



**Western Cape  
Government**  
Environmental Affairs and  
Development Planning

# **Mouth Management Plan for the Klein Brak Estuary**

October 2018

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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
EMP	Estuarine Management Plan
HAB	harmful algal blooms
I&AP	Interested and Affected Party
I&AP	Interested and Affected Party
KREF	Klein River Estuary (Advisory) Forum
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

The Klein Brak Estuary is a nearly permanently open system that closed from time to time naturally as a result of the build-up of sediment in the mouth region and extended occurrence of low flow conditions (DWS 2015). During the resultant breaching accumulated sediment are flushed out to sea to enhance tidal flows and assist with keeping the mouth open.

The concern is that the current severe reductions in the base flow is increasing the likelihood of mouth closure, while small dam development in the catchment can reduce floods and lead to increased sedimentation in the system.

## OBJECTIVE OF THE KLEIN BRAK MOUTH MANAGEMENT PLAN

- 1) To manage the estuary mouth as an integral part of the Klein Brak Estuarine Management Plan (EMP).
- 2) To ensure a healthy functional estuary, i.e. open mouth in spring and summer, no fish kills, no excessive algal blooms.

IS ARTIFICIAL BREACHING TO BE CONSIDERED AT THE KLEIN BRAK ESTUARY? <b>(Substantiation provided in section 3)</b>	No	Yes
High water levels	<b>x</b>	
Floods (emergency)	<b>x</b>	
Water quality (emergency)	<b>x</b>	
Fish kills (emergency) (at Department of Agriculture, Forestry and Fisheries (DAFF) discretion as it is a medium importance nursery)		<b>x</b>
<b>IS A MAINTENANCE MANAGEMENT PLAN REQUIRED?</b>	<b>No</b>	

## KEY DATA /INFORMATION SOURCES

The information presented below has largely been drawn from the 2015 Klein Brak Estuary Ecological Water Requirement Study (DWS 2015); the Klein Brak EMP; and the DWS continuous water level data.

## KEY RECOMMENDATIONS IN SUPPORT OF THE KLEIN BRAK ESTUARY MOUTH MANAGEMENT PLAN

- Removal of obstructions in the Brandwag and Moordkuil arms that restrict tidal flows, thereby providing extra insurance against mouth closure. The removal of weirs, in particular, will re-introduce important nursery areas in the upper estuary for exploited fish species. By increasing the shallower upper areas in the system, it will more readily develop a brackish zone. In addition, it will also improve connectivity with the catchments that will assist with the migration of fish and invertebrate species;
- Increase the baseflows to the Klein Brak Estuary to ensure open mouth conditions and a full salinity gradient.

## 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 activities 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

- IV. occurs behind the development setback line.
- V. is for maintenance purposes undertaken in accordance with a management plan agreed to by the relevant environmental authority; or
- VI. 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 authorisation 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 KLEIN BRAK ESTUARY

**Table 1: Description of the estuary and its importance**

Threat	Discussion
<p><b>Location</b></p>	<p>The Klein Brak Estuary is situated within the southern coastal belt, and is approximately 12km north of Mossel Bay (Figure 3.1). Two major tributaries, the Brandwag River and the Moordkuil River join approximately 3 km from the coast to form a well-developed flood-tidal delta (DWA 2008).</p> <ul style="list-style-type: none"> <li>• <b>Downstream boundary:</b> Estuary mouth (34° 5'31.98"S, 22° 8'55.43"E).</li> <li>• <b>Upstream boundary:</b> 34° 4'36.55"S, 22° 3'57.72"E/ 34° 2'4.54"S, 22° 8'2.91"E</li> <li>• <b>Lateral boundaries:</b> Estuary Functional Zone (5m contour above Mean Sea Level (MSL) along each bank)</li> </ul> 
<p><b>Infrastructure</b></p>	<p>A number of bridges cross the estuary. A rail bridge is situated approximately 500 m upstream of the mouth; bridges that carry the dual carriageway N2 motorway across the estuary are located about 1.5 km upstream of the mouth and another road bridge crosses the system about 100 m further upstream.</p> <p>There is one slipway downstream of the N2 road bridge and three upstream of the bridge on the eastern bank (two on the Brandwag arm of the estuary and one on the Moordkuil arm). There are at least three jetties on the eastern side of the estuary. A derelict structure, possibly a pumpstation, extends into the channel downstream of the N2 road bridge. There are remains of old jetties and pipes extending into the channel at a number of sites. The banks of the estuary were also stabilized at several sites in the middle and upper reaches.</p> <p>A causeway with culverts created a physical barrier at the upper reaches of the Moordkuil arm of the estuary and essentially forms the upper limit of tidal exchange in this arm of the estuary. A causeway also forms a physical barrier at the upper reaches of the Brandwag arm of the estuary. The culverts under the road have been blocked severely restricting tidal and freshwater exchange and the channel below the road has been bulldozed. Collectively these structures are hampering tidal flows, shortening the system and preventing free flow of water and associated biota above these points.</p> <p>There are a significant number of low-lying developments (some below 2m MSL) in the lower reaches of the Klein Brak River estuary. These properties are at risk of flooding should</p>

