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DOCUMENT USE

The National Estuarine Management Protocol (the Protocol), promulgated in May 2013 under the National Environmental Management: Integrated Coastal Management Act (Act No. 24 of 2008, as amended by Act No. 36 of 2014), sets out the minimum requirements for individual estuarine management plans.

In 2014, a review was conducted by the National Department of Environmental Affairs: Oceans and Coasts (DEA, 2014) on existing estuarine management plans to ensure, *inter alia*, the alignment of these plans with the Protocol.

This revision of the Great Brak River Estuarine Management Plan, including the Situation Assessment Report and the Management Plan itself, is in response to the comments received during the DEA review process only, to ensure compliance with the minimum requirements for EMPs as per the Protocol. In summary, this entailed:

- Updating the terminology as per the Protocol;
- Including a summary of the Situation Assessment;
- Extending the monitoring plan to explicitly include a performance monitoring plan to gauge progress towards achieving EMP objectives (i.e. using performance indicators); and
- Including a description of institutional capacity and arrangements to manage elements of EMP provided as per the Protocol.

The work of the original authors and input received from stakeholders remains largely unchanged, although certain editorial changes and factual updates will be evident. This revision does not represent, or replace, the customary full five-year review process required to re-evaluate the applicability of the plan and to provide new information. Such a full review process is therefore still required and should be part of a future revision undertaken by the nominated management and implementation agents. Nonetheless, this EMP must be considered a living document that should be regularly updated and amended as deemed necessary.

EXECUTIVE SUMMARY

Introduction

The Great Brak River estuary is one of 88 temporarily open/closed estuaries in the Warm Temperate zone (roughly Cape Point to the Mbashe River). Covering a total of 114 ha, it is a relatively large system within this estuary type, falling within the 2nd 10% percentile of estuaries in the country. While it is not considered to be very important for conservation of estuarine biodiversity on a national scale, ranking 46th of all South African estuaries in terms of its overall conservation importance (Turpie 2004), it is nonetheless an important recreational area along the Cape south coast, and is home to a well-established resident community as well as a much larger holidaying community.

The estuary has already been put under considerable pressure, particularly in terms of flow modification, but also from mouth manipulation, pollution, fishing pressure, other human disturbance and developments in the estuary zone. Manipulation of the estuary has taken place for two centuries, but pressures have intensified in the last two decades, since the construction of the Wolwedans Dam just above the estuary. As a result, the estuary requires intensive management in order to maintain water quality and the ecosystem characteristics for which it is valued, even if it is not managed to resemble its original condition. While development pressure within the estuary zone has probably stabilised to an extent, there is an ever-increasing threat of marine pollution as industrial activities and shipping intensify along the adjacent coastline, especially in the vicinity of Mossel Bay.

This document is a Management Plan for the Great Brak River estuary. It was developed under the auspices of the Cape Action Plan for the Environment (C.A.P.E.) Estuaries Management Programme, and is designed to fulfil requirements of the National Environmental Management: Integrated Coastal Management Act (Act 24 of 2008, as amended) (ICM Act) and the National Estuary Management Protocol (2013) (the Protocol), published under the above Act.

Situation Assessment

The Great Brak River estuary is situated in the Western Cape Province between Mossel Bay and George on the Cape south coast, about 420 km east of Cape Town. The Great Brak River drains a relatively small catchment area of 192 km². The estuary is located within the Mossel Bay Local Municipality, which in turn falls within the Eden District Municipality.

The estuary is approximately 6 km long, and has a water surface area of 0.6 km² at high tide, and a tidal prism of 0.3 x 10⁶ m³. The lower estuary is mostly shallow (0.5 to 1.2 m deep) with some deeper areas in scouring zones near the rocky cliffs and bridges. The middle and upper estuary is generally less than 2 m deep, apart from

some deeper areas of 3-4 m deep in the area between 2 and 4 km from the mouth. The mouth of the estuary is predominantly closed.

The Great Brak River rises in the Outeniqua mountains and covers a total area of about 192 km². The catchment falls within the Fynbos Biome, but most of the area is transformed and under agriculture (pasture, wheat and vegetables) or forestry. The catchment has also been invaded by invasive alien acacias, including black wattle (*Acacia mearnsii*) along the drainage channels. Average rainfall in the catchment area is about 722 mm per annum. Rainfall is generally fairly constant year-round, with slight peaks in spring and autumn. However, the area is subject to droughts and floods, with major floods having occurred at least twelve times in the 1900s up to the early 1980s, and the recorded annual run-off varies from as little as 4.3 x 10⁶ m³ to as large as 44.5 x 10⁶ m³. Recent estimates place the mean annual runoff (MAR) at 39.52 x 10⁶ m³/a (DWA 2008).

Development within the Great Brak catchment is small and concentrated at the estuary.

The channel and mouth dynamics of the Great Brak River estuary have been strongly influenced by anthropogenic developments in the catchment and have been actively managed for at least two centuries. Artificial breaching of the estuary dates back to at least 1814, when it was reported that locals had to open the mouth several times a year to avoid flooding of the river crossing. After the causeway was built in 1850, the Great Brak settlement was established and the river mouth was artificially opened on a regular basis to avoid flooding of the causeway and protect the settlement. Artificial breaching has continued to the present day.

Since the construction of the Wolwedans Dam, an effort has been made to release water in such a way as to maintain an open mouth condition during spring and summer as far as possible. Water is released from the Wolwedans Dam until the estuary has filled to a designated level, then breaching of the mouth is initiated mechanically. The mouth generally closes when high waves coincide with periods of low river flow. The estuary currently receives some 44.2% of its natural MAR.

Macroalgal blooms frequently occur in the Great Brak River estuary during closed mouth conditions. These macroalgae form thick algal mats in the estuary that affect available oxygen in the water. Photosynthetic oxygen production during daylight and consumption through respiration at night can cause great diurnal variations in dissolved oxygen. These have been shown to vary between a high of 9 mg.l⁻¹ during the day, to a low of 3.2 mg.l⁻¹ at night in areas where algal mats were present. Low oxygen levels at night have been known to cause fish kills in the estuary.

There are three main types of vegetation associated with the Great Brak River estuary: intertidal salt marsh, supratidal salt marsh and reeds and sedges. In addition, invasive plants have also started to take root in the estuary. The distribution and extent of these vegetation types is determined by water levels in the system and salinity.

Benthic invertebrates of the Great Brak River estuary are dominated by the mudprawn *Upogebia africana*, the sandprawn *Callinassa kraussi* and the bivalve *Loripes clausus*. Diversity and abundance is considered to be low relative to other closed estuaries in the region. Zooplankton biomass and abundance in the estuary is typical of temporarily closed systems, and is dominated by the copepods *Acartia longiptella* (during closed phases) and *Pseudodiaptomus hessei* (during open phases).

A total of 33 species of fish from 21 families have been recorded from the Great Brak River estuary, which is considered to be high compared to other temporarily open/closed estuaries in the region.

A total of 52 non-passerine waterbird species have been recorded on the Great Brak River estuary (excluding vagrants), with 39 of these species being recorded during summer, and 41 in winter. Numbers of birds on the estuary are relatively low, however. The estuary supports an average of about 240 birds in mid-summer and 153 in mid-winter. The estuary is ranked 135th out of 258 estuaries in terms of its avifauna. The upper estuary contains a heronry (breeding colony), comprising mainly White-breasted and Reed Cormorants and Blackheaded Heron. This heronry has been there for a couple of decades, and may have moved there from the Klein Brak River estuary.

Estuaries provide a range of services that have economic or welfare value. In the case of the Great Brak River estuary, the most important of these are the recreational and tourism values of the estuary as well as the provision of a nursery area for fish.

The Great Brak River estuary is a highly disturbed system, which has been manipulated for two centuries. The system is managed in a state which is quite different from its natural condition, as has been necessitated by the low-lying developments around the estuary. There are a number of factors that threaten the future health of the system and hence its biodiversity and capacity to deliver ecosystem services. The main threats to the system or areas of potential conflict are as follows:

1. Water quantity and quality:
 - a) reduction in freshwater inflows due to water abstraction in the catchment, and continuing increase in demand for abstraction;
 - b) flooding;
 - c) increasing nutrient enrichment due to activities in the catchment;
 - d) potential risk of pollution entering from the sea; and
 - e) siltation
2. Exploitation of living resources:
 - a) overexploitation of fish stocks conflicting with nursery function;
 - b) potential for future overexploitation by recreational fishers;
3. Land-use and associated disturbance:
 - a) residential/resort development around the estuary leading to change in sense of place and existence value, increased human disturbance of biota, and damage or loss of estuarine habitat;
4. Uncoordinated and ineffective management; and

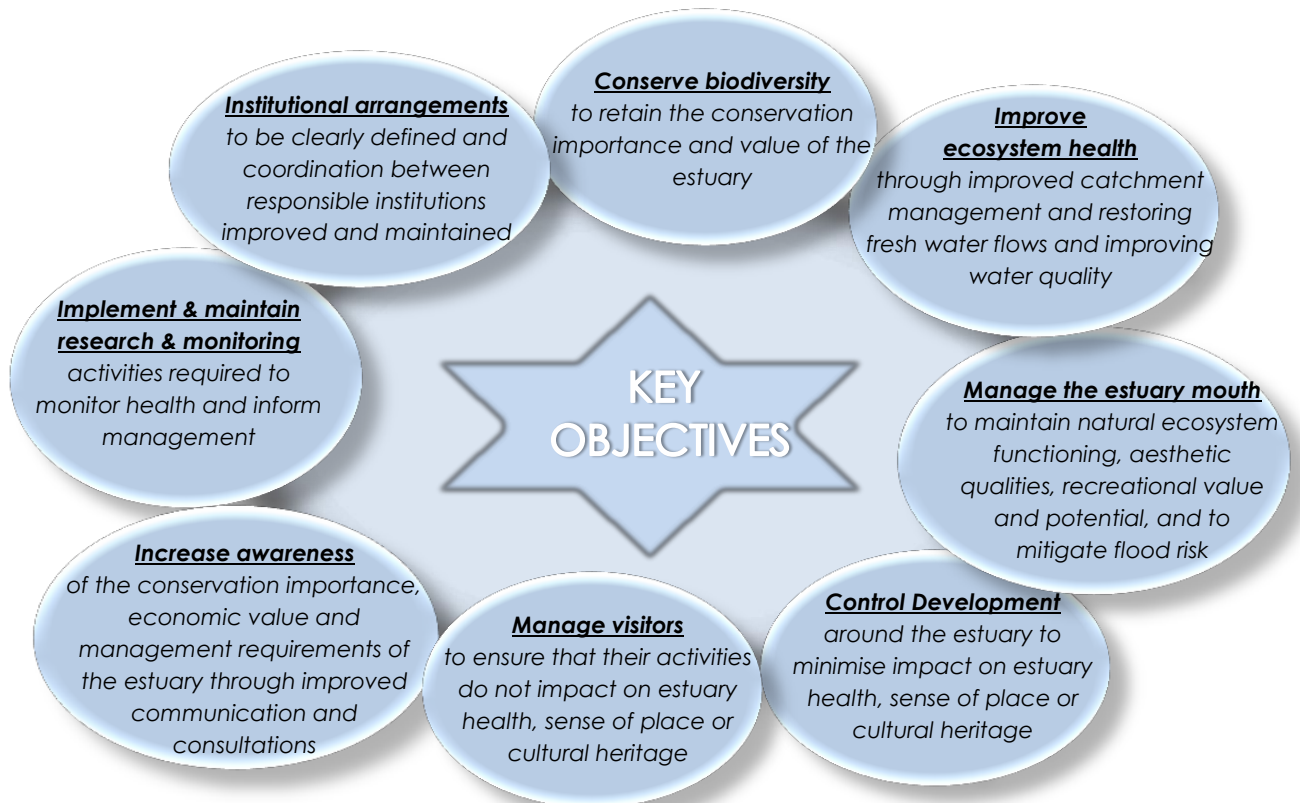
5. Insufficient education and awareness for visitors.

Vision and Objectives

The following vision was developed for the Great Brak River estuary using stakeholder input collected from multi-stakeholder meetings held in May and September 2012:

The Great Brak River estuary is managed in a transparent, accountable and cooperative manner to ensure an appropriate balance between biodiversity conservation, recreational use, human safety and development, now and in the future

Key objectives for the Great Brak River estuary were identified at a stakeholder workshop held in held in May 2012. These are all set out in the diagram below. These objectives are seen to reinforce each other and none are seen as being of greater importance than any other.



Management Objectives

Each management objective requires a number of implementation actions which can be grouped into ten management/implementation categories, namely:

1. Biodiversity Conservation;
2. Restoration of estuary health;
3. Effective and efficient mouth management;
4. Water quality management;
5. Visitor management;
6. Development Planning;
7. Co-operative and effective governance;
8. Increase awareness and education; and
9. Research and monitoring.

Each plan corresponds to a key objective and contains applicable management actions, supporting regulations, responsible institution(s), and required resources, if such information is available.

Spatial Zonation

In addition to formally demarcating the extent of the Coastal Protection Zone and Coastal Management Lines around the Great Brak River estuary, it has been proposed that a portion of the lower estuary be demarcated as a Special Management Area in terms of the ICM Act. This Special Management Area would be zoned in such a way as to satisfy the many conflicting requirements of the different user groups and stakeholders who wish to enjoy the benefits provided by the estuary. Zonation will allow for partitioning of activities within the estuary, thus permitting their co-existence without one activity precluding or conflicting with another. It will also reduce management costs as it will focus activities in particular geographic areas and hence eliminate the need to deploy management staff across the whole estuary at all times.

The proposed Special Management Area includes the whole of the estuary channel on the east side of the island from the road bridge to the point at which this channel rejoins the main channel near the mouth of the estuary (Figure 4). This area should be designated as a bait sanctuary, and collection of bait organisms should be completely prohibited in this area. Illegal commercial bait collection should also be controlled.

Institutional Arrangements

The Protocol identifies the Mossel Bay Local Municipality, or its assigned representative, as the Responsible Management Authority responsible for the development of the Great Brak River EMP as well as being responsible for the co-ordination of its implementation. This implementation function can be effected through a range of different forums and actors.

According to the Protocol, the role of the Great Brak River Estuary Advisory Forum (GBREAF) is interpreted as providing an advisory service to the RMA on issues specific to the management and implementation of the EMP, as well as being the hub that links all stakeholders, which serves to foster stakeholder engagement and to facilitate the implementation of the project plans identified. The broader community will be able to voice concerns and raise issues via the GBREAF. This includes Ratepayers' Associations, NGO's, community groups, conservancies, etc., as well as representatives from surrounding industry and agriculture. Any representatives are obliged to raise issues identified by their constituents and to provide feedback to the constituents. Importantly, the GBREAF will not represent or supplant the individual positions of its members unless specifically mandated to do so.

The successful implementation of the EMP may be seen as also dependent on the contribution of a number of governmental role players, including:

- Western Cape Government departments: Responsible for legislative support, including compliance, funding, research and monitoring;
- Eden District Municipality: Responsible for legislative support and funding;
- Relevant National government departments, especially Department of Environmental Affairs, Department of Water and Sanitation (via the regional office), Department of Forestry and Fisheries, Department of Rural Development and Land Reform; and
- Organs of State (SANparks, CapeNature, BGCMA).

The National Department of Environmental Affairs is generally responsible for national standardisation of estuarine management and approval of provincially-compiled estuarine management plans. Direct involvement in individual estuaries, such as the Great Brak, will occur via existing forums for intergovernmental coordination. These forums will have the management of the Great Brak River estuary on their agendas from time to time, and include:

- Western Cape Provincial Coastal Committee: Responsible for facilitating co-management, effective governance and provincial co-ordination of estuarine management; and
- Eden District Municipal Coastal Committee: Responsible for facilitating co-management and effective governance.

