



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

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# **Mouth Management Plan for the Piesang River estuary**

October 2019

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## TABLE OF CONTENTS

<b>1</b>	<b>OBJECTIVE OF THE MOUTH MANAGEMENT PLAN</b>	<b>1</b>
<b>2</b>	<b>DESCRIPTION OF THE PIESANG RIVER ESTUARY</b>	<b>4</b>
<b>3</b>	<b>MOTIVATION FOR ARTIFICIAL BREACHING</b>	<b>8</b>
3.1	HYDROLOGY	8
3.2	HYDRODYNAMICS	9
3.3	REVERSE OSMOSIS PLANT	13
<b>4</b>	<b>RELEVANT AUTHORITIES</b>	<b>19</b>
<b>5</b>	<b>BREACHING SPECIFICATIONS</b>	<b>20</b>
<b>6</b>	<b>OPERATIONAL PROCEDURES</b>	<b>22</b>
<b>7</b>	<b>MONITORING PROGRAMME</b>	<b>24</b>
<b>8</b>	<b>REPORTING</b>	<b>26</b>
8.1	BREACHING REPORT	26
8.2	FEEDBACK ON BREACHING ACTIVITIES	27
<b>9</b>	<b>REFERENCES</b>	<b>28</b>
<b>10</b>	<b>APPENDIX A DWS TIDAL GAUGE K6T021 LEVEL TO MEAN SEA LEVEL</b>	<b>29</b>

## TABLE OF FIGURES

Figure 1: Distribution of macrophyte habitats at the Piesang River estuary based on 2013 aerial photographs and field surveys in June 2016.	5
Figure 2: Piesang River estuary: Natural (black) and Present (red) monthly flow distribution showing a significant decrease in river inflow to the estuary in the low flow periods (Van Niekerk et al. 2015).	8
Figure 3: Historical photographs of the Beacon Island before there was any significant development (circa 1930).	10
Figure 4: The Piesang River estuary mouth after significant sea storm in 1942 which removed most marine sediment from Middle beach.	11
Figure 5: Piesang River estuary inlet channel meandering out to sea with an extensive s-curve	11
Figure 6: Photographs from 21 February 2011 (left) and 2018 (right) showing extensive build-up of sediment in the lower Piesang River estuary and low water levels	12
Figure 7: Construction of reverse osmosis plant in Piesang River estuary on 3 November 2010 (Photo: P Huizinga)	13
Figure 8: Unsuccessful excavation channel running from the mouth to the well field (Photo: Lara van Niekerk)	14
Figure 9: A flow chart illustrating the breaching plan for emergency conditions	23
Figure 10: DWS tidal gauge K6T021 level to mean sea level (MSL) for period December 2011 to June 2018.	29

## LIST OF TABLES

Table 1: Description of the estuary and its importance	4
Table 2: Summary of the hydrological change to the Piesang River estuary (Van Niekerk et al. 2015)	8
Table 3: Summary of the mouth conditions for the Piesang River estuary between 2011 and 2018	12
Table 4: Salinity gradient in the Piesang River estuary (Duvenage and Morant 1984)	13
Table 5: Summary of artificial breaching motivation	14
Table 6: Key lead authority involved in artificial breaching	19
Table 7: Piesang River estuary Breaching Specifications	20
Table 8: Monitoring programme for Piesang River estuary	24
Table 9: Content of Piesang River estuary breaching report	26
Table 10: Minimum information required on breaching feedback sessions	27

## ABBREVIATIONS

C.A.P.E	Cape Action for People of the Environment
DAFF	Department of Agriculture, Forestry and Fisheries (former government department)
DEA	Department of Environmental Affairs (former government department)
DEFF	Department of Environment, Forestry and Fisheries (formed by merging DAFF and DEA in June 2019)
DEA&DP	Western Cape Government's Department of Environmental Affairs & Development Planning
DMC	Disaster Risk Centre
DWS	Department of Water and Sanitation
EEW-EPRG	Estuary Warning - Emergency Preparedness and Response Guide
EFZ	Estuarine Functional Zone
EIA	Environmental Impact Assessment
EMP	Estuary Management Plan
I&AP	Interested and Affected Party
ICM Act	National Environmental Management: Integrated Coastal Management Act (Act No. 24 of 2008) as amended by the National Environmental Management: Integrated Coastal Management Amendment Act (Act No. 36 of 2014)
LIDAR	Light detection and ranging
MAR	mean annual runoff
MMP	Mouth Management Plan
MSL	mean sea level
NEMA	National Environmental Management Act (Act No. 107 of 1998)
NEMP	National Estuary Management Protocol
SLR	Sea level rise
SPLUMA	Spatial Planning and Land Use Management Act (Act No. 16 of 2013)
WCG	Western Cape Government
WWTW	Wastewater Treatment Works

# 1 OBJECTIVE OF THE MOUTH MANAGEMENT PLAN

## STATEMENT OF THE PROBLEM

The Piesang River estuary is a temporarily open estuary that closes for extended periods in the low flow summer season. Due to small farm dams and run-off-river abstraction the estuary is now closed for longer periods in summer, resulting in increased sediment build-up in the lower reaches and low water levels in the system.

This is further compounded by direct groundwater abstraction by a reverse osmosis plant in summer from the lower reaches of the system. The level to which the plant impacts on the functioning of estuary is dependent on whether abstraction occurs when the estuary is closed and the ability of the river inflow to replenish the groundwater table.

Ideally the estuary mouth should be open as long as possible to facilitate tidal exchange, improve water quality, and supply seawater for the reverse osmosis process.

## OBJECTIVES OF THE PIESANG MOUTH MANAGEMENT PLAN

- To manage the estuary mouth as an integral part of the Piesang River estuary Management Plan.
- To ensure a healthy functional estuary.
- To prevent long-term sedimentation in the lower reaches of the estuary.

IS ARTIFICIAL BREACHING TO BE CONSIDERED AT THE PIESANG RIVER ESTUARY? <b>(Substantiation provided in section 3)</b>	No	Yes
High water levels	✘	
Floods (emergency)	✘	
Water quality (emergency)		✘
Fish kills (at DEFF; Branch Fisheries discretion as medium important nursery)		✘
<b>IS A MAINTENANCE MANAGEMENT PLAN (MaintMP) REQUIRED?</b>	<b>No</b>	

## KEY DATA /INFORMATION SOURCES

The information presented below has largely been drawn from the 2019 Piesang River Estuary Management Plan that focused on the operational management of the Piesang River estuary; the Desktop Estuary Ecological Water Requirement Study (DWA 2015), and the Breede/Gouritz Reserve study.

## KEY RECOMMENDATIONS IN SUPPORT OF THE PIESANG RIVER ESTUARY MOUTH MANAGEMENT PLAN

The estuary should be allocated enough freshwater flows to maintain open mouth condition for as long as possible, i.e. no further reduction in base flows and no groundwater abstraction.

Nutrient and organic matter inputs to the estuary must be reduced.

Ensure that the reverse osmosis plant does not impact on the health of the Piesang River estuary by reducing open mouth conditions, lowering water levels in closed period or decreasing salinity.

