorough natural and agricultural areas for most of its length, significant portions of the lower catchment (Despatch to Port Elizabeth) are highly urbanized.

The topography of the area is dominated by the low-lying Swartkops Estuary and its floodplain. To the north is the steep Swartkops escarpment and the elevated northern hinterland (coastal plain), while the high-lying hinterland north of the escarpment represents a seaward-sloping erosion surface of the sedimentary (Uitenhage) basin.

The Swartkops River floodplain is located at an elevation of between 0 and 20m above the present sea level. The main channel of the river, and the associated network of meandering channels, is located on the floodplain. The Swartkops and Chatty River floodplains have been significantly altered by fluvial processes associated with flood events. Large flood events (greater than 1:50 year) result in large-scale flooding and significant damage to the riparian zone and floodplain. Urbanisation that has taken place within the study area below the 1:100 year floodline continues to remain at risk to flooding events.

6.4 RIVER STATUS

6.4.1 ECOLOGY

A national River Health Programme (RHP) site is located in quaternary catchment M10C, named IFR1 KwaZunga (RHP site code: M1SWAR-KWAZU). This represents a site designated for river health monitoring that provides information regarding status of the river system according to physical drivers and biotic response indicators such as fish and aquatic macroinvertebrates. Only one survey record has been published on the River Health Database.

The major issues that presently affect the Present Ecological State of the Swartkops River system are the following:
• Kwa-Zunga River: The presence of alien fish and operation of Groendal Dam.
• Elands River: The presence of extensive alien vegetation, the abstraction of water, physical manipulation of the channel and the presence of alien fish species.
• Swartkops River: The river is overall in a highly degraded state due to severe water quality problems, alien vegetation and fish, and physical manipulation of the channel as well as increased low flows.
• Chatty River: The lower Chatty River is also in a highly degraded state and basically functions as a storm and sewage drain.
• Brak River: The section of the river was also in a highly degraded state, with hardly any instream biota (no fish or frogs). The major problem seems to be extensive alien vegetation.
• Point sources of pollution that include the Motherwell Canal (litter, dead animals and sewage), Markman Canal (industrial waste and litter) and smaller sources from a variety of industries (e.g. tannery effluent).

6.5 SOCIO-CULTURAL IMPORTANCE

There are various resources that are being utilised for cultural purposes within the Swartkops catchment area. These are as follows:

• The north westerly side of Swartkops River, i.e. adjacent to the brick works and 100m from the Swartkops Nature Reserve, is currently used by Zion Christian Church for the baptism of members of its congregation.
• The river reach underneath the rail and road bridges on the Old Grahamstown Road is also used for baptisms by another congregation of the Zion Christian Church.
• The western side of the Swartkops River near Redhouse is being used by Traditional Healers to perform cleansing ceremonies and to harvest medicinal plants.

6.6 WATER QUANTITY

The Nelson Mandela Bay Municipality (NMBM) is served by a water supply system consisting of seven different schemes popularly known as the Algoa Water Supply System (AWSS). The secondary system supporting the AWSS consists of the Uitenhage aquifers and dams on a number of rivers, including the Swartkops River, i.e. Groendal Dam (KwaZunga River), and the Bulk River and Sand River Dams, both on the Elands River, a tributary of the Swartkops River (DWAF, 2007). These dams have the following capacities:

• Groendal Dam 11662 Ml
• Sand River Dam 2880 Ml
• Bulk River Dam 655 Ml

While the Swartkops Estuary is considered well mixed during low rainfall periods, it may become stratified during high flow periods, and with an average depth of 3 m, it is considered to be a shallow estuary. Salinity varies from 35‰ at the mouth to approximately 10‰ near the head of the estuary, indicating the importance of freshwater inflows to the system. The estuary experiences significant tidal water exchange and the tidal prism during spring tides is on average 3x106 m³ and the average flushing time during spring tides about 22 hr (Baird, 2001).

The various sub-catchment and Mean Annual Run-off (MAR), Mean Annual Precipitation (MAP) and Mean Annual Evaporation (MAE) values are presented in Table 6.1 (DWAF 2000).

6.7 WATER QUALITY

Three important pollution point sources into the Swartkops Estuary are the Motherwell and Markman Canals, and the Chatty River that flows into the estuary. The Uitenhage / Despatch
Sewage Treatment Works (STW) are also located in the upstream reaches of the estuary, while informal settlements occur in places on the banks of the estuary. Research conducted by Binning and Baird (2001), indicated elevated levels of heavy metals in estuarine sediments where runoff from industrial or informal residential areas enter the system. Heavy metal concentrations recorded in this study indicated an increase in metal concentrations over the past 20 years.

**Table 6.1** Mean Annual Runoff (MAR), Mean Annual Precipitation (MAP) and Mean Annual Evaporation (MAE) for the various Swartkops quaternary catchment areas (DWAF 2007).

<table>
<thead>
<tr>
<th>Catchment</th>
<th>Area (km²)</th>
<th>Decimal Coordinates</th>
<th>MAR (10^6 m³)</th>
<th>MAP (10^6 m³)</th>
<th>MAE (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>M10A (KwaZungu)</td>
<td>265</td>
<td>33.5844°S 24.9059°E</td>
<td>60</td>
<td>533</td>
<td>1600</td>
</tr>
<tr>
<td>M10B (Elands)</td>
<td>393</td>
<td>33.7990°S 25.3077°E</td>
<td>67</td>
<td>557</td>
<td>1600</td>
</tr>
<tr>
<td>M10C (Brak)</td>
<td>430</td>
<td>33.6924°S 25.2667°E</td>
<td>71</td>
<td>565</td>
<td>1550</td>
</tr>
<tr>
<td>M10D (Chatty)</td>
<td>307</td>
<td>33.6653°S 25.6345°E</td>
<td>18</td>
<td>471</td>
<td>1550</td>
</tr>
<tr>
<td>TOTAL</td>
<td>1395</td>
<td></td>
<td>56 (Avg.)</td>
<td>536 (Avg.)</td>
<td>1574 (Avg.)</td>
</tr>
</tbody>
</table>

One of the major challenges with regard to conservation and management in the estuary is the management of water quality. Activities in the downstream catchment of the Swartkops River have resulted in continued nutrient-enriched and contaminated water entering the system (E.g. industrial runoff, storm water runoff) placing the estuary under considerable pressure. Mitigation measures, such as artificial wetlands, reed beds, or algae beds, should be considered at these outfall points in order to mitigate the impacts of contaminated water entering the estuary. It may also be possible to manage the quality of water released into the system at source (e.g. monitoring industrial process water prior to discharge).