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ABBREVIATIONS

C.A.P.E.	Cape Action for People and the Environment
CARA	Conservation of Agricultural Resources Act (Act No. 43 of 1983)
CMP	Coastal Management Programme
CPZ	Coastal Protection Zone
CSIR	Council for Scientific and Industrial Research
DAFF	Department of Agriculture, Forestry and Fisheries
DEA	Department of Environmental Affairs
DEA&DP	Western Cape Government's Department of Environmental Affairs & Development Planning
DEA: O&C	Department of Environmental Affairs: Oceans & Coasts Branch (formerly MCM)
DM	District Municipality
DWS	Department of Water and Sanitation (formerly DWAF)
EAF	Estuary Advisory Forum
EFZ	Estuarine Functional Zone
EIA	Environmental Impact Assessment
EMP	Estuarine Management Plan
ERC	Ecological Reserve Category
EZP	Estuary Zonation Plan
GBREAF	Great Brak River Estuary Advisory Forum
ha	hectare
HWM	High-Water Mark
I&AP	Interested and Affected Party
IDP	Integrated Development Plan
LM	Local Municipality
MaintMP	Maintenance Management Plan
MCM	Directorate Marine and Coastal Management (DEA)
MEC	Member of the Executive Council
MLRA	Marine Living Resources Act (Act No. 18 of 1998) as amended
Mm ³	Million cubic metres
MMP	Mouth Management Plan
MSA	Municipal Systems Act (Act No. 32 of 2000)
NEM: ICMA or ICM Act	National Environmental Management: Integrated Coastal Management Act (Act No. 24 of 2008) as amended
NEM: PAA	National Environmental Management: Protected Areas Act (Act No.57 of 2003)
NEM: WA	National Environmental Management: Waste Act (Act No. 59 of 2008) as amended
NEM:BA	National Environmental Management: Biodiversity Act (Act No. 10 of 2004) as amended
NEMA	National Environmental Management Act (Act No. 107 of 1998) as amended
NWA	National Water Act (Act No. 36 of 1998) as amended
ppt	parts per thousand

RMA	Responsible Management Authority
SANParks	South African National Parks
SDF	Spatial Development Framework
SMA	Special Management Area
The Protocol	National Estuary Management Protocol
TPC	Threshold of Potential Concern

1 INTRODUCTION

1.1 Background

The Great Brak River is one of 88 temporarily open/closed estuaries in the Warm Temperate zone (roughly Cape Point to the Mbashe River). Covering a total of 114 ha, it is a relatively large system within this estuary type, falling within the 2nd 10% percentile of estuaries in the country. While it is not considered to be very important for conservation of estuarine biodiversity on a national scale, ranking 46th of all South African estuaries in terms of its overall conservation importance (Turpie 2004), it is nonetheless an important recreational area along the Cape south coast, and is home to a well-established resident community as well as a much larger holidaying community.



Figure 1: Aerial view of the Groot Brak River Estuary mouth

The estuary has already been put under considerable pressure, particularly in terms of flow modification, but also from mouth manipulation, pollution, fishing pressure, other human disturbance and developments in the estuary zone. Manipulation of the estuary has taken place for two centuries, but pressures have intensified in the last two decades, since the construction of the Wolwedans Dam just above the estuary. As a result, the estuary requires intensive management in order to maintain water quality

and the ecosystem characteristics for which it is valued, even if it is not managed to resemble its original condition. While development pressure within the estuarine functional zone has probably stabilised to an extent, there is an ever-increasing threat of marine pollution as industrial activities and shipping intensify along the adjacent coastline, especially in the vicinity of Mossel Bay.

This document is an Estuarine Management Plan (EMP) for the Great Brak River estuary. It was developed under the auspices of the Cape Action Plan for the Environment (C.A.P.E.) Estuaries Management Programme, and is designed to fulfil requirements of the National Environmental Management: Integrated Coastal Management Act (Act 24 of 2008, as amended) (ICM Act) and the National Estuary Management Protocol (2013) (the Protocol), published under the above Act.

1.2 Purpose and Scope of the Great Brak River Estuarine Management Plan

Drawing on the Situation Assessment prepared for the Great Brak River estuary (Anchor Environmental 2012), inputs from key stakeholders and other supporting documents prepared for the C.A.P.E. Estuaries Programme (e.g. Turpie & Clark 2007 – Cape Estuaries Classification, Prioritisation, Protection and Rehabilitation report), the Great Brak River EMP sets out the **Vision** and **Key Objectives** for the Great Brak River estuary. It also identifies specific **Management Objectives** needed to meet these overarching objectives, and indicates the main **Actions** required in the next five years in order to achieve the overall vision. The Great Brak River EMP focuses on strategic priorities only. While planning for some emergencies, e.g. floods, is part of this plan, it remains possible that unforeseen disasters could disrupt the prioritisation set out here.

A set of Management Priorities have been identified for the estuary for the next five years, which generally represent sectors of governance (e.g. conservation, water regulation, etc.), and contain management actions to meet the respective objectives. Each management objective will be implemented through a set of management actions and will result in a number of deliverables. A plan of action or implementation is provided for each area of priority.

1.3 Institutional Arrangement

The implementation of the actions by the Responsible Management Authority (RMA) for the estuary, the Mossel Bay Local Municipality (LM), and its strategic partners (CapeNature, Eden District Municipality, Western Cape Provincial Government, Department of Water and Sanitation(DWS), and Department of Environmental Affairs(DEA)), will be monitored by a Great Brak River Estuary Advisory Forum (GBREAF) comprising representatives of all key stakeholder groups on the estuary, using indicators within a set time-frame. In terms of the National Protocol published in terms of the ICM Act, the responsible management authority (RMA) for the Great Brak River estuary is the Mossel Bay Municipality who is responsible for the development of this EMP and will play a co-ordinating role for all other implementing agencies.

It is important to recognise that this document is designed to focus management attention at a strategic level and does not provide guidance on the day-to-day management actions required for management of the estuary. Annual Business Plans will have to be developed by the Mossel Bay Municipality and the Estuary Advisory Forum, and should be guided by this EMP in that major effort should be directed towards priority activities that support its strategic objectives included in this plan.

Progress towards achieving the objectives set out in this EMP should be reviewed on an annual basis by the Mossel Bay Municipality and the GBREAF and focal efforts adjusted to ensure targets are met within specified timeframes. This Great Brak River EMP will have to be revisited and updated within the next five years to reflect goals that have been achieved and to accommodate changing priorities.

1.4 Summary of Legal framework

Chapter 4 of the National Environmental Management: Integrated Coastal Management Act (No. 24 of 2008, as amended by Act 36 of 2014) (ICM Act), aims to facilitate the efficient and coordinated management of all estuaries, in accordance with:

- a) The Protocol (Section 33) approved by the Ministers responsible for the environment and water affairs; and
- b) Estuarine management plans for individual estuaries (Section 34).

The Protocol, promulgated in 2013, provides a national policy for estuarine management and guides the development of individual EMPs. It must be ensured that the EMPs are aligned with the Protocol and the National Coastal Management Programme (CMP) (DEA, 2014). The Protocol lays out the following:

- a) The strategic vision and objectives for achieving effective integrated management of estuaries in South Africa;
- b) The standards for the management of estuaries;
- c) The procedures regarding how estuaries must be managed and how the management responsibilities are to be exercised by different organs of state and other parties;
- d) The minimum requirements for EMPs;
- e) Who must prepare EMPs and the process to be followed in doing so; and
- f) The process for reviewing EMPs to ensure that they comply with the requirements of the ICM Act.

One of the pillars of successful integrated coastal (including estuarine) management is the establishment of effective institutional arrangements to underpin both cooperative government and cooperative governance. Cooperative governance is a system that allows government and civil society to communicate and contribute to shared responsibility in respect of coastal management objectives and must be well-organized and widely representative of all coastal stakeholders. The ICM Act details the institutional arrangements that will contribute to cooperative coastal

management in South Africa. These arrangements are made at national, provincial and municipal government levels, and the embodiment of cooperative coastal governance is vested in what will be known as coastal committees. The ICM Act provides for the permissive, i.e. if so required, establishment of municipal coastal committees, but at a national and provincial level however, the Minister and Members of the Executive Council (MECs) of coastal provinces are directed to establish national and provincial coastal committees, respectively. Provincial coastal committees must be established within one year of the commencement of the ICM Act.

The National Coastal Committee (the MINTEC Working Group 8) is established by the Minister, and its powers determined by notice in the Government Gazette. It is supported administratively by the DEA. The Premier of each coastal province must identify a lead agency (organ of state) that is responsible for the coordination, monitoring and implementation of the provincial coastal management programme, monitoring the state of the environment in the coastal zone, and identifying relevant trends and priority issues. The lead agency for coastal management is directly responsible to the MEC. Each metropolitan, district or local municipality which has jurisdiction over the coastal zone may establish a municipal coastal committee. The establishment of Municipal Coastal Committees is discretionary.

The lowest tier of institutional arrangements for estuarine management comprises the RMA and the estuary advisory forums. The role of the estuary advisory forum is to act as the hub which links all stakeholders, including both organs of state and civil society, so as to facilitate cooperative management and effective governance in terms of the EMPs, as well as facilitate and monitor implementation of an EMP.

1.5 Mandate and responsibilities of the RMA

The Protocol identifies the Mossel Bay Municipality as the management authority responsible for developing and co-ordinating implementation of the Great Brak River EMP, as the entire estuary is contained within the municipal boundary (Figure 2).

The RMA is responsible for overall co-ordination of the actions of other implementing agencies, and not the implementation actions themselves. Section 7.3 of the Protocol indicates that:

"...management actions...shall be translated into project plans by the responsible government department that is responsible for certain aspects of estuary management (as per legislative mandates)..."

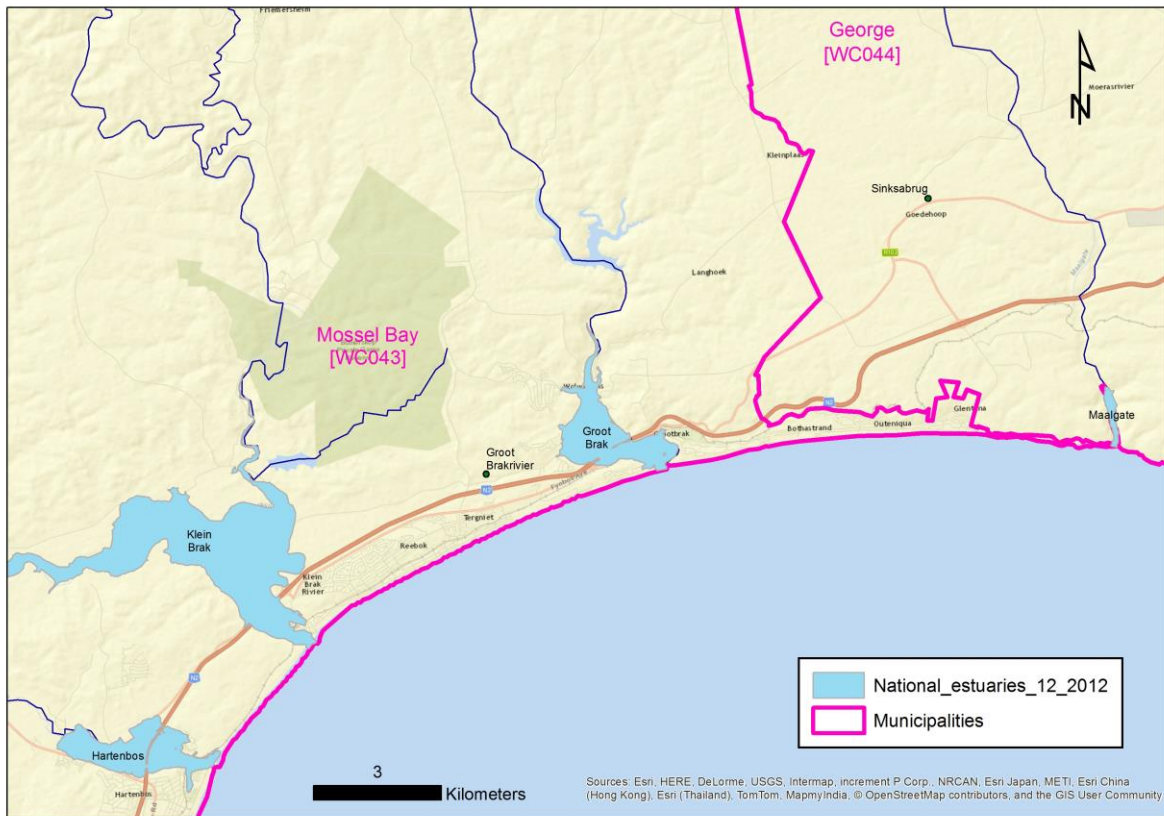


Figure 2: Location of the Great Brak River estuary within the Mossel Bay Municipality

Specifically, the RMA responsibilities are described by the Protocol as:

- Section 5: *“...authorities are **responsible for the development of EMPs and coordination of the implementation process...**”*
- Section 5(7)(e): *“The identified responsible management authority to develop the EMP needs to **budget accordingly for the development of these plans.**”*
- Section 8(1): *“The responsible management authority developing an EMP must **actively engage all the relevant stakeholders** including government departments, non-government organisations and civil society in the development and implementation of the EMP.”*
- Section 9.1(1) and 9.2: *“...it **must obtain formal approval** for the EMP...” and “Once approved...the EMP shall be formally adopted by the responsible management authority and signed by the head of the responsible management authority.”*

The responsible body contemplated in Section 33(3)(e) of the ICM Act who develops an EMP must:

- a) follow a public participation process in accordance with Part 5 of Chapter 6 of the ICM Act; and

-
- b) ensure that the EMP and the process by which it is developed are consistent with:
 - i) the Protocol; and
 - ii) the National CMP and with the applicable provincial CMP and CMP referred to in Parts 1, 2 and 3 of Chapter 6 of the ICM Act;
 - c) If applicable, ensure that relevant legislation is enacted to implement the EMP; and
 - d) Submit a bi-annual report to the Minister on the implementation of the EMP, the legislation and any other matter.

Coordination of the implementation actions by the RMA and its strategic partners (CapeNature, DEA, Eden District Municipality (Eden DM), Western Cape Provincial Government, Department of Water and Sanitation (DWS), Department of Agriculture, Forestry and Fisheries (DAFF)), will be supported by the Great Brak River Estuary Advisory Forum (EAF) representing all key stakeholder groups on the estuary.

2 SUMMARY OF SITUATION ASSESSMENT

2.1 Introduction

The Great Brak River estuary is one of 88 temporarily open/closed estuaries in the Warm Temperate zone (roughly Cape Point to the Mbashe River). Covering a total of 114 ha, it is a relatively large system within this estuary type, falling within the 2nd 10 % percentile of estuaries in the country. The Great Brak River estuary is not particularly important for estuarine biodiversity on a national scale, however, ranking 46th of all South African estuaries in terms of its overall conservation importance. Nevertheless, the Great Brak River estuary is an important recreational area along the Cape south coast, and is home to a well-established resident community as well as a much larger holidaying community.

The estuary faces pressure from reduced freshwater inflow due to the upstream Wolwedans Dam, planned rural developments and increasing tourism at the estuary mouth. Recognising the importance of the Great Brak River estuary and estuaries in South Africa more generally, the C.A.P.E. Regional Estuaries Management Programme in collaboration with the Mossel Bay Municipality commissioned the development of a management plan for the Great Brak River estuary.

This report is the Situation Assessment that forms the background material for the development of the management plan, and should be read in conjunction with the Management Plan itself.

