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Mouth Management Plan

Uilkraals Estuary

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ABBREVIATIONS

CWAC	Co-ordinated Waterbird Counts
DAFF	Department of Agriculture, Forestry and Fisheries
DEA	Department of Environmental Affairs
DEA&DP	Western Cape Government's Department of Environmental Affairs & Development Planning
DWS	Department of Water and Sanitation
EIA	Environmental Impact Assessment
EIS	Estuary Importance Score
I&AP	Interested and Affected Party
IAP	Invasive alien plants
MaintMP	Maintenance Management Plan
MAR	mean annual runoff
MMP	Mouth Management Plan
MSL	mean sea level
NEMA	National Environmental Management Act (Act No. 107 of 1998)
psu	practical salinity units
TOC	temporarily open closed

1 OBJECTIVE OF THE MOUTH MANAGEMENT PLAN

STATEMENT OF THE PROBLEM

1. The Uilkraals Etuary was historically a permanently open system with no known record of closure prior to 2008.
2. The estuary is currently experiencing abnormal periods of prolonged mouth closure attributable to:
 - Abstractions for irrigation and domestic and industrial use, e.g. Kraaibos Dam (which deplete medium and low flows in winter)
 - Significant alien infestation in the catchment (which deplete baseflow in summer and winter)
 - Long-term variations in rainfall and runoff (drought cycles).
3. The Kraaibos Dam outlet is too small to release required baseflows to the estuary.
4. Mouth closure is impacting on:
 - Water quality by exacerbated elevated levels of nutrients in the estuary originating from anthropogenic sources (waste water treatment works 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 catadromous fish (eels) between the estuary and the sea and hence the nursery function of the system which is of medium to 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), and
 - 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).
5. 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.
6. 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.

OBJECTIVE OF THE UILKRAALS MOUTH MANAGEMENT PLAN

To manage the estuary mouth as an integral part of the Uilkraals Estuary Management Plan that will maintain the healthy functional ecological processes of the estuary. For the Uilkraals Estuary this means that its assessment rating should be consistent with a B Ecological Category defined as “*Largely natural with few modifications*” under the Department of Water and Sanitation’s (DWS) A to F rating system. (Clark et al. 2012).

The objectives of the mouth management intervention(s) are therefore as follows:

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 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. Reducing the 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.

IS ARTIFICIAL BREACHING TO BE CONSIDERED AT THE UILKRAALS ESTUARY?	No	Yes
High water levels		x
Floods (emergency)		x
Water quality (emergency)		x
Fish Kills (at the discretion of the Department of Agriculture, Forestry and Fisheries (DAFF) given the classification as a nursery of medium importance)		x
IS A MAINTENANCE MANAGEMENT PLAN REQUIRED?	Yes	

KEY DATA /INFORMATION SOURCES

The information presented below has largely been drawn from the Uilkraals Ecological Water Requirement Study (Clark et al. 2012) and insights gathered during field visits.

KEY RECOMMENDATIONS IN SUPPORT OF THE UILKRAALS ESTUARY MOUTH MANAGEMENT PLAN

While it would be highly desirable to maintain the mouth of the Uilkraals Estuary in a permanently open state in order to maintain connectivity with the sea and prevent the deterioration of the estuary, this may not be easy given existing demands for freshwater in this catchment.

The following critical issues were identified as requiring urgent investigation to informing the most appropriate mouth management interventions:

- Commissioning of a detailed topographic /bathymetric survey and an assessment of sedimentary process in the estuary to evaluate if local interventions (dredging/excavating of sediments in mouth area) would assist in maintain the mouth open.
- Continuous monitoring of water levels in the estuary and inflow into the head of the system.

Two key catchment interventions were identified to improve the terrestrial input into the Uilkraals Estuary:

- Invasive alien plants (IAPs) make a significant impact on flows into the Uilkraals Estuary, reducing options for water use. The IAPs need to be cleared from the catchment in order to restore the Uilkraals Estuary to its best attainable state. Thereafter the catchment needs to be kept free of IAPs.
- There appear to be two main sources of organic pollution into the estuary – spillover from the waste water treatment works to the west, and seepage from sewage systems in the resort development at the mouth. Pollution from these sources needs to be eliminated.

KEY LEGISLATION RELEVANT TO THIS MOUTH MANAGEMENT PLAN

According to the National Environmental Management Act (No. 107 of 1998) (“NEMA”), viz, the Environmental Impact Assessment (EIA) Regulations 2014 (Government Notice No. R. 326, R 327, R. 325 and R. 324 in Government Gazette No. 40772 of 7 April 2017), the following activity may not commence without an environmental authorisation from the competent authority:

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 from:

- I. the seashore;
- II. the littoral active zone, an estuary or a distance of 100 metres inland of the high-water mark of the sea or an estuary, whichever distance is the greater; or

III. the sea.

but excluding where such infilling, depositing, dredging, excavation, removal or moving

- I. occurs behind the development setback line.
- II. is for maintenance purposes undertaken in accordance with a management plan agreed to by the relevant environmental authority; or
- III. falls within the ambit of activity 21 in this Notice, in which case that activity applies; occurs within existing ports or harbours that will not increase the development footprint of the port or harbour; or where such development is related to the development of a port or harbour, in which case Activity 26 in Listing Notice 2 of 2014 applies

[Listing Notice 1, Activity Number 18]

This Mouth Management Plan (MMP) would serve to support a formal application for authorisation to implement the interventions recommended in terms of the need for ecosystem maintenance in the form of a *Maintenance Management Plan (MaintMP)*. It is recommended that such authorisations be limited to a five-year period, at the end of which the MMP should be subject to specialist review before being re-submitted for approval by the competent authority prior to the MaintMP lapsing.

