

**STATEMENT OF THE PROBLEM**

1. The Uilkraals estuary was historically a permanently open system with no known records of closure prior to 2008.
2. The estuary is currently experiencing anomalous periods of prolonged mouth closure attributable to:
  - Significant alien infestation in the catchment (which deplete baseflow in summer and winter) as well as abstractions for irrigation and domestic and industrial use (which deplete medium and low flows in winter), and
  - Long-term variations in rainfall and runoff (drought cycles), and has recently been through a period of anomalously low flows (2010-2011).
3. Mouth closure is impacting on:
  - Water quality by exacerbated elevated levels of nutrients in the estuary originating from anthropogenic sources (WWTW and agriculture) and allowing hypersaline conditions to develop in the estuary when the mouth is closed and freshwater flow is very low;
  - Movements of estuary associated fish and invertebrates and diadromous fish between the estuary and the sea and hence the nursery function of the system which is of high regional importance due to most other systems in the region being closed for much of the time;
  - Salt marsh vegetation of the estuary, which has a high conservation importance due to the presence of genetically distinct species assemblages by drowning (prolonged inundation with fresh or brackish water),
  - Loss of intertidal habitat and associated invertebrate fauna, fish and birds through reduced tidal influence, desiccation (reduced frequency or absence of tidal inundation, and or drowning, and
  - Infrastructure in, and use of, the holiday resort located adjacent to the mouth of the estuary (Uilenkraalsmond Holiday Resort).
4. Closed mouth status likely to be progressive or “self reinforcing” due to progressive sediment build up in the estuary particularly in the mouth region thereby increasing the likelihood of future closure
5. Removal of all alien vegetation from the catchment is a high priority and will go a long way towards restoring summer and winter baseflows at the head of the estuary, but in itself may not be sufficient to keep the mouth of the estuary open.

In terms of the National Environmental Management Act (Act 107 of 1998), movement of more than 5m<sup>3</sup> of material in an estuary is a listed activity ***unless it is undertaken in accordance with an agreed management plan***: Listing Notice 1 R544 “The infilling or depositing of any material of more than 5 cubic metres into, or the dredging, excavation, **removal or moving of soil, sand, shells, shell grit, pebbles or rock of more than 5 cubic metres from:** (i) a watercourse; (ii) the sea; (iii) the seashore; (iv) the littoral active zone, **an estuary** or a distance of 100 metres inland of the highwater mark of the sea or an estuary, whichever distance is the greater **but excluding where such** infilling, depositing , dredging, excavation, **removal or moving; (a) is for maintenance purposes undertaken in accordance with a management plan agreed to by the relevant environmental authority;** or (b) occurs behind

the development setback line”.

An Estuary Management Plan<sup>1</sup> and a Reserve Determination study report<sup>2</sup> have recently been prepared for the Uilkraals Estuary by Anchor Environmental Consultants. These two documents have pulled together an extensive body of specialist knowledge regarding this estuary and address a range of issues including management of the estuary mouth. Stakeholder involvement was comprehensive through four public meetings and several technical working group sessions.

The Overberg District Municipality wishes to submit *this document* along with the “Estuary Management Plan for the Uilkraals Estuary” for agreement by the relevant authority (the Department of Environmental Affairs & Development Planning, Western Cape Government).

In terms of such an agreement, management of the estuary mouth undertaken by the Overstrand Municipality would be deemed in compliance with the applicable legislation.

## OVERALL OBJECTIVE OF THE LOCAL MOUTH MANAGEMENT PROGRAMME

### ***VISION for the Uilkraals Estuary:***

*“The Uilkraals Estuary must be restored to a healthy, intact ecosystem with good water quality, must be accessible to all, and provide benefits to present and future generations through conservation and sustainable recreational use”*

### ***Key Management Objectives:***

Key management objectives for the Uilkraals Estuary were identified at a stakeholder workshop held in Franskraal, in August 2010, and were reconfirmed at a stakeholder meeting in Gansbaai in October 2012 :

1. Conserve biodiversity

Adequate protection must be provided for estuarine biota to ensure persistence of populations, species, habitats and ecosystem processes. Alien vegetation must be monitored and controlled.