2.2 Geographic and socio-economic context

The Great Brak River estuary is situated in the Western Cape Province between Mossel Bay and George on the Cape south coast, about 420 km east of Cape Town. The Great Brak River drains a relatively small catchment area of 192 km². The estuary is

located within the Mossel Bay Municipality, which in turn falls within the Eden District Municipality.

The estuary is approximately 6 km long, and has a water surface area of 0.6 km² at high tide, and a tidal prism of 0.3 x 10⁶ m³. The lower estuary is mostly shallow (0.5 to 1.2 m deep) with some deeper areas in scouring zones near the rocky cliffs and bridges. The middle and upper estuary is generally less than 2 m deep, apart from some deeper areas of 3-4 m deep in the area between 2-4 km from the mouth. The mouth of the estuary is predominantly closed.

The Great Brak River rises in the Outeniqua Mountains and covers a total area of about 192 km². The catchment falls within the Fynbos Biome, but most of the area is transformed and under agriculture (pasture, wheat and vegetables) or forestry. The catchment has also been invaded by invasive alien acacias, including black wattle (*Acacia mearnsii*) along the drainage channels. Average rainfall in the catchment area is about 722 mm per annum. Rainfall is generally fairly constant year-round, with slight peaks in spring and autumn. However, the area is subject to droughts and floods, with major floods having occurred at least twelve times in the 1900s up to the early 1980s, and the recorded annual run-off varies from as little as 4.3 x 10⁶ m³ to as large as 44.5 x 10⁶ m³. Recent estimates place the mean annual runoff (MAR) at 39.52 x 10⁶ m³/a.

Development within the Great Brak River catchment is small and concentrated at the estuary.

2.3 Ecological characteristics and functioning of the estuary

The channel and mouth dynamics of the Great Brak River estuary have been strongly influenced by anthropogenic developments in the catchment and have been actively managed for at least two centuries. Artificial breaching of the estuary dates back to at least 1814, when it was reported that locals had to open the mouth several times a year to avoid flooding of the river crossing. After the causeway was built in 1850, the Great Brak settlement was established and the river mouth was artificially opened on a regular basis to avoid flooding of the causeway and to protect the settlement. Artificial breaching has continued to the present day.

Since the construction of the Wolwedans Dam to supply potable water to the region, an effort has been made to release water in such a way as to maintain an open mouth condition during spring and summer as far as possible. Water is released from the Wolwedans Dam until the estuary has filled to a designated level, then breaching of the mouth is initiated mechanically. The mouth generally closes when high waves coincide with periods of low river flow. The estuary currently receives some 44.2 % of its natural mean annual runoff.

A study on the environmental flow requirements for the estuary identified four different physico-chemical states of the estuary, namely "Closed mouth", "Marine

dominated", "Gradient or Transition" and "Freshwater dominated". The occurrence, duration and nature of the different physico-chemical states for the system have been greatly modified from natural as a result of changes to the flow regime of the system. Under natural conditions, the frequency of occurrence for the various states varied little across the year, with the likelihood of mouth closure peaking in January/February and June, whereas under present day conditions, the system oscillates between a primarily marine dominated state in the period October-March, and a closed mouth state in April to September.

The various components of the ecology of the Great Brak River estuary have been studied in some detail following construction of the Wolwedans Dam and as part of the environmental flow assessment that has been undertaken for the system. Average phytoplankton biomass reportedly ranges from 0.9-3.5 $\mu\text{g.l}^{-1}$ in the period 1990 to 2008, and was generally higher in the upper reaches of the estuary than closer to the mouth. These values are considered to be moderately elevated above natural conditions, which were projected to be $<1.0 \mu\text{g.l}^{-1}$. Biomass of benthic microalgae in the estuary was surveyed in 2007 and 2008, and reportedly ranged from 0.8 $\mu\text{g.g}^{-1}$ near the mouth up to 26.2 $\mu\text{g.g}^{-1}$ at the head of the estuary. This is also considered to be elevated above natural conditions, when biomass was not expected to have exceeded 3.5 $\mu\text{g.g}^{-1}$.

Macroalgal blooms frequently occur in the Great Brak River estuary during closed mouth conditions. These macroalgae form thick algal mats in the estuary that affect available oxygen in the water. Photosynthetic oxygen production during daylight and consumption through respiration at night can cause great diurnal variations in dissolved oxygen. These have been shown to vary between a high of 9 mg.l^{-1} during the day, to a low of 3.2 mg.l^{-1} at night in areas where algal mats were present. Low oxygen levels at night have been known to cause fish kills in the estuary.

There are three main types of vegetation associated with the Great Brak River estuary: intertidal salt marsh, supratidal salt marsh, and reeds and sedges. In addition, invasive plants have also started to take root in the estuary. The distribution and extent of these vegetation types is determined by water levels in the system and salinity.

Benthic invertebrates of the Great Brak River estuary are dominated by the mudprawn *Upogebia africana*, the sandprawn *Callinassa kraussi* and the bivalve *Loripes clausus*. Diversity and abundance is considered to be low relative to other closed estuaries in the region. Zooplankton biomass and abundance in the estuary is typical of temporarily closed systems, and is dominated by the copepods *Acartia longiptella* (during closed phases) and *Pseudodiaptomus hessei* (during open phases).

A total of 33 species of fish from 21 families have been recorded from the Great Brak River estuary, which is considered to be high compared to other temporarily open/closed estuaries in the region. Six of these species are reported as likely to be breeding in the estuary, five species as being dependent on the estuary as a nursery area for at least their first year of life, another seven species are at least partially dependent on estuary as a nursery area, and the final seven are freshwater species.

A total of 52 non-passerine waterbird species have been recorded on the Great Brak River estuary (excluding vagrants), with 39 of these species being recorded during summer, and 41 in winter. Numbers of birds on the estuary are relatively low, however. The estuary supports an average of about 240 birds in mid-summer and 153 in mid-winter. The estuary is ranked 135th out of 258 estuaries in terms of its avifauna. This ranking does not make the Great Brak a very high priority estuary for birds. There are no important populations of Red Data species on the estuary, although small groups of African Black Oystercatcher do occur regularly on the estuary. The upper estuary contains a heronry (breeding colony), comprising mainly White-breasted and Reed Cormorants and Blackheaded Heron. This heronry has been there for a couple of decades, and may have moved there from the Klein Brak River estuary.

2.4 Ecosystem services

Estuaries provide a range of services that have economic or welfare value. In the case of the Great Brak River estuary, the most important of these are the recreational and tourism values of the estuary as well as the provision of a nursery area for fish. There may be additional services, such as carbon sequestration, but these are not likely to be of major value.

The estuary has been a popular holiday and retirement destination for decades. Its appeal lies in the combination of its attractive marshes, birdlife and fishing areas, swimming areas and beautiful surroundings. It is also in close proximity to towns such as George and Mossel Bay, and within easy reach of Cape Town and Port Elizabeth. Recreational anglers on the Great Brak River estuary are mainly shore anglers and boat use is minimal.

2.5 Legislation and management issues

The Great Brak River estuary is a highly disturbed system, which has been manipulated for two centuries. The system is managed in a state which is quite different from its natural condition, as has been necessitated by the low-lying developments around the estuary. There are a number of factors that threaten the future health of the system and hence its biodiversity and capacity to deliver ecosystem services. The main threats to the system or areas of potential conflict are as follows:

1. Water quantity and quality:
 - a. reduction in freshwater inflows due to water abstraction in the catchment, and continuing increase in demand for abstraction;
 - b. flooding;
 - c. increasing nutrient enrichment due to activities in the catchment;
 - d. potential risk of pollution entering from the sea; and
 - e. siltation;
2. Exploitation of living resources:
 - a. overexploitation of fish stocks conflicting with nursery function; and
 - b. potential for future overexploitation by recreational fishers;
3. Land-use and associated disturbance:

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- a. residential/resort development around the estuary leading to change in sense of place and existence value, increased human disturbance of biota, and damage or loss of estuarine habitat;
 4. Uncoordinated and ineffective management; and
 5. Insufficient education and awareness for visitors.

Little legislation has been designed for estuaries in particular. However, the fact that estuaries contain freshwater, terrestrial and marine components, and are heavily influenced by activities in a much broader catchment and adjacent marine area, means that they are affected by a large number of policies and laws. There is also no specific provision for Estuarine Protected Areas. The National Departments of Water Affairs and sanitation and Environmental Affairs are the primary agencies responsible for estuarine management in South Africa with a small amount of responsibility (fisheries) attributable to the Department of Agriculture, Forestry and Fisheries. Environmental management in most instances is devolved to provincial level, aside from water resources and fisheries which remain a national competency. At a municipal level, by-laws are passed which cannot conflict with provincial and national laws. The Great Brak River estuary lies wholly within the Mossel Bay Local Municipality, which falls within the Eden District Municipality of the Western Cape Province.

The Integrated Coastal Management Act, 2008 as amended in 2014 requires that a management plan be developed for each estuary in the country. The Integrated Coastal Management Act also requires the designation of a Coastal Protection Zone extending 100 m from the high tide mark (including in estuaries) in areas zoned for residential, industrial or commercial land use, and much larger protection zone of 1000 m for public land and land zoned for agricultural use. There is also provision to extend the coastal protection zone under the Integrated Coastal Management Act where necessary. In the case of the Great Brak River estuary, land surrounding the estuary is mostly zoned for urban development, and thus in terms of the Integrated Coastal Management Act a Coastal Protection Zone of 100 m will be required around much of the estuary. A Coastal Management Line must also be designated for all coastal property, by agreement between local and provincial authorities. Within these designated management lines, no new land transformation or development may take place without a permit issued by the MEC. The National Estuary Management Protocol (the Protocol) has been published in the in terms of the Integrated Coastal Management Act and provides guidance for the management of estuaries through the development of individual estuarine management plans (such as this one). The Protocol also outlines a national vision for estuarine management in South Africa, lays out strategic objectives for effective integrated management of estuaries in this country, prescribes standards for the management of estuaries, sets out the minimum requirements for the development of estuarine management plans, and stipulates the lead agency responsible for developing and coordinating the implementation of the estuarine management plan.

The Municipal Systems Act (2000) requires the identification of development priorities for each province, district and local municipality, and the expression of development plans in a spatial layout. The latter in turn, has to be formalised in a detailed land use and management plan. Thus, the key land-use decision-making is taking place by the local municipalities, in this case the Mossel Bay Local Municipality. Their plans have to fit in with broader scale plans of the district and province. The Eden District Municipality has also developed a Coastal Management Programme that highlights a wide range of issues that are of direct relevance to the Great Brak River estuary.

Water quality and quantity are mainly controlled under the National Water Act 36 of 1998. This makes provision for an Environmental Reserve which stipulates the quantity and quality of water flow required to protect the natural functioning of each water resource, including estuaries. The extent to which an estuary's functioning is catered for is determined by the designated future management "class" (where classes A – F describe state of health), called the Ecological Reserve Category. In future, this will be determined in a recently-developed, holistic classification process. In the interim, however, the amount of freshwater allocated to estuaries is determined through a "Reserve Determination" study. Such a study was completed for the Great Brak River estuary in 2008. In terms of this assessment the estuary was allocated an overall health score of 58 out of 100 which translates into a Present Ecological Status of D+, which is classed as a large modified system. The study recommended that the estuary be allocated a greater amount of freshwater water in order to restore more of the natural ecological functioning of the system. A range of other restoration measures were also recommended to be implemented to assist with this process.

In 2012, the 2008 results of the Resource Directed Methods study were refined and the preliminary determination of the Reserve and the Resource Class was authorised by the Acting Chief Director of Water Ecosystems. The preliminary determination provides for a short-term E Preliminary Resource Class and a long-term C Preliminary Resource Class. The long-term Resource Class should be achieved subject to the implementation of certain conditions. The preliminary Reserve that is set at 1 MCM a⁻¹ is also an interim measure that is on condition that a strategy be developed and implemented within 5 years that will address the flow and non-flow related aspects in the catchment that would allow for the progressive implementation of an additional 3 to 4 MCM release to the estuary over time, thereby improving the overall health of the estuary.

Exploitation of living resources in the estuary is governed by the Marine Fisheries Policy for South Africa (1997) and the Marine Living Resources Act (1998). The policy supports sustainable use of resources and use of these resources for economic growth and development as well as ecosystem and biodiversity protection. The estuary currently supports fairly high levels of recreational angling (around 10 anglers.km⁻¹) and some illegal gill net fishing. There are currently no issues relating to mining on the Great Brak River estuary and it is not expected that these will become important in the future.

In conclusion opportunities and constraints are detailed as follows:

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- Potential for protection of the Great Brak River estuary is not warranted at this stage but merit still exists to preserve the system as an ecologically sensitive area;
 - Potential for restoration is required with a number of specific restorative measures proposed; and
 - Numerous potential socio-economic development opportunities exist which could include preserving the system, implementing various environmental management initiatives, monitoring compliance and developing an environmental education centre.

3 VISION & OBJECTIVES

A vision is a high-level statement which defines the strategic intent of a management intervention. The following vision was developed for the Great Brak River estuary using stakeholder input collected from multi-stakeholder meetings held in May and September 2012:

“The Great Brak River estuary is managed in a transparent, accountable and cooperative manner to ensure an appropriate balance between biodiversity conservation, recreational use, human safety and development, now and in the future.”

Key objectives for the Great Brak River estuary were identified at a stakeholder workshop held in May 2012. These are all set out in the form of a circular diagram (Figure 3). These objectives are seen to reinforce each other and none are seen as being of greater importance than any other.

3.1 Biodiversity Conservation

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

3.2 Improve ecosystem health

Freshwater resources and land in the Great Brak River catchment are effectively managed so as not to compromise the quality or quantity of freshwater reaching the estuary or exacerbate flood risk around the estuary. Freshwater flow reaching the estuary is increased to improve water quality and allow the mouth of the system to function more naturally.

3.3 Water Quality Management

Nutrient inputs to the estuary are reduced by reducing or treating waste water inputs to the estuary, catchment management and improving agricultural practices.

3.4 Mouth Management

Recognising that the natural flow regime of the Great Brak system has been modified to the extent that natural mouth functioning is not possible and that management is required to mitigate flood risk, the estuary mouth is managed in a manner to maintain natural ecosystem functioning, desirable aesthetic qualities of the estuary (particularly tidal flows around The Island) and the recreational value and potential of the estuary, especially during peak season.

3.5 Visitor Management

Residents and visitors are aware of the importance and economic value of the estuary, are knowledgeable regarding regulations applicable to the system, and understand the rationale for management measures and interventions. Economic benefits are enhanced through the promotion of ecotourism. The estuary is managed to maximize the value of ecosystem goods and services delivered in the long term, ensuring an equitable balance among local, regional and national benefits.

3.6 Developing planning

A clear zonation plan is in place for the system to prevent further encroachment of development onto the estuary and to preserve and maintain the sense of place, cultural heritage and conservation value of the system. Accessibility to the estuary for recreational users is improved through the implementation of facilities (e.g. parking area, boardwalks) and amenities.

3.7 Harmonious and effective governance

Institutional roles and responsibilities pertaining to the management of the estuary are clearly defined, and coordination between responsible institutions are improved and maintained.

3.8 Communication and consultation

An estuary management forum comprising representatives from various stakeholder groups (e.g. the Bird Club, Island Residents Association, Chamber of Commerce, farming associations in the catchment) and government agencies (local, provincial and national departments) responsible for various aspects of management of the estuary is established for the Great Brak River estuary. The forum oversees and facilitates the implementation of the EMP and ensures that local communities and stakeholders have input into and are informed about the management of the estuary.

3.9 Research and monitoring

Monitoring and research into ecosystem health and human utilisation of the estuary is undertaken to ensure adequate information is available to track changes in the health of the system and to inform best management of the system.