2 DESCRIPTION OF THE UILKRAALS ESTUARY

Table 1: Description of the estuary and its importance

Threat	Discussion
<p>Location</p>	<p>The Uilkraals Estuary is situated approximately 60 km northwest of Cape Agulhas and 11 km east of Danger Point on the south-west coast within the cool temperate biogeographic region of South Africa. The geographical boundaries for the study are defined as follows (Clark et al. 2012):</p> <ul style="list-style-type: none"> • Downstream boundary: Estuary mouth 34°36'23"S, 19°24'33"E • Upstream boundary: 34°35'38.03"S, 19°28'0.05"E • Lateral boundaries: 5 m contour above Mean Sea Level (MSL) as depicted by the Estuary Functional Zone below in light blue. 
<p>Estuary Importance</p>	<p>The Uilkraals River Estuary was until recently a permanently open estuary. The estuary is rated as "<i>Important</i>" based on its Estuary Importance Score (EIS) of 74 (Clark et al. 2012). The EIS takes size, the rarity of the estuary type within its biographical zone, habitat, biodiversity and functional importance of the estuary into account.</p>
<p>Conservation status</p>	<p>The Uilkraals Estuary does not have any statutory protection status at present but is included in the subset of estuaries identified as requiring protection in order to conserve South Africa's estuarine biodiversity in the National Estuary Biodiversity Plan (Turpie et al. 2012).</p>
<p>Important vegetation</p>	<p>The Uilkraals Estuary is important from a vegetation perspective. An important study by Mucina et al. (2003) on the salt marsh of the Uilkraals Estuary indicated a number of unique characteristics. The Uilkraals Estuary lies in the Cape Agulhas region that is considered as a phylogeographic break or transitioning zone between the cool temperate and warm-temperate zone (Teske et al., 2011). At these sites, several species have phylogeographic breaks, with distinct lineages that are endemic to this transition zone. This could explain the high species richness and number of endemic macrophytes found in the Uilkraals Estuary (Adams et al., 2010). Approximately 60 different macrophyte species are distributed in five different estuarine habitats: Intertidal and Supratidal salt marsh, Macroalgae, Submerged macrophytes, Reeds and Sedges. The estuary is therefore important in biodiversity conservation.</p>
<p>Important fish nursery</p>	<p>The Uilkraals is of medium to high importance as a fish nursery area (DAFF, unpublished information). A few surveys have been undertaken of fish of the Uilkraals Estuary in the last two decades (1994, 1996 and 2011), and some anecdotal reports exist on the fish fauna of the estuary prior to this time. Harrison (1999) sampled the estuary using beach-seine and gill nets in 1994, and reported the presence of only four species in the system. Clark & Turpie (Unpublished) reported 12 species in 1996. Clark et al. (2012) recorded 12 species in April 2011 and four species in August 2011 (after a flood at low water levels).</p>
<p>Important Bird site</p>	<p>The Uilkraals Estuary has been ranked 14th in terms of waterbird abundance in a conservation priority analysis study (Turpie 1995). Regionally, it was ranked 11th out of 65 coastal wetland systems in the south-western Cape in terms of total bird numbers</p>

Threat	Discussion
	<p>supported (Ryan et al. 1988). The estuary has supported large numbers of terns and migratory waders in the past (Summers et al. 1976, Heydorn & Bickerton 1982, Ryan et al. 1988) and has been recognised as one of the largest mainland tern roosts in the south-western Cape (Ryan et al. 1988). A total of 51 water-associated bird species have been recorded at the Uilkraals Estuary, with about 30 species recorded per count. In recent counts (2010-11) between 429 and 657 birds have been recorded on the estuary (Clark et al. 2012)</p>
<p>Estuary Condition w.r.t breaching</p>	<p>The Uilkraals Estuary is negatively impacted by flow reduction (abstraction / impoundment for irrigation and alien invasive plant infestation in the catchment and riparian areas) leading to mouth closure, increased nutrient loading (agricultural return flow and effluent), riparian development and road infrastructure, and disturbance of birds by residents.</p> <p>The Uilkraals River Estuary has therefore been relegated to the D category in terms of its current estuarine health, but it is considered worthy of rehabilitation and a priority for conservation (Clark et al. 2012, Van Niekerk & Turpie 2012).</p>
<p>Recommended Ecological Condition</p>	<p>The estuary is rated as "<i>Highly important</i>", and forms part of the core set of priority estuaries in need of formal protection to achieve biodiversity targets the National Estuary Biodiversity Plan (NBA 2011, Turpie et al. 2012). National biodiversity targets include, for example, the formal protection of 20% of estuarine ecosystem types. Thus the Recommended Ecological Category for the estuary is its "<i>Best Attainable State</i>" i.e. a B Ecological Category (Clark et al. 2012).</p> <p>A number of initiatives are in progress to address the pressures on the Uilkraals Estuary, including this Mouth Management Plan.</p>

3 MOTIVATION FOR ARTIFICIAL BREACHING

Anecdotal records of the Uilkraals Estuary mouth state indicate that the estuary has closed five times since 2008 (Table 6). No record exists of any closures before this time. The mouth first closed on 22-23 December 2008, for a few days. It then closed in January 2009 for about six months before being breached illegally. By the following December (2009) it closed again, and it was not until 23 October 2010 that it was opened again, this time by the Overstrand Municipality. It closed soon after, in December 2010, and was illegally opened several months later on 5 July 2011. It closed again on 12 October 2011, and was closed till 8 August 2012.

Table 2: Summary of Uilkraals Estuary mouth conditions

Year	Date	Anecdotal information on mouth conditions
2008	22 – 23 December 2008	Closes for 1st time for a few days
2009	January 2009	Mouth closed
	July 2009	Open artificially (illegally)
	December 2009	Mouth closed
2010	23 October 2010	Opened artificially by Overstrand Municipality
	11 Dec 2010	Mouth closed
2011	5 July 2011	Open artificially (illegally)
	12 October 2011	Mouth closed
2012	8 August 2012	Open artificially

Superimposing the mouth state observational data on the present state simulated monthly flows (Table 3) indicates a high sensitivity to low flows, but as no continuous water level data exists for the period of mouth closure, it is not clear at which flow ranges the estuary closes. What is clear is that the current base flow allocation is not sufficient to maintain an open mouth. The Kraaibos Dam outlet is also too small to release required baseflows to the estuary. In addition, artificial breaching of the system prevents accurate assessment of the duration of mouth closure. For this study it is assumed that the estuary mouth will be breached as soon as water levels become high enough to facilitate a breaching.

Table 3: Simulated monthly flows versus mouth condition (Clark et al. 2012)

YEAR	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2007/8	0.295	1.609	0.127	0.004	0.004	0.004	0.004	0.007	0.054	0.459	0.250	0.791
2008/9	0.250	2.431	0.396	0.004	0.004	0.004	0.004	0.011	1.350	1.837	0.620	0.100
2009/10	2.106	0.374	0.004	0.004	0.004	0.004	0.004	0.037	0.316	0.325	0.082	0.012
2010/11	0.007	0.004	0.004	0.004	0.004	0.004	0.004	0.086	0.185	0.101	0.269	0.073

The Uilkraals mouth is relatively sheltered and measurements under taken by Ed Lucas and Sue Mathews indicate a berm height 1.91 to 1.98 m msl on 9 October 2010. All available historical aerial photographs of the Uilkraals Estuary show the mouth in an open state (Figure 1 to Figure 6).