2. Enhance economic benefits

Economic benefits will be enhanced through the promotion of ecotourism. The estuary must be managed to maximize the value of ecosystem goods and services delivered in the long term, ensuring an equitable balance among local, regional and national benefits.

3. Improve access

Accessibility to the estuary for recreational users needs will be improved through the implementation of facilities (e.g. parking area, boardwalks) and amenities.

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<sup>1</sup>Anchor Environmental Consultants 2012. Uilkraals Estuary Draft Management Plan v2. Prepared for C.A.P.E. Estuaries Programme (Cape Nature) and the Overstrand Municipality. 44 pages.

<sup>2</sup> Anchor Environmental Consultants 2012. Determination of the Ecological Reserve for the Uilkraals Estuary. Report No. AEC 483-1, 146 pp.

4. Improve ecosystem health

The current health of the estuary needs to be enhanced. This will be achieved through improvements in water quality, restoration of necessary freshwater supply, decreases in pollution, the removal of alien vegetation and other measures.

5. Retain sense of place

Set back lines for development need to be defined to prevent future development from compromising the existing sense of place, cultural heritage and conservation value of the system.

6. Increase awareness

Residents and visitors need to be made aware of the importance and economic value of the estuary, be knowledgeable regarding regulations applicable to the system, and understand the rationale for management measures and interventions.

***Key management objectives relating to mouth management:***

The following management objectives were identified at a expert workshop convened as part of the RDM study for the Uilkraals estuary in May 2012 and ratified with stakeholders at a meeting in Gansbaai in October 2012

1. Enhance and maintain estuary health and ecosystem functions including:

- Maintaining connectivity with the sea and hence protecting the nursery function of the estuary and its role as a passage for diadromous fish species;
- Preventing further loss of and/or restoring conservation-worthy salt marsh vegetation in the estuary;
- Preventing macroalgae and/or benthic micro-algae from reaching unnatural densities in the estuary
- Preventing further loss of and/or restoring intertidal habitat, invertebrate and bird communities in the estuary; and
- Preventing further degradation in the water quality of the estuary and as far as possible restoring this to what it was like under reference conditions.

2. Minimise risks of the closed mouth status becoming “self-reinforcing” (i.e. of sediment build up at the mouth) and thereby increasing likelihood of future closure.

**ASSESSMENT OF RISKS, THREATS, OPPORTUNITIES ASSOCIATED WITH MOUTH MANAGEMENT DECISIONS**

GENERIC ISSUE	LOCAL SITUATION	RISK ASSESSMENT
Presence of early warning system from SAWS/Disaster Management	No early warning system required. The only infrastructure at risk from flooding due to high water levels when the mouth is closed is the Uilenkraalsmond Holiday Resort at the mouth of the estuary on the east bank. The resort is owned by The Overberg District Municipality (ODM) which is the same authority responsible for mouth breaching. The ODM will monitor warning from the SAWS when the estuary mouth is closed to ensure safety of any resident and property in the resort.	Low
Presence/Absence of a Disaster Management Contingency Plan	No	Low
Threats to human life as a result of high water levels	Unlikely	Low
Threats to immovable property and infrastructure as a result of high water levels	Flooding and subsequent overflows at sewage pumpstations, septic tanks and conservancy tanks located around Uilkraals estuary Surcharging sewers Flooding of municipal property – Uilenkraalsmond Holiday Resort	High
Threat of pollution of estuary resulting from high water levels (e.g. flooding of sewage pump station, septic tanks, conservancy tanks, etc)	Sewage pumpstations Septic tanks Conservancy tanks <ul style="list-style-type: none"> <li>• Gravity sewers</li> </ul>	High
Potential loss of crops or other agricultural resources (e.g. aquaculture farm) as a result of high water levels	Not applicable	Not applicable