Given the critical importance of the river inflow in maintaining the health of the Piesang River estuary for the local community, it is recommended that a high confidence Ecological Water Requirement study (i.e. Reserve Determination) of the freshwater needs of the Piesang River estuary be undertaken as soon as possible. Unfortunately, this was only done at the Desktop/low confidence level during in the 2015/16 Gouritz Ecological Water Requirement project with the results incorporated into the 2017/8 Breede/Gouritz Classification study. It is therefore once again recommended that regardless of the outcome of this study, a high confidence DWS Environmental Water Requirement (EWR) study be conducted to refine the Ecological flow requirements of the Piesang River estuary. This will ensure that the Resource Quality Objectives for the Piesang River estuary are achieved and that current and future freshwater abstraction does not compromise ecological functioning or ecosystem services provided by the system.

## 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**

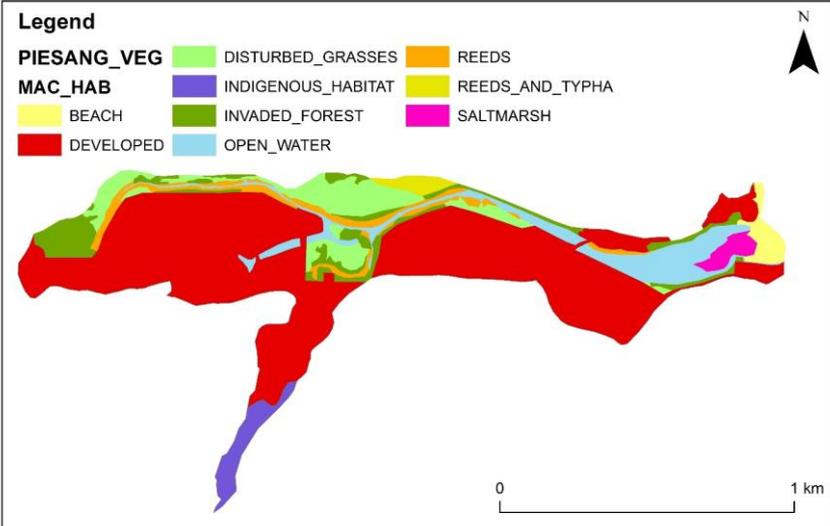
- IV. occurs behind the development setback line.**
- V. is for maintenance purposes undertaken in accordance with a management plan agreed to by the relevant environmental authority; or**
- VI. falls within the ambit of activity 21 in this Notice, in which case that activity applies; occurs within existing 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]**

## 2 DESCRIPTION OF THE PIESANG RIVER ESTUARY

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

Threat		Discussion	
<b>Type and Location</b>		The Piesang River estuary is a small temporarily open/closed estuary in Plettenberg Bay on the south coast of South Africa (DWAf 2008).	
	<b>DOWNSTREAM BOUNDARY:</b>	Estuary mouth	23.378177° E -34.060418° S
	<b>UPSTREAM BOUNDARY:</b>	Head of estuary	23.355953° E -34.062389° S
	<b>LATERAL BOUNDARIES:</b>	Approximated by the 5 m above Mean Sea Level (amsl) contour along each bank	
			
<b>Estuary Importance</b>	<p>The Piesang is a relatively small temporarily open/closed estuary in the Warm Temperate zone (roughly Heuningnes to the Mbashe River). The Estuary Importance Score takes size, the rarity of the estuary type within its biogeographical zone, habitat diversity and biodiversity importance of the estuary into account (DWAf, 2008). Biodiversity importance, in turn is based on the assessment of the importance of the estuary for plants, invertebrates, fish and birds, using rarity indices. These importance scores ideally refer to the system in its natural condition. The Piesang is an "Important estuary" with a score of 71 (Turpie and Clark 2007).</p>		
<b>Conservation status</b>	<p>The National Estuary Biodiversity Plan (NBA, 2011) (Van Niekerk and Turpie, 2012; Turpie et al., 2012) prioritised estuaries for conservation. The biodiversity plan followed a systematic approach that took pattern, process and biodiversity persistence into account. The plan indicates that, on a national scale 133 estuaries (61 require full protection and 72 require partial protection) including those already protected, would be required to meet biodiversity targets (Turpie et al., 2012).</p> <p>The Piesang River estuary forms part of the core set of priority estuaries in need of protection to achieve biodiversity targets in the National Estuaries Biodiversity Plan for the National Biodiversity Assessment (Turpie et al., 2012). The NBA 2011 (Van Niekerk and Turpie 2012) recommends that the Piesang River estuary be partially protected, and that 50% of the estuary margin be undeveloped.</p>		

Threat	Discussion
<p><b>Important vegetation</b></p>	<p>Little natural riparian habitat remains at the Piesang River estuary due to recreational and residential development and the stabilising/reclaiming of the estuary banks. Invasive plants are extensive in the valley and the remaining forest habitat has been damaged by roads and tracks around the estuary. There is some potential to rehabilitate sections of the Piesang River at the Roodefontein Golf Estate and in the upper catchment.</p> <p>Common reed <i>Phragmites australis</i> fringe the open water in the middle and upper reaches. Reeds and <i>Typha capensis</i> occur in a wetland area on the north bank. Some sedges, <i>Cyperus laevigatus</i> and <i>Cyperus textilis</i>, fringe this habitat. <i>Triglochin elongata</i> occurs in the undergrowth of the reeds in the middle reaches opposite the townhouses above the Beacon Isle Drive bridge. <i>Juncus kraussii</i>, <i>Cyperus laevigatus</i> and <i>Cyperus textilis</i> occurs on the north bank in the recreational area above the Beacon Isle Drive bridge. The sedge <i>Eleocharis limosa</i> is present in the lower reaches of the estuary on the sheltered muddy south bank below the bridge. While a small area of <i>Sarcocornia natalensis</i> subsp. <i>natalensis</i> and <i>Bassia diffusa</i> salt marsh occurs in the lower reaches of the estuary. These saltmarshes die back during periods of mouth closure. At higher elevations <i>Sporobolus virginicus</i> covers the sand. Eelgrass <i>Zostera capensis</i> has also been recorded in the estuary in the past indicating that the estuary opens regularly and experiences tidal exchange (Adams and Bornman 2007).</p>  <p><b>Figure 1: Distribution of macrophyte habitats at the Piesang River estuary based on 2013 aerial photographs and field surveys in June 2016.</b></p>
<p><b>Important fish nursery</b></p>	<p>The Piesang is listed as of medium importance as a nursery for fish due to its high species diversity and abundance in relation to its small size. Recent field observations indicate that the estuary is especially important for White Steenbrass (which is a collapsed fish resource in South Africa) (personal observations, Dr K Hutchings).</p> <p>Between 7 and 13 fish species have been recorded in the system (Duvenage and Morant (1984), Harrison (1999), SANParks, unpublished data (2004), Anchor Environmental, unpublished data (2010)). Mullet were abundant in the estuary in 1980, with about 500 juveniles Sea Barbel caught in a short trawl net sampling session</p>