Figure 1: The Uilkraals Estuary in 1938 with open mouth and relatively deep meandering channels in the middle reaches



Figure 2: The Uilkraals Estuary in 1961 with open mouth and relatively deep meandering channels in middle reaches. Note open dune field on eastern side of system.

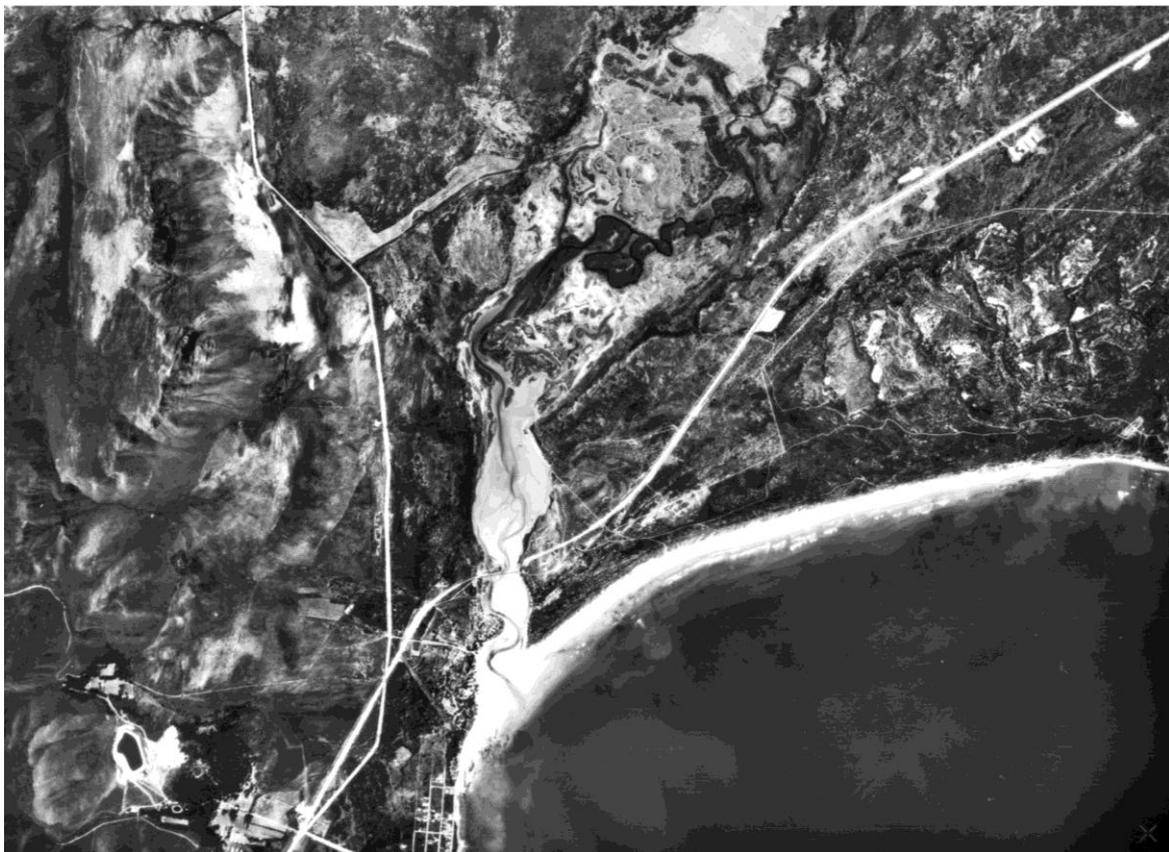


Figure 3: The Uilkraals Estuary in 1973 with open mouth. Note the road bridge over the middle reaches.



Figure 4: Uilkraals Estuary in 1990 with open mouth and relatively deep meandering channels in the middle reaches



Figure 5: The Uilkraals Estuary on November 2005 with open mouth and relatively shallow meandering channels in the middle reaches.



2011 Closed mouth with extensive inundation of intertidal and flood plain area (Source: S Mathews)



2012 Closed mouth with low water levels due to evaporation (Source: S Mathews)



2012 Closed mouth and exposed in mouth region (Source: S Mathews)

2012 Closed mouth and exposed downstream from bridge (Source: S Mathews)



2012 Closed mouth and exposed up-stream from bridge (Source: S Mathews)

2012 Closed mouth and exposed in upper reaches (Source: S Mathews)

Figure 6: Photographic record of water levels in the Uilkraals Estuary during the closed state.

Sedimentation as a contributing cause for mouth closure

There is little data on the sediments or historical sedimentation processes of the Uilkraals Estuary. Estuaries contain a mixture of river and marine sediments, the balance of which is determined by the amount of water moving in and out of the estuary during a tidal cycle, riverine base flows and floods. Historically the Uilkraals Estuary was seen as a relative sandy system (Heydorn & Bickerton 1982). From the mouth to just upstream of the bridge, sediments consist of predominantly of quartz and shell fragments indicating a marine origin. The upper reaches displayed a thin layer of fine-grained sand overlying mud in March 1981, judged to be caused by catchment erosion. In the past, the middle and upper reach may also have received more fine blown wind sand from the adjacent dune field that was stabilised in the 1970s. The bridge has also caused some infilling in the middle reaches as a result of the construction process, and a subsequent decrease in flow velocities in this area. An aerial photograph analysis indicated that the channel configuration and mouth position is also significantly more stable since the construction of the bridge (Crowther 1988).

In 1988 surface sediment in the estuary consists mainly of fine sand with a very narrow size range (Crowther 1988). The fine sediment suggested deposition under very low energy conditions. Coarser sands and pebble/shell lag deposits were limited to a small area on the right bank mostly around the bridge indicating high energy conditions in the vicinity of the bridge caused by constrictions (Figure 6). Upstream of the bridge coarser mean sediments size may have resulted from higher flow events scouring away finer material (Crowther 1988). Well sorted areas generally corresponded to areas with fine sand and moderated sorted areas corresponded to larger mean grain sizes associated with the channels and the bridge. Crowther (1988) associated the well sorted material with wind blow and marine sediments. He also indicated that the bridge may have reduced the amount of wind-blown sediment that can reach the upper part of the estuary. Core logs of the upper 5m of sediment also consisted mainly of unstratified fine sand and lesser lag deposits which consisted of varying amounts of pebble and shell material (Crowder 1988). The fine sand was frequently interspersed with fine pebbles and shell material. Laminated mud and mud balls were also infrequently present. The core consisted mainly of fine sand (2 to 3 phi) which reflects low to medium energy conditions of deposition in the upper 5m.