Upper catchment management and land-use will also have a marked impact on the quantity and quality of the water received by the estuary. While this area falls outside the Swartkops management area, collaboration and cooperation between the catchment management agencies (DWAF) and the estuary management bodies could also contribute to improvement of habitat and resource conditions in the estuary.

There has been a pronounced increase in phosphate concentrations [PO$_4^{3-}$] in the Swartkops River in the recent past, with levels increasing at 10.05 µg P/L per year. With a median value of 46 mg P/L, this translates into a phosphate concentration doubling time of less than 5 years. In combination with the high median and rising nitrate levels, the Swartkops presents itself as one of the most threatened freshwater systems in South Africa (De Villiers and Thiart, 2007).

- Seasonal nutrient profiles indicate that nitrates >400 µg/l persists for at least five months a year in the Swartkops.
Phosphate concentrations exceeding 20 μg/l prevail throughout the year in the Swartkops. Conditions favourable to the development of eutrophic conditions are present for most of the year in Swartkops River catchment.

Sedimentation of the dams within the catchment due to erosion in the upper catchment region has also been noted as significant (DWAF 2000).

6.8 ECOLOGICAL RESERVE STUDIES

(The information below is modified from a stakeholder newsletter produced for the Kromme/Seekoei Intermediate Reserve study of 2003-2006 [DWAF 2004]).

The National Water Act of 1998 (Chapter 3, Part 3) provides for the protection of significant water resources through the Reserve. As the DWEA is the custodian of the nation’s water resources, it is the Department’s responsibility to ensure the adequate protection, effective management and sustainable utilisation of these resources. The Resources Directed Measures Directorate (RDM) is the Chief Directorate within DWEA tasked with the responsibility of ensuring that Reserve requirements, which have priority over other uses in terms of the Act, are determined before licensing applications can be processed, particularly in water-stressed catchments. Reserve determinations can be conducted at a Desktop, Rapid, Intermediate or Comprehensive level. Each level of determination entails a more detailed (higher confidence) investigation than the previous level. These determinations have to take place before the water allocation process (compulsory licensing) can proceed. Once Reserve requirements are available, the allocable resource could be determined and water use applications evaluated.

This means that human (the Basic Human Needs Reserve) and ecological requirements (Ecological Water Requirements, EWR, or the Ecological Reserve) need to be met before flow can be harnessed for other users. These requirements are also set and have to be maintained at points along the rivers, streams and estuary. These points are selected via a rigorous process as they must be representative of stretches of river, and are called EWR sites. Flow, quality and biotic health objectives are set for these points. Future monitoring

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4 See text box for definitions of highlighted areas.
will then be conducted against these objectives to ensure that Reserve requirements are being met.

One of the first steps of the Ecological Reserve process is EcoClassification, or Ecological Classification. This step refers to the determination and categorization of the Present Ecological State (PES) of various biophysical attributes (i.e. drivers such as hydrology, water quality and geomorphology; biotic responses such as fish and macroinvertebrates; and riparian vegetation) relative to the natural unimpacted reference condition (Kleynhans and Louw 2007). Once the PES of these variables has been determined, the EcoStatus, or integrated ecological state is assigned according to the classification shown in Table 6.2. A description of each A-F category is shown in Table 6.3. The Recommended Ecological Category (REC) is the output of the EWR process.

Table 6.2 Generic ecological categories for EcoStatus components (DWAF 2008; modified from Kleynhans et al. 2005).

<table>
<thead>
<tr>
<th>DEVIATION FROM REFERENCE CONDITIONS</th>
<th>A-F CATEGORIES</th>
<th>SCORE</th>
</tr>
</thead>
<tbody>
<tr>
<td>No change</td>
<td>A</td>
<td>≥ 92.01</td>
</tr>
<tr>
<td></td>
<td>A/B</td>
<td>&gt;87.4 and &lt;92.01</td>
</tr>
<tr>
<td>Small change</td>
<td>B</td>
<td>82.01 – 87.4</td>
</tr>
<tr>
<td></td>
<td>B/C</td>
<td>&gt;77.4 and &lt;82.01</td>
</tr>
<tr>
<td>Moderate change</td>
<td>C</td>
<td>62.01 – 77.4</td>
</tr>
<tr>
<td></td>
<td>C/D</td>
<td>&gt;57.4 and &lt;62.01</td>
</tr>
<tr>
<td>Large change</td>
<td>D</td>
<td>42.01 – 57.4</td>
</tr>
<tr>
<td></td>
<td>D/E</td>
<td>&gt;37.4 and &lt;42.01</td>
</tr>
<tr>
<td>Serious change</td>
<td>E</td>
<td>22.01 – 37.4</td>
</tr>
<tr>
<td></td>
<td>E/F</td>
<td>&gt;17.4 and &lt;22.01</td>
</tr>
</tbody>
</table>

6.8.1 SWARTKOPS DESKTOP RESERVE ASSESSMENT

Reserve categories have been set at quaternary catchment level across the country (DWAF 2000) at a desktop, low confidence level. More detailed studies build on this database, thereby improving the confidence in the Reserve assessments. The Present Ecological State (PES) and Ecological Importance and Sensitivity (EIS) were therefore sourced for the quaternary catchments (M10A-D) of the Swartkops River and Estuary. The EIS of a river is an expression of its importance to the maintenance of ecological diversity and functioning on local and wider scales. Ecological sensitivity (or fragility) therefore refers to the system’s ability to resist disturbance and its capability to recover from disturbance once it has occurred (resilience). Both abiotic and biotic components of the system are taken into consideration in the assessment of EIS. The desktop PES, EIS and REC results of Kleynhans (DWAF 2000), are shown in Table 6.4. Note that desktop assessments are of low confidence and will require validation through higher confidence studies. A recent (2008) higher level or Intermediate
Reserve study was conducted for the Swartkops Estuary by staff at NMMU, however the results from this study are not yet available.