Threat	Discussion
	<p>Duvenage and Morant (1984). Other species caught include: Sea Barbel, Groovy Mullet, Southern Mullet, Blackhand sole, Cape stumpnose, Knysna sand goby and Prison goby. At least five species (mullet were not identified to species level), including high numbers of estuarine dependent species (white steenbras, cape stump and Cape moony) were recorded in February 2004 (Kyle Smith, SANParks, unpublished data). 13 species were collected in high numbers (&gt; 2000) in September 2010 (Anchor Environmental, unpublished data) including Southern mullet, Groovy mullet, Freshwater mullet, Flathead mullet, Estuarine goby, Knysna sand goby, silverside, Estuarine round herring, Cape Stumpnose, White Steenbras, Black hand sole, pipefish, and mosquito fish.</p> <p>Overall fish abundance was high for such a small system. The system serves as a nursery as shown by significant numbers of fish in the 0+ to 2-year age classes observed in the system. Monitoring data for the reverse osmosis plant was not readily available, but Anchor Environmental (pers. comm., Dr B Clark) rate the system as very important from a nursery perspective.</p>
<b>Important Invertebrates</b>	<p>Very little information is really available in the invertebrates of the Piesang River estuary. Duvenage and Morant (1984) report 23 taxa of zooplankton in the Piesang River estuary.</p> <p>While the reverse osmosis plant monitoring data was not readily available for incorporation in this report, unpublished data on subtidal macrobenthos indicate 21 taxa, with lowest densities near the mouth where the sediment is coarse (Anchor Environmental, 2010).</p> <p>Invertebrates are sensitive to reduction in flow, increased mouth closure, changes in the salinity regime and a decline in water quality conditions, therefore a decline in overall inveterate species richness, abundance and community composition is expected (Van Niekerk et al. 2015).</p>
<b>Important Bird site</b>	<p>Limited information is available on the birds of the Piesang River estuary, but numbers as estimated as very low due to its small size and incised topography (DWS 2015). Duvenhage and Morant (1984) only reported 2 Pied Kingfishers, 4 Cape Wagtails and 140 Black Backed Gulls. More recently (Anchor Environmental, unpublished data, 2010) observed 17 species (&gt;200 birds over 2 counts). This is considered a relative high count for a small estuary. The birds are severely disturbed by human activities in this system.</p>
<b>Estuary Condition w.r.t breaching</b>	<p>A desktop Piesang Estuarine Health Assessment was updated as part of a Water Research Commission study (Van Niekerk et al. 2015) and incorporated in the Department of Water and Sanitation Reserve Determination Studies for the Gouritz Water Management Area (DWS 2015). The health condition (also referred to as the Present Ecological State (PES)) of an estuary is defined on the similarity of its current condition to an estimated natural condition. The health condition is described using six Ecological Categories, ranging from natural (A) to critically modified (F).</p> <p>The overall ecological health of the Piesang River estuary was a D Category. The Piesang River estuary is negatively impacted by</p> <ul style="list-style-type: none"> <li>• A significant reduction in baseflows to the system;</li> <li>• Direct abstraction of water from the mouth region for the reverse osmosis plant causing increased mouth closure and low water levels;</li> <li>• A decline in water quality as a result of urban runoff;</li> <li>• Development in the Estuary Functional Zone (EFZ) and related loss of habitat; and</li> <li>• Human disturbance (which influence bird abundance).</li> </ul>

Threat	Discussion
<b>Recommended Ecological Condition</b>	<p>The Piesang River estuary should be managed towards a Recommended Ecological Condition of a Category B/C (DWS 2015). The motivation being that the estuary is of high conservation importance (Van Niekerk and Turpie, 2012). The following key interventions are required to improve its condition (DWS 2015):</p> <ul style="list-style-type: none"> <li>• Maintain the present flow regime (<math>MAR_P = 3.4 \times 10^6 \text{ m}^3</math>), but an increase in the base flow is required to meet the REC;</li> <li>• Improve the water quality;</li> <li>• Remove reverse osmosis plant from estuary functional zone.</li> </ul> <p>However, it is noted that the 2018 NBA (SANBI 2019) suggests a an REC of Category D</p>

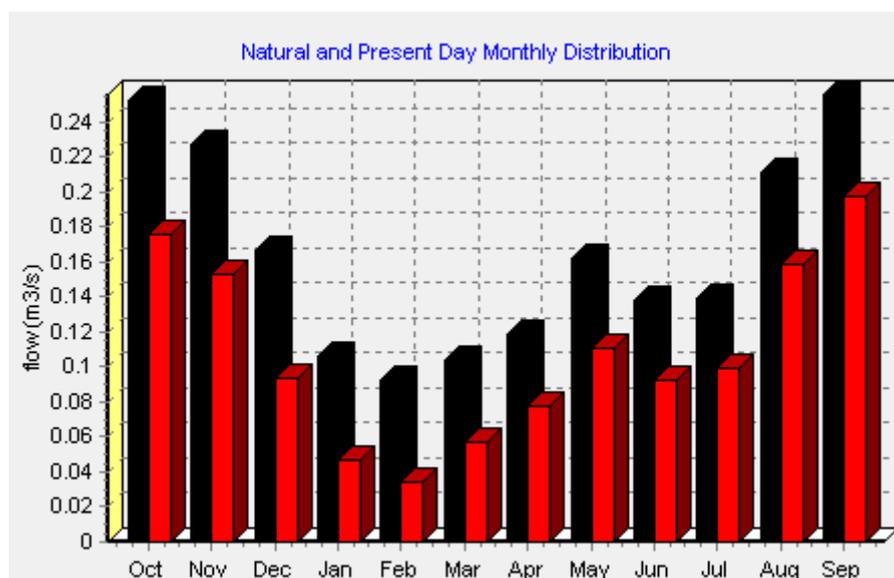
## 3 MOTIVATION FOR ARTIFICIAL BREACHING

### 3.1 Hydrology

The catchment of the Piesang River estuary is estimated at about 35 km<sup>2</sup> with a total river length of about 17 km (Duvenhage and Morant 1984). The Piesang catchment receives rainfall throughout the year, with peaks in autumn and spring. The mean annual runoff (MAR) to the Piesang River estuary was estimated at about 5.2 x 10<sup>6</sup> m<sup>3</sup> under natural condition (Table 2 & Figure 2). This has been reduced by 34% to about 3.4 x 10<sup>6</sup> m<sup>3</sup> under the Present State (DWS 2015). A broad assessment of the changes in runoff to the estuary shows both a reduction in low and high flow months with a related increase in the low flow period.