In 1997 and 1999, topographical surveys were done by the CSIR of the Uilkraals Estuary mouth using a 'wading survey' technique, which was performed using standard line surveying techniques. The data indicate that very little change took place between 1997 and 1999. The surveys clearly show how shallow the system was, with areas above the bridge measured between 0.0 and 0.5 m MSL on average. The lower reaches between the bridge and the mouth displayed some deeper areas measured between 0.0 and -0.8 m MSL.

Some sedimentation may have occurred in the lower reaches in the last two decades due to the reduction in river inflow causing the marine sediment to start accumulating in the lower reaches. The bridge is also likely to have caused a reduction in tidal flows which also may have led to increases in marine sediment in the lower reaches (Crowder 1988). While no accurate topographical data exist for the upper reaches of the estuary, field studies in 2010 indicated that the upper reaches had some deeper areas between 1 and 2 m deep (Clark et al. 2012).

It is therefore critical that a new bathymetry survey be conducted to establish to what degree sedimentation have occurred in the lower reaches of the Uilkraals Estuary. As the mouth of the estuary is very protected from wave energy, marine sedimentation processes occur at a slow rate, which means that interventions such as dredging and/or excavating of accumulated sediments could yield positive results if this is the cause of closure at the Uilkraals.

A summary of the motivations for potential artificial breaching is provided below in Table 4.

Table 4: Summary of artificial breaching motivation

		Potential Threat	Relevance	
Human wellbeing and safety		Threat to human life (as a result of high water levels)	No threats to human life	
		Threat to immovable property and infrastructure (as a result of high water levels)	The high water levels associated with the closed mouth conditions result in flooding to the adjacent Uilenkraalsmond Caravan Park & Resort. The resort is an important tourist destination, especially over the summer months and large numbers of people come to the resort to enjoy the beach and estuary (swimming, fishing, paddling etc.). High water levels result in a loss of revenue, for example, in December 2010 bookings amounted to R900 000 but a third of the holiday makers delayed paying their deposits due to their knowledge of the deterioration in the estuary condition and the possible flooding of some sites. There were also mosquitoes reported from the estuary,	
		Human health impact (e.g. flooding of sewage pump station, septic tanks, chemical storage yards, etc.)	Swimming was not recommended in the estuary under the closed mouth conditions as a result of poor water quality.	
		Potential loss of agricultural resources (as a result of high water levels)	At water levels of 2.6m there is minimal impact on agriculture practices within the estuary functional zone. In most cases properties are used for recreational use as well as grazing stock.	
		Potential impact on nearshore environment if breached (e.g. aquaculture facilities)	Not a significant consideration.	
		Loss/impaired access (e.g. roads, footpaths, cattle crossings)	Not a significant consideration.	
		Harmful / Noxious algal blooms	During long closed phases algal blooms develop along the banks in the shallow warm water. Some residents found the decaying matter to be offensive in 2010.	
		Impact(s) on recreational use (e.g. increase depth / surface area when mouth is closed, reduce fishing).		This is not a high use recreational system from a boating/yachting/wind surfing perspective as it is very shallow under normal conditions. The estuary is an important swimming area.
			Impact of artificial breaching	Open mouth condition ensure good tidal flushing and improved circulation beneficial for recreational activities.
			Impact of NOT breaching	This is not a high use recreational system as it in a very remote area. Closed mouth conditions result in a stagnant water body that is associated with algal blooms and bad smells.
Ecosystem	Impact on avifauna abundance, species richness/ community composition	Important bird habitat	The system is not a significant bird area.	
		Impact of artificial breaching	Expose intertidal areas similar to natural conditions that favour waders and migrants similar to natural conditions.	

Potential Threat		Relevance	
Impact on estuarine fish abundance, species richness/ community composition	Impact of NOT breaching	The avifauna in this system is historically representative of open mouth conditions.	
	Occurrence of avian botulism	No information available on this aspect, but not deemed a critical issue.	
	Important fish nursery	Open mouth conditions are necessary to maintain the ecological functioning of the estuary and its value as a nursery area for fish. The mouth needs to be open to ensure recruitment and emigration during the peak recruitment period during spring – early summer (August – November).	
	Impact of artificial breaching	Positive impacts are recruitment of larval and juvenile fish and return of adolescents and reproductively active fish to the sea to spawn. Aggregations of fish at the mouth just prior to and during breaching are particularly vulnerable to exploitation especially by illegal methods such as gaffing and snagging with treble-hooks. Draft legislation (in terms of the Marine Living Resources Act) has existed for the past decade that prohibits fishing of any kind in a temporarily open closed (TOC) estuary the two days before, during and one day after a breaching event albeit artificial or natural.	
	Impact of NOT breaching	Nursery area not available to juvenile fish on the Cape south coast and eventual drop in recruitment or available biomass of exploited species to marine fisheries.	
Impact on estuarine invertebrate abundance, species richness/ community composition	Occurrence of fish kills	No major fish kills recorded for this system.	
	Impact of artificial breaching	Open mouth linked to higher salinity values and opportunity for euryhaline species to increase in biomass and abundance if salinity increases from a low base (<10 practical salinity units (psu)). An open mouth is also important for the input of larvae into the estuary from the marine environment for recruitment and vice versa.	
	Impact of NOT breaching	Closed mouth leads to decrease in species richness (absence of marine-associated species). Associated decrease in salinity would have a negative impact on invertebrates within the lower reaches of the Uilkraals River Estuary which are adapted to life in a tidal system.	
Estuarine Macrophytes (plants)	Occurrence of invertebrate kills	No major fish kills recorded for this system.	
	Impact of artificial breaching	Open mouth conditions create intertidal habitat for salt marsh and reeds and sedges. Fluctuating water levels would decrease submerged macrophyte biomass and extent. Strong tidal flows could limit the establishment of submerged macrophytes in lower reaches.	
	Impact of NOT breaching (i.e. die-back of saltmarsh)	The closing of the estuary mouth may possibly alter the macrophyte species composition and habitats in the estuary	