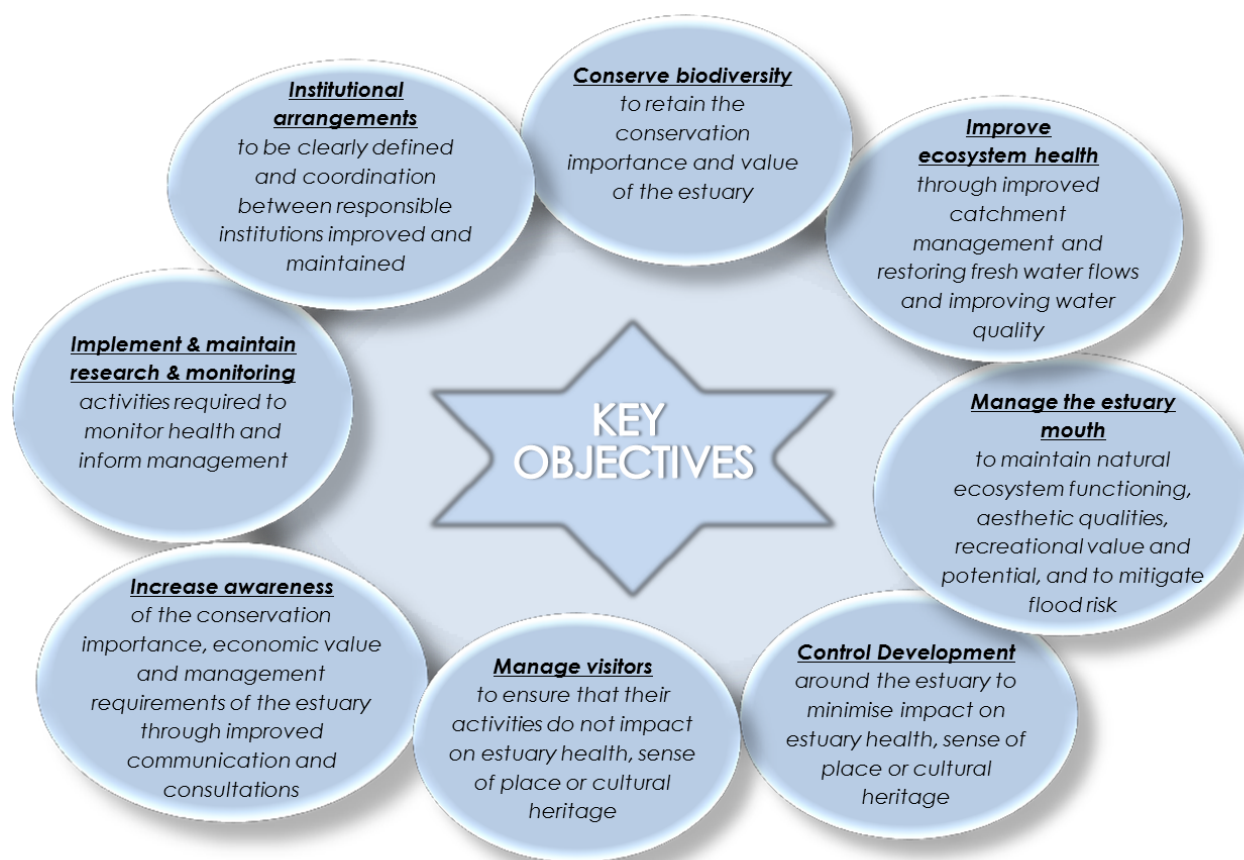


Figure 3: Key objectives to achieve the Vision for the Great Brak River estuary

4 MANAGEMENT OBJECTIVES

The management objectives required to achieve the key, or overarching objectives are summarized in Figure 4. Each management objective requires a number of actions. Note that some of the detailed management objectives are cross cutting and form part of the strategy for other key objectives.

Conservation of biodiversity will require restoration and maintenance of ecosystem health through the provision of environmental flows, as well as rehabilitation of habitats that have been damaged or modified, e.g. removal of invasive alien vegetation, and effective management of the mouth of the estuary and water quality in the estuary. Biodiversity conservation will also be facilitated if public awareness is improved, which in turn will require the provision of educational material and signage. Zonation of the estuary will support biodiversity conservation objectives, help to

manage visitors to the area, as well as assisting in the management of future developments by prevent urban encroachment into the and sensitive estuarine habitats.

Economic growth manifested in future developments will have to be subject to coastal management and development setback lines and guidelines that safeguard the sense of place of the estuary. These guidelines will need to be integrated into regional and local integrated development plans (IDPs) and spatial development frameworks (SDFs). Ecotourism growth will require attractive visitor facilities that draw people to the area and will also depend on future developments being sensitive to biodiversity and the sense of place.

Research and monitoring is required to improve our knowledge of the estuarine system processes and patterns as the basis to well-informed decision making. The management and monitoring of the estuary area, the freshwater inflows and development in the surrounding area will require cooperative governance among the estuary management agency, catchment management agency, conservation agencies, and local and national government. This in turn will require an Estuary Advisory Forum (EAF) that has representation amongst all relevant organisations and stakeholder groups.

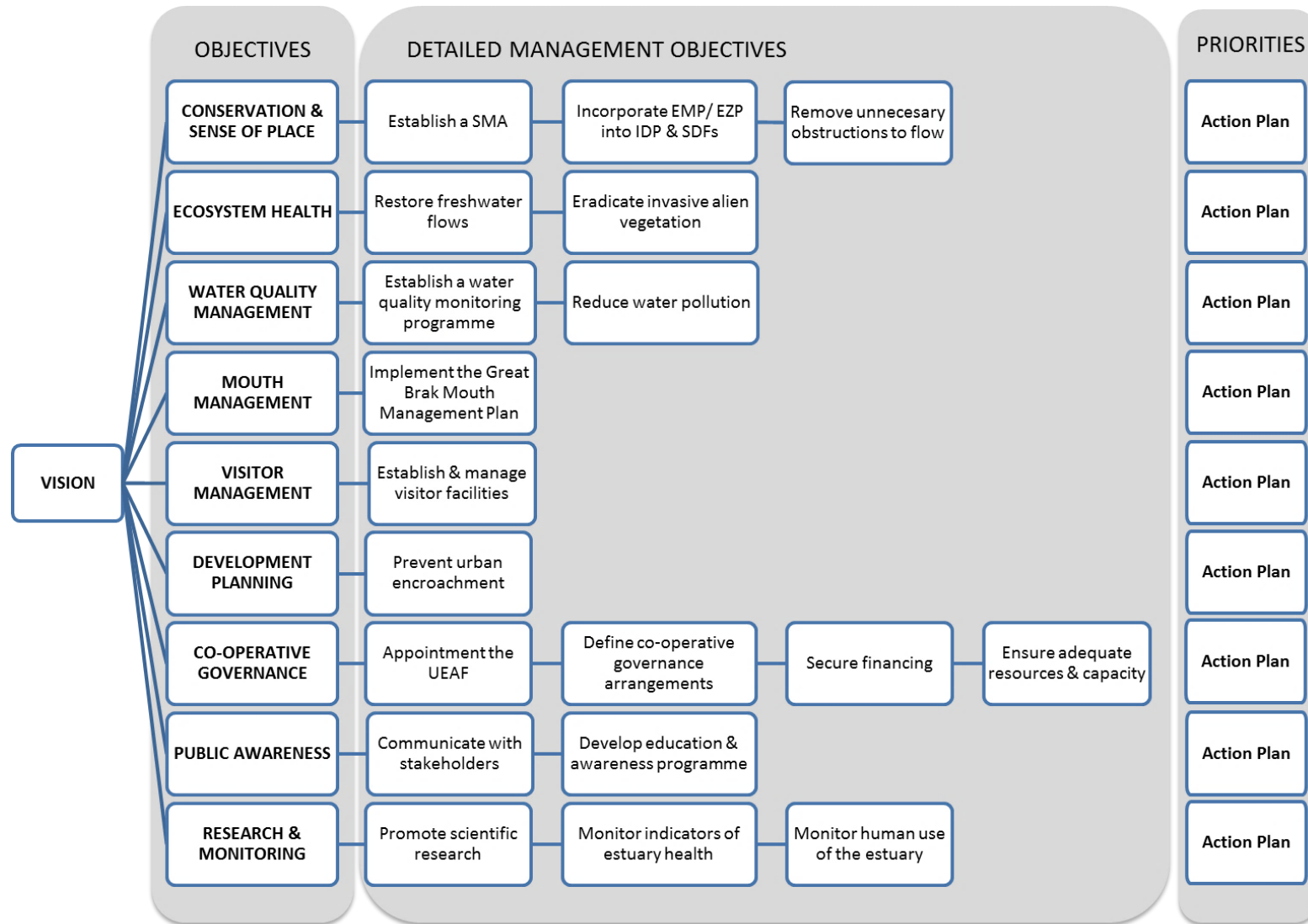


Figure 4: Structure of the Great Brak River EMP indicating detailed Management Objectives to achieve key Objectives and the Vision

Table 1: Performance Indicators for management objectives and associated actions

Management Objectives	Performance Indicators
1. Conservation of estuarine biodiversity	<ul style="list-style-type: none"> • Zonation plan for the estuary approved and implemented. • Great Brak River EMP integrated within local, district and provincial level planning documents (IDPs and SDFs). • Alien vegetation clearing and monitoring operations in place. • Future development on the estuary is constrained to ensure that it does not compromise estuary health, ecosystem functioning and/or sensitive species (e.g. no development in the 1:50 year flood line). • Harvesting of living marine resources (fish and bait) on the estuary remains within sustainable limits, resource users do not exceed applicable size and bag limits.
2. Restoration of estuary health	<ul style="list-style-type: none"> • Freshwater environmental reserve for the Great Brak River estuary implemented; revised dam operating rules for the Wolwedans are in force and respected. • Quantity and quality of freshwater reaching the estuary adequate to restore and maintain estuary health. • Sewage and storm water entering the estuary monitored and controlled.
3. Effective and efficient mouth management	<ul style="list-style-type: none"> • Mouth Management Plan (MMP) accepted and signed off by all relevant authorities (DWS, Disaster Management, Weather SA, Eden and Mossel Bay Municipalities). • Beaching protocols are implemented in accordance with the accepted Mouth Management Plan & approved Maintenance Management Plan (MaintMP).
4. Water quality management	<ul style="list-style-type: none"> • Water quality samples collected and analysed in accordance with EMP requirements. • Bacteriological (Faecal coliforms, <i>E. coli</i> and Enterococci) and physico-chemical parameters (nitrate, nitrite, ammonia, phosphorus, silica, suspended sediment, toxic substances) from water quality samples taken in the estuary.
5. Visitor management	<ul style="list-style-type: none"> • Informative and educational signage erected at key points access points that highlights the conservation importance and value of the Great Brak River estuary. • Visitors are sensitive to and aware of activities affecting health and functioning of the estuary, and management regulations governing use of the estuary. • Quality and quantity of visitor facilities (ablutions, parking, etc.) sufficient to meet visitor expectations and requirements.
6. Development planning	<ul style="list-style-type: none"> • Future development on the estuary is constrained to ensure that it does not compromise the existing sense of place, conservation value and/or cultural heritage resources associated with the Great Brak River estuary.
7. Harmonious and effective governance	<ul style="list-style-type: none"> • Great Brak River Estuary Advisory Forum convened and meets regularly. • Manager for the Great Brak River estuary appointed and capacitated.

	<ul style="list-style-type: none"> • Arrangements for co-operative governance of the Great Brak River estuary defined and agreed to by all participating agencies. • Finance required for implementation of the Great Brak River estuary EMP secured and available. • Adequate capacity and resources available for implementation of the EMP amongst participating agencies.
8. Enhanced public awareness and appreciation for the Great Brak River estuary	<ul style="list-style-type: none"> • Functional and effective stakeholder communication, education and awareness programmes are in place. • Informative and educational signage erected at key access points that highlights the conservation importance and value of the Great Brak River estuary • Great Brak River estuary recognised as an important local ecotourism destination.
9. Research and monitoring	<ul style="list-style-type: none"> • Adequate research and monitoring is being conducted that allows for quantification of utilisation patterns, changes in abiotic and biotic health, and benefits accruing to local communities and national economy.

5 SPATIAL ZONATION

5.1 Geographical extent of the estuary

Estuarine systems are defined differently under different legislative acts in South Africa. The National Water Act (Act No. 36 of 1998) defines an estuary as “a partially or fully enclosed body of water—

- a) which is open to the sea permanently or periodically; and
- b) within which the sea water can be diluted, to an extent that is measurable, with fresh water derived from land”.

This is very similar to the definition included in the National Environmental Management: Coastal Management Act (2008) and listing notices 1 (GN R. 983) and 2 (GN R. 984) published under the National Environmental Management Act (NEMA), Environmental Impact Assessment (EIA) Regulations (2014), which define an estuary as a body of surface water-

- a) that is part of a water course that is permanently or periodically open to the sea;
- b) in which a rise and fall of the water level as a result of the tides is measurable at spring tides when the water course is open to the sea; or
- c) in respect of which the salinity is measurable higher as a result of the influence of the sea;

This definition of what constitutes estuarine habitat is considerably larger in terms of listing Notice 3 (GN R 985) published under the NEMA EIA Regulations (2014), where the definition of an estuary includes the estuarine functional zone as defined in the National Biodiversity Assessment: Estuary Component (van Niekerk & Turpie 2012):

“‘estuary’ means the estuarine functional zone as defined in the National Estuaries Layer, available from the South African National Biodiversity Institute’s BGIS website (<http://bgis.sanbi.org>)”.

In defining the “estuarine functional zone” and hence in the preparation of the most recent edition of the “National Estuaries Layer”, van Niekerk & Turpie (2012) used the following definition of an estuary:

“...a partially enclosed permanent water body, either continuously or periodically open to the sea on decadal time scales, extending as far as the upper limit of tidal action or salinity penetration. During floods, an estuary can become a river mouth with no seawater entering the formerly estuarine area or when there is little or no fluvial input an estuary can be isolated from the sea by a sandbar and become a lagoon or lake which may become fresh or hypersaline”.

In each case, the estuary mouth was taken as the downstream boundary or, where the mouth was closed, the middle of the sand berm between the open water and the sea. The upstream boundary was determined as the limits of tidal variation or salinity penetration. Lateral boundaries of each estuary were defined to include all associated wetlands, intertidal mud and sand flats, beaches and foreshore environments that are affected by riverine or tidal flood events whichever penetrates furthest, and were mostly plotted as the 5 m topographical contour surrounding each estuary.

For the purposes of this management plan, the geographical limits of the Great Brak River estuary have been defined in accordance with the 2011 National Biodiversity Assessment (NBA): Estuary Component (van Niekerk & Turpie 2012) and is shown in Figure 5. Importantly, it incorporates a good deal of the developed area surrounding the Great Brak River estuary.

5.2 Coastal Protection Zone and Coastal Management Lines

The Provincial MEC in consultation with the Local Municipalities is able to refine the designated coastal protection zone of at least 1km from the coastal and estuarine high tide mark under the Integrated Coastal Management Act (2008) for all areas surrounding the Great Brak River estuary zoned agricultural or undetermined use and that are not part of a lawfully-established township, urban area or other human settlement, and a corresponding zone of 100 m for all other land. The Integrated Coastal Management Act (2008) also provides for the establishment of a coastal management line, designed to protect the coastal protection zone. Any future development seawards of the coastal management line could be subject to an Environmental Impact Assessment (EIA) and would have to be compatible with the vision and objectives defined within this management plan.

Establishment of development setback lines around the Great Brak River estuary will prevent development from encroaching too close to the estuary and hence will ensure an adequate buffer for the estuary. It is recommended that a development setback line for the Great Brak River estuary be established that corresponds with the estuarine functional zone for this estuary as defined in the 2011 National Biodiversity Assessment: Estuary Component (van Niekerk & Turpie 2012) and depicted in Figure 5. The development setback zone will serve to protect ecological functioning and integrity of the estuary, limit disturbance to estuarine flora and fauna, and will assist in retaining the wilderness character of the estuary and enhance its ecotourism appeal.