**Table 2: Summary of the hydrological change to the Piesang River estuary (Van Niekerk et al. 2015)**

Parameter	Summary of change in flow parameters
Reference MAR (million m <sup>3</sup> /a)	5.2
Present MAR (million m <sup>3</sup> /a)	3.4
% MAR similarity	66
% Base flow similarity	36
Change in high flow duration	Yes
Change in low flow duration	Yes
Shift in high flow onset month	Yes



**Figure 2: Piesang River estuary: Natural (black) and Present (red) monthly flow distribution showing a significant decrease in river inflow to the estuary in the low flow periods (Van Niekerk et al. 2015).**

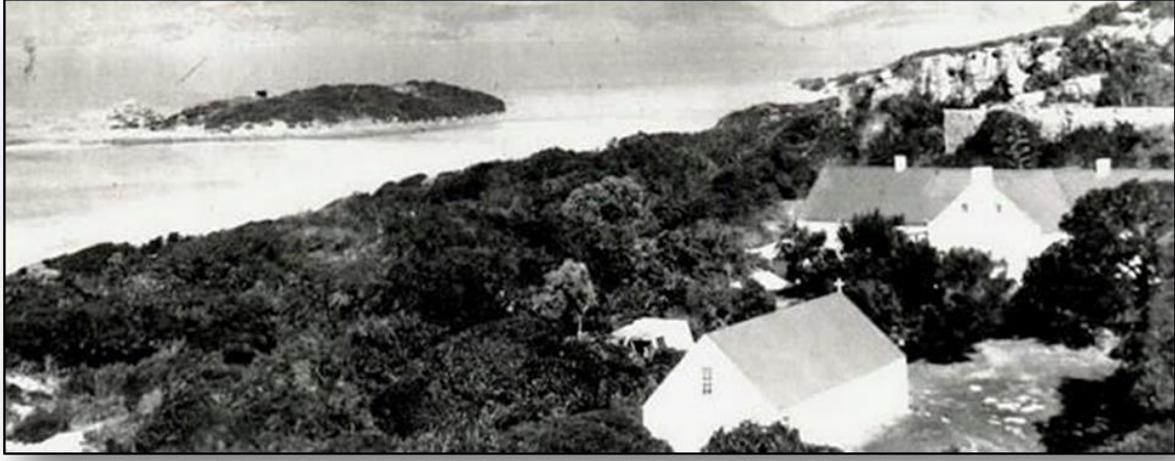
## 3.2 Hydrodynamics

There is limited scientific information on the hydrodynamics of the Piesang River estuary. The estuary stretches for about 2 km from its mouth at the Beacon Island to the upper road bridge below a golf estate. The river leaves the narrow valley at the Otto du Plessis bridge and enters an open basin, 200 x 600 m in extent behind the sand bars adjoining Beacon Island. A shallow channel, 0.5 x 0.75 m deep and about 20 m wide, scours its way to the sea along the rocks at the landward side of the Beacon Island. This channel is kept open by river flow. The mouth is very constricted with tidal exchange generally very weak. During dry periods, mainly summer, the mouth closes. Extensive developments occur within the EFZ of the Piesang River estuary. Three large bridges obstruct natural water flow in the system (Duvenhage & Morant 1984). A 45 m concrete foot bridge links the Beacon Island Hotel to the Central Beach. It is supported on two columns in the estuary. Occasionally the width of the mouth is greater than the length of the footbridge, thus preventing pedestrians from using it.

To the north-east of the estuary mouth, a large sand bar (80 x 100 m wide) blocks the lower estuary basin and is fused with Central Beach. This sand bar is breached by high flow and flood events, but historical records show that artificial breaching has also been practised to prevent flooding of the Caravan park upstream of the Otto du Plessis bridge. Holiday houses, situated on the outer bend of the river and only a few metres above normal flow levels, could also be prone to inundation during floods.

Along the South African high energy coastline, the longer an estuary mouth stays closed, the more the sediment builds up in its mouth region under the influence of wave action and aeolian transport over time. This process is further exacerbated by sea storms. The extended mouth closure of the Piesang River estuary as a result of the abstraction of estuarine and subsurface fresh water thus not only caused reduced open water area and water levels, but also contributed towards the build-up of significant sediment in the mouth region of the estuary in response to prolonged closed periods. It should also be noted that accumulated sediments, manifesting in increased berm height and width, pose a flood risk to adjacent riparian properties and developments.

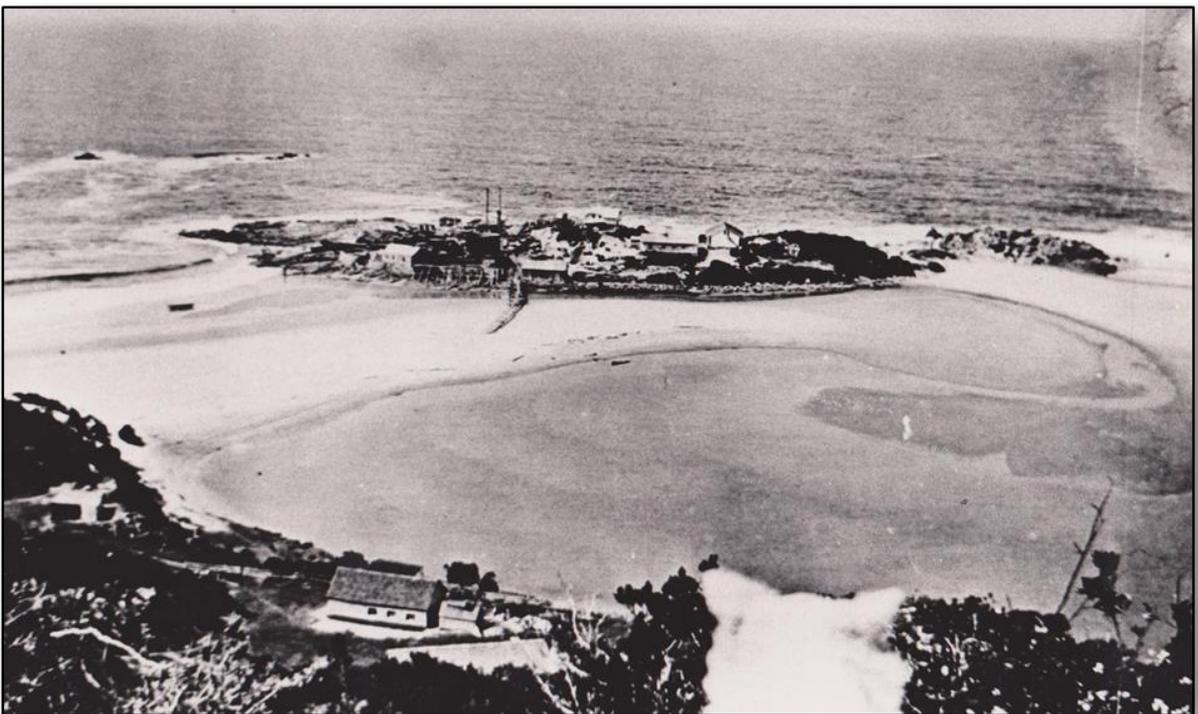
Historical imagery show that the Piesang River estuary channel meandered across the lower reaches of the system in extensive s-curves. Looking at the pre-development photographs, it is highly likely that the estuary outlet could have mouthed out either side of the Beacon Island and that it often was a real island (Figure 3, Figure 4 and Figure 5). The road and other developments connecting Beacon Isle now constrain the estuary mouth to opening on Central beach (Figure 6). These historical images also show a large open water area in the lower estuary near the mouth. Also evident from these images is the fact that the estuary was a predominantly open system in contrast with the photograph taken during February 2018 showing a very small open water area Figure 6.