Table 6.3 Generic ecological categories for EcoStatus components (Kleynhans et al. 2005).

<table>
<thead>
<tr>
<th>ECOLOGICAL CATEGORY</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Unmodified, natural.</td>
</tr>
<tr>
<td>B</td>
<td>Largely natural with few modifications. A small change in natural habitats and biota may have taken place but the ecosystem functions are essentially unchanged.</td>
</tr>
<tr>
<td>C</td>
<td>Moderately modified. Loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged.</td>
</tr>
<tr>
<td>D</td>
<td>Largely modified. A large loss of natural habitat, biota and basic ecosystem functions has occurred.</td>
</tr>
<tr>
<td>E</td>
<td>Seriously modified. The loss of natural habitat, biota and basic ecosystem functions is extensive.</td>
</tr>
<tr>
<td>F</td>
<td>Critically / Extremely modified. Modifications have reached a critical level and the system has been modified completely with an almost complete loss of natural habitat and biota. In the worst instances the basic ecosystem functions have been destroyed and the changes are irreversible.</td>
</tr>
</tbody>
</table>

Table 6.4 Desktop Ecological Reserve results for Swartkops catchments (DWAF 2000).

<table>
<thead>
<tr>
<th>QUATERNARY CATCHMENT</th>
<th>PES</th>
<th>EIS</th>
<th>REC</th>
<th>TOTAL EWR FLOWS (MCM/annum)</th>
<th>EWR% OF NATURAL MAR</th>
</tr>
</thead>
<tbody>
<tr>
<td>M10A: KwaZunga</td>
<td>A</td>
<td>High</td>
<td>A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>M10B: Elands</td>
<td>D</td>
<td>High</td>
<td>C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>M10C: Swartkops</td>
<td>E-F</td>
<td>High</td>
<td>D</td>
<td>9.531</td>
<td>11.44</td>
</tr>
<tr>
<td>M10D: Swartkops</td>
<td>E-F</td>
<td>High</td>
<td>D</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

EWR flow requirements for M10C are taken from a desktop water quantity study done in 2004. The RDM surface water database of January 2009, and the Reserve tracking system of 14 April 2009, was used to identify where Reserve data are available in M10 (i.e. EWR flow data for M10C).

Note the following conditions concerning the use of these databases.

- The database is continuously updated, and only accounts for the Reserves that have been determined up to the dates indicated, but an attempt has been made to access the most recent information.
- The database, and associated Reserve templates, is prepared in response to Water Use License Applications (WULA). Reserve templates are therefore relevant only to the water
use for which the Reserve was requested. New applications would therefore require an assessment of currently determined Reserves, or re-calculation of the Reserve.

- The database is specifically concerned with surface waters.

6.9 PRESSURES / RISKS / THREATS

Due to the high human densities and variety of human activities in the vicinity of the Swartkops Estuary, a wide range of man made threats to sustainable development and conservation exist in the area. In addition to these, the geology and geomorphology of the area also present certain risks to development and potential future land use. While some of the pressures / threats / risks in the area are generic to both the terrestrial and aquatic/wetland habitats, many of these are specific to the different environments. In the section below the risks associated with the high lying Swartkops escarpment and the coastal plain, which can essentially be considered terrestrial systems, are treated separately to the floodplain, saltmarsh and estuary, which are more closely linked with the river.

**Escarpmment and Coastal Plain**

- Informal residential development
  - Loss of natural habitat
- Pollution due to poor service delivery
  - Improper sanitation, illegal dumping, domestic waste disposal and littering
  - Potential soil and water pollution

**Estuary, floodplain and saltmarsh**

- Flow constriction due to causeways, roads, railway lines, pipelines.
  - Potential flooding and damage to property and infrastructure.
  - Prevents flushing of saltmarsh areas resulting in hypersaline soil conditions.
  - Impedes flow to wetland areas resulting in loss of wetland habitat.
- Potential erosion along cattle pathways.
  - Insufficient development setback distances.
  - Potentially necessitates bank stabilization and reclamation due to bank erosion.
  - Risk of damage to property during flooding events.
  - Loss of supratidal saltmarsh habitat.
- Poorly planned hard structures e.g. jetties, slipways, culverts.
  - Unnatural erosion / accretion in channel.
  - Risk of damage during flooding events.
- Discharge of polluted runoff and stormwater from industrial and residential areas, as well as contaminated process water e.g. industrial / sewage effluent.
- Poor land use practices in the catchment resulting in increased sediment input, nutrient enrichment and pollution.
- Uncontrolled water abstraction and impoundment resulting in altered flow regime, i.e. reduced base flow required for ecological functioning, and insufficient freshwater pulses for mouth maintenance.
CHAPTER 7 - CLASSIFICATION, ECONOMIC VALUE, PROTECTION AND REHABILITATION

7.1 CLASSIFICATION

The Swartkops Estuary is a warm-temperate, medium-large, permanently open, tidally dominated barred estuary that displays a good ichthyofaunal community and water quality and only moderate aesthetic appeal (Harrison et al. 2000; Whitfield 2000); overall condition of the system is rated as fair despite extensive urban development and floodplain modification. A more recent study by Turpie and Clark (2007) ranked the Swartkops as the 11th most important estuary in South Africa in terms of biodiversity with an overall importance score of 92 out of a possible 100. This ranking was based on a detailed assessment of both ichthy- and avifauna. They also ascribe an A/B management class to the system based on the freshwater requirements.