In addition to these provisions, the NEMA EIA regulations also list a number of activities which, if undertaken within the estuarine precinct, require an EIA.

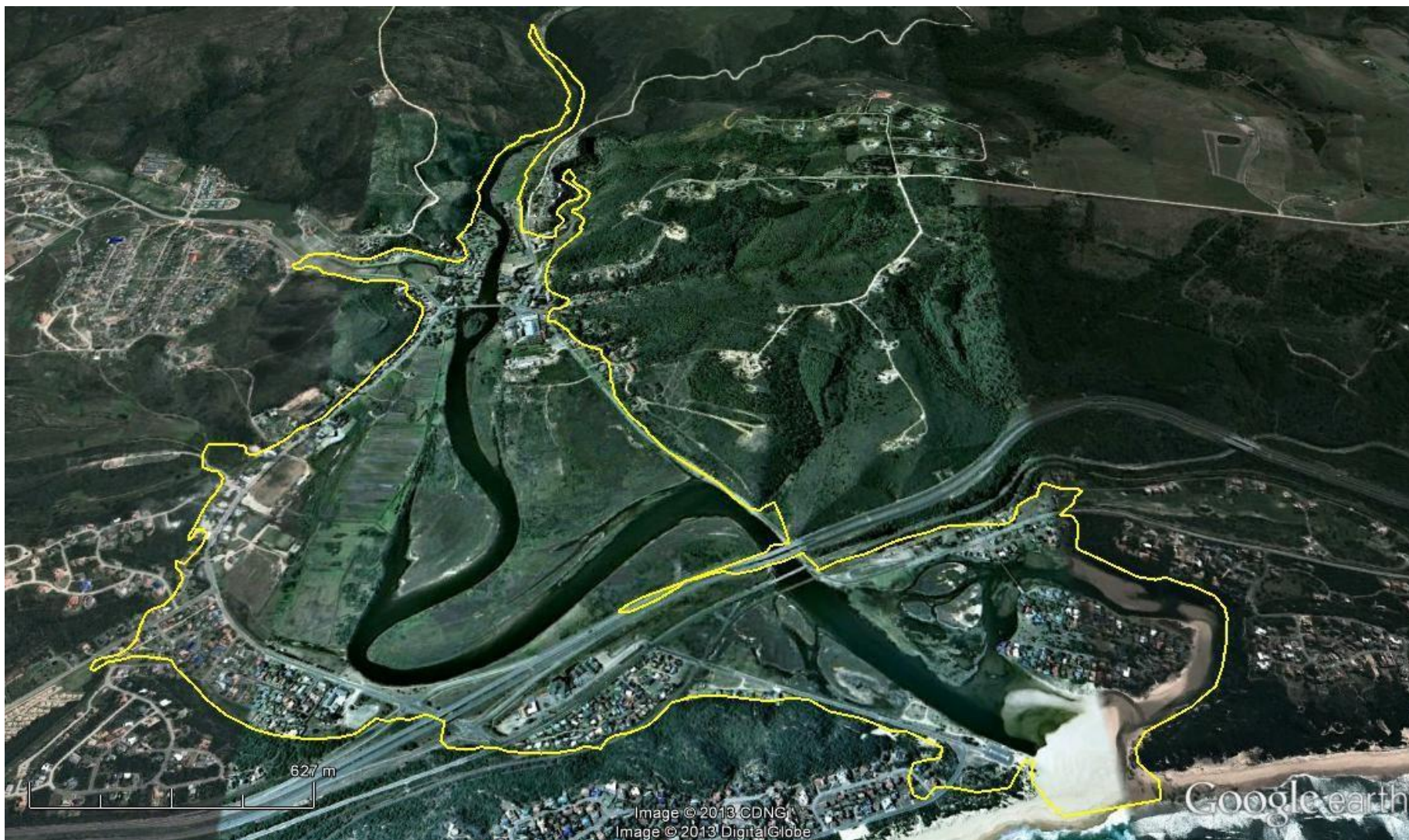


Figure 5: Geographical extent of the estuarine functional zone of the Great Brak River estuary as defined in the NBA (van Niekerk & Turpie 2012)

The National Water Act (1998) also places some restrictions on development adjacent to water courses, which includes estuaries. This Act requires that authorisation (a water use licence) be obtained for any alterations to the bed, banks, course or characteristics of a water course (which includes changes in land use, vegetation cover, topography, soil, etc.) or the adjacent riparian habitat (defined as any flooded area adjacent to the river channel) from the Department of Water & Sanitation (DWS). The riparian habitat is considered to include everything within the 1:100-year flood line of a water course. The 1:50 and 1:100-year flood lines have not yet been delineated for the Great Brak River estuary, but fortunately the onus is on the prospective developer to delineate the extent of the riparian area and the 1:100-year flood line in accordance with guidelines published by the Department of Water and Sanitation. It is recommended that no further development be permitted within the 1:100-year flood line surrounding the Great Brak River estuary.

5.3 Zonation of Activities

In addition to formally demarcating the extent of the Coastal Protection Zone, Coastal Management Lines and development set-back line around the Great Brak River estuary, it has been proposed that a portion of the lower estuary be demarcated as a Special Management Area (SMA) in terms of the ICM Act. This Special Management Area would be zoned in such a way as to satisfy the many conflicting requirements of the different user groups and stakeholders who wish to enjoy the benefits provided by the estuary. Zonation will allow for partitioning of activities within the estuary, thus permitting their co-existence without one activity precluding or conflicting with another. It will also reduce management costs as it will focus activities in particular geographic areas and hence eliminate the need to deploy management staff across the whole estuary at all times.

The proposed SMA includes the whole of the estuary channel on the east side of the island from the road bridge to the point at which this channel re-joins the main channel near the mouth of the estuary (Figure 6). This area should be designated as a bait sanctuary, and collection of bait organisms should be completely prohibited in this area.

The zonation of activities should be reviewed, as an urgent action, to inform recreational use and cover other main activities (not just a bait sanctuary area) and should be guided by water quality. It is however acknowledged that the water body is generally unsuitable for wind activities due to its shallow nature, limited size and submerged structures. Zonation should preferably not include jetskis, windsurfing or power boating.



Figure 6: Originally proposed special management area (bait sanctuary) in the Great Brak River estuary, on the eastern side of The Island

6 MANAGEMENT PRIORITIES

6.1 Biodiversity Conservation

The Great Brak River estuary is a moderately important estuary in South Africa from a conservation perspective. Historically it was likely to have been much more important, providing habitat and food resources for large populations of resident and migrants water birds and fish. For these reasons alone, it is strongly recommended that appropriate steps be taken to ensure that the habitats and biota are protected from encroachment by development and human activities, and as far as possible, restored to their former state.

Positive steps in this respect would be the establishment of a Coastal Management Line and development set-back line corresponding with the estuarine functional zone of the estuary as defined in the NBA: Estuary Component (van Niekerk & Turpie 2012) such that any development within this zone would in future be subject to an Environmental Impact Assessment. While this would not preclude and further development in this area, it would go a long way towards ensuring that it does not further compromise biodiversity conservation, existing natural vistas, cultural heritage, and the sense of place of the estuary. It is further recommended that a portion of the lower estuary (the channel on the east side of the island) be established as a bait sanctuary - Special Management Area in terms of the ICM Act.

Table 2: Management Actions for Biodiversity Conservation

Management Objectives	Management Actions	Legislation	Deliverables / Indicators	Timing	Responsible Agent(s)
a. Establish a Special Management Area (Bait Sanctuary) that incorporates the channel on the east side of the Island	i. Establish a Special Management Area (Bait Sanctuary) that incorporates the channel on the east side of the island	ICM Act 2008 NEM: Protected Areas Act 2003 (NEM: PAA)	Joint memorandum from GBREAF, C.A.P.E. and DEA: O&C to Minister of DEA requesting proclamation of a new Bait Sanctuary on the Great Brak River estuary	2018	GBREAF, DAFF DEA: O&C
	ii. Prepare notice of intent to proclaim the SMA to be published in the government gazette		Notice of intent in government gazette		
	iii. DEA: O&C to consider comments on gazette notice and to prepare responses to I&APs and Minister		Response letters		
	iv. Preparation of final gazette notice		Proclamation notice in government gazette		
b. Integrate Great Brak River EMP into development planning	i. Ensure that the coastal management line and other developmental needs and restrictions are integrated into IDPs and SDFs	ICM Act 2008 Municipal Systems Act 2000 (MSA)	SDFs reflect requirements of EMP Coastal Management Line gazetted	2018	Mossel Bay LM

	ii. Apply for legal status of the coastal management line under the ICM Act				
c. Removal of unnecessary or derelict structures that impede water movement	i. Obtain definite proof that obstructions are the cause of flooding	NWA Act 1997 NEMA 1998	Hydrological studies to ascertain flooding risks	2018	Mossel Bay LM DWS Transnet SANRAL
	ii. Investigation into improved water flow through Charles Searle Bridge and causeway				

6.2 Restoration of Estuary Health

Freshwater flows reaching the Great Brak River estuary have been strongly influenced by anthropogenic developments in the catchment. The estuary currently receives only 44.2% of its natural MAR and overall variability in the flow regime shows little resemblance to the natural condition. Construction of the Wolwedans Dam immediately upstream of the estuary, is to a large extent accountable for these changes. When the Wolwedans Dam was commissioned in 1990, 1.0×10^6 m³ per annum of water was initially allocated to the estuary to meet the ecological requirements. At the time, it was recognised that this volume of water was probably inadequate and it was agreed that it should be raised to 2×10^6 m³/yr (CSIR 1990). These recommendations were never implemented, however, and in fact, even the minimum flow requirements of 1 Mm³/y have not been met for much of the time since the construction of the dam. This has necessitated extensive artificial manipulation of the mouth of the estuary to maintain basic estuarine functioning.

More recently, a reserve determination study was conducted for the Great Brak River estuary in 2008 under the auspices of the Resource Directed Measures (RDM) Directorate of the then Department of Water Affairs (now DWS) (DWA 2008). The study determined that reductions in flow received by the estuary and changes in flow patterns had had a severe impact on the health of the system, which at the time was rated as a Class D or "largely modified". Recommendations were put forward for a water release policy that was projected to restore the health of the estuary to a Class C or "Moderately modified" condition, that required releases of at least 5.0 Mm³/y when the Wolwedans dam was >90% full, 3.3 Mm³/y when levels were between 80 and 90%, 2.2 Mm³/y at a level of 70-80%, dropping to 1.0 Mm³/y only when levels dropped to <70%. These recommendations were accepted by DWS subject to confirmation that such level could be sustained in the face of water demands of the region (principally industrial, agricultural and domestic requirements). The recently completed "Mossel Bay Regional Water Supply Scheme Operations Analysis" indicates that this is indeed feasible provided optimal use is made of alternate supplies of water in the region including other dams and a recently constructed desalination plant.

The route is thus technically clear for restoring some of the historic freshwater flows to the estuary and hence the health of the system.

Table 3: Management Actions for Estuary Health

Management Objectives	Management Actions	Legislation	Deliverables / Indicators	Timing	Responsible Agent(s)
a. Restoration of freshwater flow to the Great Brak River estuary	i. Ascertain estuary allocation from Breede-Gouritz allocation study ii. GBREAF to lobby DWS for acceptance of the "Mossel Bay Regional Water Supply Scheme Operational Analysis" and implementation of the recommendations of the 2008 Estuary Reserve Determination Study	NWA 1998	Publication of final "Mossel Bay Regional Water Supply Scheme Operational Analysis" by DWS Implementation of EFR for the estuary	2017	GBREAF Mossel Bay LM DWS
	iii. Publication of operating rules for the Wolwedans Dam in accordance with "Mossel Bay Regional Water Supply Scheme Operational Analysis"		Operating rules and flow records for releases from the Wolwedans Dam	2018	
	iv. DWS to establish level of application of recommended measures				
b. Eradication of alien invasive species from the estuary and catchment	i. Maintenance of saltmarsh habitats of alien cordgrass <i>Spartina alterniflora</i>	CARA 1983 NWA 1998 NEMBA 2004	Records form alien clearing programmes (ha cleared of alien vegetation) On-going monitoring	2018-2021	GBREAF DWS DEA WfW SANBI
	ii. Ascertain status of infestation in upper catchment				
	iii. Clearance of alien invasive vegetation (<i>Acacia</i> spp.) from the Great Brak catchment				
	iv. Clearance of alien invasive vegetation (<i>Acacia</i> spp.) from municipal owned land (implemented as per available budget)				Mossel Bay LM

6.3 Water Quality Management

The water quality characteristics of the Great Brak River estuary are influenced by a number of factors the most of important of which are runoff and mouth status. Four dominant states of the estuary are recognised, namely “Closed mouth”, “Marine dominated”, “Gradient or Transition” and “Freshwater dominated” (DWA 2008). Characteristics of the main drivers (runoff and mouth state) and key water quality parameters (salinity distribution, water temperature, pH, dissolved oxygen, turbidity, and nutrient concentrations) under these different states are presented in the Situation Assessment Report (Anchor Environmental 2012). As long as the mouth of the estuary is open or runoff is sufficient to maintain adequate flushing in the system, water quality characteristics of the estuarine waters is generally good and poses no risk to human health or the health of the fauna or flora of the estuary. However, following periods of prolonged closure water quality characteristics can changes rapidly and begin to pose a threat to either human or ecosystem health. For example, prolonged exposure to either very low (hyposaline <5 PSU) or very high (hypersaline, >40 PSU) conditions can cause mass mortality of marine (mostly the former) and estuarine organisms (mostly the latter), while even short-term exposure to low levels of dissolved oxygen (< 4 mg/l) can cause mass mortalities of all types or organisms. High levels of nutrients (nitrates, ammonia, phosphorus) in the estuary can lead to proliferation of macroalgae or blooms of microalgae in the estuary (phytoplankton or benthic microalgae) which are unsightly, can smother natural vegetation (e.g. saltmarsh), clog gills of fish, inhibit feeding by fish and birds, and frequently leads to occurrence of low oxygen events. High levels of indicator bacteria (*E. coli*, faecal coliforms and/or Enterococci) are indicative of the presence of pathogens or disease-causing organisms in the estuary that can pose a risk to the health of recreational users or neighbouring residents of the estuary.

Poor water quality in the estuary can arise from direct inputs of waste water into the estuary (e.g. leaking or malfunctioning septic tanks) and from contaminated runoff from the catchment (e.g. sewage and stormwater inputs into the catchment and/or agricultural return flow that contain high levels of fertilizers).

Water quality in the Great Brak River estuary must be monitored regularly (at least on a monthly basis) such that it is possible to identify pending problems before they become critical and to also inform both long-term and short-term management actions (e.g. encouraging farmers in the catchment to adopt improved agricultural practices, improved treatment or diversion of waste waters out of the catchment, artificial breaching of the estuary mouth).