Potential Threat		Relevance
		<p>and must be carefully monitored. The diversity of macrophytes in the upper floodplain reaches and the relationship with topographical gradients and substrate type needs further investigation. According to Mucina et al. (2003) the estuary's sand flats consist of greyish-white sands that are derived from the nutrient poor sandstones and lime rich sand deposits.</p> <p>An opposing impact to that of closed mouth high water level conditions is that decreased base flow may cause large areas of this marsh to desiccate and die. The middle-upper reaches also appear to become disconnected during low flow conditions partially attributable to bridge construction, sedimentation and decrease in tidal flows.</p>
Water quality (Thresholds of concern that would compromise estuarine ecosystem or ecosystem services)	Salinity thresholds of concern (high or low) that would compromise ecosystem or ecosystem services	Not applicable.
	Dissolve Oxygen levels	< 4 mg/l
	Ammonia levels	Not applicable.
	Toxic substance in the context of breaching	Not applicable.
	Pollution source include sewage, septic tanks.	
Eutrophication	Excessive reed growth	Not a significant consideration.
	Macrophyte blooms	Not a significant consideration.
	Harmful algal blooms	During long closed phases algal blooms develop along the banks in the shallow warm water. Some residents found the decaying matter to be offensive in 2010.
Sedimentation	On-going sedimentation	No information on this aspect as no recent bathymetric surveys have been carried out in the estuary.
Type	Yes/No	Motivation
Major flood events associated with severe flood damage	Yes	It is an emergency if estuary water level is high and a severe flood is eminent (i.e. cut-off low/1:20 year flood).
Poor water quality	yes	<p>Low oxygen levels throughout the system may be considered an emergency (must be verified through regular monitoring and estuarine specialist consultation)</p> <p>Salinity levels are not a consideration because the system is characteristically saline.</p> <p>Artificial breaching will not be considered to flush polluted water out of the estuary.</p>

Potential Threat		Relevance	
	Fish kills	Yes	DAFF to determine cause of fish kill and then establish if major fish kill can be remedied by breaching. Written findings to be provided to breaching committee.
	Hazardous spill	Yes	Breaching will only be considered if hazardous substance holds no risk to the nearshore environment and is registered as a disaster. In the event of an oil spill at sea, the mouth of the Uilkraals Estuary can temporarily be closed to prevent oil from entering the system. Spillage of organic waste should be addressed using standard biological control measures.

4 RELEVANT AUTHORITIES

Table 3 lists the Key lead authorities involved in artificial breaching at the Uilkraals Estuary.

Table 5: Key lead authority involved in artificial breaching

Management authority	Overstrand Municipality	
Advisory Committee	Uilkraals River Estuary Advisory Forum	
Authorisation (breaching / emergency)	DEA&DP	
Lead authority	Breaching sub-committee	Minimum consultation In case of Emergency
Overstrand Municipality (Environmental Management and Disaster Management sections)	✓	✓
District Municipality (Environmental Management and Disaster Management sections)	✓	✓
DEA&DP	✓	✓
Department of Environment Affairs (DEA)	✓	✗
DAFF, Branch Fisheries	✓	✓
DWS	✗	✗
CapeNature	✓	✓
SANParks	✗	✗
Research organisation with recognised estuarine expertise (e.g. CSIR)	✓	✗
Non-Governmental Organisations	✓	✗
<p>The decision to artificially breach will be made by a Breaching sub-committee comprising the Overstrand Municipality's Environmental Manager, the estuary Forum and Cape Nature: Overberg Business Unit Manager following consultation with at least two estuarine ecological specialists (e.g. from the CSIR and DAFF: Inshore Fisheries Research and DEA: Estuaries Management). These lead authorities are important role players with respect to emergency situations and administer their relevant empowering provisions (Disaster Management Act 2002, NEMA 1998, and the Integrated Coastal Management Act 2008).</p> <p>Data on water level, berm height, salinity, as well as water quality parameters where feasible, will be collated by the Overstrand Municipality in conjunction with CapeNature and the specialists team.</p> <p>Once the Breaching sub-committee has decided that an artificial breach must occur, the Disaster Management unit of the Overstrand Municipality (in conjunction with Cape Nature), shall be responsible for overseeing the breaching activities.</p>		
Disaster Management	Authority/Organisation	Status
Early warning system	South African Weather Services (weather)	No
	DWS warning system (flow/water levels/dam safety)	No
Disaster Management Plan	Municipality	Yes
Approved Maintenance Management Plan	Municipality	Yes, in process of update.

5 BREACHING SPECIFICATIONS

The following breaching specifications need to be met before artificial breaching of the Uilkraals Estuary can be considered (Table 6):

Table 6: Uilkraals Estuary Breaching Specifications

Breaching considerations	Details		
Minimum breaching level (water level should be as high as possible before breaching)	>2.0 m msl	Y/N	Level to MSL
Optimum breaching period (if applicable)	In the absence of "emergency" conditions (defined below), artificial breaching must not be contemplated at water levels below 2.0 m MSL. Higher levels are preferred.		
Neap-spring breaching considerations	Historically the Uilkraals Estuary was permanently open, there is thus no optimum breaching period, but if closure should occur it is preferred that the estuary be open during spring and summer to facilitate ecological processes.		
Timing of breaching	Preferably 3-4 days before spring tide, but consideration should be given to wave conditions and water levels. Local observation is required on the degree to which waves will hinder during the planned breaching. The higher the berm, the more the system is buffered against the effects of high waves from the ocean. A calm period of 1 to 2 days is preferred.		
Consider safety of public during breaching	Higher water levels generate greater outflow so this recommendation can be over ruled to prevent significant seepage and evaporation losses as a result of its large surface area (Clark et al. 2012).		
Breaching trench to maximize outflow	Breach 2 hrs before high tide, or just after high tide (to prevent high waves from closing the opening), to maximize the outflow.		
Location of the breaching position.	Breaching at the Uilkraals Estuary hold a risk to public safety, e.g. surfers wanting to body surf standing waves, children and dogs falling in outflow channel. Care should be taken with the general public to ensure their safety. Cordoned the area off with the aid of red and white emergency tape to keep the public out of the area were breaching will take place. Ideally an official or security person must man the area in question. Temporarily close the designated area in circumstances that could pose a danger to the human life or property. This must be accompanied by appropriate signage.		
Estimate amount of sediment to be moved during breaching	Excavate a 2m deep and 4m wide trench before breaching to maximize outflow.		
	At the lowest position of the berm, opposite the previous year's channel (these mostly coincide) to assist with the efficient removal of sediment during the breaching. However, allow enough space for separate ebb and flood tidal channels to develop. Breaching too far to the sides often result in a single confined channel for both the ebb and the flood tidal flows. If possible, artificial breaching should line up with historical channels to assist with the removal of sediment during the breaching. Significant scouring potential is lost if the system has to cut new channels in the lower reaches during a breaching. This consideration may require the alignment of the breaching channel with an older historical channel configuration.		
	Not applicable, as amounts vary significantly between breachings. It cannot be determined in advance.		