Threat	Discussion
	<p>the system close for long periods of time and cause back flooding - a likely scenario under future water resource development scenarios for the region.</p> <p>In addition, there are a large number of developments (formal and informal settlements) on the floodplain of the estuary causing infilling and estuarine habitat destruction. Roads to and from these settlements also traverse the saltmarshes and severely degrade the quality of the habitat.</p>
<b>Estuary Importance</b>	<p>The Klein Brak Estuary is rated as 'Average Importance' on a national scale based on its Estuary Importance Score (EIS) of 58 (DWS 2015). This index takes size, estuary type rarity and biodiversity (plants, invertebrates, fish, birds) into account. While, on a national scale, the Klein Brak Estuary may be of average importance, it is a large estuary in this region and plays a very important role as fish nursery for exploited and endangered fish species and providing an open estuary along a coast where a significant number of systems are seasonally closed.</p>
<b>Conservation status</b>	<p>The Klein Brak Estuary does not have any statutory protection status at present. The estuary does not form part of the core priority estuaries in need of protection as stipulated in the National Estuary Biodiversity Plan (Turpie et al. 2012).</p>
<b>Important vegetation</b>	<p>The National Biodiversity Assessment (Van Niekerk and Turpie 2012) estimated the total functional estuarine zone within the 5m contour line at 980 ha. Adams et al. (2010) sampled the estuary on 22 August 2009 and identified four estuarine macrophyte habitat types; supratidal salt marsh (278 ha), intertidal salt marsh (17 ha), reeds and sedges (2 ha), and submerged macrophytes (&lt;1 ha). Present assessments of the latest aerial photography and using GIS, estimate the total open water surface area at 98 ha.</p>
<b>Important fish nursery</b>	<p>Thirty-five species of fish from 19 families have been recorded in the Klein Brak Estuary which is comparable to that of the adjacent Groot Brak and Gouritz estuaries of equivalent size. Of these, 12 (38%) are entirely dependent on estuaries to complete their life-cycle, of which 4 are estuarine breeders; estuarine round-herring, Cape halfbeak and river goby. Eight species, including Cape stumpnose, dusky kob, white steenbras, leervis and spotted grunter are dependent on estuaries as nursery areas for at least their first year. Another 10 species (31%) are at least partially dependent on estuaries, e.g. southern mullet, groovy mullet, elf, dassie, white stumpnose. In all, 69% of the fish species recorded from the Klein Brak Estuary are either partially or completely dependent on estuaries for their survival. Most of the remaining species were marine species (22).</p> <p>Along-stream distribution was largely a reflection of salinity preferences and the estuary-dependence category to which the fish belonged. The highest densities of the facultative catadromous <i>Myxus capensis</i> as well as the opportunistic marine <i>L. richardsonii</i> occurred in the &lt;10 practical salinity units (psu) zone with peaks in the 20-30 psu reach as well. However, these high densities may be partly explained by fish backing up against the Brandwag and Moordkuils weirs. Most individuals (60-100%) of species that have a preference for the &lt; 10 psu REI zone e.g. were in the "middle reaches" just below either weirs even when salinities were high throughout the system. On the whole, the fish assemblage was dominated by estuarine associated species with very small contributions by both freshwater and marine vagrant species.</p>
<b>Important Bird site</b>	<p>A total of 60 non-passerine waterbird species have been recorded on Klein Brak Estuary (DWS 2015). In the lower estuary, most birds were either at the mouth or on a river bank roost site between the N2 and R102 road bridges, while a small number of birds were in the pans among the salt marshes. The lower estuary area was dominated by gulls, terns and sandy beach waders at the mouth, and gulls and other waders further upstream. The middle reaches, which contained muddy margins and areas of saltmarsh were dominated by waders, gulls and wading birds. A pair of Blue Cranes, not counted among the waterbirds, was using the salt marsh island for breeding. Relatively few birds occur along the Moordkuil and Brandwag estuarine tributaries, and their communities were quite different. While wading birds and kingfishers were most common along the Moorkuil which was lined with grassy verges and overhanging trees, the Brandwag section had a handful of gulls and wading birds, plus more waterfowl than other stretches. The highest numbers of birds occur in the marshy floodplain above the weir on the Brandwag tributary. This part of the estuary had high numbers of waders (dominated by Little Stint), wading birds (dominated by Sacred Ibis) and kingfishers compared with the rest of the estuary.</p>

Threat	Discussion
<b>Estuary Condition w.r.t breaching</b>	<p><b>The Present Ecological Status of the Klein Brak Estuary is a Category C, but the system is on a negative trajectory of change. If the current (low) base flow regime, as well as certain non-flow related impacts on the system continue as at present, the estuary is likely to move into a Category C/D, or even a Category D (DWS 2015).</b></p>
<b>Recommended Ecological Condition</b>	<p>The Recommended Ecological Category for the Klein Brak Estuary is set as a Category C, but realising that this will entail some improvements to the present situation (DWS 2015). Key non-flow related factors that should be addressed are:</p> <ul style="list-style-type: none"> <li>• Removal of weirs in the Brandwag and Moordkuil arms so as to increase tidal flows providing extra insurance against mouth closure. The removal of the weirs will re-introduce important nursery areas in the upper estuary for exploited fish species. By increasing the shallower upper areas in the system, it will more readily introduce REI zone. In addition, it will also improve connectivity with the catchments that will assist with the migration of fish and invertebrate species;</li> <li>• Rehabilitate degraded areas in the flood plain, e.g. consolidate access routes so as not to have a web of small roads on the salt marsh;</li> <li>• Removal of invasive alien vegetation, e.g. Eucalyptus trees in the supratidal area of the estuarine functional zone (EFZ)</li> <li>• Introduce fish ladders above weir in Moordkuils River (e.g. adding cobbles on both sides of the weir);</li> <li>• Reduce fishing pressures and (illegal) bait collecting through increased compliance (existing DAFF initiative); and</li> <li>• Institute a ban on night fishing that targets large breeding stock of collapsed and endangered fish species (proposed DAFF initiative).</li> </ul>

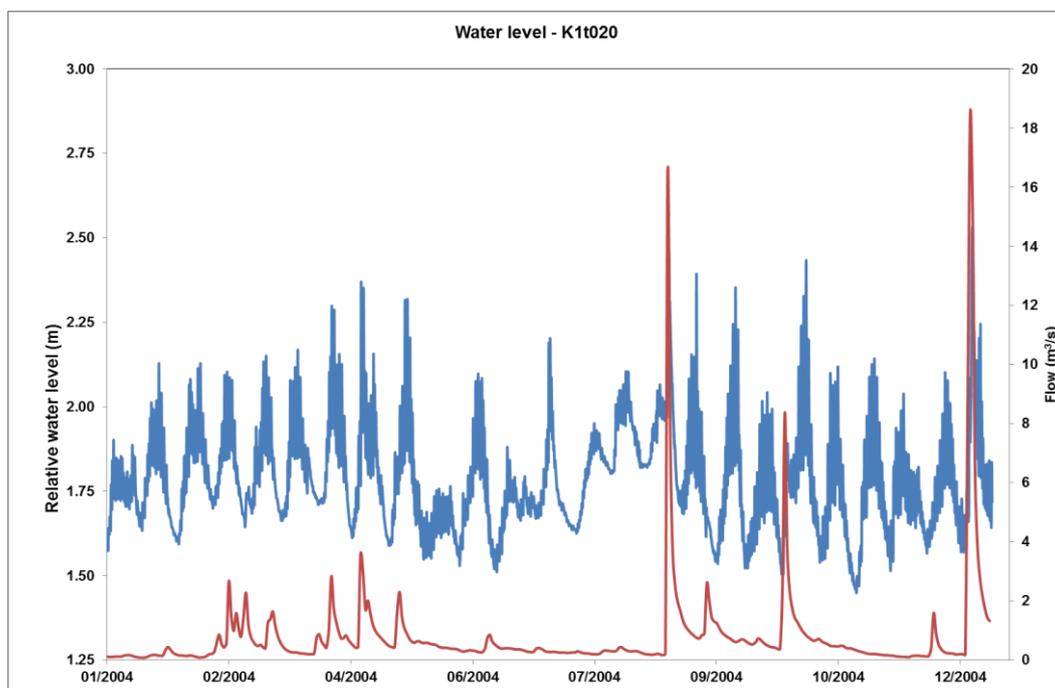
## 3 MOTIVATION FOR NOT ARTIFICIALLY BREACHING

### 3.1 Background

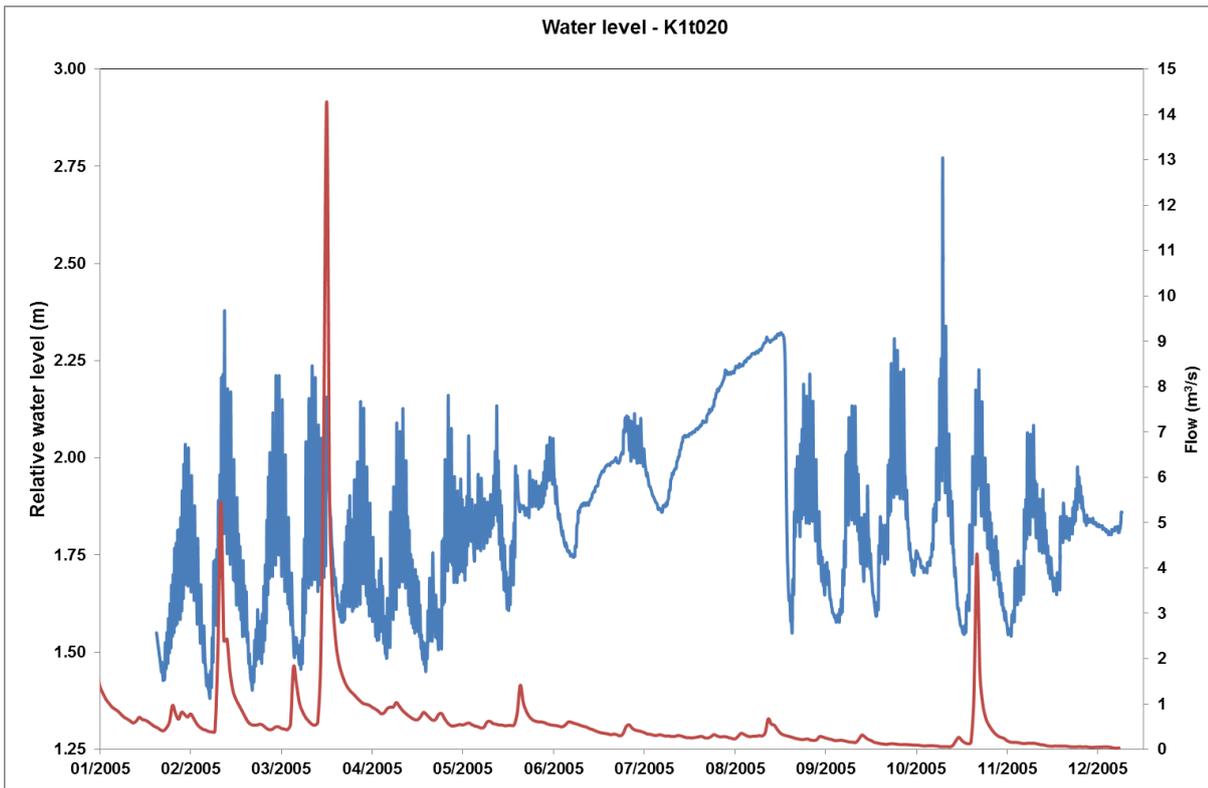
The Klein Brak is a nearly permanently open estuary (DWS 2015). There is only a limited number of mouth closure event documented for the Klein Brak, e.g. shown on a CSIR 1991 bathymetry survey and recorded in 2005 and 2006 on the DWS K1T020 water level recorder situated near the Klein Brak Estuary mouth. The closure of 2005 is the best documented event. The tidal record of 2004 shows no mouth closure events (demonstrated by tidal fluctuation throughout the time period) (Figure 1), but the tide becomes severely constricted to amplitudes of less than 0.5 m during July/August as a result of low flows and higher waves associated with winter.

A series of mouth closures can be observed in the tidal records of 2005 between 3 July 2005 to 10 September 2005, with the estuary mouth solidly closed 2 August to 10 September 2005 (refer to Figure 2). Flow varied between 0.2 m<sup>3</sup>/s and 0.4 m<sup>3</sup>/s in the 8 weeks before closure. Breaching occurred as result of a gradual infilling and overtopping, i.e., not a flood, and did not remove significant sediment from the mouth.

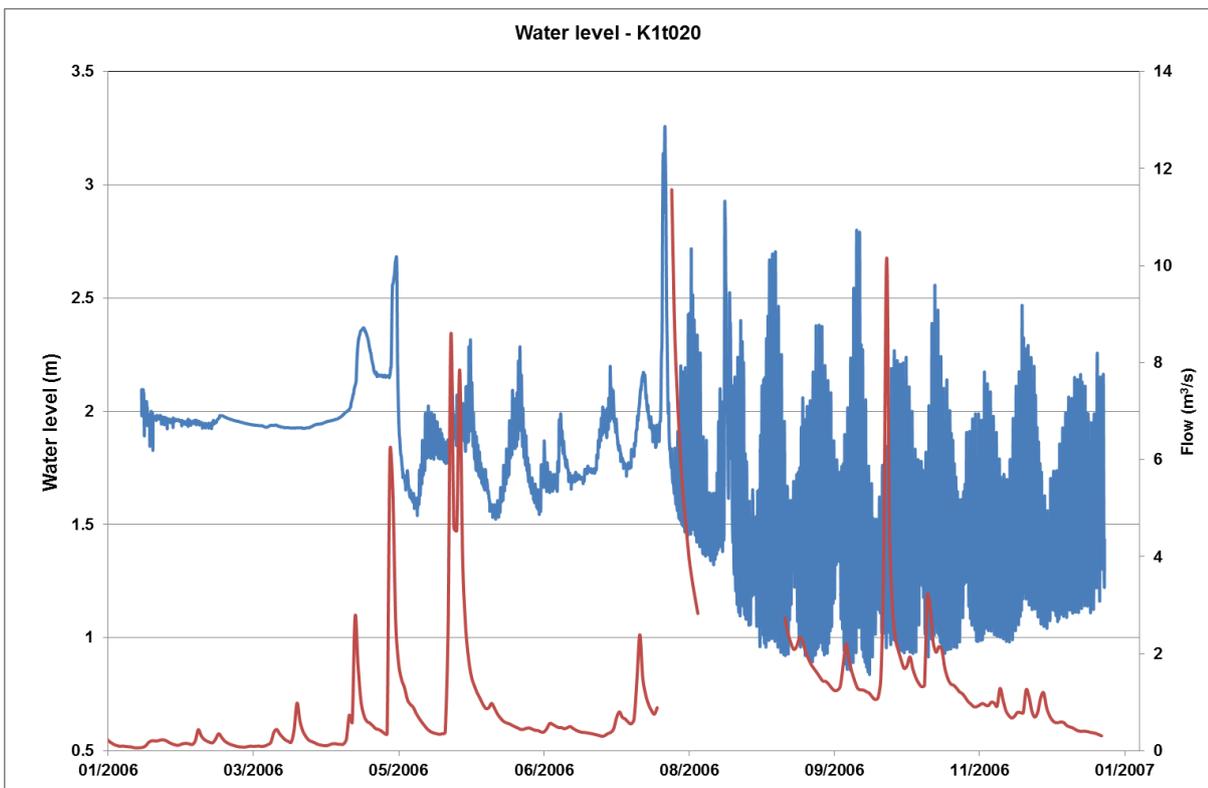
An additional mouth closure is also observed between 4 March 2006 and 20 April 2006. Flow varied between 0.06 m<sup>3</sup>/s and 0.4 m<sup>3</sup>/s in the 8 weeks before closure. What is also notable from this Figure 3 is that the estuary mouth remained constricted (low tide levels are still truncated) until a resetting flood on 2 August 2006, which scoured the system significantly (low tide levels are about 60 cm lower after the flood). This shows the important role floods play in the mouth dynamics of the Klein Brak Estuary.



**Figure 1: Klein Brak Estuary water levels (blue) (Tidal gauge K1T020) correlated with inflow (red) from the Moordkuil and Brandwag tributaries for 2004**



**Figure 2: Klein Brak Estuary water levels (blue) (Tidal gauge K1T020) correlated with inflow (red) from the Moordkuil and Brandwag tributaries for 2005**

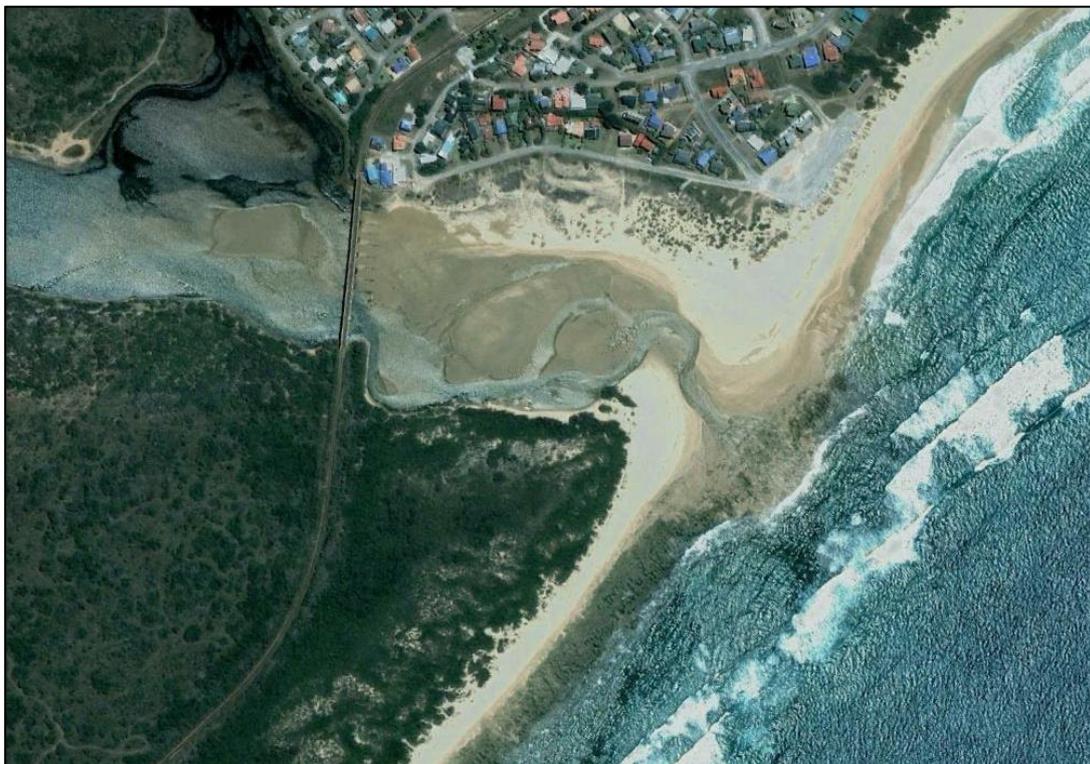


**Figure 3: Klein Brak Estuary water levels (blue) (Tidal gauge K1T020) correlated with inflow (red) from the Moordkuil and Brandwag tributaries for 2006**

A closed and restricted mouth state is indicated in **Figure 4 and Figure 5** respectively.



**Figure 4: Satellite image of the Klein Brak Estuary for 7 August 2005 showing closed mouth conditions (Source: Google Earth)**



**Figure 5: Satellite image of the Klein Brak Estuary for 3 December 2005 showing very constricted mouth conditions (Source: Google Earth)**

## 3.2 Marine sediment intrusion

Historical photographs of the Klein Brak Estuary show significant accumulation of marine sediment up to the railway bridge or just upstream from this bridge (**Figure 6 to Figure 9**). It is possible that this bridge therefore affects the sediment dynamics of the lower estuary. The degree to which this “sediment plug” develops between flood events is a major contributing factor to the mouth state of the Klein Brak Estuary. Significant ingress of marine sediments in the lower reaches results in the increase of tidal friction, reduced tidal amplitude and reduced open water area resulting in a decrease in tidal flows. During periods when reduced tidal flow coincides with low river inflow (< 0.5 m<sup>3</sup>/s) and high wave conditions (often associated with winter) this can result in mouth closure. Historical imagery from 1940-1970 shows sediment accumulation up to the railway bridge. Imagery from 1972 shows progression well past the railway bridge, with a resetting to below the bridge between April and December 1980. By 1987 the sediment once again intrudes past the rail way bridge and reaches its maximum intrusion on the 2005 imagery.

A major flood occurred in the Klein Brak River on 22 November 2007 when large quantities of sediments were flushed out of the estuary. This could be the reason that the sand banks connected to the berm seem to extent further upstream on the Google Earth™ photographs taken before that date and less far on the photographs taken after this date.



1940

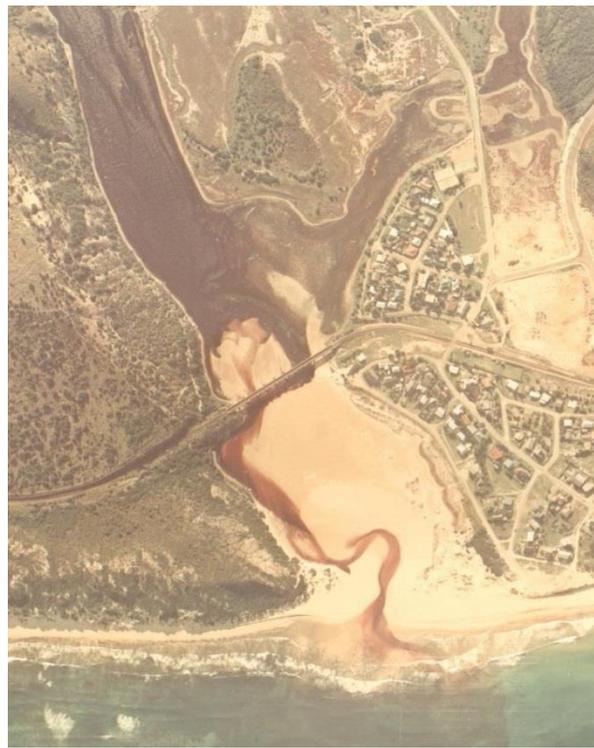


30 April 1970 (possible closed mouth)

**Figure 6: Klein Brak Estuary mouth showing sedimentation in the lower reaches below railway bridge (Source: Google Earth)**



22 September 1972 (possible closed mouth)



4 April 1976



8 April 1977



21 April 1979

**Figure 7: Klein Brak Estuary mouth showing progressive sedimentation in the lower reaches above railway bridge in 1970s (Source: Google Earth)**



9 April 1980 (possibly closed mouth)



December 1980



December 1981



February 1987

**Figure 8: Klein Brak Estuary mouth showing progressive sedimentation in the lower reaches above railway bridge in 1980s (Source: Google Earth)**



28 February 2010



13 September 2013

**Figure 9: Klein Brak Estuary mouth showing progressive sedimentation in the lower reaches above railway bridge in the 2010s (Source: Google Earth)**

### 3.3 Tidal amplitude and loss of upper reaches tidal flows

Tidal flows have also been reduced as a result of the reduction in open water areas caused by dirt roads and blocked culverts on both the Moordkuil and Brandwag arms of the Klein Brak Estuary (refer to **Figure 10**). The loss in tidal flows is estimated at about 5%.



**Figure 10: Roads and blocked culverts preventing tidal flows and salinity penetration into the upper reaches of the Klein Brak Estuary**

### 3.4 Sediment dynamics

Very little data are available on sediment dynamics and estuarine morphology of the Klein Brak Estuary. Large floods are important in flushing out sediment accumulations within the estuary (both from riverine and marine origin), and preventing the encroachment of reeds and sedges into the main estuary channel. There are no large dams in the catchment of the Klein Brak Estuary. Freshwater abstraction from the Moordkuil tributary is transferred to the off-channel Klipheuwel Dam to supply the town of Mossel Bay. In addition, there are numerous relatively small farm dams in the catchment capturing first flushes and freshettes, as well as run of river abstraction. Thus, it is estimated that there is a significant reduction in river inflow to the estuary. Flood events are expected to occur relatively untransformed from Reference Condition to Present State, i.e., in the order of 10% change from Reference. This results in slightly reduced mobility and flushing of sediments in the estuary, and potentially increased penetration of marine sediments. The small dams will preferentially trap a larger proportion of the coarser sediments, but have very low sediment trapping efficiency and capacity, and with the Klipheuwel Dam an off-channel impoundment, there is also little effect on sediment yield from the catchment.

The railway bridge near the mouth has a significant effect on the hydrodynamics as well as on the sediment dynamics in the area, with a number of the historical images showing the accumulation of sand from the sea up to the railway bridge or just upstream from this bridge. This bridge therefore appears to affect the sediment dynamics of the lower estuary.

### 3.5 Summary of breaching motivations

A summary of the motivations for potential artificial breaching is provided below in Table 2.

**Table 2: Summary of artificial breaching motivation**

	Potential Threat	Relevance		
Human wellbeing and safety	Threat to human life (as a result of high water levels)	No threat to human life, although low-lying properties will be affected		
	Threat to immovable property and infrastructure (as a result of high water levels)	There are some low-lying properties in the Estuary Functional Zone that will be flooded when levels rise above 2m MSL.		
	Human health impact (e.g. flooding of sewage pump station, septic tanks, chemical storage yards, etc)	Not a significant consideration under closed mouth conditions.		
	Potential loss of agricultural resources (as a result of high water levels)	There are some low-lying properties in the Estuary Functional Zone that will be temporarily flooded when levels rise above 2.5m MSL.		
	Potential impact on nearshore environment if breached (e.g. aquaculture facilities)	Not a significant consideration.		
	Loss/impaired access (e.g. roads, footpaths, cattle crossings)	If water levels become too high local farmers may be required to drive around the estuary instead of taking a shortcut through the estuary for a short period (weeks)		
	Human Health	Contact recreation is limited to swimming, but no information is available on water quality being a problem from a human health perspective.		
	Harmful / Noxious algal blooms	No information available on this aspect.		
	Impact(s) on recreational use (e.g. increase depth / surface area when mouth is closed, reduce fishing).	Boating/canoeing occurs in the system under open mouth conditions.		
		Impact of artificial breaching	Not relevant. The system is predominantly open.	
Impact of NOT breaching		Closed mouth conditions result in deeper waters which will not impair boating.		
Impact of NOT breaching		Closed mouth conditions result in deeper waters which will not impair boating.		
Ecosystem requirements	Impact on avifauna abundance, species richness/ community composition	Important bird habitat	The system is of average importance from a bird perspective.	
		Impact of artificial breaching	Exposure of intertidal areas is essential for estuarine birds, with the majority of species depending upon these habitats for food, and several more using intertidal areas for roosting.	
		Impact of NOT breaching	Fresh water conditions associated with closed mouth conditions favour water birds.	
		Occurrence of avian botulism	No information available on this aspect.	
	Impact on estuarine fish abundance, species richness/ community composition	Important fish nursery	The system is of medium to high importance as a fish nursery. The system has very high densities of juvenile dusky cob.	
			The fish assemblage show a high degree of estuarine dependency and most species are able to withstand prolonged periods of mouth closure.	
		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.	

Potential Threat		Relevance
Impact on estuarine invertebrate abundance, species richness/ community composition	Impact of NOT breaching	Nursery area not available to juvenile fish.
	Occurrence of fish kills	Yes, have been recorded in the system.
	Impact of artificial breaching	Open mouth linked to higher salinity values and opportunity for euryhaline species to increase in biomass and abundance. 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 Klein Brak River Estuary which are adapted to life in a tidal system.
Estuarine Macrophytes (plants)	Occurrence of invertebrate kills	No information available on this aspect.
	Impact of artificial breaching	The open mouth condition is important as this ensures tidal flushing and introduces saline water maintain a full salinity gradient.
Water quality (Thresholds of concern that would compromise estuarine ecosystem or ecosystem services)	Impact of NOT breaching (i.e. die back of saltmarsh)	Mouth closure occurs for < 5% of the time. The plants in the estuary i.e. reeds and grasses, are adapted to open mouth conditions. There are large salt marsh areas with succulent species that would be sensitive to prolonged inundation.
	Salinity thresholds of concern (high or low) that would compromise ecosystem or ecosystem services	Not applicable.
	Dissolved Oxygen levels	< 4 mg/l
	Ammonia levels	Not applicable.
	Toxic substance in the context of breaching	No information available on this aspect.
Eutrophication	Pollution source include septic tanks, caravan park, agricultural drains.	
	Excessive reed growth	No, reed growth is being impaired due to loss of freshwater input.
	Macrophyte blooms	No applicable.
Sedimentation	Harmful algal blooms	Yes, have been recorded in this system in the upper reaches.
	On-going sedimentation	No information on this aspect as no recent bathymetric surveys have been carried out in the estuary.

Event Type	Breach Yes/No	Motivation
Major flood events associated with severe inundation	No	Water levels must be as high as possible to scour sediment from the system. Limited infrastructure or property at risk of inundation, but no clear risk of catastrophic damage.
Poor water quality	No	Low oxygen levels throughout the system will not be considered an emergency (must be verified through regular monitoring and estuarine specialist consultation). Pollution must be fixed at source. Salinity levels are not a consideration because the system is characteristically saline. Artificial breaching will not be considered to flush polluted water out of the estuary.
Fish kills	Yes (emergency only)	DAFF to determine cause of fish kill. Written findings to be provided to breaching committee.
Hazardous spill	Yes (emergency only)	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 Klein Brak 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 Klein Brak Estuary.

**Table 3: Key lead authority involved in artificial breaching**

<b>EMP Responsible Management Authority (RMA) (as per the National Estuarine Management Protocol)</b>	Mossel Bay Local Municipality	
<b>Breaching Actions</b>	Garden Route District Municipality (Disaster Management)	
<b>Advisory Committee</b>	Klein Brak Estuary Advisory Forum	
<b>Authorisation (breaching / emergency)</b>	DEA&DP	
Lead authority	Minimum consultation In case of Emergency	
Garden Route District Municipality (Environment Management and Disaster Management sections)	✓	
CapeNature	✓	
Department of Agriculture, Forestry and Fisheries	✓	
Garden Route District Municipality (Environment Management and Disaster Management sections)	✓	
DEA&DP	✓	
Department of Environmental Affairs	✗	
Department of Water and Sanitation	✗	
Research organisations (e.g. CSIR)	✗	
Non-Governmental Organisations	✗	
<p>The decision to artificially breach will be made by a Breaching sub-committee comprising Garden Route District Municipality, Mossel Bay Local Municipality, DAFF: Inshore Fisheries Research, CapeNature and the local estuary advisory forum following consultation with estuarine ecological specialists (e.g. a research organisation, or 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 column oxygen, water levels, berm height, salinity, as well as water quality parameters where feasible, will be collated by the RMA or agents identified in the EMP. Once the Breaching sub-committee has decided that an artificial breach must occur, the Disaster Risk Management unit of the Garden Route District Municipality (in conjunction with CapeNature), shall be responsible for overseeing the breaching activities.</p>		
Disaster Management	Authority/Organisation	Status
<b>Early warning system</b>	South African Weather Services (weather)	No
	DWS warning system (flow/water levels/dam safety)	No
<b>Disaster Management Plan</b>	Municipality	Yes
<b>Approved Maintenance Management Plan</b>	Municipality	Yes, in process of update.

## 5 BREACHING SPECIFICATIONS

The following breaching specifications need to be met before artificial breaching of the Klein Brak Estuary can be considered (Table 4):

**Table 4: Klein Brak Estuary Breaching Specifications**

Breaching considerations	Details		
	> 2 m MSL	Breach Y/N?	Only in defined emergency situations
Minimum breaching level (water level should be as high as possible before breaching)	Not a consideration in an emergency		
Optimum breaching period (if applicable)	Not a consideration in an emergency.		
Neap-spring breaching considerations	Not a consideration in an emergency.		
Timing of breaching	Breach 2 hours before high tide, or just after high tide (to prevent high waves from closing the opening), to maximize the outflow.		
Consider safety of public during breaching	Breaching at the Klein Brak Estuary holds little risk to public safety. Nevertheless, care should be taken with the general public to ensure their safety. Cordoning off the works area with the aid of red and white emergency tape will aid in keeping the public out of the area where 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.		
Breaching trench to maximize outflow	Excavate a 2m deep and 4m wide trench before breaching to maximize outflow.		
Location of the breaching position.	At the lowest position of the berm, opposite the previous year's channel to assist with the efficient removal of sediment during the breaching.		
Estimate amount of sediment to be moved during breaching	Not applicable, as the amounts vary significantly between breachings, cannot be determined in advance.		
Disposal of sediment removed during excavation	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. 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.		

Breaching considerations	Details
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&amp;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>Garden Route District Municipality retains the management responsibility of the designated area (as a function of Disaster Management), 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: &lt; 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 generally distinguished, namely (a) Planned artificial breaching undertaken according to an approved MaintMP and (b) Emergency breaching (e.g. to avoid danger of severe fish kills). **In the absence of more detailed information on the mouth behaviour of the Klein Brak Estuary only emergency breaching under extremely rare conditions is considered appropriate. Planned artificial breaching are therefore not recommended.**

Garden Route District Municipality (Disaster Management) is responsible for the operational aspects of the Klein Brak Estuary MMP. They can delegate this function, but ultimately they have oversight. The Municipality is required to co-ordinate the breaching activities, which include:

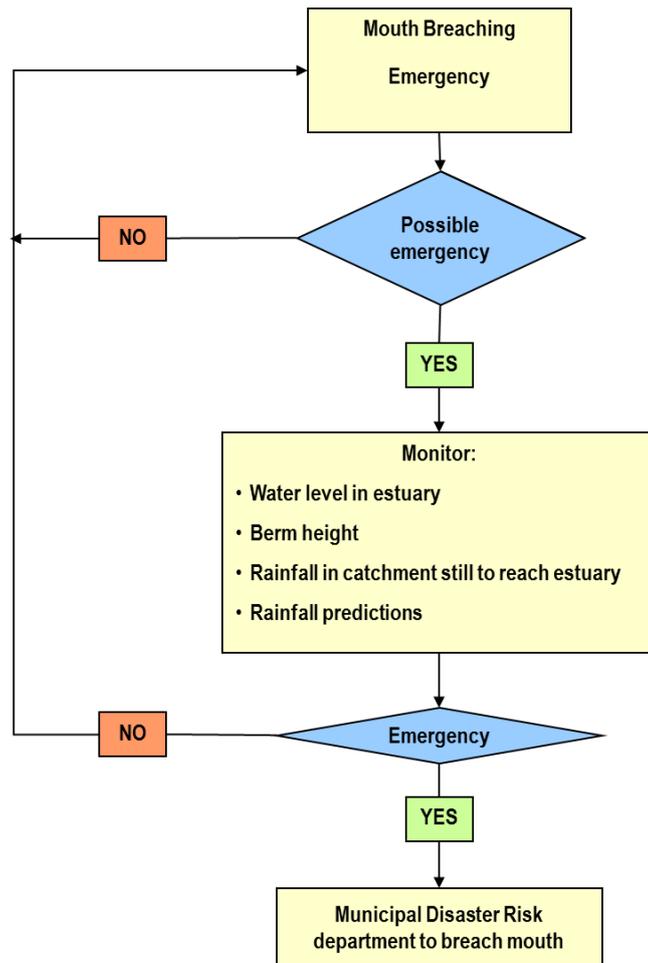
- Convening emergency breaching meetings;
- Recording the minutes of the meetings;
- Distributing relevant information to the committee members; and
- Sharing the post-breaching incident report;

The Municipality is also responsible for continuous monitoring of the conditions in the estuary when oxygen levels become low (<4 mg/l). Once the emergency breaching criteria (see Section 5) is met, the decision to artificially breach will be made by the Municipality. Note, that an estuary mouth is highly dynamic and unforeseen events may require special management actions. In such an event, verbal (followed by written) authorisation may be required from the authorising authority (i.e. DEA&DP).

A flow chart for the undertaking of mouth breaching under emergency conditions is included in Figure 11. Breachings should be undertaken in the swiftest manner possible and in most cases Garden Route District Municipality is responsible. While breaching should be conducted according to an Estuary Mouth Management Plan some of the general breaching principles may be waived under emergency conditions to ensure an expedient breaching.

Emergency conditions could develop when the estuary mouth is closed and a fish kill occurs in the system. Constant monitoring of the conditions in the estuary is required when emergency conditions develop. Communication between the different role players, i.e. the Garden Route District Municipality, local municipality and key authorities (DEA&DP) involved, should take place, if time is available, to monitor the situation. Included in the monitoring are:

- The oxygen levels in the estuary.
- The water level in the estuary and its rate of increase.
- The actual and expected rainfall in the catchment.
- 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.



**Figure 11: A flow chart illustrating the breaching plan for emergency conditions**

Once Garden Route District Municipality has established that the relevant criteria have been met and that artificial breach must occur, they shall be responsible for overseeing the following:

- Ensuring the availability of earth moving equipment on day of breaching;
- Establishing the exact location 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.

Finally, Garden Route District 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).

## 7 MONITORING PROGRAMME

The following monitoring programme supports the responsible management of artificial breaching (Table 5):

**Table 5: Monitoring programme for Klein Brak 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	Yes	DWS water level gauge
River inflow data	Daily	Yes	DWS flow gauges
Bathymetric surveys	Every 3 years	No	As per EMP
Salinity	Monthly (and day before and after, and 5 to 10 days after a breaching)	Yes	As per EMP
<i>In situ</i> water quality measurements (e.g. oxygen)	Monthly	Yes	As per EMP
Berm levels	Monthly (and just before breaching if breaching is planned)	Yes	As per EMP
Photographs	To be arranged between authorities before, during and after breaching	Yes	As per EMP
Observations on estuarine vegetation (e.g. inundation of salt marsh, reeds & sedges, occurrence of algal blooms)	Quarterly (and just before breaching)	Yes	As per EMP
Observations on Invertebrate behavior (e.g. invertebrate kills)	Quarterly (and just before breaching)	Yes	As per EMP
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	As per EMP, public

## 8 REPORTING

Following an emergency breaching a Breaching Incidence Report needs to be compiled and provided to DEA&DP within 14 days of breaching. This report should contain as much as possible information on the breaching motivation for the breaching and the process followed.

In addition to the Breaching Report, the Managing authority needs to compile an Annual 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.

### 8.1 Breaching Report

Table 6 below summarises the minimum content of post-breaching report in the event the Klein Brak Estuary were breached under emergency conditions. The initial incidence report should be compiled within 14 days of breaching, with data gaps (e.g. duration open) addressed after mouth closure.

**Table 6: Content of Klein Brak Estuary breaching report**

ACTIONS	LOCAL REQUIREMENT - YES/NO	AGENCY RESPONSIBLE
<u>Met-ocean information</u> <ul style="list-style-type: none"> <li>State of the tide (spring-neap/ high-low tide)</li> <li>Sea conditions (calm/stormy)</li> </ul>	Yes	CapeNature
<u>Estuary Information</u> <ul style="list-style-type: none"> <li>Water level from DWS (and volume) before breaching</li> <li>Maximum outflow rate during breaching calculated from water levels and surface area of system</li> <li>Outflow duration (from water level graph)</li> <li>Lowest water level achieved after breaching (from water level graph)</li> <li>Volume of sediment removed during breaching and what was done with the excavated sediment?</li> <li>Did flooding problems arise before or during the breaching? If so, quantify these problems.</li> <li>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.</li> <li>Could further problems arise by design of new developments at too low levels?</li> </ul>	Yes	DWS & CapeNature

ACTIONS	LOCAL REQUIREMENT - YES/NO	AGENCY RESPONSIBLE
<ul style="list-style-type: none"> <li>Were there problems with septic tanks before the breaching? If so quantify date since last reaching</li> </ul>		
<u>Location of channel</u> <ul style="list-style-type: none"> <li>Align with historical position of channels</li> <li>Reduce channel length</li> <li>Estimated volume of sediment excavated during the breaching</li> </ul>	Yes	CapeNature
Period for which the mouth stayed open	Yes	CapeNature
Bathymetric surveys before breaching events to establish erosion /deposition rates	Yes	CapeNature
Salinity measurement before and after breaching	Yes	CapeNature
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 1 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. 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 7: Minimum information required on breaching feedback sessions**

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

## 9 REFERENCES

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