GENERIC ISSUE	LOCAL SITUATION	RISK ASSESSMENT
Threats to waterbird habitat as a result of high water levels and loss of tidal influences	The Uilkraals estuary was historically a permanently open system with no known records of closure prior to 2008. The estuary has historically supported very high numbers of waterbirds (mostly waders). It has also been identified as an important bird area (Barnes 1996). Numbers of birds on the estuary have dropped dramatically in recent years primarily due to loss of natural tidal influences which regularly inundate sand and mud flats in the estuary. Loss of tidal function occurs when the estuary mouth is closed.	High
Threats to intertidal saltmarsh as a result of high water levels and loss of tidal influences	Extensive salt marsh area (with its genetically distinctive species) and high macrophyte diversity make the Uilkraals Estuary unique along the southern Cape coast. Closed mouth conditions pose a major threat to these salt marsh habitats due either to desiccation when the mouth is closed and water levels are low (no tidal inundation) or drowning due to inundation with fresh water when the mouth is closed and water levels are high.	High
Potential loss of estuarine fish populations, and other species, through breaching, resulting in mortalities	The Uilkraals estuary was historically a permanently open system with no known records of closure prior to 2008. The fish fauna of the estuary have evolved to operate under open mouth conditions.	Low
Extended mouth closure, resulting in loss of the estuary as a nursery habitat for marine fish and preventing entry of breeding stock into the marine environment	Recent period of prolonged closure represent an anomalous condition in the Uilkraals estuary and pose a major threat to the value of the estuary as a nursery area. Juvenile fish are denied an opportunity to enter estuary when the mouth is closed and cannot leave at this time and can be subject to high levels of mortality due to predation or poor water quality.	High

GENERIC ISSUE	LOCAL SITUATION	RISK ASSESSMENT
Salinity reaches exceptionally high or low levels, representing a threat to estuarine system, relieved by restoration of tidal flow	The Uilkraals estuary was historically a permanently open system with no known records of closure prior to 2008. Under these conditions a natural gradient exists in the system where salinity near the mouth approximates that of sea water (35 PSU) while that at the head of the estuary approximates that of freshwater (0 PSU). Conditions at any particular point in the system vary between 0 and 35 PSU due to variations in freshwater runoff and tidal state. Organisms living in the estuary are accustomed to this variation and have evolved to cope with this variability. Under closed mouth conditions however, natural variability is lost (conditions are much more stable), and extreme conditions (hyper- or hypo-salinity) are allowed to persist for long periods and can lead to mass mortalities or facilitate the proliferation of pest species.	High
Access impacts – more difficult for people to access the middle and upper reaches of the estuary or to cross the estuary when the mouth is closed and water levels are high	When the mouth is closed and water levels are high, it is difficult to access the middle and upper reaches of the estuary or to cross the estuary. Recreational utility of the estuary is reduced at these times	Medium
Impacts on recreational amenity – larger water body when mouth is closed, a consideration for organisers of sailing regattas, water skiing, etc.	Historically water levels in the estuary have always been low and have fluctuated with the rise and fall of the tides. The estuary has never been used for sailing or for motorized vessels	Low
Access / recreational amenity – effects of water level variation on water's edge infrastructure (e.g. jetties, launch sites, hardened edges)	There are no jetties, launch sites, hardened edges on the estuary.	Low
Aesthetic amenity – water level variations affect view, perceptions of exposed mud flats	The Uilkraals estuary was historically a permanently open system with no known records of closure prior to 2008. As such sand and mudflats in the estuary have always been exposed twice daily at low tide. This is the normal situation.	NA

GENERIC ISSUE	LOCAL SITUATION	RISK ASSESSMENT
Precautionary principle - adopt a risk-averse and precautionary approach under conditions of uncertainty	The recent RDM study undertaken on the estuary has eliminated much of the uncertainty regarding the functioning and conservation importance of the estuary. It has been agreed that maintenance of the open mouth condition is extremely important.	Low