**Figure 3: Historical photographs of the Beacon Island before there was any significant development (circa 1930).**



**Figure 4: The Piesang River estuary mouth after significant sea storm in 1942 which removed most marine sediment from Middle beach.**



**Figure 5: Piesang River estuary inlet channel meandering out to sea with an extensive s-curve**



**Figure 6: Photographs from 21 February 2011 (left) and 2018 (right) showing extensive build-up of sediment in the lower Piesang River estuary and low water levels**

Water level data were only available from 2010 for the Piesang River estuary (Table 3 and Appendix A). The data show that the estuary was mostly open or partially open from about mid-2011 to October 2013. The system was mostly closed with overwash in 2014 to about April 2015. From then onwards the estuary was mostly open again till December 2016, albeit at times with a small tidal amplitude and ingress by significant overwash during spring tides. However, from January 2017 to May 2018, the estuary closed, with only limited overwash during September to December 2018 connecting it to the sea. This period correlates with a very low river inflow of 0.05 m<sup>3</sup>/s measured during that period. What is also clear from the water level data is how low the water was during the 2017/18 closed period (between 0.5 and 1.0 m) in comparison with other closed periods (between 1.0 and 1.5 m).

**Table 3. Summary of the mouth conditions for the Piesang River estuary between 2011 and 2018**

Open		Closed		Comment
Date	Water level (m)	Date	Water level (m)	
		2010	1.176	Record starts during a closed period
07/05/2011	1.907	03/06/2011	1.356	
08/06/2011	1.57	14/05/2012	0.779	Closing with a lot of overwash
14/07/2012	1.572	16/07/2013	0.911	
23/07/2013	1.351	31/07/2013	0.967	
08/08/2013	1.544	14/09/2013	1.104	Closed with overwash
02/11/2013	1.162	09/01/2014	1.029	Closed with overwash
25/04/2014	1.624	03/06/2014	1.66	
15/06/2014	1.92	24/06/2014	1.106	
29/08/2014	1.776	06/09/2018	1.222	Closed with overwash
04/04/2015	2.02	13/04/2015	0.791	Closing with significant overwash
01/09/2015	1.637	03/02/2016	0.575	Opening with good tidal influence, moving to a closed state with significant over wash
03/09/2016	1.515	10/01/2017	0.91	Variable tidal or over wash influence not clear closure
24/08/2017	2.062	27/09/2017	1.013	Closed with overwash

### 3.3 Reverse osmosis plant

Since 2010, a reverse osmosis plant (see Figure 7) has started taking water directly from the Piesang River estuary leading to an increase in closed mouth conditions when it is operating and a decline in water levels under the closed mouth state (DWS 2015). During 2018 the water levels in the Piesang River estuary were alarmingly low (Figure 7).



**Figure 7: Construction of reverse osmosis plant in Piesang River estuary on 3 November 2010 (Photo: P Huizinga)**

The Piesang is a typical black water oligotrophic, acidic system. Salinities in the estuary varies considerably from nearly fresh during the closed phase to very saline during the open state (Table 4)

**Table 4: Salinity gradient in the Piesang River estuary (Duvenage and Morant 1984)**

Date	Salinity gradient
Dec 1968	31 to 35 (head of the estuary to the mouth)
May 1969	27 to 32 (head of the estuary to the mouth)
March 1984	7 to 35 (salt wedge detected 2.5 km from mouth)
Sep 1981	0.5 to 35

In an unsuccessful attempt to facilitate seawater intrusion onto the well field area in the lower estuary during an extended closed phase, an inlet channel was excavated from the mouth to the reverse osmosis plant (Figure 8). However, this practise is strongly discouraged as it can cause further long-term sediment intrusion into the lower estuary during storm events, compounding the issue of reduced open water area and potentially disrupt the natural salinity profile of the estuary. Such interventions would thus further degrade the estuary physical processes which support its ecological functioning and which in turn are driving the system into an altered state of a lower ecological value.



**Figure 8: Unsuccessful excavation channel running from the mouth to the well field  
(Photo: Lara van Niekerk)**

A summary of the motivations for potential artificial breaching is provided below in Table 5.

**Table 5: Summary of artificial breaching motivation**

		Potential Threat	Relevance
Human wellbeing and safety	Threat to human life (as a result of high-water levels)		N/A
	Threat to immovable property and infrastructure (as a result of high-water levels)		Not recorded, but needs to be verified.
	Human health impact (e.g. flooding of sewage pump station, septic tanks, chemical storage yards, etc.)		Not recorded, but the stagnant conditions associated with a closed mouth could pose a risk for bathers.
	Reverse osmosis plant		During open mouth conditions when the inlet channel is well formed the plant can abstract seawater from the lower mouth area.  During closed mouth conditions the plant will not have access to seawater and would be using mixture of estuarine and subsurface ground water from the river.
	Potential loss of agricultural resources (as a result of high-water levels)		Not relevant.
	Potential impact on nearshore environment if		Not relevant.

Potential Threat		Relevance	
	breached (e.g. aquaculture facilities)		
	Loss/impaired access (e.g. roads, footpaths, cattle crossings)	Higher water levels will inundate foot bridge at Beacon Island and could potentially inundate some of the walkways along the estuary for short periods.	
	Harmful / Noxious algal blooms	During closed mouth conditions macrophyte blooms developed in the Piesang River estuary as a result of stagnant conditions and nutrient enrichment.	
		Impact of artificial breaching	Recreational Fishing: The small estuary does not support significant recreational fishing. Swimming: Local residents generally prefer open mouth conditions.
		Impact of NOT breaching	Access: Foot bridge to Beacon Island Hotel will be inundated. Recreational Fishing: The small estuary does not support significant recreational fishing. Swimming: Some local residents associate poor water quality and noxious algal blooms with closed mouth state and therefore prefer an open state.
Ecosystem requirements	Impact on avifauna abundance, richness/ composition, species community	Important bird habitat	Not relevant as not considered important bird habitat.
		Impact of artificial breaching	Water fowl benefit from closed mouth conditions.
		Impact of NOT breaching	Mouth closures and related high-water levels have a negative effect on waders, gulls and terns as they prefer the sandbanks in lower estuary. The associated higher water levels and reduction in fish abundance also indirectly impact on the Cormorants, wading piscivores, kingfishers and fish-eagles.
		Occurrence of avian botulism	No data.
	Impact on estuarine fish abundance, richness/ composition, species community	Important fish nursery	Piesang River estuary is of medium importance as a fish nursery area, but does play an important function in supporting endemic fish species (90% of fish found in the systems are endemics). The most important exploited fish species in the Piesang and other estuaries in the region are <i>Argyrosomus japonicus</i> , <i>Lithognathus lithognathus</i> , <i>Lichia amia</i> and <i>Pomadasy commersonii</i> . All four of these are obligated to spend at least their first year of life in estuaries. The accessibility of the Piesang and high catchability of juveniles and subadults in the estuary makes these species extremely vulnerable to overexploitation. Nationally, the stocks of <i>A. japonicus</i> and <i>L. lithognathus</i> are in a collapsed state. Estuarine fish stock cannot be