Table 4: Management Actions for Water Quality Management

Management Objectives	Management Actions	Legislation	Deliverables / Indicators	Timing	Responsible Agent(s)
a. Water quality	i. Implement/continue a programme for	NWA 1998	Water quality data	2017-	DWS (physic-chemical data)

monitoring in the Great Brak River estuary	monitoring water quality ¹ in the Great Brak River estuary on a regular (monthly) basis, results of which are available to all stakeholders on a real-time basis		from the Great Brak River estuary available on real-time basis		GBREAF Eden DM (bacteriological /human health indicators)
b. Reduce inputs of nutrients and waste water to the Great Brak River estuary	i. Lobby farmers to reduce the application of inorganic fertilizer in the Great Brak catchment		Improve water quality in the estuary as evidenced by water quality monitoring data	2017-	Mossel Bay LM (in terms of by-laws re illegal discharges to sewer & stormwater) DEA: O&C DWS Eden DM GBREAF DAFF
	ii. Enhance monitoring and enforcement of all discharges of wastewater into the Great Brak estuary and catchment				
	iii. Diversion of wastewater outside of the Great Brak catchment				
	iv. Improvement management of stormwater discharge				

6.4 Effective and Efficient Mouth Management

The channel and mouth dynamics of the Great Brak River estuary have been strongly influenced by anthropogenic developments in the catchment and have been actively managed for at least two centuries. Artificial breaching of the estuary dates back to at least 1814, when it was reported that locals had to open the mouth several times a year to avoid flooding of the river crossing. Requirements to artificially manage the mouth of the estuary relate in part to the high variability in rainfall and runoff in the catchment and the presence of low lying settlements surrounding the estuary (much of it below the 5 m contour, Figure 5), but also high levels of water demand in the catchment. Major floods have occurred at least twelve times in the 1900s up to the early 1980s, and annual run-off reportedly varies from as little as $4.3 \times 10^6 \text{ m}^3$ to as large as $44.5 \times 10^6 \text{ m}^3$ (Morant 1983). Frequent floods combined with extensive development in the low-lying areas surrounding the estuary implies that risks to both property and human life are high in this area, nowhere more so than on the island where access (or escape) is restricted to a single lane wooden bridge. Mitigating these risks requires advance warning of impending floods, effective and efficient evacuation strategies

¹ Monitoring to include salinity, temperature, pH, dissolved oxygen, turbidity, nutrient concentrations and bacterial indicators

that can be put in place at short notice and protocols that allow for breaching of the estuary mouth at short notice to minimise flood risk.

Historically, artificial manipulation of the mouth of the Great Brak River estuary has also been used as the primary means to mitigate impacts of anthropogenically induced changes to the natural flow regime of the Great Brak River system on the ecological functioning of the estuary and recreational utility. The goal has been to maintain open mouth conditions during Spring and Summer to facilitate access to and from the estuary by marine species and to maintain water quality in the system. This has mostly been achieved through planned water releases from the Wolwedans Dam in accordance with recommendations contained in a management plans prepared by the CSIR in 1990 and 2004 (CSIR 1990, 2004) supplemented with mechanical breaching as required.

Two types of breachings were distinguished in the 2004 management plan, namely planned breachings undertaken for the management of the estuary and emergency breaching to avoid danger of flooding. A Draft Mouth Management Plan for the Great Brak River estuary was prepared in accordance with the standard format for the C.A.P.E. Estuaries Programme and was updated in 2017 by the CSIR (DEA&DP, 2017).

The 2018 Mouth Management Plan (DEA&DP 2017) confirms that natural mouth breaching is no longer possible at the Great Brak Estuary because of significant development in the Estuary Functional Zone (EFZ). Artificial breaching at low water levels is also linked to ongoing sedimentation in the system. The construction of the Wolwedans Dam upstream of the estuary on the Great Brak River resulted in a significant reduction in the river flow reaching the estuary. It noted that there is a need to balance the environmental requirements of the estuary with those related to reducing the risks of flooding of properties. Both the short-term and the long-term impacts should be considered, e.g. short-term flood elevation at low levels will result in long-term sedimentation and an increase in flood risk.

Objectives of the 2018 MMP include:

- Manage the estuary mouth as an integral part of the Great Brak Estuarine Management Plan.
- Ensure a healthy functional estuary, i.e. open mouth in spring and summer, no fish kills, no excessive algal blooms.

Key recommendations included in the 20201817 MMP:

- To prevent prolonged closures of the mouth and extensive build-up of the berm it is essential that regular breachings occur which will result in more open mouth conditions. Considerably more water is therefore needed for the management of the estuary than is presently considered. It is therefore strongly recommended that the DWS takes this requirement into account in their

decision on the final water allocation as part of the “Classification” and the associated Ecological Water Requirement for the Great Brak Estuary.

- It is recommended that extra water be allocated to the estuary (i.e. non-ecological breaching) to undertake precautionary breachings when flood conditions are expected.
- An increase of the water level in the estuary will improve the effectiveness of a mouth breaching. It is therefore recommended that the controlled planned breachings be carried out at levels 10 cm higher than at present, i.e. >2.1 m MSL.
- Flooding should be expected along the Great Brak estuary, even when the mouth is open. It is strongly recommended that owners of low-lying properties on the Island and further upstream along the estuary, which are at risk of being flooded, consider flood-proofing their dwellings (e.g. raise floor levels, use tiles instead of carpets, and constructing retaining walls (which may require Municipal and/or Environmental Impact Assessment approval)).
- The Charles Searle road bridge in the Great Brak Village is a serious bottleneck during river floods, causing back-flooding of the town. By implication, a process of assessing the flood dynamics and identifying an appropriate intervention is required. This will require collaboration between different authorities.
- The Great Brak Monitoring needs to be reinstated to keep abreast of fundamental changes in estuary behaviour (e.g. sediment build-up, non-flushing of organic material from basin areas, and the health of ecological components).

Table 5: Management Actions for Mouth Management

Management Objectives	Management Actions	Legislation	Deliverables / Indicators	Timing	Responsible Agent(s)
a. Finalise and implement an MMP for the Great Brak River estuary	i. Submit the Draft MMP for the Great Brak River estuary for stakeholder review and sign-off, followed by approval of a MaintMMP based on the MMP.	ICM Act 2008 NEMA 1998	MMP for the Great Brak River estuary accepted and approved	2017	GBREAF C.A.P.E. Mossel Bay LM Eden DM DWS
	ii. Implementation of the MMP for the Great Brak River estuary (costs to be recovered by Mossel Bay LM from DWS & Eden DM)		MMP for the Great Brak River estuary implemented	2017-	GBREAF Mossel Bay LM Eden DM DWS SAWS

6.5 Visitor Management

The Great Brak River estuary is one of the most scenic of the larger estuaries along the southern Cape coast. The primary challenge facing the future management agency of the estuary is to provide a quality experience for visitors to the estuary while at the

same time managing visitors in a manner that ensures that they do not compromise the resource that attracted them in the first place.

Table 6: Management Actions for Visitor Management

Management Objectives	Management Actions	Legislation	Deliverables / Indicators	Timing	Responsible Agent(s)
a. Establish, maintain and manage visitor facilities	i. Erect informative and educational signage at key points and access points that highlight the conservation importance and value of the Great Brak River estuary.		Visitor infrastructure and facilities Visitors are sensitive to and aware of activities affecting health and functioning of the estuary, and management regulations governing use of the estuary	2018-	Mossel Bay LM GBREAF
	ii. Ensure that visitor facilities are maintained in good condition at all times to maximise visitor experiences		Facilities receive good reviews		

6.6 Development Planning

The ICM Act requires that a management plan be developed for each estuary in the country. The ICM Act also designates a Coastal Protection Zones (CPZ) extending 100 m from the high tide mark (including in estuaries) in areas zoned for residential, industrial or commercial land use, and much larger protection zone of 1 km for public land and land zoned for agricultural use. A Coastal Management Line (CML) must also be designated for all coastal property, by agreement between local and provincial authorities. Within these designated development management zones, no new land transformation or development may take place without environmental authorisation (Environmental Impact Assessment) that can only be issued by the MEC. There is also a provision to create a larger CPZ under the ICM Act where necessary. In the case of the Great Brak River estuary, land surrounding the estuary is mostly zoned for urban development, and thus in terms of ICM Act, a default CPZ of 100 m will be required around much of the estuary.

However, it is recommended that in the case of the Great Brak River estuary, where existing development has already encroached significantly into the estuarine functional zone where a high potential flood risk exists, a CML be established at a position corresponding with the 5 m contour (i.e. which includes the whole of the estuarine functional zone as defined in the NBA: Estuary Component, van Niekerk & Turpie 2012) as depicted in Estuary Zonation Plan (EZP) (Figure 3). Further to this, the 10 m topographical contour is the proposed maximum width of the CPZ around estuaries, as per the West Coast District Setbacks Project (DEA&DP 2014) and the Overberg Setback Refinement Project (DEA&DP, 2014).

This CML and CPZ would also need to be incorporated into the IDP and SDF documents of the Eden District and Mossel Bay municipalities and the Eden District Coastal Management Programme.

Table 7: Management Actions for Development Planning

Management Objectives	Management Actions	Legislation	Deliverables / Indicators	Timing	Responsible Agent(s)
a. Prevent further encroachment by development into the estuarine functional zone of the Great Brak estuary	i. Finalise and adopt the zonation plan for the Great Brak River estuary including the position of the coastal protection zone and coastal management line(s)		Final zonation plan ratified and adopted by all stakeholders	2017	Mossel Bay LM Eden DM DEA:O&C GBREAF
	ii. Incorporate coastal management line proposals into the IDP and SDF documents published by the Eden and Mossel Bay Municipalities and the Eden District Coastal Management Programme.	ICM Act 2008 MSA 2000	Management lines contained in the Great Brak EMP zonation plan incorporated into the municipal IDP and SDF documents	2018	

6.7 Harmonious and Effective Governance

Owing to their position on the boundary between freshwater, terrestrial and marine environments, management of estuaries requires cooperation from a large number of separate national, provincial and local government agencies, each acting under a different legislative mandate. As a minimum, the following national government agencies are involved in management of the Great Brak River estuary: Department of Environmental Affairs: Oceans and Coasts (DEA: O&C), Department of Water & Sanitation (DWS), Department of Public Works (DPW), and the Department of Agriculture, Forestry & Fisheries (DAFF). Provincial and local government agencies involved in management of the estuary include the Department of Environmental Affairs & Development Planning (DEA&DP), Cape Nature, Eden District Municipality (DM), and the Mossel Bay Local Municipality (LM).

Recognising that the difficulties of ensuring a sufficiently high level of integration and cooperation amongst all of these different agencies is likely to extend beyond the capacity of the RMA, Mossel Bay Municipality, it has been recommended that an estuary advisory forum (GBREAF) be established, that will include representatives from all of the principal national, provincial and local government agencies as well as key

stakeholder groupings. The purpose of the Forum will be to provide a body for stakeholders with an interest in the future of the Great Brak River estuary to exchange information and ideas, and to reach agreement on action for the effective management of the estuary. It is essential that all these agencies work cooperatively to ensure the vision and defined management objectives can be realised. Individual agencies may also have to make provision for the funding required to fulfil their obligations in the medium and long-term.

Table 8: Management Actions for Effective Governance

Management Objectives	Management Actions	Legislation	Deliverables / Indicators	Timing	Responsible Agent(s)
a. Constitute the Great Brak River Estuary Advisory Forum (GBREAF)	i. Reconstitute and formalise the GBREAF.	ICM Act 2008	A list of members of the forum and their contact details	2017	Mossel Bay LM
b. Define co-operative governance arrangements for management of the Great Brak River estuary	i. Estuary Forum to obtain agreement from the Responsible Management Authority and other participating agencies in respect of their roles and responsibilities.	ICM Act 2008	Signed letters of commitment from all agencies to be involved with the management of Great Brak River estuary	2017	DEA: O&C DWS DPW DAFF DEA&DP CapeNature Eden DM GBREAF
c. Secure financing	i. Individual government agencies to make provision for the necessary resources in the short, medium and long-term expenditure frameworks to create and fill posts, and acquire necessary infrastructure and resources for effective management of the Great Brak River estuary	ICM Act 2008 NWA 1998 CARA 1983 MSA 2000	Provisions made for estuarine management in budgets and expenditure frameworks	2017-	DEA: O&C DWS DPW DAFF DEA&DP CapeNature Eden DM GBREAF
	ii. Develop a long-term financing plan				
d. Adequate resources and capacity	i. Individual agencies to acquire necessary equipment (office equip, water quality		Staff & resources deployed for	2018-	DEA: O&C DWS DPW DAFF

Management Objectives	Management Actions	Legislation	Deliverables / Indicators	Timing	Responsible Agent(s)
	meter, boat, vehicle) for effective management		estuarine management		DEA&DP CapeNature Eden DM GBREAF
	ii. Individual agencies to identify and address training needs among staff involved in estuary management		Training records		
	iii. Evaluate performance of staff, contractors and volunteers		Performance evaluations	2019-	

6.8 Enhanced public awareness and appreciation for the Great Brak River estuary

Effective management of the Great Brak River estuary will be dependent on stakeholder buy-in (through adequate consultation and communication) and visitors' appreciation of the management regulations. Education is also considered to be among the most important functions provided by estuaries. Estuaries are heavily utilised for recreational purposes and provide opportunities where the public are able to view species in their natural environments, and (preferably) to experience ecosystems in a largely undisturbed state. Provision of interpretive and educational material at these sites can greatly enhance this experience as it focuses attention of visitors on goods and services provided by the environment of which they may not have been aware, highlights key aspects of the environment that are special or unique to the area, and can be used to highlight the impact of human activities on the environment. Furthermore, the better people understand the issues surrounding the management of a protected area, the more they are likely to respect the management requirements and regulations. Thus, the various agencies responsible for the management of the Great Brak River estuary will need to provide state of the art service in this field.

Table 9: Management Actions for Public Awareness, Appreciation and Education

Management Objectives	Management Actions	Legislation	Deliverables / Indicators	Timing	Responsible Agent(s)
a. Create effective mechanisms for on-going communication with stakeholders	i. Develop an effective communication strategy	ICM Act 2008	Communication strategy	2017	Mossel Bay LM GBREAF Eden DM
	ii. Maintain stakeholder database		Stakeholder database		
	iii. Explore alternative communications		Record of Communications		

Management Objectives	Management Actions	Legislation	Deliverables / Indicators	Timing	Responsible Agent(s)
	mechanisms (workshops, signage, radio etc.)				
b. Develop an effective education and awareness programme for the Great Brak that enhances visitor experiences	i. Source and/ or commission educational and informative material including signage, posters, pamphlets, and relevant literature to be housed in the visitor centre and other appropriate localities that will enhance visitor experiences.		Posters, pamphlets, signage, literature compiled and disseminated	2018	Mossel Bay LM GBREAF Eden DM
	ii. Encourage field excursions to the estuary by local schools, community groups, and other stakeholder groupings		Field excursions	2018-	
	iii. Evaluate Groot Brak River Museum initiative		Assessment		

6.9 Research and Monitoring

This EMP has been devised based on current understanding of the functioning of the estuary. There are gaps in this understanding, and there will be an ongoing need to improve understanding through research. Increasing use by visitors, surrounding development, changes in freshwater supply from the catchment, and climate and sea-level change could also impact on the health and ecological functioning of the estuary, as well as its value at different spatial scales.

Monitoring and research are essential to enable the respective agencies responsible for management of the Great Brak River estuary to adapt management plans, operational plans and activities to changing circumstances. Key focal areas for monitoring and research associated with the Great Brak River estuary include water quantity and quality, mouth management, physical characteristics, and biodiversity.

Recommended protocols for monitoring the health of the Great Brak River estuary are included in Appendix 2. Related to this, the “*Ecological Specifications*” and “*Thresholds of Potential Concern*” (TPCs) for the Great Brak River estuary are included as Appendix 3. In addition to monitoring the biotic and abiotic health of the Great Brak River estuary, it is also strongly recommended that visitor numbers, profiles, behaviour and opinions are monitored on a regular basis to gauge management

effectiveness and user responses to management. Monitoring protocols for these aspects are also included in Appendix 2.