**INTEGRATED ASSESSMENT: UILKRAALS**

Summary of findings

Findings from the recent Reserve Determination (RDM) Study on the Uilkraals estuary (Anchor Environmental Consultants 2012)<sup>3</sup> have revealed that the estuary was historically a permanently open system with no known records of closure prior to 2008. The estuary is currently experiencing anomalous periods of prolonged mouth closure due to reduced fresh water inflow during the summer months, attributable to significant alien infestation in the catchment (which deplete baseflow in summer and winter) as well as abstractions for irrigation and domestic and industrial use (which deplete medium and low flows in winter), and long-term variations in rainfall and runoff (drought cycles).

Leading estuarine experts that participated in the recent RDM study agree that mouth closure is impacting on the following important attributes of the estuary

- Water quality by exacerbated elevated levels of nutrients in the estuary originating from anthropogenic sources (WWTW and agriculture) and allowing hypersaline conditions to develop in the estuary when the mouth is closed and freshwater flow is very low;
- Movements of estuary associated fish and invertebrates and diadromous fish between the estuary and the sea and hence the nursery function of the system which is of high regional importance due to most other systems in region being closed for much of the time;
- Salt marsh vegetation of the estuary, which has a high conservation importance due to the presence of genetically distinct species assemblages by drowning (prolonged inundation with fresh for brackish water),
- Loss of intertidal habitat and associated invertebrate fauna, fish and birds through reduced tidal influence, desiccation (reduced frequency or absence of tidal inundation, and or drowning, and
- Infrastructure in and use of the holiday resort located adjacent to the mouth of the estuary.

Breaching thresholds

Experts involved in the RDM study on the Uilkraals estuary (Anchor Environmental Consultants 2012) are in agreement that the closed mouth status of the estuary is likely to be progressive or “self reinforcing” due to progressive sediment build up in the estuary particularly in the mouth region

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<sup>3</sup> Anchor Environmental Consultants 2012. Determination of the Ecological Reserve for the Uilkraals Estuary. Report No. AEC 483-1, 146 pp.

thereby increasing the likelihood of future closure. As such, it is considered imperative that the mouth of the system should not be permitted to stay closed for prolonged periods. These experts also acknowledge, however, that there is considerable value in allowing water levels in the estuary to build up as high as possible before artificially breaching the mouth as this will ensure maximum scouring and sediment removal during such a breach event. A trade-off thus exists between benefits that would be accrued by delaying breaching (and hence allowing water levels to build up as high as possible) versus breaching as soon as possible after initial closure to minimise risks to the salt marshes in the estuary and property on the banks of the estuary. It has thus been agreed that an artificial breach should only be effected if any of the following thresholds are exceeded:

- Water level at the road bridge rises above 2.0 m AMSL;
- Salinity levels anywhere in the system rise above 40 PSU (i.e. the system become hypersaline);  
or
- The mouth remains closed for a continuous period of three months or more over the period Sep-Feb and average water levels over this period exceed of 1.5 m AMSL.

Method to be used to open the mouth:

The mouth of the Uilkraals estuary has only been artificially breached on one occasion in the past. This was undertaken by the Overberg District Municipality on Saturday 24 October 2010. The breaching exercise was the result of a collective decision between key departments and role-players after the evaluation of the river system's health after the extensive closure of the estuary for 10 months.

The following people were present at the time of the breaching to oversee the procedure and ensure the minimization of the impact:

Andre Marais – Cape Nature

Pierre de Villiers - Cape Nature – Programme Manager: Marine Protected Areas, Islands and Estuaries

Benjamin Kondokter.- Overstrand Municipality – Environmental Officer

Johan Botha – Overberg District Municipality – Resort manager, Uilenkraalsmond

Melt Carstens – Overberg District Municipality – Municipal Health Official

Francois Kotze – Overberg District Municipality – Head: Environmental Management

An excavator was used for the digging of the channel. The excavator was offloaded in the Uilenkraalsmond Camp and moved through the mouth (along the edge of the estuary) onto the berm. This ensured the shortest route was followed with the minimum impact. The section through which the excavator moved were scoured after the breaching and therefore left no impact on the system itself. No invertebrates were present on the section that was crossed (old sandbank that was normally exposed and dry).