Disposal of sediment removed during excavation	<p>The sand excavated from the trench should be pushed out into the sea where wave action will take it away and not be stored on the banks next to the trench. Otherwise the sand stored on these banks will drop back into the excavated channel reducing the effectiveness of the outflow and the wider and deeper scouring of this trench.</p> <p>In the unlikely event of marine sediment remaining on the beach after a breaching, no additional action is required as it will generally wash away after a few high tides.</p>
Mobilizing machinery and equipment on site during breaching	<p>Equipment and machinery to be utilised in a breaching must be in be in a good state. Oil leaks are not to cause additional pollution.</p> <p>Care should be taken to ensure that earth moving equipment do not disturb indigenous vegetation of conservation worthiness on route to the excavation site. Bird nesting areas are to be avoided. Where possible existing access roads / tracks should be used.</p> <p>Once it has been established that a clear outflow channel has formed and breaching is progressing on its own momentum the earth moving equipment may be removed from the beach.</p> <p>Implement an appropriate control mechanism, such as erecting comprehensive signage with information of the launching areas and the associated dangers.</p> <p>Allow DEA&DP officials access to the designated area for the purpose of assessing and/or monitoring compliance with the conditions contained in the MMP, at all reasonable times.</p> <p>Be responsible for all costs necessary to comply with these conditions unless otherwise specified</p> <p>The municipality retains the management responsibility of the designated area, even though the applicant may grant permission to manage the designated area, on their behalf, to any competent contractor /service provider. Ensure that all users adhere to the local authority By-Laws relating to the designated areas at all times.</p> <p>The legal requirements associated with the use of the designated area must be brought to the attention of all persons that are granted access to the designated area by the applicant (licensee) in terms of the conditions of this licence and the applicant shall take measures necessary to bind such persons to these requirements.</p>
Noise & light pollution	Noise on during a breaching should be kept to a minimum and within the relevant noise control by-laws/regulations of the municipality.
Water Quality considerations (Thresholds of Concern)	<p>Salinity: Not a consideration</p> <p>Oxygen: < 4 mg/l</p> <p>Toxins: Not a consideration</p>
Ecological considerations	<p>Birds: Open mouth conditions per natural conditions.</p> <p>Fish: Open mouth conditions per natural conditions.</p> <p>Invertebrates: Open mouth conditions per natural conditions.</p> <p>Plants: Open mouth conditions per natural conditions.</p>

6 OPERATIONAL PROCEDURES

Two types of breaching are distinguished for the Uilkraals Estuary, namely (a) Planned artificial breaching undertaken according to the Mouth Management Plan (MMP) and (b) Emergency breaching (e.g. to avoid danger of flooding). Each type is briefly discussed below and illustrated with a flow chart.

6.1 Planned mouth breaching procedures

The Overstrand Municipality is responsible for the operational aspects of the Uilkraals Estuary MMP. They can delegate this function, but ultimately they have oversight over the functioning of the Breaching Sub-committee. It is therefore recommended that the Breaching Sub-committee be established as a formal structure under the Municipal Coastal Committee. The Overstrand Municipality (or its delegated structure) are required to coordinate the Breaching Sub-committee, which include:

- Convening Breaching Sub-committee meetings (when listed specifications are triggered or are expected to be triggered in the near future due to inclement weather);
- Recording the minutes of the Breaching Sub-committee meetings;
- Distributing relevant information to the Breaching Sub-committee members; and
- Sharing the post-breaching incident report of the Breaching Sub-committee;
- Sharing process followed with Estuary Advisory Forum (if time permits).

The municipality is also responsible for continuous monitoring of the conditions in the catchment when water levels become elevated (>1.5 m MSL). Communication between the different role players, i.e. the local municipality, CapeNature and key authorities (stipulated in Section 4), should take place at a regular basis. This can be done at an advisory committee/ forum meeting or as email communications summarising critical aspects. The day-to-day monitoring should include the following aspects:

- The actual and expected rainfall in the catchment;
- The water level in the estuary and its rate of increase;
- The height and width of the sand berm at the mouth;
- The actual and predicted wave conditions;
- The availability of equipment to breach the mouth;
- Water quality conditions (if applicable); and
- Biotic responses to elevated water levels (e.g. fish aggregations at mouth, formation of algal blooms, die-back of macrophytes, bird nesting behaviour).

Once the breaching criteria (see Section 5) is met, the decision to artificially breach will be made by the Breaching Sub-committee (See Section 4 for list) comprising, at a minimum, the Overstrand Municipality's Environmental Manager, the Estuary Advisory Forum Chairperson and the CapeNature: Overberg Business Unit Manager in consultation with at least two ecological specialists (e.g. CSIR, DAFF: Inshore Fisheries Research and DEA: Estuaries Management, Nelson Mandela University). Note, that while the Breaching Sub-

committee is tasked with executing the approved MMP, it should be recognized that an estuary mouth is highly dynamic and unforeseen events may require special management actions. In such an event, additional verbal (followed by written) authorisation may be required from the authorising authority (i.e. DEA&DP) which needs to be supported by specialist comment and suggestions.). A flow chart for a planned mouth breaching procedures to be followed by the breaching committee is included in Figure 7.