Potential Threat		Relevance	
			considered as discrete and in isolation from the marine environment. The current status of estuarine stocks is largely a reflection of the nationwide decline that has occurred for most linefish species. Lamberth & Turpie (2003) (updated in 2018) estimated a total landed catch of 4 tonnes per annum from the Piesang River estuary.
		Impact of artificial breaching	Facilitate estuarine connectivity to the sea and allows young adult fish to return to the sea.
		Impact of NOT breaching	Low water levels and poor water quality in the Piesang during the closed phase could reduce growth and impact on nursery function.
		Occurrence of fish kills	Not recorded.
Impact on estuarine invertebrate abundance, species richness/ community composition		Importance for invertebrates	Not relevant as not considered important invertebrate's habitat.
		Impact of artificial breaching	The continued existence of Mud prawn <i>Upogebia africana</i> is directly dependent on an open tidal inlet. Opening of the mouth during the breeding season enable populations survive over time in some estuaries. However, should the mouth remain mostly closed during the breeding season (summer), recruitment ceases and estuarine mud prawn densities decline or even become locally extinct.
		Impact of NOT breaching	Closed mouth conditions lead 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 Piesang River Estuary which are adapted to life in a more tidal system and loss of recruitment of key species such as Mud prawn <i>Upogebia Africana</i> .
		Occurrence of invertebrate kills	Not applicable.
Estuarine Macrophytes (plants)		Impact of artificial breaching	Open mouth conditions create intertidal habitat for reeds and sedges. Fluctuating water levels 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)	Macroalgae can proliferate during the closed mouth phase. Anthropogenic nutrient inputs can encourage macroalgal growth and cause macroalgal blooms by opportunistic algae. <i>Ulva</i> , <i>Enteromorpha</i> and <i>Cladophora</i> often form accumulations due to their filamentous nature and higher nutrient uptake rates than thicker algae. The formation of these mats has

Potential Threat		Relevance
		<p>many unpleasant side effects; they choke waterways, limit light penetration to deeper waters, cause extinction of benthic fauna and flora and pollute recreational beaches. When these mats decompose, they cause anoxia and anaerobic bacterial activity leads to increased levels of hydrogen sulphide in the sediment and the atmosphere.</p> <p>Water depth and water level fluctuations influence distribution and abundance of reeds. Submergence affects the plants differently depending on the season. Submergence during autumn is likely to have a negative impact since this is when nutrients are remobilised for spring growth. In spring new plants and shoots are establishing and submergence would inhibit growth. Leaves cannot photosynthesis underwater. Winter submergence is less severe than for the other seasons as this is when the plants die back naturally.</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 relevant.
	Dissolved Oxygen levels	< 4 mg/l
	Ammonia levels	Not relevant.
	Toxic substance in the context of breaching	Not relevant.
	Pollution sources include agricultural return flow, storm water and hydrocarbons from boat fuel.	
Eutrophication	Excessive reed growth	Extended mouth closure and associated low salinities and stagnant conditions favour excessive reed growth.
	Macrophyte blooms	Macrophyte blooms occur in parts of the estuary under closed mouth conditions (observed in 2018)
	Harmful algal blooms	No data, but could occur during closed mouth conditions in summer.
Sedimentation	Ongoing sedimentation	Concerns exist that freshwater abstraction may reduce flow and cause sedimentation in the lower reaches. However artificial breaching at low water levels can further reduce sediment scouring and can cause on-going sedimentation.

Event Type	Breach Yes/No	Motivation
Major flood events associated with severe (river) flood damage	No	Most properties are above the flood level. Not aware of regular flood damage.
High flood levels because of influx of water through the mouth or over the berm because of very high waves in the sea.	No	Not been observed at this system.
Poor water quality	No	Low oxygen levels throughout the system may be considered an emergency (must be verified through estuarine specialist consultation). Salinity levels are not a consideration because the system fluctuates significantly in salinity regime.
Fish kills	No	DEFF to determine if major fish kill can be remedied by breaching, as the estuary is <b>an important nursery estuary for White Steenbras</b> (Collapsed fish stock).
Hazardous spill	Yes	Breaching will only be considered if the hazardous substance holds no risk to nearshore environment and the incident is registered as a disaster In the event of an Oil spill at sea, the mouth of the Piesang River estuary can temporarily be closed to prevent oil from entering the system.

## 4 RELEVANT AUTHORITIES

Table 6 lists the Key lead authorities involved in artificial breaching at the Piesang River estuary.

**Table 6: Key lead authority involved in artificial breaching**

<b>Management authority</b>	Bitou Municipality (or other Managing authority))	
<b>Advisory Committee</b>	Piesang River estuary Forum	
<b>Authorisation (breaching emergency)</b>	DEA&DP	
<b>Lead authority</b>	<b>Minimum consultation In case of Emergency</b>	
Bitou Municipality (including Disaster Management)	✓	
Garden Route District Municipality	✓	
DEA&DP	✓	
Department of Environment, Forestry and Fisheries	✓	
CapeNature	✓	
<p>The decision to artificially breach in an emergency will be made by a sub-committee comprising of as a minimum the Local Municipality, DEA&amp;DP, DEFF: Branch Fisheries and CapeNature.</p> <p>Data on water level, berm height, salinity, as well as water quality parameters where feasible, will be collated by the managing authority in conjunction with the Garden Route District Municipality, CapeNature and representatives of the local community.</p>		
<b>Disaster Management</b>	<b>Authority/Organisation</b>	<b>Status</b>
<b>Early warning system</b>	South African Weather Services (weather)	Yes
	DWS warning system (flow/water levels/dam safety)	No
<b>Disaster Management Plan</b>	Municipality	Yes
<b>Approved Maintenance Management Plan</b>	Municipality	No

## 5 BREACHING SPECIFICATIONS

The Piesang River estuary mouth is, like almost every estuary mouth, highly dynamic. Mouth conditions and configuration of channel and sand banks upstream of the mouth are ever changing. In principle, interference to rectify perceived problems such as sedimentation, should thus not be allowed.

Generally, the constricted entrance channel is flushed open after medium to large floods, only to become constricted again during periods of lower flow over time. However, as concerns exist about increased sedimentation, regular bathymetric surveys should be undertaken and the results analysed and compared with those of earlier surveys, before artificial breaching or other interventions such as dredging are implemented. Concerns regarding sedimentation were also raised in the past, but little information is available to quantify this. It was therefore not justified to undertake substantial remedial measures to manage sedimentation.