The lowest point on the berm was selected on arrival after which the contractor was briefed on the digging procedure. The channel was dug from the GPS point (34° 36' 378" S and 19° 24' 517" E). This correlated with the GPS map of the original channel and lined up with the historical channel of the river mouth.

The channel was dug to a depth of one meter (average depth before seepage takes place) from the

water's edge into the lagoon. This channel was formed through a sand bank to ensure an effective link between the berm and the original channel of the river.

The excavation was closely monitored to ensure that no marine or estuarine organisms were harmed. No prawns, bloodworms, white mussel or any other organism were observed during the excavation period.

The total channel length was approximately 85 m with a width of 5 m and an average depth of 1 m. An estimated 425m<sup>3</sup> of sand was removed to form the channel.

After the channel was dug (11h30) the excavation was stopped and time was allowed for the high-tide to reach its maximum level at 15h15. Two earth plugs remained in the channel. The first one prevented the water from the lagoon entering the channel while a sea side plug prevented the high tide from entering into the channel.

One hour was allowed for the water to recede after high tide before the final breach took place. At 16h00 the plug in the lagoon was removed and water flooded into the channel up to the sea side of the channel after which the final breach to the sea took place at 16h15.

The water flow after breaching was strong and adequate to ensure a good scouring of the sandbank in the mouth area. By Sunday morning 24 October 2010 the mouth was approximately 60m wide and over 2 meters lower than the original berm height.

The breaching was successful and everyone involved was happy with the outcome. Photographs of the breaching procedure are included below (courtesy of Francois Kotze, Overberg District Municipality).

It is recommended that a similar procedure to that described above be followed in the future and that representative from all the respective agencies (Overberg District Municipality, Overstrand Municipality, Cape Nature) are present during the breaching process.



Additional research required prior to breaching

Findings from the recent RDM study indicate that it is likely that there had been some sediment build up in the lower estuary, however, this need to be confirmed as it will inform the long-term strategy for the management of the mouth of the estuary. Specifically, if there are particular areas in the mouth of the estuary where excess sediment has accumulated as a result of reduced freshwater runoff to the estuary, this sediment should be removed to reduce the risks of mouth closure becoming self-reinforcing and to reduce the frequency at which the mouth will need to be breached in future.

Topographic survey data is available dating back to 1970's and 1990's. These surveys need to be repeated now to enable an assessment to be made of the extent to which sediment has accumulated in the estuary and where efforts need to be focused to address this situation. This may be in the area above or below the bridge or indeed in both areas of the estuary.