Coetzee et al. (1997) applied a botanical rating system to estuaries, which allowed each system to be scored according to area covered by each plant community type, its association with the estuary, its condition and the plant community richness (number of species). Thirty-three estuaries were evaluated between the Olifants in the Western Cape and the Great Kei in the Eastern Cape and the plant community types considered were supratidal saltmarsh, intertidal saltmarsh, submerged macrophyte beds and reeds & sedges. The Swartkops Estuary was rated tied 18th overall together with the Nahoon and Hartenbos systems with a rating score of 170 (normalised score of 41 out of 100); the top-rated estuary overall was the Olifants with a score of 410 (normalised score of 100). Within the Eastern Cape region, the Swartkops was rated tied 4th (with the Nahoon) out of eight systems, with the Kabeljous near Jeffreys Bay rated highest with a score of 300. Amongst the permanently open estuaries, the Swartkops was only rated tied 12th out of 14 systems. Of the four plant community types, the intertidal saltmarsh was most important (70) followed by reeds/sedges (60), with supratidal saltmarsh and submerged macrophytes both receiving low individual importance scores (20). This rating system can be slightly misleading as the score and ranking does not necessarily reflect the overall health of a system but merely the state of the botanical community. It does, however provide an indication of which estuaries should be accorded a high conservation status and be allocated sufficient freshwater in order to maintain it present state.

A modification of the botanical rating system that took functional importance, species richness, plant community type richness and plant community type rarity into account (Colloty et al 2001) resulted in the Swartkops Estuary being ranked 4th in South Africa with a botanical importance rating of 350. The top ranked estuary is St. Lucia with a score of 400. Of the warm-temperate estuaries, the Swartkops ranks 2nd behind the Knysna estuary.

7.2 ECONOMIC VALUE

Turpie and Clark (2007) placed the following economic values on the Swartkops Estuary:

Subsistence - ranked 1st amongst temperate systems with a value of R808 953 per annum.
Property – ranked 19th amongst temperate systems in terms of property value related to estuaries with a value of R155 million; top rated is Knysna with a value of R1.4 billion; range of property value related to all temperate estuaries is between R1 million and R2 billion; most systems fall into the R10 – 50 million range.
Tourism – ranked 7th amongst temperate systems in terms of tourism value attributed to estuaries with a value of R50 million per year; total value for all temperate systems is R2.08 billion; most are between R10 000 and R1 million although 23 estuaries have an estimated tourism value of < R10 000.

Nursery – ranked 5th amongst temperate systems with a value of R32.8 million per annum; top value is Knysna at R167.6 million.

Existence – does not rank amongst the top 40 temperate estuaries; overall the public’s willingness to pay (WTP) for estuary conservation in SA for all income groups is valued at R80 842 180.

7.3 PROTECTED AREA STRATEGY AND POTENTIAL

7.3.1 ESTUARINE PROTECTED AREAS

The establishment of a core Estuarine Protected Area (EPA) network around the South African coastline should take into account the following goals (after Turpie and Clark 2007):

- Representativeness: all estuarine species within a bioregion should be represented in viable numbers in the protected areas network.
- Maintenance of ecological processes: the protected area network should allow for connectivity and interaction with other adjoining ecosystems.
- Maintenance of fishery stocks: the protected area network should provide enough protection to exploited species that they are able to act as source areas for surrounding exploited areas.
- Minimization of economic opportunity costs: biodiversity targets should be met at least possible opportunity cost, through careful selection of the estuaries included in the protected area network. Estuaries where protection offers greatest economic benefits or lowest economic costs should be prioritized in the EPA selection process.
- Implementability: consideration should be given to the practicalities of protection in each estuary.

The biodiversity protection targets addressed in Sections 7.3.2 to 7.3.4 below address the first three goals listed above. The final choice of estuaries that will be used as part of an EPA network that will realize these targets will be subject to the final two goals listed above.

7.3.2 PROTECTION OF HABITAT TYPES

Targets for the protection of estuarine habitat types (as a percentage of the total estuarine habitat measured in hectares) have been recommended by Turpie and Clark (2007). The percentages for habitat types found in the Swartkops are as follows; supratidal salt marsh (30%); intertidal salt marsh (40%); reeds and sedges (20%); sand/mud banks (40%); submerged macrophytes (40%); and estuary channel (30%). The overall percentage of all habitat types combined that should be protected is 30% of the total available 25 095 hectares.

7.3.3 PROTECTION OF FISH AND BIRD SPECIES

Similarly targets for the protection of fish and bird species (as a percentage of the total population) were set at 50% of the population of red data (threatened) species; 40% of the population of exploited species; and 30% of the population of all other species. The effective targets for selected individual species that are associated with the Swartkops are provided in
Table 7.1 (after Turpie and Clark 2007). Amongst the bird species it is only the African Black Oystercatcher that is a listed threatened species with the remaining assemblage falling under the 30% protection target. No red data fish species are listed but all those that feature prominently in Swartkops catches and which are considered to be over-exploited, such as dusky kob, spotted grunter and white steenbras are targeted for 40% protection of the population.

Table 7.1 Target percentages for the protection of estuarine fish and bird species (after Turpie and Clark 2007).