Table 10: Management Actions for Research & Monitoring

Management Objectives	Management Actions	Legislation	Deliverables / Indicators	Timing	Responsible Agent(s)
a. Promote scientific research	i. Identify information gaps and shortfalls in monitoring programme(s) aimed at gathering/consolidating data on biodiversity		Research projects Scientific reports, papers and publications	2017-	GBREAF DST DWS DEA:O&C Eden DM DAFF
	ii. Engage local research institutions and universities to collaborate on priority research projects				
	iii. Solicit research funding support				
b. Monitor biophysical indicators of estuary health	i. Carry out monitoring programme as outlined in Appendix 2 and assess results in terms of Thresholds of Potential Concern (Appendix 3)	NWA 1998	Monitoring data and reports	2017-	DAFF DWS DEA:O&C
c. Monitor human use of estuary health	i. Carry out monitoring programme as outlined in Appendix 2		Monitoring data and reports	2017-	GBREAF Eden DM

7 SUMMARY OF MANAGEMENT ACTIONS AND TIMING

Table 11 provides a summary of the tasks to be carried out over the next 5 years for the implementation of the Great Brak River EMP. The Mossel Bay LM is the primary agency responsible for co-ordinating the management of the estuary (mandated in terms of the Protocol, published under the ICM Act) but will be assisted by the GBREAF and a range of other government agencies including the DWS, DEA: O&C, DAFF, the DEA&DP, Cape Nature, and the Eden DM.

Table 11: Summary of actions and timing of actions pertaining to each of the key result areas over the period Jul 2017 – Jun 2021

Management Objective	Action	Agencies responsible	2017	2018	2019	2020	2021
1. Conservation of estuarine biodiversity	a. Establish a Special Management Area (SMA)	GBREAF, Mossel Bay LM, DEA: O&C					

Management Objective	Action	Agencies responsible	2017	2018	2019	2020	2021
	b. Eradication of alien invasive species from the estuary and catchment	GBREAF, Mossel Bay LM, DWS					
	c. Removal of unnecessary or derelict structures that impede water movement in the estuary	GBREAF, Mossel Bay LM, DWS, Transnet, SANRAL					
2. Restoration of estuary health	Implementation of the recommendations of the 2008 Estuary Reserve Determination study and dam operating rules for the Wolwedans Dam	GBREAF, DWS					
3. Effective and efficient mouth management	Finalise and implement the Draft MMP for the Great Brak Estuary, and obtain approval for a MaintMP	GBREAF, Mossel Bay LM, Eden DM, DWS, SAWS					
4. Water quality management	Implement water quality monitoring in the Great Brak River estuary	GBREAF, DWS, Eden DM					
	Reduce inputs of nutrients and waste water to the Great Brak River estuary	GBREAF, DWS, Mossel Bay LM, Eden DM, DAFF					
5. Visitor management	Establish and manage visitor facilities	GBREAF, Mossel Bay LM					
6. Development planning	Prevent further encroachment by development into the estuarine functional zone of the Great Brak	GBREAF, DEA: O&C, Mossel Bay LM, Eden DM					
7. Harmonious and effective governance	Constitute the Great Brak River estuary Advisory Forum	Mossel Bay LM					
	Define co-operative governance arrangements for management of the Great Brak River estuary	GBREAF, DEA: O&C, DWS, DPW, DAFF, DEA&DP, CapeNature, Eden DM, Mossel Bay LM					
	Secure financing for effective management	Mossel Bay LM					

Management Objective	Action	Agencies responsible	2017	2018	2019	2020	2021
	Secure resources and capacity for effective management						
8. Enhanced public awareness and appreciation for the estuary	Create effective mechanisms for on-going communication with stakeholders	GBREAF, Mossel Bay LM, Eden DM					
	Develop and implement an effective education and awareness programme for the estuary that enhances visitor experiences						
9. Research and monitoring	Promote scientific research	GBREAF, DWS, Eden DM, DEA: O&C					
	Monitor biophysical indicators of estuary health		DWS, Eden DM, DEA: O&C, DAFF				
	Monitor human use of the estuary	Mossel Bay LM, Eden DM					

8 INSTITUTIONAL ARRANGEMENTS

8.1 Key Role Players

It is essential that this EMP is regarded as a strategic plan that can guide the detailing of implementation actions and identification of implementing agents. Therefore, it does not specify the required resources (human and financial) required for proper management of the estuary. However, it does offer a schedule or phased planning approach that incorporates capacity building and implementation at the local level over a five-year period. It is crucial that champions/project leaders/teams are identified who will be responsible for the formulation of detailed action plans and the implementation thereof. Ways of empowering historically disadvantaged individuals with regards to the local management of the Great Brak River estuary must be explored and implemented.

Co-management and effective governance has already been identified as the keystone to the efficient and effective management of the Great Brak River estuary.

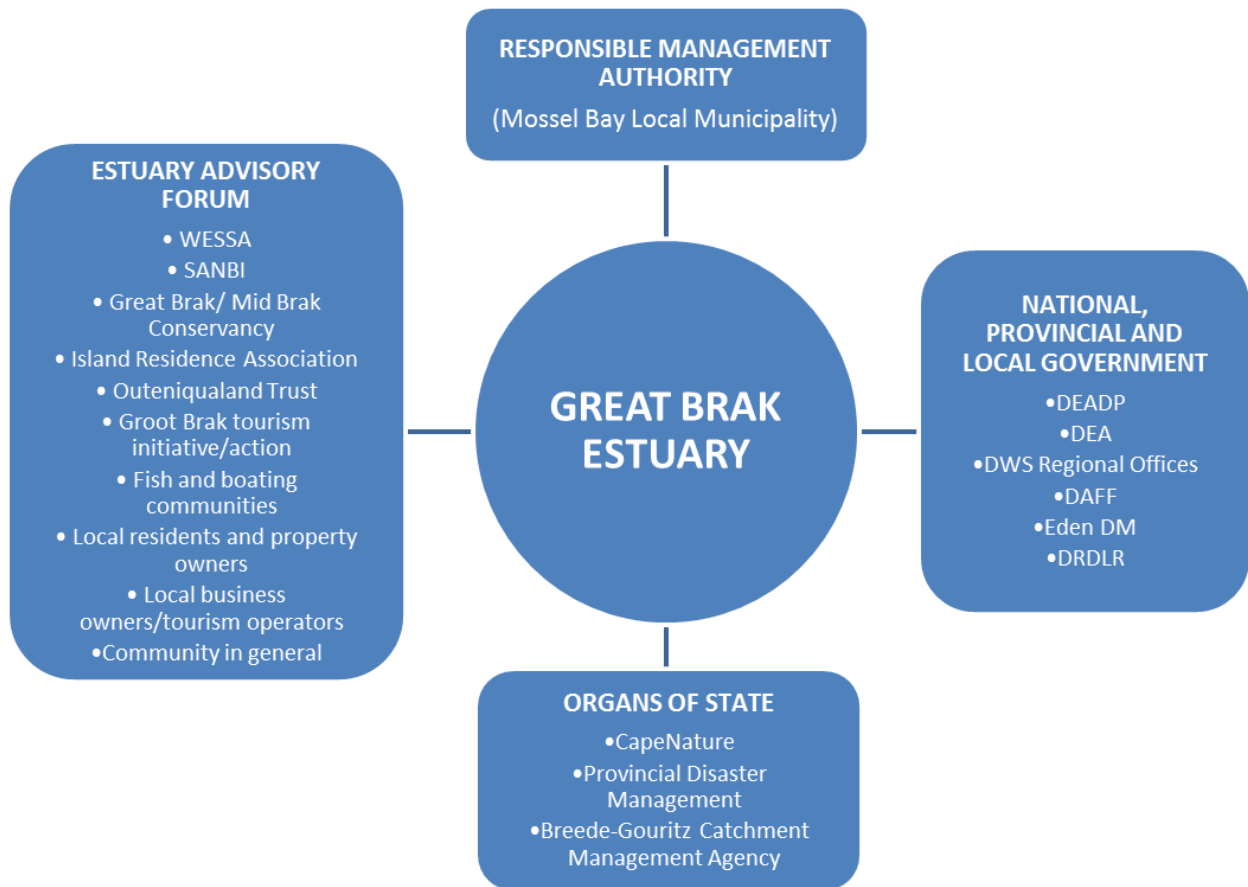


Figure 7: Key role players for the management of the Great Brak River estuary

8.1.1 Responsible Management Authority

The Protocol identifies the **Mossel Bay Local Municipality**, or its assigned representative, as the **Responsible Management Authority** responsible for the development of the Great Brak River EMP as well as being responsible for the co-ordination of its implementation. This implementation function can be effected through a range of different forums and actors.

8.1.2 Great Brak River Estuary Advisory Forum

According to the Protocol, the role of the **Great Brak River Estuary Advisory Forum (GBREAF)** is interpreted as providing an advisory service to the RMA on issues specific to the management and implementation of the EMP, as well as being the hub that links all stakeholders, which serves to foster stakeholder engagement and to facilitate the implementation of the project plans identified. The broader community will be able to voice concerns and raise issues via the GBREAF. This includes Ratepayers' Associations, NGO's, community groups, conservancies, etc., as well as representatives from surrounding industry and agriculture. Any representatives are obliged to raise issues identified by their constituents and to provide feedback to the constituents. Importantly, the GBREAF will not represent or supplant the individual positions of its members unless specifically mandated to do so.

8.1.3 Government Departments and organs of state

The successful implementation of the EMP may be seen as also dependent on the contribution of a number of governmental role players, including:

- **Western Cape Government departments:** Responsible for legislative support, including compliance, funding, research and monitoring;
- **Eden District Municipality:** Responsible for legislative support and funding;
- Relevant **National government departments**, especially DEA, DWS (via the regional office), DAFF and the Department of Rural Development and Land Reform; and
- Organs of State (SANparks, CapeNature, BGCMA).

The DEA is generally responsible for national standardisation of estuarine management and approval of provincially-compiled estuarine management plans. Direct involvement in individual estuaries, such as the Great Brak River, will occur via existing forums for intergovernmental coordination. These forums will have the management of the Great Brak River estuary on their agendas from time to time, and include:

- **Western Cape Provincial Coastal Committee:** Responsible for facilitating co-management, effective governance and provincial co-ordination of estuarine management; and
- **Eden District Municipal Coastal Committee:** Responsible for facilitating co-management and effective governance.

9 MONITORING AND EVALUATION

9.1 Resource Monitoring

Appendix 2 provides a list of recommended abiotic and biotic parameters to be monitored on the Great Brak River estuary to assess changes in health of the system over time. Additional recommendations have been included for monitoring of visitor numbers, profiles and opinions, and angler catch and effort required in terms of the management plan.

9.2 Review and evaluation

This EMP should be reviewed and updated on a five-yearly basis to ensure that objectives and targets are being achieved. An audit should be undertaken alongside the review and evaluation to determine and grade the success and failures with the implementation of the management plan according to the specified performance indicators (Appendix 4). The audit should ultimately be the responsibility of Mossel Bay Local Municipality, supported by the GBREAF and CapeNature.

The review will involve revisiting the Situation Assessment to determine the progress or changes that have come about as a result of the EMP in terms of the objectives that were originally set as well as any changes in legislation or policies, and followed by revisions or refinement of the objectives and where necessary, aspects of the management actions plans or monitoring protocol.

10 REFERENCES

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APPENDIX 1: 2018 MOUTH MANAGEMENT PLAN

APPENDIX 2: RECOMMENDED MONITORING PROTOCOLS

The following table provides a list of recommended abiotic and biotic parameters to be monitored on the Great Brak River estuary to assess changes in health of the system over time. Recommendations for monitoring of visitor numbers, profiles and opinions, and angler catch and effort required in terms of the management plan are also included here.

ECOLOGICAL COMPONENT	MONITORING ACTION	RELATED TPC (see	TEMPORAL SCALE (frequency	SPATIAL SCALE (No.	RESPONSIBLE AGENCY
1. BIRDS	Undertake counts of all water-associated birds. All birds should be identified to species level and total	1.1 – 1.2	Annual (winter and summer)	Entire estuary	Cape Nature
2. FISH	Conduct fish surveys using both seine and gill nets as primary gear.	2.1 – 2.6	Winter and summer survey every 3 years	Entire estuary (5 stns)	DAFF
3. INVERTEBRATES	Zooplankton: Collect quantitative samples using a flow meter after dark, preferably during neap tides (mid to high tide). Sampling to be done at mid- water level, i.e. not surface.	3.1	Same as for fish	Entire estuary (5 stns)	DAFF
	Include chlorophyll a Benthic invertebrates: Collect (subtidal) samples using a Zabalocki-type Eckman grab sampler with 5-9 randomly placed grabs (replicates) at	3.2	Same as for fish	Entire estuary (5 stns)	DAFF
4. MACROPHYTES	Map main macrophyte communities using aerial photos or GPS	4.1 – 4.5	Every 3 years	Entire estuary	DAFF
5. MICROALGAE	Phytoplankton: Conduct water column chlorophyll a measurements and counts of	5.1 – 5.3, 5.5	Same as for fish	Entire estuary (5 stns)	DAFF
	Benthic microalgae: Conduct benthic chlorophyll measurements	5.4	Same as for fish	Entire estuary (5 stns)	DAFF, DWS
6. WATER QUALITY	Collect data on conductivity, temperature, suspended matter/turbidity, dissolved oxygen, pH, inorganic	6.6, 6.7 & 6.8	Monthly	Head of estuary (one station)	DWS
	Collected longitudinal salinity & temperature profiles (in	6.1 – 6.5	To be measured when biotic surveys require information for interpretation	Entire estuary (10 stns)	DWS
	Water quality measurements taken along the length of the estuary (surface and bottom samples) for pH, dissolved oxygen, suspended solids/turbidity, and inorganic	6.7 – 6.12		Entire estuary (5 stns)	DWS
7. HYDRODYNAMICS	Water level recordings	7.1-7.3	Continuous	At bridge (one	DWS
	Flow gauging	7.1-7.3	Continuous	Head of the estuary	DWS

ECOLOGICAL COMPONENT	MONITORING ACTION	RELATED TPC (see	TEMPORAL SCALE (frequency	SPATIAL SCALE (No.	RESPONSIBLE AGENCY
	Mouth State	7.1-7.3	Continuous	Mouth	DWS
8. SEDIMENT DYNAMICS	Aerial photographs of estuary (spring low tide)	7.2, 8.3 and 8.4	Annually	Entire estuary	DWS, DEA: O&C
	Bathymetric survey: Series of cross-section profiles and a longitudinal profile collected at fixed 500 m intervals, but more detailed in the mouth	8.3 – 8.4	Every 3 years	Entire estuary	DWS, DEA: O&C
	Set sediment grab samples (at cross section profiles) for analysis of particle size	8.1 - 8.4	Every 3 years	Entire estuary	DWS, DEA: O&C
9. HUMAN USE	Collect statistics on the profile (origin, sex, age, income category) and		Continuous	Visitor entry points and key sites of	Mossel Bay LM
	Conduct regular counts of users, collecting statistics on the profile (origin, sex, age, income category) and activities of visitors to the		Continuous	Visitor entry points and key sites of interest	Mossel Bay LM
	Conduct regular counts of users and boats, separated		Twice per week	Entire estuary	Mossel Bay LM
	Survey visitor opinions on impacts of key management		Intensively (3x/week)	Entire estuary	Mossel Bay LM
	Creel surveys of Catch, Effort and C.P.U.E. for shore and boat based anglers		Intensively (3x/week) every 5th	Entire estuary	DAFF

APPENDIX 3: ECOLOGICAL SPECIFICATIONS AND THRESHOLDS OF POTENTIAL CONCERN (TPC) FOR MONITORING PARAMETERS LISTED IN APPENDIX 2

The following table provides “Ecological Specifications/Resource Quality Objectives” and “Thresholds of Potential Concern” (TPC) for the Great Brak River estuary adapted from those prepared for ecological freshwater requirements study completed for the Olifants estuary (Taljaard et al. 2006). In this context, “Ecological Specifications/Resource Quality Objectives” are defined as being clear and measurable specifications of ecological attributes (in the case of estuaries - hydrodynamics, sediment dynamics, water quality and different biotic components) that define a specific ecological reserve category, in this case a Category B, while “Thresholds of Potential Concern” are defined as measurable end points related to specific abiotic or biotic indicators that if reached (or when modelling predicts that such points will be reached) should prompt management action. Note that thresholds of potential concern endpoints are generally defined such that they provide early warning signals of potential non-compliance to ecological specification (i.e. not the point of “no return”). Thus, indicators (or monitoring activities) included here incorporate biotic and abiotic components that are considered particularly sensitive

to ecological changes associated with changes in river inflow and should be interpreted as such.