## MONITORING AND MANAGEMENT REQUIREMENTS ASSOCIATED WITH A BREACHING EVENT

MONITORING ACTIONS	LOCAL REQUIREMENT - YES/NO	AGENCY RESPONSIBLE
Mouth condition	Regular (daily) observations and records need to be kept on the state of the mouth of the Uilkraals estuary (open/closed/closed and over topping)	Overberg District Municipality/ Overstrand Local Municipality
Estuarine water level, and initial ocean water level (high-low, spring-neap tide), when breaching should be effected	<p>The Department of Water Affairs has installed an automatic water level recorder at the mouth of the estuary. However, this water level recorder stands high and dry out of the water most of the time and needs to be relocated to a position underneath the road bridge. DWA have agreed to do this.</p> <p>Until such time that the recorder is operational, manual readings should be taken at the Road Bridge as frequently as possible. These levels are used to determine whether rising water to levels that present a flooding risk.</p> <p>Water level constraints:</p> <ul style="list-style-type: none"> <li>• Flooding - occurs at 1.3m amsl and above.</li> </ul>	Department of Water Affairs (DWA)
Bathymetry survey	Bathymetry surveys should be undertaken approximately every 5 years to monitor sediment build-up and change in the lower reaches of the Uilkraals estuary. This will help to inform future breaching protocols.	Overberg District Municipality/ Overstrand Local Municipality/Breede Overberg Catchment Management Agency (BOCMA)
Water quality	Water quality should be monitored at least on a monthly basis at 3 stations up the length of the system (near the mouth, below the road bridge, and at a site approximately 1.5 km upstream of the bridge). This includes in situ measurements of salinity, temperature, and dissolved oxygen, and collection of water samples for analysis of inorganic nutrients (NO <sub>3</sub> , NO <sub>2</sub> , NH <sub>4</sub> , SiO <sub>4</sub> , PO <sub>4</sub> ).	Department of Water Affairs (DWA)
Other (describe)	Recommendations for additional monitoring activities for tracking the future state of health of the Uilkraals estuary covering a full range of ecosystem components (hydrodynamics, sediment dynamics, water quality, microalgae, macrophytes, vegetation, invertebrates, fish and	BOKMA, DWA, Overberg District Municipality, Overstrand Local Municipality

MONITORING ACTIONS	LOCAL REQUIREMENT - YES/NO	AGENCY RESPONSIBLE
	birds) were included in the recent RDM study on the estuary. These monitoring recommendation have been included in Annexure A. It cannot be reasonably expected that all of these components be monitored as part of a mouth management plan although these would certain contribute hugely towards understanding the impacts (both positive and negative) of any interventions that are implemented.	
Environmental Awareness and Communication	Recommendation for Environmental Awareness and Communication activities are included in the Uilkraals EMP. These should simply be extended to cover mouth management operations as they are an integral component of the management of the Uilkraals estuary.	UEF, Overberg District Municipality, Overstrand Local Municipality, BOKMA

Assessment record compiled by:	Barry Clark based on input provided at an expert workshop convcned as part of a recent RDM study of the Uilkraals estuary (Anchor Environmental Consultants 2012)
	Anchor Environmental Consultants
	Tel: 021 7013420 Email: <a href="mailto:barry@anchorenvionemntal.co.za">barry@anchorenvionemntal.co.za</a>
Workshop venue, town, date:	The documentation to be submitted to DEADP for approval will be discussed with stakeholders at the next Ulikraals Estuary Forum (UEF) meeting scheduled for January 2013 in Franskraal.



**Figure 1. DWA water level recorder on the Uilkraals estuary (Photo: Sue Mathews)**

**Annexure A: Monitoring recommendations included in the RDM study report for the Uilkraals estuary (Anchor Environmental Consultants 2012)**

**Annexure B: References**

**Monitoring requirements included in the RDM study report for the Uilkraals estuary  
(Anchor Environmental Consultants 2012)**

Recommended minimum monitoring requirements to ascertain impacts of changes in freshwater flow to the estuary and any improvement or reductions therein are listed in the table below.