<table>
<thead>
<tr>
<th>FISH SPECIES</th>
<th>TARGET %</th>
<th>BIRD SPECIES</th>
<th>TARGET %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acanthopagrus berda</td>
<td>30%</td>
<td>White-breasted Cormorant</td>
<td>30%</td>
</tr>
<tr>
<td>Anguilla mossambica</td>
<td>30%</td>
<td>African Black Oystercatcher</td>
<td>50%</td>
</tr>
<tr>
<td>Argyrosomus japonicus</td>
<td>40%</td>
<td>Common Ringed Plover</td>
<td>30%</td>
</tr>
<tr>
<td>Atherina breviceps</td>
<td>30%</td>
<td>White-fronted Plover</td>
<td>30%</td>
</tr>
<tr>
<td>Caffrogobius gilchristi</td>
<td>30%</td>
<td>Grey Plover</td>
<td>30%</td>
</tr>
<tr>
<td>Caffrogobius natalensis</td>
<td>30%</td>
<td>Terek Sandpiper</td>
<td>30%</td>
</tr>
<tr>
<td>Caffrogobius nudiceps</td>
<td>30%</td>
<td>Common Sandpiper</td>
<td>30%</td>
</tr>
<tr>
<td>Diplodus sargus capensis</td>
<td>40%</td>
<td>Curlew Sandpiper</td>
<td>30%</td>
</tr>
<tr>
<td>Elops machnata</td>
<td>40%</td>
<td>Common Greenshank</td>
<td>30%</td>
</tr>
<tr>
<td>Galeichthys feliceps</td>
<td>40%</td>
<td>Red Knot</td>
<td>30%</td>
</tr>
<tr>
<td>Gilchristella aestuaria</td>
<td>30%</td>
<td>Little Stint</td>
<td>30%</td>
</tr>
<tr>
<td>Hemiramphus far</td>
<td>30%</td>
<td>Sanderling</td>
<td>30%</td>
</tr>
<tr>
<td>Heteromycteris capensis</td>
<td>30%</td>
<td>Bar-tailed Godwit</td>
<td>30%</td>
</tr>
<tr>
<td>Lichia amia</td>
<td>40%</td>
<td>Eurasian Curlew</td>
<td>30%</td>
</tr>
<tr>
<td>Lithognathus lithognathus</td>
<td>40%</td>
<td>Common Whimbrel</td>
<td>30%</td>
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<tr>
<td>Liza dumerilii</td>
<td>40%</td>
<td>Pied Avocet</td>
<td>30%</td>
</tr>
<tr>
<td>Liza richardsonii</td>
<td>40%</td>
<td>Black-winged Stilt</td>
<td>30%</td>
</tr>
<tr>
<td>Liza tricuspidens</td>
<td>40%</td>
<td>Kelp Gull</td>
<td>30%</td>
</tr>
<tr>
<td>Monodactylus falciformis</td>
<td>30%</td>
<td>Caspian Tern</td>
<td>30%</td>
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<tr>
<td>Mugil cephalus</td>
<td>40%</td>
<td>Swift Tern</td>
<td>30%</td>
</tr>
<tr>
<td>Myxus capensis</td>
<td>40%</td>
<td>Sandwich Tern</td>
<td>30%</td>
</tr>
<tr>
<td>Omobranchus woodi</td>
<td>30%</td>
<td>Common Tern</td>
<td>30%</td>
</tr>
<tr>
<td>Pomadasys commersonii</td>
<td>40%</td>
<td>Little Tern</td>
<td>30%</td>
</tr>
<tr>
<td>Pomatomus saltatrix</td>
<td>40%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Psammogobius krysnaensis</td>
<td>30%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rhabdosargus holubi</td>
<td>40%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sarpa salpa</td>
<td>40%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Solea bleekeri</td>
<td>30%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Syngnathus acus</td>
<td>30%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Torpedo sinuspersici</td>
<td>30%</td>
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</tbody>
</table>

7.3.4 PROTECTION OF ECOSYSTEM AND LANDSCAPE-LEVEL PROCESSES

The protection of habitat types and associated fauna in estuaries may only be considered effective if the populations benefiting from these measures are viable, that is to say that they are sufficiently large and there is a degree of overlap between protected areas/populations to ensure the maintenance of genetic integrity and evolutionary processes. In order to achieve this, Turpie and Clark (2007) recommended the following measures which would also serve
to help maintain landscape-level processes that maintain ecological integrity at a large scale (relevance to the Swartkops estuary is also provided:

- **Viability:** EPAs should protect a minimum of 33% of each habitat within an estuary as a no take sanctuary. Although this may not be a realistic measure it is potentially attainable due to the large size of the estuary and extent of individual habitats.
- **Viability:** Systems in an unacceptable state of health should be excluded, particularly canalized systems. The Swartkops is in a fair state of health according to Whitfield (2000) and enjoys a high biodiversity importance rating of 92, placing it in 11th position amongst the country’s estuaries.
- **Connectivity:** There should be a relatively even distribution of protected estuarine area around the coast. A network of EPAs has yet to be set up and it is not known how the Swartkops would feature in this arrangement.
- **Landscape level processes:** Estuaries adjoining terrestrial or marine protected areas will be prioritized in the selection process, and those adjoining undeveloped land should be prioritized over those that are developed. There is not much undeveloped land in the lower and middle reaches of the estuary although the Swartkops and Aloes Nature Reserves represent relatively pristine areas.
- **Viability, ecosystem processes, evolutionary processes and representativeness:** Large open systems should be prioritized over smaller systems but a range of different sized estuaries should nevertheless be represented. The Swartkops is a medium/large open system.
- **Efficiency:** Systems with higher conservation importance scores should be given greater priority. The Swartkops has a high score (92) in this regard.

### 7.3.5 TYPE OR LEVEL OF PROTECTION

The study by Turpie and Clark (2007) concluded that in order for conservation targets and goals to be achieved, 80% of temperate estuaries needed some form of partial protection rather than a few with total protection; in many instances this was because the benefits of partial protection were seen to outweigh the management and opportunity costs. Furthermore it became apparent that a greater level of protection of estuaries would be desirable from a socio-economic perspective than would be necessary just in order to meet biodiversity conservation targets. The partial protection of 80% of estuaries was also deemed desirable from a management perspective, in that it would facilitate the introduction of an almost universal sanctuary zone in each estuary which is marked by standard markers, which in turn would facilitate public awareness about the estuarine protection system.

Initial guidelines for the conservation of estuarine biodiversity (Turpie 2004) required that estuaries be assigned to one of three categories, namely:

- **Estuarine Protected Areas (EPAs) -** part or all of an estuary is a sanctuary, providing protection from consumptive use; state-run; selected with both biodiversity representation and socio-economic considerations in mind;
- **Estuarine Conservation Areas (ECAs) -** co-managed estuaries in which general regulations are augmented by estuary-specific regulations; initiated by local communities through estuary forums which would also design zonation schemes and bylaws; likened to the role of private nature reserves and conservancies in the protection of terrestrial biodiversity, and are generally not considered to contribute to protected area conservation targets because their contribution to conservation is less secure in the long term; and
Estuarine Management Areas (EMAs) - to which general regulations apply; at least must have a management plan in order to facilitate compliance with general regulation and maintain estuarine health at an acceptable level.