COMPONENT	ECOLOGICAL SPECIFICATIONS/RESOURCE QUALITY OBJECTIVES	THRESHOLD OF POTENTIAL CONCERN	POTENTIAL CAUSES
<p>1. BIRDS</p>	<p>Retain the species richness, abundance and diversity of the bird community, representative of resident and migrant waders, wading birds and water fowl as under the Natural State</p>	<ul style="list-style-type: none"> Community composition or bird numbers deviates by more than 50% of average seasonal baseline counts for two consecutive summer or winter seasons, focusing on waders, wading birds, terns & water fowl (summer and winter), and specifically red data species which are supported by the system (e.g. Pelican, Oyster catchers, Chestnut banded plover) In the case of water fowl densities decline by 20% of average seasonal baseline counts for two consecutive summer or winter seasons 	<p>Changes in:</p> <ul style="list-style-type: none"> Salinity Invertebrate biomass/abundance Fish biomass/abundance in smaller size classes Vegetation habitats (e.g. reed beds, submerged macrophytes, salt marsh) Mud flats Human disturbance (not at moment)
<p>2. FISH</p>	<p>Retain the species richness, abundance and diversity of the fish community as for the natural state, including the following representative groups: estuarine resident species, partially estuarine dependent species, and obligate estuarine dependent</p>	<ul style="list-style-type: none"> Level of estuarine species drop below 50% of present day abundance Levels of obligate estuarine dependent species drop below 50% of present day 	<p>Changes in:</p> <ul style="list-style-type: none"> Insufficient spawn biomass (national stock – marine) Spawning failure due to environmental conditions (marine) Recruitment failure (e.g. no cues reaching the sea from the estuary) Habitat (macrophytes) Water column (temperature, salinity,

COMPONENT	ECOLOGICAL SPECIFICATIONS/RESOURCE QUALITY OBJECTIVES	THRESHOLD OF POTENTIAL CONCERN	POTENTIAL CAUSES
		abundance <ul style="list-style-type: none"> Levels of partially estuarine dependent species drop below 50% of present day abundance Levels of exotic freshwater species above 50% (e.g. Mozambique tilapia) 	turbidity, dissolved oxygen) <ul style="list-style-type: none"> Toxic substances (?) Food availability (Invertebrate & fish) Exploitation Introduction in aliens
	Maintain recruitment of adult and juvenile fish at Reference Condition levels. This requires maintaining sufficient flow for freshwater plume (temperature, salinity and olfactory gradient) entering the sea. This implies that there should be a significant number of 0-1 year old fish and no missing year classes.	There are a missing year classes within a species	Failure in recruitment due to sand bar at mouth, bad catchment practises/destruction of habitat, blockage of migration due to dams.
3. INVERTEBRATES	Retain Present State species richness and mix (low species abundance, high dominance).	Species richness is changes by more than 50% from present day	Changes in: <ul style="list-style-type: none"> Variability in intra-annual flow, e.g. loss of high flow pulses (>20 m³/s) in autumn/spring (salinity) Sediment grain size distribution and organic content
	Indicator species such as <i>Capitella capitata</i> , should not dominate benthic species at any site	<i>Capitella capitata</i> exceeds 50% abundance of benthic species at any site	Increase in pollution (low oxygen high organic loading)
	<i>Callianassa</i> and <i>Upogebia</i> distribution patterns as under Present State	Abundance levels or areas of distribution decreases by more than 50% (mainly lower sandy reaches)	Changes in sediment characteristics along the estuary
4. MACROPHYTES	Maintain the present distribution and abundance of the different plant community types	Greater than 20% change in the area covered by different plant community types	Increase in salinity and reduced flooding influencing depth to groundwater and groundwater salinity. Increase in turbidity would reduce submerged macrophyte cover.
	Reduce the areas covered by macroalgae (<i>Enteromorpha</i> sp.) in the upper reaches by	Lower 15 km of estuary with greater than 50% of estuary mudflats covered	Low flow, lack of flushing and reduced current speeds. Reduced flooding that resets the estuary. High nutrient input from

COMPONENT	ECOLOGICAL SPECIFICATIONS/RESOURCE QUALITY OBJECTIVES	THRESHOLD OF POTENTIAL CONCERN	POTENTIAL CAUSES
	50% compared to the Present State (summer 2004).	by Enteromorpha sp.	agricultural activities and return flow.
	Control the spread of invasive aliens in the riparian zone (e.g. Acacia spp.).	Greater than 20% increase in area covered by invasive plants.	Disturbance of riparian zone due to human impacts such as bulldozing and clearing of natural vegetation
	Prevent an increase in bare ground in the floodplain salt marsh by maintaining groundwater salinity at <70 ppt and depth to the water table at < 1.5 m	Greater than 20% increase in bare ground in salt marsh.	Reduced flow and flooding, increase in groundwater salinity and depth to groundwater.
5. MICROALGAE	Maintain a low phytoplankton biomass with a small REI (i.e. 10 ppt to river +1 ppt) zone	<ul style="list-style-type: none"> Phytoplankton biomass exceeds 10 µg/l chlorophyll a in summer or winter Blue-green algae exceeds 10% of phytoplankton cell counts 	Water flow rates falling too low in winter or summer.
	Maintain microalgal group diversity as measured under Present State	Flagellates cease to be the dominant group and diatoms become less diverse (<10 taxa per site)	Reduced freshwater inflow rates and high salinity near the upper areas of the estuary.
	Maintain intertidal and subtidal microphytobenthic biomass as measured under Present State (2004).	Benthic microphytobenthic biomass exceed 40 mg/m ² chlorophyll a	Elevated nutrient in the inflowing freshwater.
	Maintain a low frequency of dinoflagellates	The frequency of dinoflagellates exceeds 5% of the total phytoplankton counts	Eutrophication of inflowing river water.
6. WATER QUALITY	Salinity intrusion should not to cause exceedence of TPCs for fish, invertebrates, macrophytes and microalgae (see above)	<ul style="list-style-type: none"> Salinity greater than 5 ppt for long than 3 months Salinity of groundwater increases to 50 ppt and depth to water table to 1 m. (flood plain salt marsh) Total dissolved solids (measure of 'salinity') of river inflow exceeds 3500 mg/l 	<ul style="list-style-type: none"> Modification of volume of river inflow Mouth closure Quality of agricultural return flow

COMPONENT	ECOLOGICAL SPECIFICATIONS/RESOURCE QUALITY OBJECTIVES	THRESHOLD OF POTENTIAL CONCERN	POTENTIAL CAUSES
		(phytoplankton) <ul style="list-style-type: none"> Salinity in estuary exceeds 35 ppt (prevent hypersalinity) (phytoplankton) Salinity greater than 10 ppt occurs above 16 km upstream of the mouth (fish) 	
	System variables (Temperature, pH, turbidity, dissolved oxygen, suspended solids and turbidity) not to cause exceedence of TPCs for biota (see above)	River inflow: <ul style="list-style-type: none"> Summer temp < 20oC pH < 6.5 'Turbid' river inflow (to be determined) Dissolved oxygen < 4 mg/l Secchi disc reading above 8 km from the mouth is greater than 1 m (proxy for turbidity in estuary) pH > 8.5 or < 6.5 in river inflow or in estuary Water column DO drops below 4 mg/l (1 m above bottom except in deep holes) (need to investigate DO level at night in dense macrophyte beds)	<ul style="list-style-type: none"> Changes in water quality of river inflow at head of estuary and as a result of agricultural return flow along the banks of the upper estuary. Excessive macroalgal/microalgal growth in the estuary
	Inorganic nutrient concentrations not to cause exceedence of TPCs for macrophytes and microalgae (see above).	<ul style="list-style-type: none"> When average river inflow is less than 5 m3/s and average DIN concentrations exceed 100 µg/l in river inflow and DIN concentrations in the upper reaches of the estuary (above 16 km from mouth) exceed 100 µg/l During high flow season (flows > 20 m3/s) 	Changes in water quality of river inflow at head of estuary and as a result of agricultural return flow along the banks of the upper estuary.

COMPONENT	ECOLOGICAL SPECIFICATIONS/RESOURCE QUALITY OBJECTIVES	THRESHOLD OF POTENTIAL CONCERN	POTENTIAL CAUSES
		<p>average DIN concentrations exceed 500 µg/l in river inflow and average DIN concentrations in the upper reaches of the estuary (above 16 km from mouth) exceed 500 µg/l</p> <ul style="list-style-type: none"> • Average DRP concentration exceed 100 µg/l in river inflow and average DRP concentrations in the upper reaches of the estuary (above 16 km from mouth) exceed 100 µg/l 	
	<p>Presence of toxic substances not to cause exceedence of TPCs for biota (see above).</p>	<p>For pesticides/herbicides baseline studies still need to be undertaken before TPCs can be set (special concern in upper reaches with extensive agricultural activities along banks of estuary)</p>	<p>Inputs from agricultural activities in the catchment and along the banks of the estuary in upper reaches</p>
7. HYDRO-DYNAMICS	<p>Maintain a flow regime to ensure estuary mouth remains open during Spring and Summer, thus creating the required habitat for birds, fish, macrophytes, microalgae and water quality</p>	<ul style="list-style-type: none"> • River inflow distribution patterns differ by more than 5% from present • River inflow decreases to below 1.5 m³/s at any time • River inflow below 2 m³/s persist for longer than 4 months 	<p>Modification to inflow at head of estuary</p>
8. SEDIMENT DYNAMICS	<p>Flood regime to maintain the sediment distribution patterns and aquatic habitat (instream physical habitat) so as not to exceed TPCs for biota (see above)</p>	<ul style="list-style-type: none"> • River inflow distribution patterns (flood components) differ by more than 10% (in terms of 	<p>Modification to inflow at head of estuary</p>

COMPONENT	ECOLOGICAL SPECIFICATIONS/RESOURCE QUALITY OBJECTIVES	THRESHOLD OF POTENTIAL CONCERN	POTENTIAL CAUSES
		<p>magnitude, timing and variability) from that of the Present State</p> <ul style="list-style-type: none"> • Suspended sediment concentration from river inflow deviates by more than 10% of the sediment load discharge relationship to be determined as part of baseline studies 	
	<p>Changes in sediment grain size distribution patterns not to cause exceedance of TPCs in benthic invertebrates (see above).</p>	<ul style="list-style-type: none"> • The median bed sediment diameter deviates by more than a factor of two from levels to be determined as part of baseline studies (Present State). • Sand/mud distribution in middle reaches (8-20 km) change by more than 20% from Present State • Changes in the channel bathymetry in the upper reaches (above 20 km upstream of the mouth) change by more than 20% from Present State • Changes in tidal amplitude below the Steenboksfontein of more than 20% from Present State 	<p>Modification to inflow at head of estuary; Catchment activities</p>

APPENDIX 4: RECOMMENDED PERFORMANCE MONITORING PLAN

MANAGEMENT OBJECTIVES	PERFORMANCE INDICATOR	TIMING	LEGISLATION	RESPONSIBILITY
1. Biodiversity Conservation				
a. Establish a Special Management Area (Bait Sanctuary)	Part of Great Brak River estuary receives formal protection as a SMA	Once a year	ICM Act NEM:PAA	GBREAF, CapeNature, DEA
b. Integrate Great Brak River EMP into IDPs/SDFs	EMP is reflected in the local/district and coastal management line is gazetted	Every IDP/SDF review cycle	ICM Act MSA	Mossel Bay LM
c. Removal of unnecessary or derelict structures that impede water movement	<ul style="list-style-type: none"> All obstructions removed Restoration/improvement in estuarine flow and impacted habitats 	Once a year	NWA NEMA	Mossel Bay LM DWS
2. Restoration of estuary health				
a. Restoration of freshwater flows	Ecological health Category of C is achieved and maintained	Biannual for DWS	NWA	Mossel Bay LM, DWS, GBREAF
b. Eradication of alien invasive species from the estuary and catchment	Increased number of tons removed/ hectares cleared	Ad hoc visual monitoring during normal daily activities Assess area every 2 years	CARA	Mossel Bay LM, GBREAF, CapeNature
3. Effective and efficient mouth management				
a. Finalise and implement the Draft Mouth Management Protocol	Ecological health Category of C is achieved and maintained	Twice a year	EIA NWA	Mossel Bay LM, GBREAF, CapeNature
4. Water quality management				
a. Implement a water quality monitoring programme	Ongoing databases and reports produced	Biannual for DWS Monthly for GBREAF		Mossel Bay LM, GBREAF, DWS
b. Reduce inputs of nutrients and waste water	Improved water quality in the estuary	Biannual for DWS Monthly for GBREAF	NWA	Mossel Bay LM, GBREAF, DWS
5. Visitor management				
a. Establish and manage visitor facilities	<ul style="list-style-type: none"> Increase in number of tourists per year Increase in contribution of tourism to GDP 	Once a year		Mossel Bay LM,, GBREAF,
6. Development Planning				

a. Prevent development encroachment into the estuarine functional zone	<ul style="list-style-type: none"> Zonation plan adopted by all stakeholders and enforced Coastal Protection Zone and Coastal Management Lines incorporated into municipal IDP and SDF documents 	End of 1st year Every IDP/SDF review period	ICM Act MSA	Mossel Bay LM Eden DM GBREAF
7. Co-operative and effective governance				
a. Reconstitute the Great Brak River Estuary Advisory Forum	Confirmed members & reconstituted GBREAF	End of 1st year	ICM Act	Mossel Bay LM
b. Define co-operative governance arrangement	Confirmed roles & responsibilities of participating agencies	Assess every 2 years	ICM Act, NEM:PAA	GBREAF, CapeNature, Mossel Bay LM, DEA, DWS
c. Secure financing	Funding is secured for next 5 years	Assess twice a year	ICM Act, NWA, CARA, MSA	Mossel LM, Key partners
d. Ensure adequate resources and capacity	<ul style="list-style-type: none"> Office equipment and field equipment obtained, manned by knowledgeable and well-trained staff Ongoing training for staff Positive outcomes of staff performance appraisals 	Assess twice a year		Mossel LM, DEA&DP, Key partners
8. Increase awareness, appreciation and education				
a. Create mechanisms for communication with stakeholders	<ul style="list-style-type: none"> Widespread and effective communication to a diversity stakeholders who are well informed through their preferred method of communication 	Once a year	ICM Act	Mossel Bay LM, GBREAF,
b. Develop education and awareness programme	<ul style="list-style-type: none"> Visitor center open to public Increase in number of newsletters, pamphlets, and posters; Sufficient number of public notice boards; Increase public participation in coastal/estuary/river clean ups and other initiatives. Increase in number of visiting school groups to visitor center 	Once a year	ICM Act	Mossel Bay LM, GBREAF,
9. Research and monitoring				
a. Promote scientific research	Increase in number of research projects and monitoring programmes	Once a year		Mossel Bay LM, GBREAF, CapeNature.
b. Monitor biophysical indicators of estuary health	Ongoing databases and reports produced	Biannual for DWS Monthly for GBREAF	NWA	Mossel Bay LM, GBREAF DWS
c. Monitor human use of the estuary	Ongoing databases and reports produced	Ad hoc visual monitoring	MLRA	Mossel Bay LM, GBREAF, CapeNature

		during normal daily activities		
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