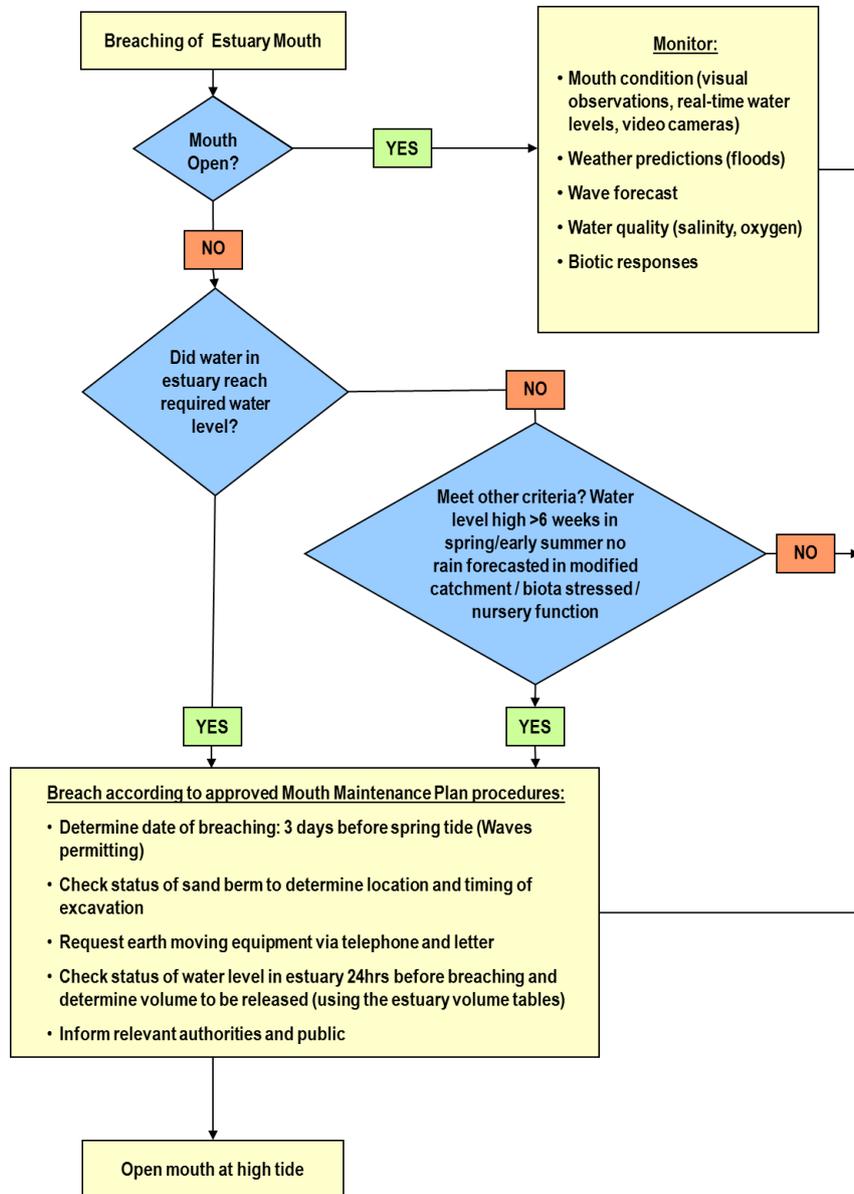


Figure 7: A flow chart illustrating the breaching plan for normal conditions

Once the Breaching Sub-committee has established that the relevant criteria have been met and that artificial breach must occur, the Disaster Management Department of the Overstrand Municipality (in conjunction with Cape Nature), shall be responsible for overseeing the breaching activities.

The Disaster Management Department of the Overstrand Municipality is responsible for the following:

- Ensuring the availability of Earth moving equipment on day of breaching;
- Establishing the exact location and time of the breaching channel;
- Verifying that the sandberm at the mouth is high enough above the water line that there is no risk of “fluidization” of berm sediment (i.e. turns to quicksand) and associated risk to operator and equipment;
- Deployment of flags and signage to warn public of risk to safety; and
- Breaching of the estuary mouth (it should be noted that the excavations may take several hours).

Finally, the Overstrand Municipality is responsible for the compilation of a Breaching Incident Report to be provided to DEA&DP within 14 days of the actual breaching (see Section 8 for more detail on the report).

6.2 Emergency

A flow chart for the undertaking of mouth breachings under emergency conditions is included in Figure 8. Breachings should be undertaken in the swiftest manner possible and in most cases the Disaster Management Department of the local municipality is responsible. While breaching should be conducted according to an Estuary Mouth Management Plan and an approved Mouth Maintenance Management Plan, some of the general breaching principles may be waived under emergency conditions to ensure an expedient breaching.

Emergency conditions could develop when an estuary mouth is closed/constricted and severe rainfall occurs in the catchment causing a large flood. Alternatively, they could also develop at the (largely unlikely) event of a break of the dam wall. Constant monitoring of the conditions in the catchment is required when emergency conditions develop. Communication between the different role players, i.e. the local municipality, CapeNature and key authorities (DAFF) involved, should take place, if time is available, to monitor the situation. Included in the monitoring are:

- The actual and expected rainfall in the catchment.
- The water level in the estuary and its rate of increase.
- The height and width of the sand berm at the mouth.
- The actual and predicted wave conditions.
- The availability of equipment to breach the mouth on short notice.

While most emergency breachings relate to floods Section 3 lists some additional events that can constitute an emergency at the Uilkraals Estuary.

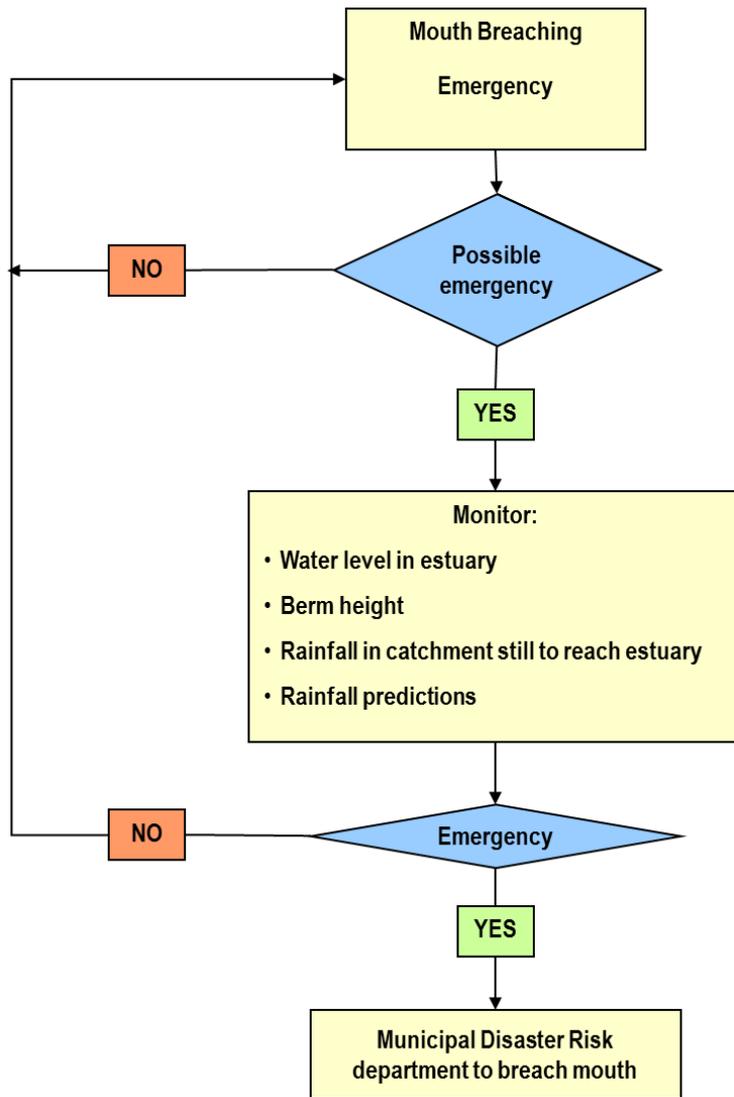


Figure 8: A flow chart illustrating the breaching plan for emergency conditions

7 MONITORING PROGRAMME

The following monitoring programme supports the responsible management of artificial breaching (Table 7):