However, due to complications that arise between fully and partially protected systems with respect to national legislation and the subsequent administration of EPAs and ECAs it has been recommended that the above categories be scrapped and that zonation be used instead as a general strategy in the management of estuaries (Turpie and Clark 2007). Essentially this means that the estuaries selected to form part of an overall protection network should contain a sanctuary zone and should receive sufficient protection and sufficient quantity and quality of freshwater inflows to be maintained in an appropriate state of health.

The zonation strategy means that individual estuaries may contain a fully-protected (sanctuary) area which would include terrestrial margins, and a conservation area that would be zoned according to the vision and objectives/requirements for that estuary. Sanctuary areas would fulfill the same function as an EPA and as such would have to be set up and managed by an organ of the state. Conservation areas may be managed by a wide variety of styles within a co-management setup where the community and an estuary management forum are the main role players. By adopting a system like this on all selected estuaries, it is likely to be easier and more efficient to manage the entire network, especially if similar rules apply and similar markers and mapping styles are used in all estuaries to denote sanctuaries and other types of use zones (Turpie and Clark 2007).

7.3.6 THE SWARTKOPS IN PERSPECTIVE

Based on the findings of Turpie and Clark (2007), the following can be said about the Swartkops estuary with regards to requirements in terms of protection:

- The Swartkops is one of the core set of temperate estuaries required to meet the targets for biodiversity protection of estuarine resources; scores (out of 100) that contributed to the overall rating of 92 for the Swartkops were size (100), habitat importance (100), zonal type rarity (20) and biodiversity importance (100).
- The recommended extent of sanctuary protection is HALF of each habitat type within the system.
- The recommended extent of undeveloped margin is 50%; an average score for public perception of optimal level of development around SA estuaries was 40%.
- The recommended minimum water requirement falls under the A/B management class, which means a high priority and requirement.
- The priority for rehabilitation is HIGH.

Preliminary thoughts on a zonation plan for the Swartkops Estuary are that the sand and mudbanks adjacent to the N2 bridge on the north-west side be considered for protection (invertebrates) as well as the Redhouse Saltpans (birds) above the railway bridge. The saltpans are leased to Cerebos at present and negotiations will have to be entered into in this regard. The added attraction is that the saltpan area will effectively link up with the southern boundary of the Swartkops Nature Reserve. However, full stakeholder involvement will be required before any proposals are considered and this will be achieved during the upcoming stakeholder workshop. In addition to the protected areas, the estuary will be zoned for various user groups (e.g. water skiing), designated wake-free areas and no-go areas in terms of future development.
7.4 RESTORATION/REHABILITATION

A workshop attended by estuarine scientists and managers was held to determine which temperate estuaries should be prioritized for rehabilitation (see Turpie and Clark 2007) and which issues should be addressed in each estuary. A total of 50% of temperate estuaries were considered to be in need of some form of rehabilitation; these included systems ranging from a poor to excellent state of health. Thirty-nine estuaries, including the Swartkops, were given a HIGH priority status for rehabilitation. According to the consensus opinion at the workshop the requirements for rehabilitation on the Swartkops estuary are water quality (pollution), clearing of alien vegetation and restoration of areas that have undergone inappropriate bank stabilization. An additional cause for concern was the disturbance created by bait collectors (no indication whether this referred to subsistence operators or to all collectors).

Water quality has been raised as a concern in the past by numerous stakeholder groups, particularly the Zwartkops Trust, and it is mostly due to contaminated runoff or point sources that contain industrial effluent, raw sewage and litter. At present the effects appear to be localized due to the strong flushing effect of the tides and the dilution factor in such a large body of water. The extent and severity of this problem can only be determined through a dedicated monitoring programme but more stringent measures together with increased compliance monitoring may be required to avert ecological impacts and the threat to human health.

A new project to develop an artificial wetland in the vicinity of the Motherwell Canal has recently been undertaken by SRK Consulting. Together with other structures, this project aims to improve the water quality emanating from the canal before it enters the estuary.

The greater catchment area is thought to be in good condition, however a dedicated catchment management plan run through a catchment management agency is required to consider estuary specific issues. Although the water requirements for the estuary have been determined via a desktop reserve assessment (see Section 6.8.1), a higher level study needs to be undertaken at a higher confidence level before recommendations are made in this regard. This will ultimately ensure that the estuary receives its allocated quota of freshwater, which will help sustain ecological processes.
CHAPTER 8 - THE WAY FORWARD: OBJECTIVE II

8.1 LOCAL ESTUARY MANAGEMENT FORUM

Objective II involves the process of formulating an Integrated Management Plan (IMP) for the Swartkops Estuary and Swartkops and Aloes Nature Reserves through a workshop aimed at obtaining stakeholder input with regards aspects such as the vision, strategic objectives, management action plans and monitoring programmes. Ideally the IMP should be developed with the help of a constituted local management institution, which represents all the relevant stakeholders and their interests. The Swartkops Trust is already in existence and could possibly be used as a starting point for a constituted management body. In accordance with the National Estuarine Management Protocol, the management institution would take the form of an Estuary Management Forum (EMF) and would comprise the following (van Niekerk and Taljaard 2007):

- A chairperson, to be elected by the forum and to take the lead in the development and implementation of the local EMP.
- Technical Working Groups for each of the following key sectors:
  - Conservation;
  - Social (and cultural) issues;
  - Land-use and infrastructure development;
  - Water quantity and quality; and
  - The exploitation of living resources.
- The forum itself comprising all stakeholders.

The Technical Working Groups should ideally include representatives from the authorities who have a mandate and executive powers within the specific sector (e.g. conservation; water quality) as well as competent natural or social-science specialists acting in an advisory role. It will be proposed that the EMF also takes on the responsibility of overseeing the implementation of the Swartkops and Aloes Nature Reserve management plans.

Because the Swartkops does not possess a management forum at present, Enviro-Fish Africa (EFA) are fulfilling the role of initiating the IMP and will make recommendations that a constituted forum be set up to ensure the implementation and monitoring of the IMP.

8.2 THE INTEGRATED MANAGEMENT PLAN

Key to the formulation of an IMP will be the organization of a stakeholder workshop in order to develop a vision and objectives for the Swartkops Estuary and the two Nature Reserves based on the Situation Assessment (this report) and the future needs and desires of the stakeholders. These outcomes together with the assessment provided by Turpie and Clark (2007; Section 10 above) and the C.A.P.E. Generic Framework for EMPs (van Niekerk and Taljaard 2007) will be used to formulate the IMP.