The following breaching specifications need to be met before artificial breaching of the Piesang River estuary can be considered (Table 7):

**Table 7: Piesang River estuary Breaching Specifications**

Breaching considerations	Details		
Minimum breaching level (water level should be as high as possible before breaching)	>2.5 m MSL (to be confirmed)	Yes	Level to MSL
	Natural breaching at water levels > 3.5 m above MSL is preferred with no or minimal interference. In the absence of "emergency" conditions (see Section 3), artificial breaching must not be contemplated to prevent on-going sedimentation.		
Optimum breaching period (if applicable)	Not relevant.		
Water releases	Not relevant.		
Neap-spring breaching considerations	Preferably 3-4 days before spring tide, but priority should be given to wave conditions and water levels.		
Timing of breaching	Breach at or shortly after high tide, provided waves will not be interfering. (At 3-4 days before springtide this will normally be by mid-afternoon.)		
Consider safety of public during breaching	Care should be taken with the general public to ensure their safety during emergencies.		
Breaching trench to maximize outflow	Excavate a deep and wide trench before breaching to maximize outflow. A large bulldozer would be ideal to achieve this. A backactor or even a small bulldozer is far less sufficient for this.		
Location of the breaching position.	At an emergency breaching the mouth should be breached where the berm is the lowest and narrowest.		
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		

Breaching considerations	Details
	reducing the effectiveness of the outflow and the wider and deeper scouring of this trench.
Estimate amount of sediment to be moved during breaching	Not applicable, as amounts vary significantly between breachings. This can therefore not be determined in advance.
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 does not disturb indigenous vegetation of conservation worthiness on route to the excavation site. Bird nesting areas are to be avoided. Where possible existing access road / track should be used.</p> <p>Implement an appropriate control mechanism, such as erecting comprehensive signage with information of the breaching area 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>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: &lt; 4 mg/l</p> <p>Toxins: Not a consideration</p>
Ecological considerations	Vegetation: Breaching per natural conditions in early spring.
	Fish: Breaching per natural conditions in early spring.
	Invertebrates: Breaching per natural conditions in early spring.
	Birds: Not a key consideration

## 6 OPERATIONAL PROCEDURES

Two types of breachings are generally distinguished, namely:

- Planned artificial breachings undertaken according to an approved maintMP; and
- Emergency breaching (e.g. to avoid danger of flooding).

**In the absence of more detailed information on the mouth behaviour of the Piesang River estuary only emergency breaching under extremely rare conditions is considered appropriate.**

The managing authority (in consultation with DEA&DP) is responsible for the operational aspects of the Estuary MMP. They can delegate this function, but ultimately, they have oversight. The managing authority 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;

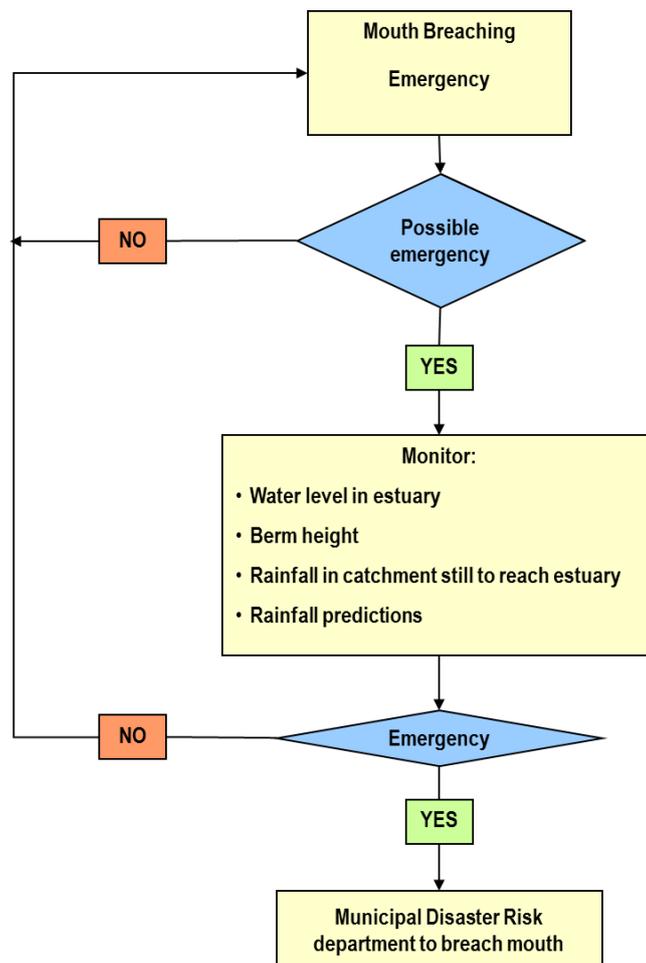
The delegated authority is also responsible for continuous monitoring of the conditions in the estuary when oxygen levels become low (<4 mg/l). Once the emergency breaching criteria (see Section 5) have been met, the decision to artificially breach will be made by the DEA&DP. Note, that an estuary mouth 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 9. Emergency breachings should be undertaken in the swiftest manner possible according to this Estuary MMP.

Emergency conditions could develop when an estuary mouth is closed and severe rainfall occurs in the catchment causing a large flood. 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 and key authorities 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; and
- The availability of equipment to breach the mouth on short notice.

While most emergency breaching operations relate to floods Section 3 lists some additional events that can constitute an emergency at the Piesang River estuary.



**Figure 9: A flow chart illustrating the breaching plan for emergency conditions**

Once 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, the delegated authority 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 8):

**Table 8: Monitoring programme for Piesang River 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 K6T021 (2010-2019)
River inflow data	Daily	Yes	DWS gauge
Bathymetric surveys	Every 3 years	Yes	Delegated authority
Salinity	Monthly (and day before and after 5 to 10 days after a breaching)	Yes	Delegated authority
<i>In situ</i> water quality measurements (e.g. oxygen)	Monthly	Yes	Delegated authority
Berm levels	Monthly (and just before breaching if breaching is planned)	Yes	Delegated authority
Observations on estuarine vegetation (e.g. inundation of salt marsh, reeds & sedges, occurrence of algal blooms)	Quarterly (and just before breaching)	Yes, just before breaching	Delegated authority
Observations on Invertebrate behaviour (e.g. invertebrate kills)	Quarterly (and just before breaching)	Yes, just before breaching	Delegated authority
Fish surveys Distribution, abundance, movement and behaviour (e.g. recruitment, aggregations, fish kills)	Bi-annually	Yes	DEFF
Co-ordinated Water bird Counts (CWAC)	Bi-annually	Yes	CapeNature

Given the critical importance of the river inflow in maintaining the health of the Piesang River estuary for the local community, it is recommended that a high confidence Ecological Water Requirement study (i.e. Reserve Determination) of the freshwater needs of the Piesang River estuary be undertaken as soon as possible. Unfortunately, this was only done at the Desktop/low confidence level during in the 2015/16 Gouritz Ecological Water Requirement project with the results incorporated into the 2017/18 Breede/Gouritz Classification study. It is therefore once again recommended that regardless of the outcome of this study a high confidence DWS

Environmental Water Requirement (EWR) study be conducted to refine the Ecological flow requirements of the Piesang River estuary. This will ensure that the Resource Quality Objectives for the Piesang River estuary are achieved and that current and future freshwater abstraction do not compromise ecological functioning or ecosystem services provided by the system.

## 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 information as possible 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 9 below summarises the minimum content of a Piesang River estuary Breaching Report. The initial report should be compiled within about two weeks of breaching, with data gaps (e.g. duration open) addressed after mouth closure.