Table 7: Monitoring programme for Uilkraals Estuary

MONITORING ACTIONS	FREQUENCY	LOCAL REQUIREMENT - YES/NO	AGENCY RESPONSIBLE
Weather forecast (projected rainfall and waves)	Period leading up to breaching	Yes	SA Weather Services
Water levels	Continuous Ideally, automated daily monitoring of the mouth state of the estuary (e.g. using a web cam)	Yes	DWS G4R004 (1979-2016)
River inflow data	Daily Preferably, continuous monitoring of freshwater inflows at the head of the estuary	Yes	DWS gauge
Bathymetric surveys	Every 3 years	Yes	Municipality
Salinity	Monthly Day before and after 5 to 10 days after a breaching	Yes	Municipality
<i>In situ</i> water quality measurements (e.g. oxygen)	Monthly	Yes	Municipality
Berm levels	Monthly (and just before breaching if breaching is planned)	Yes	Municipality
Photographs	To be arranged between authorities before, during and after breaching	Yes	Municipality
Observations on estuarine vegetation (e.g. inundation of salt marsh, reeds & sedges, occurrence of algal blooms)	Quarterly (and just before breaching)	Yes	Municipality
Observations on Invertebrate behavior (e.g. invertebrate kills)	Quarterly (and just before breaching)	Yes	Municipality
Fish surveys Distribution, abundance, movement and behavior (e.g. recruitment, aggregations, fish kills)	Bi-annually	Yes	DAFF
Co-ordinated Waterbird Counts (CWAC)	Bi-annually	Yes	CapeNature
Water quality parameters	Nutrients NOx and PO4 on an ad hoc basis when problems develop e.g. macro- or microalgal blooms);	No	DAFF/ Municipality

	Dissolved oxygen (ad hoc as above); and Continuous monitoring of temperature and salinity below and above the bridge		
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8 REPORTING

Following an estuary mouth opening a Breaching Incidence Report needs to be compiled and provided to DEA&DP within 2 weeks of breaching. This report should contain as much as possible information on the breaching motivation and the process followed during the breaching.

In addition to the Breaching Incidence Report, the Managing authority needs to compile an Annual Mouth Breaching Report that summarises information on all mouth manipulation activities, ecological responses and consequences to human well-being and safety. The Annual Breaching Report needs to be presented to all Interested and Affected Parties (I&AP) (relevant authorities and civil society) to communicate progress with the implementation of the MMP. Such feedback sessions provide the opportunity for a critical review of current breaching practises and discussions on possible improvements to future MMPs. The Annual Mouth Breaching Report will also serve as a national reporting document.

8.1 Breaching Report

Table 8 below summarises the minimum content of a Uilkraals Estuary Breaching Report. The initial Breaching (incidence) report should be compiled within two weeks of breaching, with data gaps (e.g. duration open) addressed after mouth closure.

Table 8: Content of Uilkraals Estuary breaching report

ACTIONS	LOCAL REQUIREMENT - YES/NO	AGENCY RESPONSIBLE
<u>Met-ocean information</u> <ul style="list-style-type: none"> State of the tide (spring-neap/ high-low tide) Sea conditions (calm/stormy) 	Yes	Overstrand Municipality
<u>Breaching specifications that triggered the event;</u> <ul style="list-style-type: none"> Indicate which of section 5 specification necessitate the breaching (include supporting specialist communications where need be) 	Yes	Overstrand Municipality
<u>Estuary Information</u> <ul style="list-style-type: none"> Water level from DWS (and volume) before breaching Maximum outflow rate during breaching calculated from water levels and surface area of system Outflow duration (from water level graph) Lowest water level achieved after breaching (from water level graph) Did flooding problems arise before or during the breaching? If so, quantify these problems. Could measures be taken to prevent such problems in the future? For example by protection of low laying properties. Distinguish between short-term and long-term measures. Date since last breaching 	Yes	DWS & Overstrand Municipality

ACTIONS	LOCAL REQUIREMENT - YES/NO	AGENCY RESPONSIBLE
<u>Location of channel</u> <ul style="list-style-type: none"> Align with historical position of channels (photographs and GPS location) Reduce channel length 	Yes	Overstrand Municipality
Period for which the mouth stayed open (not required in initial incident report if mouth remains open)	Yes	Overstrand Municipality
Bathymetric surveys.	Yes	Overstrand Municipality
Salinity measurement before and after breaching	Yes	Overstrand Municipality
Observations on macrophyte conditions	No	
Fish recruitment survey	Yes, in summer after breaching	DAFF
Avifauna counts (CWAC)	Yes	CapeNature
Other		
<u>Assessment record compiled by:</u> Name: Organization: Date: Contact details:		

8.2 Feedback on breaching activities

Table 9 below summarises the minimum information required as evidence of breaching feedback reporting. Ideally the breaching report should be provided to the Estuary Advisory Forum and other interested stakeholders / specialists post breaching. The breaching process should be communicated to the forum on an ongoing basis throughout the process to keep stakeholder abreast of all developments and decisions taken. If this is not possible, such report back sessions should be held at least once a year to ensure that the correct breaching procedures are being followed and that additional interventions are not required.

Table 9: Minimum information required on breaching feedback sessions

ACTIONS	LOCAL REQUIREMENT - YES/NO
Responsible agency /authority	Overstrand Municipality
Place & Workshop venue	
Date	
Meeting/committee/workshop participants (attached attendance register)	
Workshop chaired by	
Key lessons learned that could assist with future breaching	
Material presented at meeting (including copies of presentations)	

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