Essentially the following tasks will be performed for Objective II:

- Assist in setting a Vision and Strategic Objectives for the Swartkops Estuary, the Swartkops Nature Reserve and the Aloes Reserve.
- Develop a range of Management Strategies to achieve the Vision and Objectives.
• Prepare an Estuarine Zonation Plan and Operational Objectives based on the above. It is proposed that the Conservation Development Framework (CDF; SRK 2008b), developed for the terrestrial reserves, be implemented in its existing form.
• Identify Management Action Plans (MAPs) to achieve all strategies and operational objectives including implementation procedures (includes human and financial resources).
• Propose an institutional structure for implementation of the management plans.
• Develop a monitoring and evaluation programme including a description of a process for reviewing the management plans.
• Identify research priorities.

8.3 THE STAKEHOLDER WORKSHOP

The workshop will be held at Port Elizabeth City Hall at a date yet to be determined and will concentrate on the development of a vision, strategic objectives and management strategies for the Swartkops estuary. An Estuary Zonation Plan (EZP) will also need to be considered in relation to the management strategies. The zonation plan for the two nature reserves devised by SRK (2008b) in the CDF will also be presented for discussion.

In order to provide stakeholders attending the workshop with some idea of what to expect, some useful background information is supplied in the sections below.

8.3.1 VISION

The Vision for the estuary should be inspirational, representing a higher level statement of strategic intent, while taking into account the Vision set for all estuaries within the greater Cape Floristic Region.

| Vision for Estuaries in the CFR: Our estuaries are beautiful, rich in plants and animals, they attract visitors, sustain our livelihoods and uplift our spirits |

8.3.2 STRATEGIC OBJECTIVES

The strategic objectives are generally qualitative statements of the values defined in the vision and should be statements of outcomes rather than means of achievement. For the Swartkops, the strategic objectives proposed for the larger CFR (see text box below) need to be considered and can provide inspiration for the setting of estuary specific objectives.

The developed Vision and Strategic Objectives for the Swartkops may not conflict with that developed for the CFR. Strategic objectives for specific systems should be listed in priority order to guide subsequent management decisions. The Strategic Objectives must form the foundation for quantitative, operational objectives.

8.3.3 MANAGEMENT STRATEGIES

The Vision and Strategic Objectives may be achievable through various management strategies and these will be investigated and evaluated so as to optimally utilize financial and human resources. Existing institutional management strategies must be incorporated where
appropriate. Before finalization of an EZP and the development of the Operational objectives, the different management strategies may have to be refined through collaboration with stakeholders; this will be addressed during the course of the workshop.

### Strategic Objectives for the Estuaries of the CFR include:

- **Living resources:** Achieve targets for ecosystem biodiversity and health in terms of the long-term habitat persistence of habitats, species, community structure, biomass and functioning by 2015.

- **Water quantity and quality:** Determine, implement, monitor and review Resource Quality Objectives (RQOs) (taking into account public health) in order to maintain or restore estuarine structure and function in the best attainable state for five priority estuaries within the CFR by 2010.

- **Land-use and infrastructure planning:** Define estuarine areas, assess their current status and values and formulate appropriate integrated management plans to regulate development and other activities impacting upon them, with particular reference to cumulative impacts, by 2008 (focusing on mechanisms).

- **Institutional and management structures:** Cooperatively manage estuaries, through relevant institutions of management comprising appropriate spheres of government and civil society, according to appropriate management plans by 2010.

- **Climate change:** Minimise the detrimental impacts of predicted climate change by 2010 through:
  1) Taking a long-term precautionary approach to infrastructure development and water-resource planning;
  2) Influencing land management in upper and middle catchments to reduce impacts on estuaries; and
  3) Promoting long-term sustainable livelihoods through estuarine management that minimises risks.

- **Education and awareness:** Generate education and awareness regarding CFR estuaries by 2010, having:
  1) Contributed to integrated, collaborative and informed action and decision making regarding estuaries;
  2) Contributed to a sustainable quality of life;
  3) Promoted good management practices that will sustain healthy estuarine functioning;
  4) Raised awareness of the intrinsic value of estuaries and developed a sense of ownership of estuaries not only among local communities but throughout South Africa; and
  5) Raised awareness of and insight into the legal context and obligations of all levels of government (national, provincial, local and community).

### 8.3.4 ZONATION PLANS

Once management strategies have been agreed upon, these will need to be translated into zonation plans and Operational Objectives for the estuary and nature reserves. As mentioned
above, the zonation for the nature reserves, proposed in the CDF (SRK 2008b) will be used. Zonation Plans will be in the form of a map that clearly demarcates the following:

- Geographical boundaries;
- Conservation/Protected zones as well as degree or class of protection needed;
- Zones demarcated for the exploitation of living marine resources (e.g. fishing and bait collection);
- Important bio-physical features (open channel areas, Macrophyte beds, invertebrate beds, mud banks, sand banks, wetlands, salt marshes, indigenous vegetation etc);
- Areas earmarked for rehabilitation;
- Land-use and planning provisions of surrounding areas;
- Infrastructure (e.g. roads, bridges);
- Cultural and heritage sites;
- Existing recreational and cultural activities (e.g. swimming, skiing, traditional ceremonies etc);
- Wastewater discharges (sewage, industrial)
- Stormwater drains
- Solid waste-dump sites.