**Recommended minimum requirements for long term monitoring**

<b>Ecological Component</b>	<b>Monitoring action</b>	<b>Temporal scale (frequency and when)</b>	<b>Spatial scale (no. Stations)</b>
<b>Hydrodynamics</b>	Record water levels	Continuous	At bridge
	Measure freshwater inflow into the estuary	Continuous	At Kraaibosch dam and Boesmans above the estuary
	Aerial photographs of estuary (spring low tide)	Every 3 years	Entire estuary
<b>Sediment dynamics</b>	Bathymetric surveys: Series of cross-section profiles and a longitudinal profile collected at fixed 500 m intervals, but in more detailed in the mouth (every 100m). The vertical accuracy should be about 5 cm.	Every 3 years	Entire estuary
	Set sediment grab samples (at cross section profiles) for analysis of particle size distribution (PSD) and origin (i.e. using microscopic observations)	Every 3 years (with invert sampling)	Entire estuary
<b>Water quality</b>	Collect data on conductivity, temperature, suspended matter/turbidity, dissolved oxygen, pH, inorganic nutrients and organic content in river inflow	Monthly continuous	At river inflow
	Assess and better quantify wastewater input (e.g. nutrients and organics) from diffuse sources (e.g. caravan park, WWTW).	Once-off detailed Possibly long-term (e.g. peak seasons) if input remains significant (preferably these should be mitigated)	In stream (source/s)
	Record longitudinal salinity and temperature profiles (and any other in situ measurements possible e.g. pH, DO, turbidity)	Seasonally, every year	Entire estuary (10 stns)

<b>Ecological Component</b>	<b>Monitoring action</b>	<b>Temporal scale (frequency and when)</b>	<b>Spatial scale (no. Stations)</b>
	Take water quality measurements along the length of the estuary (surface and bottom samples) for system variable (pH, dissolved oxygen, suspended solids/turbidity) and inorganic nutrients in addition to the longitudinal salinity and temperature profiles	Seasonal surveys, every 3 years or when significant change in water inflows or quality expected	Entire estuary (10 stns)
<b>Microalgae</b>	Record relative abundance of dominant phytoplankton groups, i.e. flagellates, dinoflagellates, diatoms and blue-green algae  Chlorophyll-a measurements taken at the surface, 0.5 m and 1 m depths, under typically high and low flow conditions using a recognised technique, e.g. HPLC, fluoroprobe  Intertidal and subtidal benthic chlorophyll-a measurements,	Summer and winter survey every 3 years	Entire estuary (5 stns)
<b>Macrophytes</b>	Ground-truthed maps;  Record number of plant community types, identification and total number of macrophyte species, number of rare or endangered species or those with limited populations documented during a field visit;  Record percentage plant cover, salinity, water level, sediment moisture content and turbidity on a series of permanent transects along an elevation gradient;  Take measurements of depth to water table and ground water salinity in supratidal marsh areas	Summer survey every 3 years	Entire estuary (5 stns)
<b>Benthic Invertebrates</b>	Record species and abundance of zooplankton, based on samples collected across the estuary at each of a series of stations along the estuary.  Record benthic invertebrate species and abundance, based on van Veen type grab samples in subtidal and core samples in intertidal at a series of stations up the estuary, and counts of hole densities.  Measures of sediment characteristics at each station	Summer and winter survey every 3 years	Entire estuary (5 stns)
<b>Zooplankton</b>	Record species and abundance of zooplankton, based on samples collected across the estuary at each of a series of stations along the estuary.	Summer and winter every 3 years	Entire estuary 5stn
<b>Fish</b>	Record species and abundance of fish, based on seine net and gill net sampling.	Summer and winter survey every 3 years	Entire estuary (5 stns)

Ecological Component	Monitoring action	Temporal scale (frequency and when)	Spatial scale (no. Stations)
Birds	Undertake counts of all water associated birds, identified to species level.	A series of monthly counts, followed by winter and summer survey every year	Entire estuary (3 sections)

### **Annexure B: References**

Anchor Environmental Consultants 2010. Uilkraals Estuary Situation Assessment report. Prepared for C.A.P.E. Estuaries Programme (Cape Nature) and the Overstrand Municipality. 76 pp.

Anchor Environmental Consultants 2010. Towards an Uilkraals Estuary Breaching Discussion and Decision. October 2010. 11 pp.

Anchor Environmental Consultants 2012. Uilkraals Estuary Management Plan v2. Prepared for C.A.P.E. Estuaries Programme (Cape Nature) and the Overstrand Municipality. 44 pp.

Anchor Environmental Consultants 2012. Determination of the Ecological Reserve for the Uilkraals Estuary. Report No. AEC 483-1, 146 pp.