**Table 9: Content of Piesang River 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 (waves calm/stormy)</li> </ul>	Yes	Managing authority/DEA&DP
<u>Estuary Information</u> <ul style="list-style-type: none"> <li>Water level before breaching</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? Distinguish between short-term and long-term measures.</li> <li>Could further problems arise by approval of new developments at too low levels?</li> <li>Were there problems with septic tanks before the breaching? If so quantify.</li> <li>Photographs</li> </ul>	Yes	Managing authority/DEA&DP
<u>Location of channel</u> <ul style="list-style-type: none"> <li>Align with historical position of channels</li> <li>Reduce channel length</li> </ul>	Yes	Managing authority/DEA&DP

ACTIONS	LOCAL REQUIREMENT - YES/NO	AGENCY RESPONSIBLE
Period the mouth stayed open	Yes	Managing authority/DEA&DP
Do bathymetric surveys result show ongoing sedimentation?	Yes	Managing authority/DEA&DP
Salinity measurement before and after breaching	Yes	Bitou Municipality/ DEA&DP
Macrophyte conditions	Yes	
Fish recruitment survey	Yes	DEFF
Avifuna counts (CWAC)	Yes	CapeNature
Other		
<u>Assessment record compiled by:</u>		
Name:		
Organization:		
Date:		
Contact details:		

## 8.2 Feedback on breaching activities

Table 10 below summarises the minimum information required as evidence of breaching feedback reporting. 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.

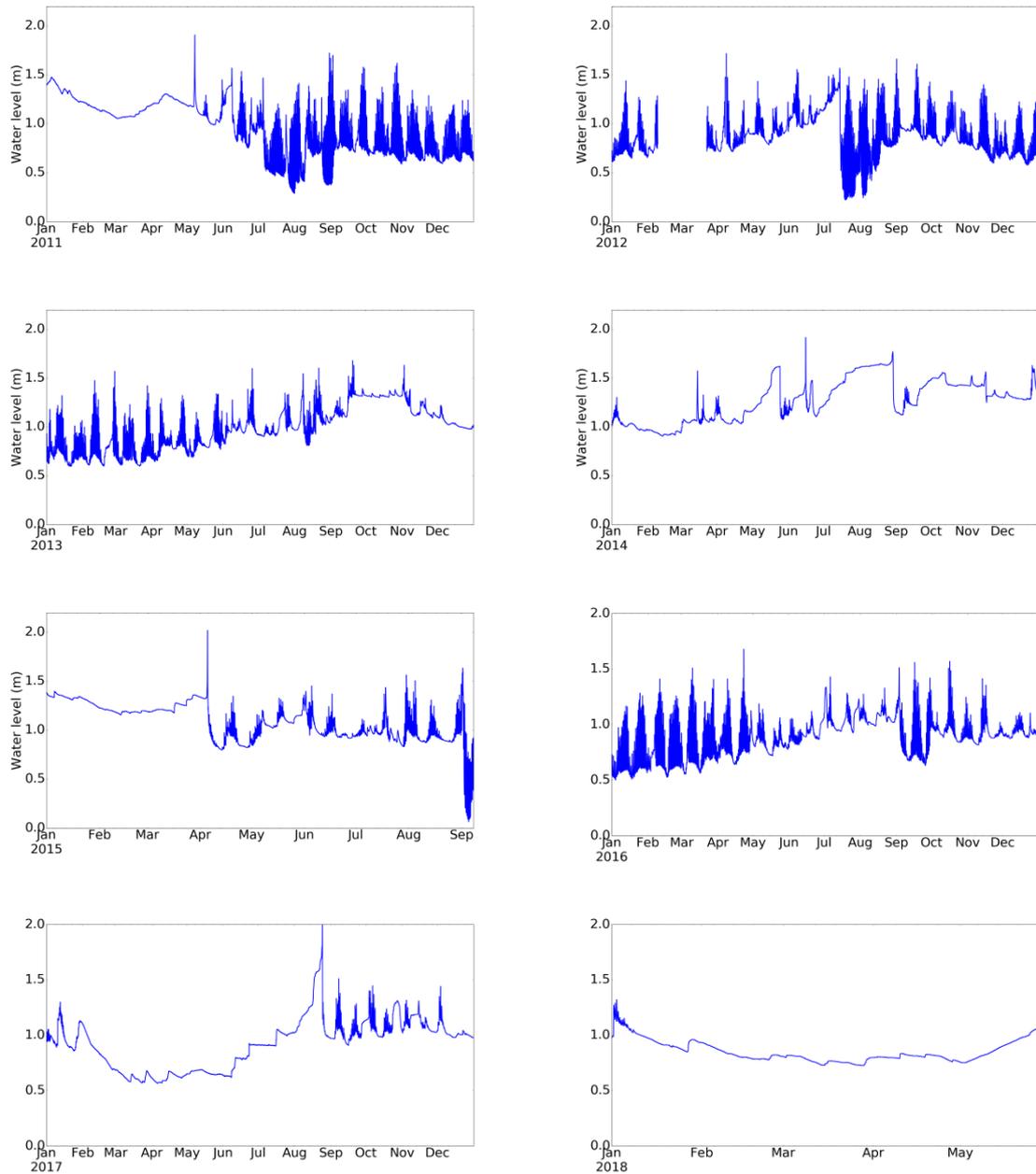
**Table 10: Minimum information required on breaching feedback sessions**

ACTIONS	LOCAL REQUIREMENT - YES/NO
Responsible agency /authority	Managing Authority
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)	

## 9 REFERENCES

- Department of Water Affairs and Forestry (DWAF). 2008. Water Resource Protection and Assessment Policy Implementation Process. Resource Directed Measures for protection of water resources: Methodology for the Determination of the Ecological Water Requirements for Estuaries. Version 2. Pretoria.
- Department of Water and Sanitation (DWS), 2015. Reserve Determination Studies for Selected Surface Water, Groundwater, Estuaries and Wetlands in the Breede-Gouritz Water Management Area. Project Technical Report 6: Estuary RDM Report – Desktop Assessment. Report No. RDM/WMA16/04/CON/0613. Pretoria, South Africa.
- Duvenhage, I.R. and Morant, P.D. 1984. Report No. 31 Estuaries of the Cape. Part II: Synopses of available information on individual systems. Report No. 31: Keurbooms/Bitou System (CMS 19), Piesang (CMS 18). Stellenbosch. CSIR Research Report 430.
- Lamberth SJ and Turpie JK (2003) – The role of estuaries in South African fisheries: economic importance and management implications. *African Journal of Marine Science* 25: 131-157.
- South African National Biodiversity Institute (SANBI) (2019). National Biodiversity Assessment 2018: The status of South Africa's ecosystems and biodiversity. Synthesis Report. South African National Biodiversity Institute, an entity of the Department of Environment, Forestry and Fisheries, Pretoria. pp. 1–214.
- Turpie, J.K. and Clark, B.M. 2007. Development of a Conservation Plan for temperate South African estuaries on the basis of biodiversity importance, ecosystem health and economic costs and benefits.
- Van Niekerk L.; Taljaard S; Adams J.B.; Fundisi D.; Huizinga P.; Lamberth S.J.; Mallory S.; Snow G.C.; Turpie J.K.; Whitfield A.K.; Wooldridge T.H. (2015). Desktop provisional eco-classification of the temperate estuaries in South Africa. WRC K5/2187. WRC Report number 2187/1/15.

# 10 APPENDIX A DWS TIDAL GAUGE K6T021 LEVEL TO MEAN SEA LEVEL



**Figure 10: DWS tidal gauge K6T021 level to mean sea level (MSL) for period December 2011 to June 2018.**