The Operational Objectives and Management Action Plans required to achieve these objectives will be addressed subsequent to the workshop as will the implementation plan, monitoring and evaluation programme. A draft IMP report will be circulated to all IAPs for comment prior to finalization of the report.
CHAPTER 9 - REFERENCES


APPENDIX 1

PERMIT CONDITIONS REGARDING CATCHING, POSSESSION AND SALE OF SWARTKOPS BAIT
DIGGING ON A SMALL SCALE BASIS - 2009

1. **GENERAL**

1.1 This permit is issued subject to the provisions and regulations of the following laws:

   (a) The Marine Living Resources Act, 1998 (Act No. 18 of 1998) ("the Act"), and in particular, the regulations that designate marine protected areas;

   (b) The National Environment Management Act, 1998 (Act 107 of 1998) ("NEMA"), and in particular, the regulations that controls vehicle use in the coastal zone (as amended);

   (c) The National Biodiversity Act (Act No.10 of 2004);

   (d) The National Protected Areas Act, 2003 (Act No. 57 of 2003)

   (e) The Sea Birds and Seals Protection Act, 1973 (Act No. 46 of 1973); and


1.2 If, in the opinion of the Director: Inshore Fisheries Management: Branch: Marine and Coastal Management, Department of Environmental Affairs and Tourism, there are sound reasons for doing so, the Director may, without prior notice to the Permit Holder, amend the conditions of the exemption.

1.3 The permit may be revoked, suspended or cancelled if the Permit Holder contravenes or fails to comply with an exemption condition or with the provisions of the Act(s) or is convicted of an offence in terms of the Act(s) or fails to effectively utilize the exemption or in the opinion of the Director it is necessary to revoke or cancel the permit.

1.4 The Director: Inshore Fisheries Management may withdraw the permit of any person who contravenes or fails to comply with any of the Act(s), Regulations or conditions of this permit.

1.5 The permit may at any time be withdrawn or its conditions amended by the Director: Director: Inshore Fisheries Management.

1.6 A permit to exercise an existing right in terms of the Act(s) may be refused if the conditions of a previously issued exemption had not been adhered to.

1.7 The permit may be withdrawn or suspended if the Permit Holder fails to submit correct information to which the Department is entitled.
1.8 An application for an exemption may be refused if the conditions of a previously issued permit have not been adhered to.

1.9 In terms of the Act, the Permit Holder is obliged to report to the Minister any contravention of the provisions of the Act(s) by any other person.

1.10 The permit must be available at the site of fishing and shall be produced on demand to any Fishery Control Officer.

1.11 The Permit Holder shall obey accredited Community Catch Data Monitors at all times and allow catches to be weighed and measured.

1.12 This permit is only valid for use once within any calendar day.

1.13 Fishing activities shall be restricted to the days on which community resource-use monitors operate, as indicated by the calendar issued by the Local Subsistence Co-management Committee (LSCC).

1.14 This permit may only be used by the Permit Holder or an authorized representative. Written permission for an authorized representative must be obtained from the Director: Inshore Fisheries Management.

1.15 This permit is not transferable and is only valid if the identity number or the date of birth of the Exemption Holder has been inscribed thereon.

1.16 This permit shall only be used by household members authorized Director Inshore Fisheries Management in the event of the Permit Holder being incapacitated. Written permission for an authorized representative must be obtained from the Director: Inshore Fisheries Management.

1.17 This permit does not grant the Permit Holder a future legal right to be in the subsistence sector.

1.18 The Permit Holder shall not be in possession of, transport or sell more than any of the restricted bait species below per day:

   (i) 200 Prawns (mud and sand combined)
   (ii) 60 Pencil bait (razor clam), unless any other bait organism listed herein is also caught that day, in which case the limit is 20 Pencil bait.
   (iii) 5 Tape worm only
   (iv) 5 Bloodworm

1.19 Gear restriction

   (i) No spades and forks are to be used for the collection of bait anywhere at any time except on Fridays and Public Holidays only; however this remains subject to review.
(ii) Only hand-operated suction pumps, pressure pumps (or equivalent use of this) may be used for harvesting Prawns.

(iii) Only suction pumps may be used for Bloodworm.

(iv) Only a single length or wire less than 0.5 m in length must be used for Pencil bait.

(v) Digging of bait is only allowed on the mud and sand banks, NOT ON THE VEGITATED AREAS

1.20 Bait collecting is restricted between 06h00 and 16h00, Monday to Sunday, with the exception of Tuesdays in which neither harvesting nor sale shall be allowed, unless Tuesdays are: Public Holidays, fall within the month of December, January or February, or fall within school holidays for Government Schools in the Eastern Cape.

1.21 No school children and / or other new adult arrivals shall render assistance to the Permit Holder to collect or sell bait.

1.22 The bait point of sale shall be restricted to 3 (three) demarcated areas which have been determined in consultation with Fishers and the Nelson Mandela Metro authorities the Truck Stop, the Swartkops Bridge and the Pump-house; and specifically excluding Strand Street.

1.23 Bait selling, by the Permit Holder, shall be restricted to recreational and not to commercial fishing, unless authorised in writing by the Director: Inshore Fisheries Management: Branch Marine and Coastal Management at the Department of Environmental Affairs and Tourism.

1.24 The Department of Environmental Affairs and Tourism: Branch Marine and Coastal Management reserves the right to close any bait collection areas for a specified period in terms of this exemption in which case the Permit Holder shall be notified.

1.25 This permit is issued in accordance with an interim management plan for the Swartkops Bait Fishery which is subject to change, and therefore no Permit Holder shall have a future legal expectation to be granted a long term bait and line-fish right in the Swartkops Estuary or elsewhere.

2. FISHING AREA

2.1 The permit is valid only in the Swartkops River Estuary. Fishing in other marine areas controlled by the South African National Parks, is subject to regulations promulgated under the National Parks Act, 1976 (Act No 57 of 1976) as amended.

2.2 Fishing should occur from:

- Coro Brick Canal at Swartkops river ( S 33° 50.179’ E 025° 35.698”) to Swartkops River Mouth ( S 33° 51.825’ E 025° 37.765”)

3. COMPLIANCE

The Permit Holder is obliged in terms of the MLRA to report to the Minister any contravention of the MLRA or Permit conditions by any other person. Any such
contravention must be reported to the Department in writing and should be faxed to (021) 402 3113, The Chief Director: Monitoring, Control and Surveillance.

The Permit Holder shall abide by the control imposed by the Co-management Committee in the interest of stock sustainability.

4. PERMIT VALIDITY PERIOD

4.1. This conditions and its permit is valid for a period of one year (from date of issue to December 31, 2009).

Acting) DIRECTOR: INSHORE FISHERIES MANAGEMENT
DATE: