



CapeNature

MAINTENANCE MANAGEMENT PLAN FOR THE
VERLORENVLEI ESTUARY MOUTH UNDER
SPECIFIC CONDITIONS

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STATEMENT OF THE PROBLEM

The Verlorenvlei Estuary is nearly permanently closed. It only breaches to the sea during periods of high inflow. During the closed phase, under high inflow conditions, water backflows into the wetlands downstream of Redelinghuys, inundating grazing land and prompting requests for premature breaching of Verlorenvlei.

Resultant lower water levels, together with nutrient enrichment causes eutrophication in the form of phytoplankton algal blooms (green or brown water column), excessive reed growth around the edges and/or submerged macrophyte growth. Phytoplankton algal blooms depletes oxygen and stress fish, while reed growth at the low water bridge increase risk of flooding.


OVERALL OBJECTIVE OF THE LOCAL MOUTH MANAGEMENT PROGRAMME

1. Management of the estuary mouth as an integral part of the Verlorenvlei Estuary Management Plan (EMP).
2. Managing the Verlorenvlei Estuary mouth to optimally support estuary functioning.

DESCRIPTION OF THE VERLORENVLEI ESTUARY

Table 1. Description of the estuary and its importance.

Aspect	Discussion
Location	Verlorenvlei extends between the West Coast villages of Elands Bay and Redelinghuys and when the mouth is open outflow occurs into Elands Bay in the Atlantic Ocean approximately 25 km south of Lambert's Bay, the nearest sizeable town. Verlorenvlei is one of the largest estuarine lakes in South Africa and is one of the country's few coastal freshwater lakes.
Downstream boundary:	Estuary mouth (32°18'58.34"S, 18°20'5.96"E)
Upstream boundary:	Head of the estuary (32°25'55.82"S, 18°29'57.78"E)
Lateral boundaries:	Estuary Functional Zone (~5m above mean sea level (MSL))

Aspect	Discussion
	
Estuary Importance	<p>The Estuary is a large estuarine lake system. The estuary is an “Important estuary from a biodiversity perspective” (Importance rating score = 72) (Turpie and Clark 2007, Van Niekerk et al. 2012).</p>
Conservation status	<p>Verlorenvlei is a proclaimed a Ramsar site (No. 525) and the vlei itself is owned by the state. The Verlorenvlei estuary, however, does not have any statutory protection; it is, however, included in the subset of estuaries identified as requiring protection in order to conserve South Africa’s estuarine biodiversity estate in the National Estuary Biodiversity Plan (Van Niekerk et al. 2012).</p>
Important vegetation	<p>Verlorenvlei exhibits a transition from salt tolerant species near the mouth to freshwater species further inland. More salt tolerant species include: <i>Sarcocornia natalensis</i>, <i>Scirpus maritimus</i> and <i>Juncus kraussii</i>. Extensive beds of emergent aquatic macrophytes occur along the margins of the vlei with <i>Phragmites australis</i>, <i>Typha latifolia</i> and sedges as dominants. Downstream of Redelinghuys there are fairly wide and open wetlands with patches of mixed sedges and reed communities along the course of the Verlorenvlei River over a distance of 11km. Dense reedbeds are present in the upper part of the lake. There has been a substantial increase in <i>Typha</i> and <i>Phragmites</i> growth especially in the lower and upper reaches of Verlorenvlei since the 1930s. During the late 1980s <i>Myriophyllum spicatum</i>, a submerged macrophyte, dominated large areas of the lake where the water is less than 2m deep. This submerged macrophyte was not present during the 2003 Sandveld study (DWAF 2003) nor during a 2008 field visit (personal observation), but has since been observed in 2012, and possibly again in 2016. The reason for the switch between macrophytes and microalgal blooms was not clear and is something that needs further investigation.</p> <p>The water lily, (<i>Nymphaea capensis</i>), a species which is becoming rare in South Africa as a result of wetland destruction, occurs in small numbers in the system.</p>
Important fish nursery	<p>The Ramsar Information Sheet, updated in 2018, indicates the following:</p> <p>A total of 14 fish species from 9 families has been recorded from Verlorenvlei and a further two are expected to occur (Harrison et al. 2000, Sinclair et al. 1986, Robertson 1980, Poggenpoel 1996, DWAF 2003). Four (25%) of these are entirely dependent on estuaries to complete their lifecycles. One, the estuarine round-herring <i>Gilchristella aestuaria</i>, breeds and spends its entire lifecycle in the estuarine environment whereas three, the white steenbras <i>Lithognathus lithognathus</i>, flathead mullet <i>Mugil cephalus</i> and freshwater mullet <i>Myxus capensis</i> are dependent on estuaries as nursery areas for at least their first year of life. In addition, <i>Myxus capensis</i> and to a lesser extent, <i>Mugil cephalus</i> are facultative catadromous species that require estuaries as transit routes between the marine and freshwater environment. A further three (19%) species namely the harder <i>Liza richardsonii</i>, white stumpnose <i>Rhabdosargus globiceps</i> and Knysna sand-goby <i>Psammogobius knysnaensis</i> are at least partially dependent on estuaries. In all, 44% of the fish species recorded, or expected to occur, in Verlorenvlei can be regarded as either partially or completely dependent on estuaries for their survival. All 9 (66%) of the remaining species are euryhaline freshwater species whose penetration into estuaries is determined by</p>

Aspect	Discussion
	<p>salinity tolerance. Three of these, the Cape galaxias <i>Galaxias Zebratus</i>, Cape kurper <i>Sandelia capensis</i> and the recently described Verlorenvlei redfin <i>Pseudobarbus verloreni</i> are endemic to the south-western Cape (CSIR 2009, Chakona, Swartz & Skelton, 2014). Six, the Mozambique Tilapia <i>Oreochromis mossambicus</i>, carp <i>Cyprinus carpio</i>, banded tilapia <i>Tilapia sparrmanii</i>, smallmouth bass <i>Micropterus dolomieu</i>, largemouth bass <i>Micropterus salmoides</i> and tench <i>Tinca tinca</i>, are introduced species. (CSIR 2009). Six (38%) of the estuarine fish and three (1 %), of the freshwater fish recorded in Verlorenvlei, are South African or south-western Cape endemics. Verlorenvlei represents about 30% of the available habitat to estuarine fish on the west coast (Lamberth and Turpie 2003).</p>
<p>Important Bird site</p>	<p>Verlorenvlei is regarded as one of the ten most important wetlands for wading birds in the south-western Cape, being a particularly important feeding area for the Great White Pelican and supporting a number of threatened bird species.</p> <p>Information collated by Birdlife South Africa (2019) indicates:</p> <p>Verlorenvlei supports more than 189 bird species, of which 75 are waterbirds. The wetland occasionally hosts more than 4 000 birds; the highest number recorded in a single count was 11 891, according to the data from counts undertaken by CapeNature since 1990. At least 26% of the Western Cape's Great White Pelican <i>Pelecanus onocrotalus</i> population congregates at this site at times. Greater Flamingo <i>Phoenicopterus roseus</i> and Lesser Flamingo <i>Phoeniconaias minor</i> (Near Threatened) also occur here occasionally, when conditions at Rocher Pan (35 km south) or Wadrifsootpan (13 km north) are unsuitable or water levels in the lake are very low, as occurred in the 2004–2005 season. Relatively large numbers of Little Bittern <i>Ixobrychus minutus</i> and Caspian Tern <i>Sterna caspia</i> occur regularly in the wetland.</p> <p>Historically an important moulting ground and summer refuge for Anatidae (swimming ducks), the area supported large numbers of Yellow-billed Duck <i>Anas undulata</i>, Cape Shoveler <i>A. smithii</i> and South African Shelduck <i>Tadorna cana</i>. However, many of these species have declined over the past decades, as data from CapeNature illustrate. Large numbers of Great Crested Grebe <i>Podiceps cristatus</i>, Red-knobbed Coot <i>Fulica cristata</i> and White-breasted Cormorant <i>Phalacrocorax lucidus</i> can also be found at this wetland. There is a high density of African Marsh Harrier <i>Circus ranivorus</i>, which forages over the marsh and reedbed areas. Black Stork <i>Ciconia nigra</i> breeding in the Olifantsrivierberge and Swartberge to the east and Piketberge to the south very occasionally forages in the vlei. The site also holds 4–5 pairs of African Fish Eagle <i>Haliaeetus vocifer</i>, and Verreaux's Eagle <i>Aquila verreauxii</i> occurs on the cliffs around the vlei.</p> <p>African Black Oystercatcher <i>Haematopus moquini</i> and Chestnut-banded Plover <i>Charadrius pallidus</i> (Near Threatened) are recorded at the estuary mouth from time to time. The palustrine habitats are diverse and rich and hold populations of secretive Rallidae such as African Rail <i>Rallus caerulescens</i> and Baillon's Crake <i>Porzana pusilla</i>. Red-chested Flufftail <i>Sarothrura rufa</i> may occur, but has not been confirmed. Rallid species are particularly abundant between Matjiesgoeddrif and Redelinghuys, where the composition and structure of the palustrine vegetation are diverse and the area has extensive and excellent habitat for them and for waders. The diverse ecotonal terrestrial vegetation around Verlorenvlei's fringes supports several biome-restricted assemblage species. In recent years, a pair of Goliath Herons seems to have been resident in the area and may be breeding.</p> <p>The Important Bird and Biodiversity Area (IBA) centred on Verlorenvlei hosts more than 1% of the biogeographic population of Great Crested Grebe (maximum 140 individuals), South African Shelduck (maximum 489 individuals), Pied Avocet <i>Recurvirostra avosetta</i> (maximum 1 256 individuals), Hartlaub's Gull <i>Chroicocephalus hartlaubii</i> (maximum 377 individuals), Caspian Tern (maximum 34 individuals), Great White Pelican (maximum 478 individuals), White-breasted Cormorant (population regularly exceeds 130 individuals), Kelp Gull <i>Larus dominicanus</i> (population exceeded 700 individuals on two counts), Greater Flamingo (population exceeded 750 individuals on one count) and Whiskered Tern <i>Chlidonias hybrida</i> (population exceeded 85 individuals on one count). The site also supports more than 0.5% of the population of Lesser Flamingo (maximum 320 individuals), Egyptian Goose <i>Alopochen aegyptiaca</i> (maximum 2 041 individuals) and Red-knobbed Coot (maximum 3 104 individuals).</p>
<p>Estuary Condition w.r.t breaching</p>	<p>To assist in the development of an Estuary Management Plan for Verlorenvlei a provisional health rapid level assessment was done following the Estuarine Resource Directed Measures (RDM) methodology developed for determining the Ecological Water Requirements of an estuary (DWF 2008). Verlorenvlei is currently in a "Moderately to largely modified state", i.e. Category C/D. The degradation of the system's health is largely attributed to:</p> <ul style="list-style-type: none"> • Significant reduction in the freshwater inflow (ground- and surface water) to the system;

Aspect	Discussion
	<ul style="list-style-type: none"> • A decrease in open mouth conditions (i.e. frequency and duration); • Increase in the nutrient and sediment load to the system; • Increased coverage by reeds and sedges; and • Changes in the species composition and abundance of fish in the system.
Recommended Ecological Condition	<p>As the Verlorenvlei is a Ramsar site it should be in a much better condition, but it is highly unlikely that the flow reduction to the system can be alleviated easily and as this is the major driver for change in the system it was felt that the Best Attainable State is a moderately modified system (i.e. Category C).</p> <p>The provisional recommended ecological category for the Verlorenvlei, based on the present health state, estuarine importance and conservation importance is a C Category.</p> <p>It is very important that this provisional health rating of Verlorenvlei be confirmed by an Intermediate or Comprehensive level Estuarine Reserve (Ecological water requirement) study to determine its Estuarine Recommended Ecological Category with a confidence that would allow for decisive management actions. A high confidence reserve determination would also allow for stricter licensing and more decisive action from the relevant authorities regarding the necessary intervention required to increase the health of the system. An updated hydrological assessment of the combined impact of abstraction on surface and ground water resources is urgently needed to halt further decline in condition.</p> <p>In the meantime, decisions and actions should follow a precautionary approach based on the existing evidence; evidence that confirms the estuary's ecological and social value, and the severity of the threats faced.</p>

MOTIVATION FOR ARTIFICIAL BREACHING

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

Artificial breaching reduces water levels, increases the risk of the vlei drying out during drought conditions, increases reed growth and reduces estuarine connectivity with the marine environment and with the catchment thus decreasing the nursery function of Verlorenvlei. Not enough information is presently available to justify the artificial mouth breaching of the Verlorenvlei to address problems relating to local hotspots around the estuary. Little information is available regarding flow and catchment dynamics, however the existing body of knowledge shows that freshwater reduction and the road and rail bridge obstructions have already markedly impacted on the connectivity in the system, with the occurrence of both lower and higher water levels being significantly reduced from natural. Imposing further artificial manipulations on the mouth of the vlei will result in further decline in condition and ecosystem services.

A summary of the motivations for potential artificial breaching of the Verlorenvlei 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 threats to human life
	Threat to immovable property and infrastructure (as a result of high water levels)	No threats to immovable property, but some movable intake points and abstraction pumps can become inundated under high water levels.
	Human health impact (e.g. flooding of sewage pump station, septic tanks, chemical storage yards, etc.)	Under severe flood conditions, domestic septic tanks and soakaways will get inundated.
	Potential loss of agricultural resources (as a result of high water levels)	Some backflooding under closed mouth conditions occur in the upper reaches near Redelinghuys. This is the main pressure for artificial breaching.
	Potential impact on nearshore environment if breached (e.g. aquaculture facilities)	Not applicable.
	Loss/impaired access (e.g. roads, footpaths, cattle crossings)	Some footpaths are inundated under high water levels in the upper reaches of the system. Road bridges can be overtopped under flood conditions.
	Harmful / Noxious algal blooms	No information. Assume not relevant.
	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. Motorboats with engines in excess of five horsepower are not permitted on the lake. The deeper areas are suitable for sailing. However, the varying depth of the vlei throughout the year and the fringing

	Potential Threat	Relevance		
		and submerged vegetation can place considerable limitations on sailing in terms of access to open water. Swimming, although not prohibited, due to the thick layer of silt and its unhygienic water conditions, is discouraged. Recreational line fishing is allowed under normal permit conditions, but under most conditions this will only land alien freshwater fish. The vlei and its environs lend themselves to ideal bird-watching conditions.		
		Impact of artificial breaching	Varying conditions render this irrelevant	
		Impact of NOT breaching	Varying conditions render this irrelevant	
Ecosystem requirements	Impact on avifauna abundance, species richness/ community composition	Important bird habitat	Yes, large concentrations of waterbirds. Ramsar site.	
		Impact of artificial breaching	Premature breaching can disturb feeding and breeding cycles.	
		Impact of NOT breaching	Birds adapted to varying water levels in the system. Higher water levels associated with more productive system, i.e. more food availability and better water quality.	
		Occurrence of avian botulism	Unconfirmed records of bird deaths believed to be linked to avian botulism.	
	Impact on estuarine fish abundance, species richness/ community composition	Important fish nursery	An important nursery system. Verlorenvlei represents about 30 % of the available habitat to estuarine fish on the west coast (Lamberth & Turpie 2003). In terms of fishery yield (including nursery function), Verlorenvlei contributes approximately R3 030 / ha or R 3,03 million to the value of the inshore fisheries annually. This represents 15 % of the total value of the seine and gillnet fishery or 30 % of the estuarine contribution to the value of the inshore marine fisheries on the west coast (Lamberth & Turpie 2003).	
		Impact of artificial breaching	Timing of breaching is important: to permit fish recruitment an estuary has to be open during the appropriate period. Mullet is a partially estuarine dependent species which spawns throughout the year with peaks in the summer months. Juveniles are equally at home in estuaries and the marine environment and can remain in the surf-zone until such time as an estuary opens with a chance of recruitment Steenbras on the other hand	

	Potential Threat	Relevance
		<p>is entirely dependent on estuaries for its first year of life and has a relative short spawning season. Its recruitment window is thus very short and if an open estuary is not found within that period the larvae or juveniles will die. The recruitment window is probably 2 of 3 months, August-October of each year depending on when spawning took place and the proximity of the estuary encountered to the spawning ground. In Verlorenvlei, water abstraction has resulted in the mouth staying open for shorter periods and closing earlier than it did historically. The recruitment opportunities for <i>L. lithognathus</i> therefore has been greatly reduced.</p>
	Impact of NOT breaching	<p>The ability of fish to recruit into an estuary varies between species and can only really be gauged by their relative abundance or presence / absence within a particular system. Mullet species and white Steenbras are known to recruit through wave overwash into temporarily open / closed systems. In addition, they also recruit by swimming from standing wave to standing wave in systems where there is a strong outflow. In all, the high abundance and presence of mullet as opposed to the absence of Steenbras in Verlorenvlei may be at least partially explained by their being much more adept at recruiting into the system.</p>
	Occurrence of fish kills	<p>Some fish kills in lower estuary due the system drying out and/or hyper saline conditions developing. In addition, lesions have been observed on most adult Mozambique Tilapia.</p>
Impact on estuarine invertebrate abundance, species richness/ community composition	Impact of artificial breaching	<p>Open mouth linked to increased opportunity for invertebrate species to increase in biomass and abundance.</p>
	Impact of NOT breaching	<p>Closed mouth leads to decrease in species richness (absence of marine associated species).</p>
	Occurrence of invertebrate kills	<p>No information available</p>

	Potential Threat	Relevance
	<p>Estuarine Macrophytes (plants)</p>	<p>Impact of artificial breaching</p> <p>Lowens the water level and dries out the wetland in the upper reaches of the system.</p> <p>Die-back of salt marsh and reeds and sedges due to inundation and high water level (>1.6 m MSL). Submerged macrophytes may expand further if maximum levels are not maintained for long periods. Anthropogenic nutrient inputs presently encourage macroalgal growth.</p> <p>In summary, as a result of reduce freshwater input, estuary mouth management can only in a limited manner contribute to the management of reeds: 1) slowing down growth through inundation at higher water levels for longer periods (similar to reference) and 2) through the limited scouring that now occurs at the bridges during an breaching outflow event. The higher the water level before a breaching, the more the scouring potential and outflow period, the more reeds will be removed.</p> <p>These interventions should be supported by a “Reeds maintenance management plan (maintMP)” at local hot spots, however a large-scale reed eradication programme WILL lead to further algal and macrophyte blooms causing oxygen problem in the systems. A better long term strategy is to look a nutrient reduction from agricultural activities in the vicinity of the vlei.</p>
	<p>Water quality (Thresholds of concern that would compromise estuarine ecosystem or ecosystem services)</p>	<p>Salinity (high or low) that would compromise ecosystem or ecosystem services</p> <p>Currently there are no limits set related to policy</p> <p>Dissolve Oxygen levels</p> <p>< 4 mg/l</p> <p>Ammonia levels</p> <p>Currently there are no limits set related to the breaching policy</p> <p>Toxic substances</p> <p>Currently there are no limits set related to the breaching policy</p>

Potential Threat		Relevance	
		Pollution source are mostly agricultural runoff.	
Eutrophication		Excessive reed growth	Yes. Extensive beds of emergent aquatic macrophytes occur along the margins of the vlei with <i>Phragmites australis</i> , <i>Typha latifolia</i> and sedges as dominants. Reeds are regularly removed from the lower bridge in winter to prevent the obstruction of outflowing water.
		Macrophyte blooms	Yes. During the late 1980s <i>Myriophyllum spicatum</i> , a submerged macrophyte, dominated large areas of the lake where the water is less than 2m deep (Sinclair <i>et al</i> 1986). <i>Myriophyllum spicatum</i> was observed in 2012, and again in 2016-17.
		Harmful algal blooms	Yes, alga blooms, including cyanobacterial such as <i>Microcystis aeruginosa</i> occur in spring. Phytoplankton assemblage is representative of an eutrophic system. The microalgal assemblage mainly comprised cyanobacterial of the genera <i>Anabaena</i> , <i>Lyngbya</i> , <i>Anabaenopsis</i> , <i>Merismopedia</i> , <i>Microcystis</i> with minor contributions from chloro- (<i>Scenedesmus</i>) and <i>bacillariophytes</i> (<i>Cyclotella</i> , <i>Nitzschia</i>). The algal assemblage was indicative of an elevation in trophic status that has been in place for some time and probably reflects eutrophication-associated damage to the lower levels of the foodweb (e.g. depauperate zooplankton and coarse fish dominance) (DWAF 2003). Large masses of filamentous green algae, including <i>Chaetmorpha</i> and <i>Cladophora</i> , are common in the channel, particularly between the railway bridge and the mouth, where the water is often stagnant and hypersaline (Sinclair <i>et al</i> 1986).
Sedimentation		On-going sedimentation	No information available
Event Type	Breach Yes/No	Motivation	
Major flood events associated with severe flood damage	No	Artificial breaching will not be considered to prevent water inundation of low-lying private or public properties as much higher levels were experienced during the time period the berm were in place.	

	Potential Threat		Relevance
	Poor and/or unfavourable water quality	No	<p>Low oxygen levels are not considered an outright emergency in this estuary.</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 (which will pollute the nearshore).</p>
	Fish kills	Yes	<p>A medium important nursery system.</p> <p>Department of Agriculture, Forestry and Fisheries (DFFE) to determine if major fish kill can be remedied by breaching, but in general breaching under low oxygen conditions will only reduce the oxygen for the fish that remain in the system.</p>
	Hazardous spill	Yes	<p>Breaching will only be considered if hazardous substance holds no risk to nearshore environment and registered as a disaster</p> <p>In the event of an oil spill at sea, the mouth of the Verlorenvlei Estuary can temporarily be closed to prevent oil from entering the system.</p>

INTEGRATED ASSESSMENT

The following criteria apply to the Verlorenvlei should emergency procedures be invoked (Table 3):

Table 3: Verlorenvlei Estuary Breaching Specifications

Breaching considerations	Details	
Minimum breaching level (water level should be as high as possible before breaching)	>2 m MSL	Level to MSL
	Ideally breaching should occur naturally. If artificial breaching needs to be undertaken then the water level should be as high as possible	
Optimum breaching period (if applicable)	The Verlorenvlei Estuary only occasionally breaches dependent on the occurrence of rainfall and high river flow. Ideally, a breaching should occur in late winter or spring (August to October). The later in the season the better as the incidence of high sea storms reduce from winter to summer, assisting in maintaining open inlet conditions.	
Neap-spring breaching considerations	Preferably 3-4 days before spring tide, but priority should be given to water levels and wave conditions.	
Timing of breaching	Breach 2 hours before high tide, or just after high tide (to prevent high waves from reclosing the opening), to maximize the outflow.	
Consider safety of public during breaching	Breaching holds a small risk to public safety. Care should be taken with the general public to ensure their safety. Cordon 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.	
Breaching trench to maximize outflow	Excavate a deep and wide trench with a backactor before breaching to maximize outflow.	
Location of the breaching position.	At the lowest position of the berm. Care should be taken with the breaching location to ensure that the outflow channel does not become unnecessarily long resulting in increased bottom friction, reduction in tidal flushing and premature closure.	

Breaching considerations	Details
<p>Propose area of breaching position</p>	<p>Verlorenvlei estuary</p> <p>Summer Winds</p> <p>Winter Winds</p> <p>- 33.316S ; 18.334E</p> <p>Critical Biodiversity Areas</p> <ul style="list-style-type: none"> CBA: River CBA: Terrestrial CBA: Wetland CBA: Estuary CBA: Forest Verlorenvlei estuary - breaching site Verlorenvlei estuary - access road Provincial reserves <p>100 0 100 200 300 400 m</p>
<p>Estimate amount of sediment to be moved during breaching</p>	<p>Not applicable, as amounts vary significantly between breachings, and cannot be determined in advance.</p>
<p>Disposal of sediment removed during excavation</p>	<p>The sand excavated from the trench should be stored on the banks adjacent to the trench.</p>
<p>Mobilizing machinery and equipment on site during breaching</p>	<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>

Breaching considerations	Details
	<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 DFFE officials access to the designated area for the purpose of assessing and/or monitoring compliance with the conditions contained in the MMP/MaintMP, 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 related to breaching	Salinity: Currently not a consideration for breaching in this system
	Oxygen: >4 mg/l
	Ammonia: Currently not a consideration for breaching in this system
	Toxic substances: Currently not a consideration for breaching in this system
Ecological considerations	Birds: Annual breaching per natural conditions. Maintain the highest possible water levels.
	Fish: Annual breaching per natural conditions. Maintain the highest possible water levels.
	Invertebrates: Annual breaching per natural conditions. Maintain the highest possible water levels.
	Plants: Annual breaching per natural conditions. Maintain the highest possible water levels.

According to the new Environmental Impact Assessment (EIA) Regulations promulgated on 18 June 2010 in terms of the National Environmental Management Act 107 of 1998, the artificial mouth breaching 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. a watercourse;
- II. the sea;
- III. the seashore;
- IV. 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

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

- I. is for maintenance purposes undertaken in accordance with a management plan agreed to by the relevant environmental authority; or
- II. occurs behind the development setback line.

[Listing Notice 1, Activity Number 18]

Application for a special dispensation to implement the mouth management plan for a period of five years (at which time it will be subject to specialist review) is therefore required from DFFE in terms of the need for ecosystem maintenance.

RELEVANT AUTHORITIES

Table 4 lists the key lead authorities involved in artificial breaching at the Verlorenvlei Estuary.

Table 4: Key lead authority involved in artificial breaching

Management authority	CapeNature
Advisory Committee	Verlorenvlei Estuary Forum
Authorisation (breaching / emergency)	DFFE
Lead authority	Minimum consultation In case of Emergency
CapeNature	✓
Cederberg Municipality (Environmental Management and Disaster Management sections)	✓
DEA&DP	✓
Department of Forestry Fisheries and Environment Affairs	✗
Department of Agriculture	✓
DWS	✓
West Coast District Municipality (Environmental Management and Disaster Management sections)	✓
Non-Governmental Organisations	✗

The decision to artificially breach under emergency conditions will be made by CapeNature in consultation with Cederberg Municipality's Environmental Manager, DFFE and DEA&DP. 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). Data on Oxygen levels, water level and berm height, as well as rainfall where feasible, will be collated by the Municipality. Once the RMA has decided that an artificial breach must occur and authorisation (can be verbal) obtained from DFFE, the Disaster Risk Department of the Cederberg Municipality and CapeNature, shall be responsible for overseeing the breaching activities.

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 MaintMP	CapeNature	In process

Planned mouth breaching procedures

In the absence of more detailed information on flow reduction and the mouth behaviour of the Verlorenvlei Estuary only emergency breaching under extremely rare conditions is considered appropriate, i.e. where people's lives are endangered and not agricultural infrastructure or livestock.

Two types of breachings are generally distinguished, namely (a) Planned artificial breachings undertaken according to an approved Maintenance Management Plan and (b) Emergency breaching (e.g. to avoid danger of flooding).

The CapeNature is responsible for the operational aspects of the Verlorenvlei Estuary MMP. They can delegate this function, but ultimately they have oversight. CapeNature (or its delegated structure) are 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;

CapeNature is also responsible for continuous monitoring of the conditions in the estuary and catchment. Once the emergency breaching criteria (Table 3) is met, the decision to artificially breach will be made by CapeNature. 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. DFFE).

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

Emergency conditions could develop when an estuary mouth is closed and oxygen levels falls below 4 mg/l. Constant monitoring of the conditions in the system is then required when emergency conditions develop. Communication between the different role players, i.e. the local municipality and

key authorities (DFFE) 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 breaching relate to floods, Table 3 lists some additional events that can constitute an emergency at the Verlorenvlei Estuary.

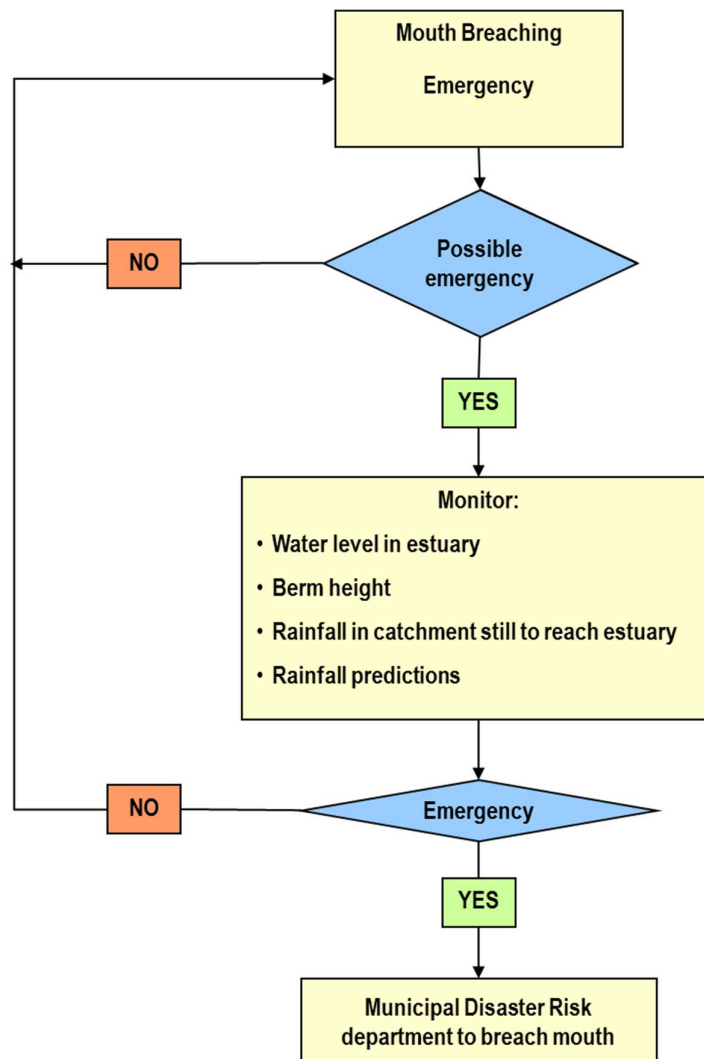


Figure 1: A flow chart illustrating the breaching plan for emergency conditions

Once CapeNature has established that the relevant criteria have been met and that artificial breach must occur, the Disaster Risk Department of the Municipality, shall be responsible for

overseeing the breaching activities. The Disaster Risk Department of the Cederberg Municipality is responsible for 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, CapeNature is responsible for the compilation of a Breaching Incident Report to be provided to DFFE within 14 days of the actual breaching (see “Reporting” for more detail on the report).

Emergency

A flow chart for the undertaking of mouth breachings under emergency conditions is included in Figure 2. 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 (DFFE) 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.
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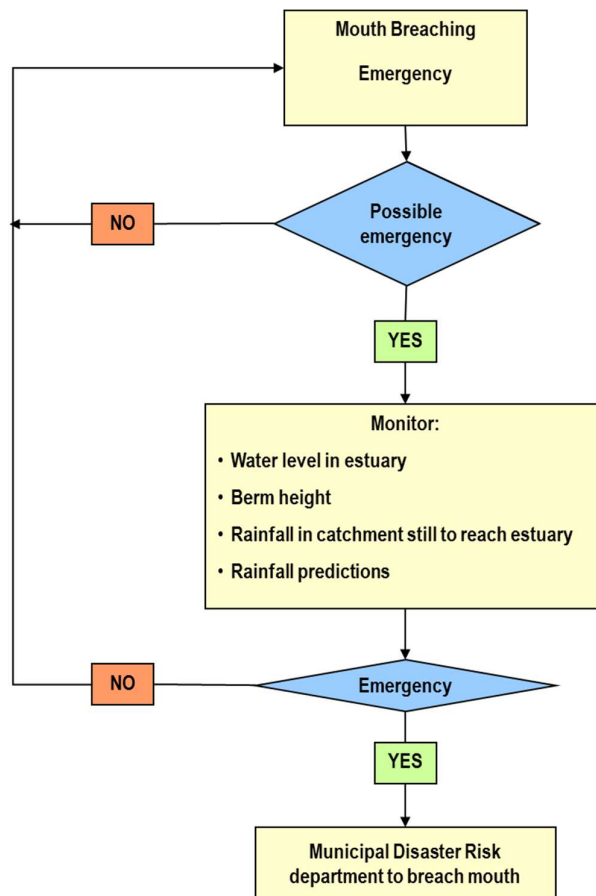


Figure 2: A flow chart of the procedures of an emergency breaching plan

MONITORING PROGRAMME

The following monitoring programme supports the responsible management of artificial breaching in the event of an emergency breaching (Table 1):

Table 1: Monitoring programme for the Verlorenvlei Estuary

MONITORING ACTIONS	FREQUENCY	CRITICAL REQUIREMENT - YES/NO	AGENCY RESPONSIBLE
Weather forecast	Period leading up to breaching	Yes	SA Weather Services
Water levels	Continuous	Yes	DWS gauge
River inflow data	Daily	Yes	DWS gauge (proposed)
Bathymetric surveys	Every 3 years	No	CapeNature
Salinity (quarterly)	Monthly	Yes	CapeNature
<i>In situ</i> water quality measurements (e.g. oxygen)	Monthly	Yes	CapeNature
Berm levels	Monthly (and just before breaching)	Yes	CapeNature
Photographs	To be arranged between authorities before, during and after breaching	Yes	CapeNature
Observations on estuarine vegetation (e.g. inundation of salt marsh, reeds & sedges, occurrence of algal blooms)	Quarterly (and just before breaching)	Yes	CapeNature
Observations on Invertebrate behavior (e.g. invertebrate kills)	Quarterly (and just before breaching)	Yes	CapeNature
Fish surveys Observations on fish behavior (e.g. spawning aggregations, fish kills)	Bi-annually	No	DFFE
Co-ordinated Water bird Counts (CWAC)	Bi-annually	Yes	CapeNature

REPORTING

Following an emergency breaching a Breaching Incidence Report needs to be compiled and provided to DFFE 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. Such feedback sessions provide the opportunity for a critical review of breaching practises and discussions on possible improvements to future MMPs.

Breaching Report

Table 2 below summarises the minimum content of post-breaching report in the event the Verlorenvlei 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 2: Content of Verlorenvlei 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	CapeNature
<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) • Volume of sediment removed during breaching and what was done with the excavated sediment • 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. • Could further problems arise by design of new developments at too low levels? 	Yes	DWS & CapeNature

ACTIONS	LOCAL REQUIREMENT - YES/NO	AGENCY RESPONSIBLE
<ul style="list-style-type: none"> Were there problems with septic tanks before the breaching? If so quantify data since last breaching 		
<u>Location of channel</u> <ul style="list-style-type: none"> Align with historical position of channels Estimated volume of sediment excavated during the breaching 	Yes	CapeNature & Cederberg Municipality
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	DFFE
Avifauna counts (CWAC)	Yes	CapeNature
Other		
<u>Assessment record compiled by:</u> Name: Organization: Date: Contact details:		

Feedback on breaching activities

Table 3 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 stakeholders 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 3: Minimum information required on breaching feedback sessions

MONITORING ACTIONS	LOCAL REQUIREMENT - YES/NO
Responsible agency /authority	CapeNature
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)	
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